74-9,165

ANDERSON, Eugene Lawrence, 1939-
AN EXPERIMENTAL EVALUATION OF PROGRAMMED AGRICULTURE
INSTRUCTION IN A PRIVATE TANZANIAN SECONDARY SCHOOL

The University of Wisconsin, Ph.D., 1973
Education, theory and practice

University Microfilms, Inc., Ann Arbor, Michigan

AN EXPERIMENTAL EVALUATION OF PROGRAMMED AGRICULTURE INSTRUCTION IN A PRIVATE TANZANIAN SECONDARY SCHOOL

A thesis submitted to the Graduate School of the
University of Wisconsin in partial fulfillment of
the requirements for the degree of Doctor of Philosophy

BY

EUGENE LAWRENCE ANDERSON

Degree to be awarded: December ~~January~~ 1973 June 19______ August 19______

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DOCTOR OF PHILOSOPHY
(Curriculum and Instruction)
at the

UNIVERSITY OF WISCONSIN

1973

ACKNOWLEDGEMENTS

The completion of this dissertation was possible only with the assistance of many people. I have sincerely appreciated the help received from:

Professors Walter T. Bjoraker, John F. Thompson and Harold R. Matteson whose extra efforts, advice, and suggestions were invaluable during the entire period of my graduate study and especially during the writing of this dissertation.

The students of Tumaini Secondary School for their participation in the experiment conducted as part of this study.

International Agriculture Programs at the University of Wisconsin for the Research Assistantship which provided financial support during a portion of my graduate study.

The Division of World Mission and Ecumenism of the Lutheran Church in America for its financial support and for making it possible for me to pursue an advanced degree.

Lora and Zachary for their understanding and patience.

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AN EXPERIMENTAL EVALUATION OF PROGRAMMED AGRICULTURE INSTRUCTION IN A PRIVATE TANZANIAN SECONDARY SCHOOL

Eugene Lawrence Anderson

Under the supervision of Professor Walter T. Bjoraker

The purpose of this study was to determine the effectiveness of programmed instruction for teaching agriculture in a Tanzanian secondary school. The rapid expansion of agriculture in the secondary school curriculum in Tanzania has created problems due to the lack of teachers, the use of underqualified teachers, and lack of teaching materials. Programmed instruction was identified as an alternative which could help alleviate some of these problems.

An experiment was conducted using a two-sample posttest-only control group design. The performance of students who used programmed instruction was compared with the performance of students taught by the lecture-discussion method traditionally used in Tanzania. All the students in Form I and Form II at Tumaini Secondary School during first term 1973 participated in the experiment. Twenty-two programmed units of agriculture instruction were developed. Each of the units became an experimental trial. The mean scores of the unit tests for the experimental and control groups were compared using the sign test, a

nonparametric statistical procedure. Posttests were given following each unit and retention tests were given four to six weeks later.

Two hypotheses were tested. One concerned the students' performance under programmed instruction. The other concerned the relationship of selected student characteristics and performance under the experimental methods. The following statistically significant results were observed in Form I and II agriculture classes at Tumaini Secondary School:

1. Programmed instruction was the more effective method of instruction for Form I students at posttest time.
2. Programmed instruction was the more effective method of instruction at posttest time for Form I students who academically ranked in the lower half of their English class.
3. Programmed instruction was the more effective method of instruction at posttest time for Form I and Form II students who academically ranked in the lower half of their agriculture class and also for those who academically ranked in the lower half of their form.

4. Programmed instruction was the more effective method of instruction at posttest time for Form I and Form II students who preferred the programmed instruction method over the lecture-discussion method.

Other observations included:

1. The statistically significant results favoring the programmed instruction method observed on posttest results tended to fade out by the time the retention tests were made.
2. None of the results of the experiment would have been statistically significant in favor of the lecture-discussion method if it had been compared with programmed instruction.

It was concluded that in agriculture classes at Tumaini Secondary School programmed instruction was at least as good as the lecture-discussion method and in certain instances it was a superior method. The effectiveness of programmed instruction observed in this study indicates that it should next be attempted at other Tanzanian secondary schools.

Approved by____________________

Date____________________

CHAPTER I

EDUCATION IN TANZANIA AND THE RESEARCH PROBLEM

Education is an important tool of national development in Tanzania.[1] One of the purposes of education is to produce skilled manpower to develop the nation. In post-primary education the number of students and the kind and amount of education depend on the manpower requirements needed to fulfill the goals of the national development plan (Government of Tanzania, 1969, p. 148).[2]

Until recently, the only basic change since independence in Tanzania's secondary school system had been an increase in size. The number of schools and number of students had grown to meet the manpower demands of the development plans, but the form and basic purpose had not changed since before independence in 1961. The purpose of secondary school during the colonial period was to train the people needed in the lower and middle levels of government service and prepare students for the few places allotted to Tanzanians in higher education. Traditional European subjects were taught and the students wrote an overseas version of the Cambridge school leaving examination.

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[1] The Tanganyika and Zanzibar portions of Tanzania have separate educational systems. In this dissertation "Tanzania" refers only to the Tanganyika section of the country.

[2] Internal footnotes are used throughout this dissertation. Complete bibliographical data are located in the bibliography.

Changes in national philosophy began to penetrate the educational system following the Arusha Declaration (Tanganyika African National Union, 1967). This document identified the path that the country would follow in order to achieve social and economic development. It changed the emphasis of development efforts from industry to agriculture, and it proclaimed socialism as the appropriate means of achieving development.

The role of education in the development of the country was defined, for the first time, by President Nyerere (1967, p. 8) shortly after the Arusha Declaration. The goals of producing the required manpower and achieving self-sufficiency in all jobs would continue. However, the means of achieving these goals and the philosophy of education needed to be changed to be in accord with the new emphasis on agricultural development in a socialist context. The educational system inherited from the colonialists did not provide the proper socialist atmosphere for the country's schools--nor did it provide the proper education for the students who would eventually be working with farmers and villagers in rural areas to develop the nation.

Some changes toward providing an agricultural emphasis in the secondary schools took place quickly with the development of school farms and agricultural projects. These were changes which the secondary school staff members could make at their own schools. However, the secondary school curriculum was not affected. All secondary school leavers in Tanzania write a national examination. Their performance on this examination determines their future; whether they go on to higher education, obtain employment, or become one of the educated unemployed. The examination forced adherence to a national curriculum. An individual school cannot make a curriculum change without jeopardizing the future of its students. So the schools could not make curriculum changes to incorporate the political, social, and economic changes being made in the country. They had to wait for changes to be made first at higher levels.

I. SECONDARY SCHOOL REORGANIZATION

The political and social philosophies chosen in 1967 finally penetrated the secondary school curriculum in 1972 with a plan for the reorganization of the secondary education system (Ministry of National Education, 1971, pp. 11-13). The reorganization eliminates the arts and sciences divisions in secondary schools and establishes five new kinds of secondary schools which are intended to provide the education needed for the development of the country. The five new biases are agriculture, commercial, home economics, technical, and craft. The reorganization is to be completed by 1975 at which time each secondary school will have assumed one or more of the new biases.

The purpose of the reorganization is to produce secondary school leavers who have had a specialized education in one of the areas important for national development. Practical work and training is to constitute a large part of the education. The purpose of secondary education continues to be the meeting of the manpower requirements of the country. The secondary school leavers in agriculture, for example, will go on to higher education in agriculture or assume technical positions in agriculture development work.

The plan for the reorganization of secondary schools called for the establishment of the agricultural bias at twenty-three of the seventy-seven government secondary schools which are to be in operation by 1975. In addition, some of the thirty-two private secondary schools currently in operation will probably also select an agricultural bias. Before the reorganization began in 1971, only one secondary school in the entire country taught a full agriculture course.

II. EDUCATIONAL PROBLEMS

The development of agricultural secondary schools under the reorganization plan faced many problems. There were but few agriculture teachers in the country when the plan was announced, and this has affected the rate of implementation of the plan. For example, in 1973 fifteen schools were scheduled to have begun the new agricultural curriculum, but only four were actually teaching agriculture during the first term. Agriculture extension personnel are being trained as teachers to alleviate this problem.

Each year the Ministry of National Education specifies the number of student openings in each of the divisions of the University of Tanzania based on projected manpower requirements. In 1968 and 1969 the places for students in the science divisions were not filled because even though more than sufficient numbers of students completed secondary school in science areas, there were not enough who qualified academically for admission to the university (Government of Tanzania, 1969, p. 151). This may help illustrate another problem which exists in secondary education in Tanzania, teacher quality. The agriculture curriculum is new so it is impossible to judge the quality of agriculture instruction, but it is possible that poorly qualified teachers will be used in the beginning, at least, to implement the reorganization plan.

Another problem is a shortage of teacher and student materials. Tanzanian secondary level agricultural text and reference books are non-existent. Very few are produced elsewhere in East Africa. Secondary school instruction is mainly in English so materials from other English-speaking countries could be used, but in most cases they are not appropriate. The basic principles of agricultural production are the same, but the application of these principles and the examples used are generally foreign to Tanzanian agriculture. The lack of materials results in the agriculture teacher lecturing to the students using information selected from available sources and from his own experience. The lecture is presented to the students, who dutifilly copy the information into their notebooks for reviewing before taking their secondary school leaving examination.

III. THE RESEARCH PROBLEM

The problem which existed in the development of the agriculture bias in Tanzanian secondary schools led to the research study which is the basis for this dissertation. The shortage of teachers, probable low quality of instruction, and lack of suitable teaching materials prompted a search for alternatives. One of the alternatives which showed promise was programmed instruction.

Programmed instruction has been developed and used in a wide range of situations in many subject matters at many levels of education in developed countries. Many studies and experiments to determine its effectiveness have accompanied its development. Studies in the United States and England have shown that programmed instruction can teach effectively; that students who use it do learn (Stulurow, 1969, p. 223; Lindvall and Bolvin, 1967, p. 1020). Studies comparing programmed instruction with other teaching methods indicate that programmed instruction produces results no worse than other teaching methods (Silverman, 1960, p. 33; Stolurow, 1962, p. 434; Lang, 1972, p. 59; Kay and others, 1968, p. 121).

Since programmed learning is an effective teaching method in the United States and England it should be useful in other countries such as Tanzania. Hartley (1964,

p. 24), however, warns that the effectiveness of programmed instruction in an emerging nation can only be guessed at and that research on it in a developed country may not be valid in a developing country. One of the possible problems, he points out, is that the main method of learning for students in emerging nations has been rote-memorization. This may affect how well the students respond to the programmed instruction method. In the more developed countries, students have shown only a minimum of unfavorable reaction to programmed instruction (Lysaught and Williams, 1963, p. 155). Bunyard (1971, p. 264) found a similar favorable reaction to it in a study in a Nigerian school. But no research on the use of programmed instruction in Tanzanian secondary schools has been reported.

There are some reports about the use of programmed instruction which indicate it might be appropriate in Tanzania. Lawless (1969, pp. 190-192) surveyed the subject of programmed instruction in Africa and reported that there were only isolated examples of its use in schools. He cited four examples from Africa of studies which compared the use of programmed instruction with traditional methods of instruction. The results indicated that there was no significant difference between programmed instruction and the other methods. He concluded that African students can learn from programmed materials, but that the program must be validated for local conditions if programs from other countries are used.

Schramm (1964, pp. 31-32) reported on a programmed instruction workshop which was held in Nigeria. The workshop concluded that programmed instruction is a potentially valuable addition to classroom learning when used carefully for topics suited to that method. It also concluded that programmed instruction has great potential value in teaching subjects in secondary schools. The workshop recommended that research and demonstration projects in programmed instruction be started in Nigeria. A recommendation for the integration of programmed instruction into the school curriculum was also made by the Fourth Commonwealth Education Conference (1968).

The role and qualifications of the teacher in programmed instruction is not clear. The Nigerian workshop (Schramm, 1964, pp. 31-32) concluded that programmed instruction has great potential value where qualified instructors are scarce. The Fourth Commonwealth Education Conference (1968) recommended that programmed instruction should be used to improve the quality of education where it was necessary to employ teachers with low academic qualifications. On the other hand, Pocztar (1972, p. 9) and Lysaught and Williams

(1963, pp. 21, 154) argue that a program doesn't substitute for a teacher; that a teacher is necessary. The use of a program permits the teacher to be more effective by providing personalized tutorial assistance in counseling, guiding, assisting, and stimulating the individual student. Corcoran (1970, p. 10) believes that programmed instruction requires good teachers. Poor teachers cannot teach well with programmed materials.

The use of English, a foreign language to the students, may affect the usefulness of programmed instruction in Tanzanian secondary schools. The results of one study of programmed instruction with medical students whose native tongue was not English showed that programmed instruction was more effective than the lecture (Owen and others, 1965, p. 10). In another case, Corcoran (1970, p. 11) reported that programmed instruction had merit for use with American Indian students and he recommended further study with them.

It is a waste of the teacher's time, according to Silverman (1960, p. 30), to present factual material in lecture form because it can be better provided by programmed instruction methods. Programmed instruction would therefore be a useful method for presenting the factual material taught in agriculture. Programmed instruction could also be valuable in Tanzania in relieving the problem of teacher shortage because it eliminates some of the tasks of preparation and presentation necessary with the other teaching methods. It thereby permits the teacher to supervise a larger group of students and still provide time for assisting individual students (DeCecco, 1964, p. 12; Jacobs and others, 1966, p. 2).

Lysaught and Williams (1963, pp. 149-150) advocate that selected units of a course be programmed and inserted into the existing curriculum. They argue that it is difficult to program entire courses, but it would be advantageous to substitute programmed units for conventional methods of teaching in order to complement, enrich, remedy, and review other instruction. They also report (pp. 15-16) that slower learners generally do better when taught by programmed instruction methods. This is not always true, as Stolurow (1969, p. 1020) reports that a study in an American school showed that low aptitude students did better with a teacher and conventional methods while high aptitude students did better with a teacher and programmed methods.

From the foregoing it seems that programmed instruction could provide at least a partial solution to some of the problems encountered in the development of agricultural secondary schools in Tanzania. The problem of teacher shortage would be alleviated because the teacher using programmed instruction could devote more time to the students and less time to preparation and presentation and probably effectively teach a larger number of students. The expert preparation of programmed materials for use in all agricultural secondary schools would help eliminate the problem of low quality instruction. Finally, the local preparation of programmed materials would help solve the problem of textbook shortage. Before efforts are made to prepare programmed instruction materials, it must be decided whether or not this kind of material is effective in a Tanzanian classroom. This is the problem for this study.

IV. OBJECTIVES OF THE STUDY

The primary objective of this study is the evaluation of the effectiveness of using programmed instruction to teach agriculture in Tanzanian secondary schools. A related secondary objective is to determine the relationship of selected student characteristics and performance under programmed instruction. These characteristics include: sex, success in school, English language ability, and attitude toward the programmed instruction method of learning.

This chapter introduces the subject of this dissertation. It focuses on education in Tanzania, the present situation, and on some of the current problems. Programmed instruction, as suggested by current research, was identified as a possible solution to some of the educational problems in Tanzania. The research problem was then defined and the objectives of the study stated. The next chapter will be concerned with the variables under study in the experiment devised to solve the research problem presented in this chapter. Later chapters will be concerned with the experiment itself, its analysis, and its findings.

CHAPTER II

PROGRAMMED INSTRUCTION, THE ALTERNATIVE

I. TEACHING METHODS

A teaching method is a particular way of teaching. The material to be learned is organized and presented to the student in a pattern or manner which can be repeated at another time by another teacher. The teaching method is purposely and recognizably directed toward the goal of student assimilation of some material (Hyman, 1970, p. 25). It takes into account all the psychological and socio-cultural factors involved in learning the material. It also encompasses the various devices, aids, and techniques which are used to make the transmission and assimilation possible (Pocztar, 1972, p. 47). It is the job of the teacher to facilitate the transmission and assimilation.

There are several distinct teaching methods. More than one method may be used in a particular teaching-learning situation. However, the activities at any particular moment can often be defined in terms of a particular method. The teaching methods employed by a teacher depend on many things: his philosophy of education, his knowledge of the psychology of learning, his understanding of child growth and development, the resources available, the students, the type of school, and his own personality (Keuthe, 1968, pp. 126-127).

The traditional teaching methods of lecture, discussion, project, and recitation have been developed during the long history of teacher-student relations. New knowledge and understanding of the psychology of learning has resulted in the development of new teaching methods. Simulated environments, teaching games, and programmed instruction are three of the new methods which have been developed. These new methods are not as commonly used as the older methods and their application is usually more specialized (Kuethe, 1968, pp. 128-134).

II. PROGRAMMED INSTRUCTION - THE INDEPENDENT VARIABLE

> "Programmed instruction is the process of arranging materials to be learned in a series of easy-to-master steps designed to lead a student through self instruction from what he knows into the unknown of more complex knowledge and skill. The student responds at each step and when the response is correct he may proceed to the next step. If errors are made, the student is corrected immediately, before he proceeds to the next step." (Schramm, 1964, p. 31)

Programmed instruction resembles the Socratic method of asking a series of progressively more difficult questions in order to lead the student toward understanding and knowledge of a particular subject. Programmed instruction developed out of modern research in the psychology of learning. Although B.F. Skinner was not the first to develop the idea of programmed instruction, he is credited with being the first to bring the various parts of it together and with much of its development as a teaching method (Stolurow, 1969, p. 5).

A number of the principles of the psychology of learning which are difficult or impossible to apply with the traditional teaching methods are incorporated in programmed instruction. Programmed units of instruction are written to produce specific terminal behavior in the student. The objectives are stated in terms of performance, not as understandings or abilities (Brethower, 1963, p. 25).

With programmed instruction, each student has his own set of materials with which to work. This permits a degree of individualized instruction because it allows each student to work at his own pace; as fast or as slow as he likes, with no effect on the other class members. Another dimension of programmed instruction is that the teacher is free to assist individual students with their problems as they develop.

The kind, level, and amount of information to which a student is exposed is completely controlled by the physical construction of programmed instruction units. The structure of a program demands that a student focus his attention and concentration on one unit of information at a time, without being distracted by other information. The material is presented to the student in a series of small steps. This step by step construction of the program permits the information to be presented to the student in a logical, graded process; from simple to complex and from the familar to the unfamilar.

Active participation by the learner and immediate feedback are two more learning principles incorporated into programmed instruction. The student is required to actively respond regularly throughout a program to the material being presented to him. This response may be convert or overt, simple or complex. Immediately following his response, the student learns it correctness. A correct response is thereby immediately reinforced. Errors seldom occur because the programs are written in a manner designed so the learner can usually respond correctly. If an incorrect response is made, the student observes that it is incorrect and proceeds with the program. After an incorrect response the student may either continue on to the next frame in the program or he may be directed to a review sequence of frames, depending on the construction of the program. The student is not penalized or marked down. An error, in effect, is disregarded. Learning is encouraged by continuous positive feedback (Pocztar, 1972, pp. 45-47).

Frames are the basic unit of programmed instruction. They are the structural units which are presented to the student one at a time. Frames are classified, according to what they contain, as teaching, review, practice, or test frames (Silverman, 1970, Panel S). Teaching frames are the most common. They contain a piece of new information; a stimulus which is often in the form of a question to elicit a response; and the correct response which is revealed to the student when he has completed his own response (Klaus, 1961, pp. 43-45).

A program is a series of frames ordered and ready for the student to follow. It is the completed route to mastery of the subject for which it has been prepared.

Teaching machine and programmed textbook are the most common techniques used to present programs to the student. A teaching machine is, simply, any mechanical device which presents a program to a student frame by frame. It has the advantage of complete control of program presentation because it insures that the student responds to each frame before the next one is presented. The disadvantages of teaching machines are that they are usually expensive and are not usually portable. Programmed textbooks are portable and their cost is similar to other types of textbooks, but the student must exercise self discipline in order to use them properly.

Programs, whether presented by machine or book, may be either linear or branching. The linear or extrinsic program is "a sequential development of the material through which each student, regardless of his response, proceeds in exactly the same order. The student responds to the first item and then after receiving word of the accuracy and adequacy of his response, proceeds to the second item, and so on. The items are short, sequences build through graduated development, and the responses can be constructed by the student." (Lysaught and Williams, 1963, p. 71)

With the branching or intrinsic form of program the "material to be learned is given in small logical units.

Immediately after reading and digesting a unit the student is given a short test on it. The results of the test are used to determine what next unit of information shall be presented to the student." (Lysaught and Williams, 1963, p. 81)

Although linear programming is more widely used than branching programs, neither type has proved to be consistently superior to the other (Jacobs and others, 1966, p. 14; Stolurow, 1969, p. 1020). The branching form does make it possible to include review and repetition branches for students who make incorrect responses. They can be directed to parts of the program which are passed over by the student who responds correctly.

Programmed instruction was the independent variable selected for this study. It was the experimental method in an experiment designed to determine its effectiveness in a classroom situation. The lecture-discussion teaching method became the control method in the experiment. The lecture-discussion method was selected as the control method because it is the common teaching method employed by secondary school teachers in Tanzania. It is the method with which the students are more familiar. It was the method of instruction used in agriculture class before the experiment began.

III. STUDENT PERFORMANCE - THE DEPENDENT VARIABLE

Educational achievment in Tanzanian secondary schools is determined by student performance on the secondary school leaving examination. This is a nationally set examination. Students write an examination in each subject matter field for which they have studied. The agriculture examination, like many other of the subject matter areas, required factual recall. For example, students might be asked to: label the parts of a ruminant stomach, name three causes of damage to untreated wood used on the farm, or show the four successive strokes in the working of an internal combustion engine (Armbrester and others, 1967, pp. 98-112). Tests of factual recall are also commonly used to determine classroom achievement and to assign end of term marks.

The dependent variable chosen for this study was the amount of material learned under the conditions of the experiments. The amount of material learned was measured by the students' performance on multiple choice tests of the material taught. These tests were also used to determine the term marks for the students involved in the experiment.

IV. THE HYPOTHESES

The foregoing discussion provides a basis for testing the following hypotheses:

1. There is no significant difference, in a Tanzanian secondary school, between the performance of students taught agriculture by programmed instruction and the performance of those taught by the lecture-discussion method.
2. There is no relationship between the performance of students taught by programmed instruction and differences in their:
    - a. sex
    - b. success in school
    - c. English language ability
    - d. attitude toward the programmed instruction method

CHAPTER III

AN EXPERIMENT AT TUMAINI

I. TUMAINI SECONDARY SCHOOL

Ideally, the sample for this study would have been randomly selected from the population of all secondary schools in Tanzania. Two reasons made this impossible. First, the experimental materials were restricted to use in agriculture classes and only four of the 112 secondary school in Tanzania (during 1973) were teaching agriculture. Second, the researcher was assigned to Tumaini Secondary School and distance, time, and transportation problems made it impossible to conduct the experiment elsewhere. The next nearest secondary school was 40 miles away and it was over 150 miles to the next nearest school with an agriculture bias.

The necessity and convenience of Tumaini as the experimental site added another factor to the selection problem. This factor was that Tumaini was a private school. In 1973 the 112 secondary school were composed of 74 government schools, 32 private schools, and 16 seminaries. So Tumaini was not randomly selected and may not have been representative of other Tanzanian secondary schools.

Tumaini is a private co-educational boarding school located in Singida region in the central part of Tanzania. It was opened in 1969. The government is expected to assume operation of it in the near future. In 1973 it was operated as a non-profit institution by a religious organization. The operating costs of the school were met by the fees paid by the students.

The school entered the agricultural bias in 1972 with the introduction of agriculture into the Form I curriculum. The new bias was being phased in year by year. Agriculture was taught to Forms I and II in 1973. It will be extended to Form III in 1974. The secondary school year in Tanzania had two terms. This experiment was conducted during the first term (January-June) of 1973. All the students studying agriculture, which included Form I and II students, participated in this experiment.

II. THE STUDENTS

Agriculture was a required class for all students in Forms I and II during the first term of 1973. These students were the subjects in this experiment. Each of the forms was divided into two streams (grade sections). The two streams in each form became the experimental and control groups in this experiment. The students were randomly assigned to the streams by the investigator. An attempt was made to stratefy the randomization according to sex so that the two streams of each form would have equal numbers of boys and girls. Table 1 shows that the actual numbers of boys and girls in each stream was not equal. This happend in Form II because all of the expected students did not come. The unequalness in Form I resulted when some of the selected students did not arrive and substitutes were called. The substitutes were often not of the same sex as those they replaced on the original list. The randomization was not redone bacause some of the students arrived after the experiment began.

The students who participated in the experiment came from many parts of Tanzania. Table 2 shows that 18 of Tanzania's 22 regions were represented. Slightly more than half (55.6%) came from homes in Singida region where Tumaini was located.(The questiónnnaire used to gather this information is located in Appendix A).

TABLE I

The Sex Distribution of Students in Forms I and II at
Tumaini Secondary School First Term 1973

	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Boys	31	68.9	25	55.6	56	62.2	21	61.8	25	69.4	46	65.7	102	63.8
Girls	14	31.1	20	44.4	34	37.8	13	38.2	11	30.6	24	34.3	58	36.2
Total	45	100	45	100	90	100	36	100	36	100	70	100	160	100

TABLE 2

The Home Regions of the Form I and II Students at Tumaini Secondary School First Term 1973

	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
Region	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Singida	24	53.5	27	60.0	51	56.8	19	56.0	19	52.8	38	54.3	89	55.6
Kili.	6	13.4	5	11.2	11	12.4	4	11.9	7	19.5	11	15.7	22	13.7
Shinya.	3	6.7	1	2.2	4	4.4	3	8.9	1	2.7	4	5.7	8	5.0
Tabora	2	4.4	2	4.4	4	4.4	1	2.9	2	5.6	3	4.3	7	4.3
Mbeya	-	---	3	6.8	3	3.3	1	2.9	2	5.6	3	4.3	6	3.7
Arusha	1	2.2	-	---	1	1.1	2	5.8	1	2.7	3	4.3	4	2.5
Bukoba	1	2.2	-	---	1	1.1	-	---	3	8.4	3	4.3	4	2.5
Tanga	1	2.2	1	2.2	2	2.2	2	5.8	-	---	2	2.9	4	2.5
Coast	1	2.2	1	2.2	2	2.2	-	---	-	---	-	---	2	1.3
Dodoma	1	2.2	-	---	1	1.1	1	2.9	-	---	1	1.4	2	1.3
Iringa	1	2.2	1	2.2	2	2.2	-	---	-	---	-	---	2	1.3
Kigoma	1	2.2	1	2.2	2	2.2	-	---	-	---	-	---	2	1.3
Morogoro	1	2.2	-	---	1	1.1	1	2.9	-	---	1	1.4	2	1.3
Mwanza	-	---	2	4.4	2	2.2	-	---	-	---	-	---	1	1.3
Mara	-	---	1	2.2	1	1.1	-	---	-	---	-	---	1	0.6
Mtwars	1	2.2	-	---	1	1.1	-	---	-	---	-	---	1	0.6
Musoma	-	---	-	---	-	---	-	---	1	2.7	1	1.4	1	0.6
Ruvuma	1	2.2	-	---	1	1.1	-	---	-	---	-	---	1	0.6
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

Table 3 indicates the location of the homes of the students. Almost one quarter (24.5 percent) came from city homes. This in in contrast to the general population of Tanzania of which about five percent live in cities.

The occupational distribution of the fathers of the students shown in Table 4 indicates that 32.5 percent are farmers. The remaining 67.5 percent of the students' fathers are engaged in paid employment. This again is in contrast to most Tanzanians of whom approximately 90 percent are engaged in production agriculture.

The occupational distribution of the mothers of the students is more similar to the occupations of the general population than the fathers' distribution. Table 5 shows that 81.9 percent of the mothers are housewives or farmers. The housewife and farmer categories are the responses given by the students to an open-ended question. They are combined here because they may be be mutually exclusive.

Table 6 shows the highest level of education attained by the fathers of the students. It indicates that 6.3 percent had no formal education and 45.0 percent of the students had fathers who had completed two or more years of secondary education. The mothers of the Tumaini students (Table 7) have not attained educational levels as high as the fathers. The students reported that 13.7 percent of their mothers had no education and 7.6 percent received some secondary

TABLE 3

The Home Location of Form I and II Students at Tumaini Secondary School First Term 1973

Home Location	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Village	13	28.9	16	35.3	29	32.2	12	35.3	13	36.1	25	35.7	54	33.4
Ujamaa Village	12	26.7	18	40.0	30	33.3	9	26.5	10	27.8	19	27.1	49	30.7
City	14	31.1	8	17.8	22	24.5	9	26.5	8	22.2	17	24.3	39	24.5
Farm	5	11.1	3	6.7	8	8.9	4	11.7	5	13.9	9	12.9	17	10.7
No Response	1	2.2	-	---	1	1.1	-	---	-	---	-	---	1	0.7
TOTAL	45	100	45	100	90	100	34	100	36	100	70	100	160	100

TABLE 4

The Occupational Distribution of the Fathers of Form I and II Students
at Tumaini Secondary School First Term 1973

Father's Occupation	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Farming	15	33.3	14	31.1	29	32.2	12	35.3	11	30.6	23	32.9	52	32.5
Education	10	22.2	10	22.2	20	22.2	7	20.5	8	22.2	15	21.4	35	21.9
Civ. Ser.	9	20.0	7	15.6	16	17.8	6	17.6	7	19.4	13	18.6	29	18.2
Business	4	8.8	2	4.5	6	6.7	1	3.0	6	16.7	7	10.0	13	8.1
Medical	2	4.5	5	11.1	7	7.8	3	8.8	3	8.3	6	8.6	13	8.1
Religious	2	4.5	4	8.8	6	6.7	3	8.8	-	---	3	4.3	9	5.6
Politics	2	4.5	2	4.5	4	4.4	1	3.0	-	---	1	1.4	5	3.1
Craft	-	---	1	2.2	1	1.1	1	3.0	1	2.8	2	2.8	3	1.9
Engin.	1	2.2	-	---	1	1.1	-	---	-	---	-	---	1	0.6
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

TABLE 5

The Occupational Distribution of the Mothers of Form I and II Students
at Tumaini Secondary School First Term 1973

Mother's	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
Occupation	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Farming	20	44.4	28	62.3	48	53.3	19	55.9	18	50.0	37	52.9	85	53.1
Housewife	16	35.6	10	22.2	26	28.9	9	26.5	11	30.6	20	28.6	46	28.8
Education	3	6.7	2	4.4	5	5.6	3	8.8	4	11.1	7	10.0	12	7.5
Medical	4	8.9	2	4.4	6	6.7	2	5.9	2	5.5	4	5.7	10	6.3
Politics	-	---	3	6.7	3	3.3	-	---	-	---	-	---	3	1.9
Civ. Ser.	1	2.2	-	---	1	1.1	1	2.9	-	---	1	1.4	2	1.2
Business	1	2.2	-	---	1	1.1	-	---	-	---	-	---	1	0.6
No resp.	-	---	-	---	-	---	-	---	1	2.8	1	1.4	1	0.6
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

TABLE 6

The Higest Educational Level Attained by the Fathers of Form I and II Students at
Tumaini Secondary School First Term 1973

Amount of Education	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
None	3	6.7	3	6.7	6	6.7	-	---	4	11.1	4	5.7	10	6.3
1-4 yrs	9	20.0	3	6.7	12	13.3	3	8.8	6	16.7	9	12.9	21	13.1
5-8 yrs	13	28.9	19	42.2	32	35.6	11	32.4	13	36.1	24	34.3	56	35.0
2 yrs sec.sch.	8	17.8	11	24.5	19	21.1	13	38.2	1	2.8	14	20.0	33	20.6
3-4 yrs sec. sch.	6	13.3	4	8.9	10	11.1	6	17.7	11	30.5	17	24.3	27	16.9
Form 6	2	4.4	2	4.4	4	4.4	-	---	-	---	-	---	4	2.5
Univ.	4	8.9	2	4.4	6	6.7	1	2.9	1	2.8	2	2.8	8	5.0
No. resp.	-	---	1	2.2	1	1.1	-	---	-	---	-	---	1	0.6
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

TABLE 7

The Highest Educational Level Attained by the Mothers of Form I and II Students at Tumaini Secondary School First Term 1973

Amount of Education	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
None	11	24.5	6	13.4	17	18.9	1	2.9	4	11.1	5	7.1	22	13.7
1-4 yrs	8	17.8	16	35.6	24	26.7	11	32.4	8	22.2	19	27.1	43	26.9
5-8 yrs	22	48.9	18	40.0	40	44.5	19	55.9	21	58.3	40	57.2	80	50.0
1-2 yrs sec sch	2	4.4	2	4.4	4	4.4	1	2.9	1	2.8	2	2.9	6	3.8
3-4 yrs sec sch	-	---	3	6.6	3	3.3	2	5.9	1	2.8	3	4.3	6	3.8
No resp.	2	4.4	-	---	2	2.2	-	---	1	2.8	1	1.4	6	3.8
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

education. The educational attainment of the parents of the Tumaini students is higher than that of the average Tanzanian. In 1973 Tanzania's limited educational facilities made it impossible for 50 percent of eligible children to enter standard 1 (first grade). At the same time, approximately 10 percent of those that finished primary school (standard 7) were able to go on to secondary school. The percentage that attended school at the time the parents did would have been lower because the number of schools has been greatly expanded in recent years.

The information in Table 8 on the religious affiliation of the students shows that the majority (78.8 percent) are Christians. This is not surpirsing since the school is run by a Christian organization. The rest (21.2 percent) of the students are Moslem. Every student is a Christian or a Moslem. One-third of the people in Tanzania do not profess either of these religions so the students are not typical of the country's population in this respect.

Tumaini is a private school and there are various reasons why the students come to study. The subjects in this experiment were asked for their main reason for attending secondary school. The responses were divided into two categories: self or personal reasons (to get a job with a good salary, for example) and for nationalistic reasons

TABLE 8

The Religious Affiliation of Students in Forms I and II at Tumaini Secondary School First Term 1973

Religion	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Christian.	35	77.8	37	82.3	72	80.0	29	85.3	25	69.4	54	77.1	126	78.8
Islam	10	22.2	8	17.7	18	20.0	5	14.7	11	30.6	16	22.9	34	21.2
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

(to help build the nation, for example). The distribution of the responses is shown in Table 9. The responses were equally divided in Form II while in Form I a majority (60 percent) favored the personal reasons.

The future employment desires of the students is given in Table 10. Differences between Form I and II students appear in the clerical, agricultural, and education areas. The clerical and education areas are more popular with Form I students, while the Form II students prefer agriculture to a greater extent than the Form I students.

The information about the students presented in the foregoing tables indicates that they are not typical of Tanzanians of their age group. These Tumaini students are more likely to come from urban homes. Their parents are more likely to be educated and have salaried jobs. The fact that they are able to pay the fees to attend a private school also indicates that they are unusual. Many people could not afford to pay those fees.

The family and social background of the Tumaini students is different from other young Tanzanians. However, they are likely to be similar to other private secondary school students because, like them, they failed to qualify academically for entrance into a government school and they are able to pay the fees for a private shcool. The similarity

TABLE 9

Distribution of Form I and II Students at Tumaini Secondary School According to Whether or Not They Were Attending Secondary School for Personal or Nationalistic Reasons First Term 1973

Reason for attending school	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Personal reasons	27	60.0	27	60.0	54	60.0	17	50.0	18	50.0	35	50.0	89	55.6
Nationalistic reasons	18	40.0	17	37.8	35	38.9	17	50.0	18	50.0	35	50.0	70	43.8
No resp.	-	---	1	2.2	1	1.1	-	---	-	---	-	---	1	0.6
Total	45	100	45	100	90	100	34	100	36	100	80	100	160	100

TABLE 10

Field of Work Desired After Completion of Education by Form I and II Students at Tumaini Secondary School First Term 1973

Work	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
Desired	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Agricult.	8	17.8	16	35.5	24	26.7	18	53.0	12	33.3	30	42.9	54	33.8
Medical	8	17.8	5	11.2	13	14.5	7	20.6	11	30.6	18	25.7	31	19.4
Education	10	22.2	11	24.4	21	23.3	5	14.8	2	5.5	7	10.0	28	17.5
Clerical	7	15.6	3	6.7	10	11.1	1	2.9	-	---	1	1.4	11	6.9
Police/ Army	2	4.4	2	4.4	4	4.4	-	---	6	16.7	6	8.6	10	6.2
Craftsmn	1	2.2	3	6.7	4	4.4	1	2.9	1	2.8	2	2.9	6	3.8
Engineer	2	4.4	3	6.7	5	5.6	1	2.9	-	---	1	1.4	6	3.8
Law	2	4.4	-	---	2	2.2	-	---	-	---	-	---	2	1.2
Newsp.	-	---	1	2.2	1	1.1	1	1.1	-	---	1	1.4	2	1.2
Aviation	-	---	-	---	-	---	-	---	1	2.8	1	1.4	1	0.6
Railway	-	---	1	2.2	1	1.1	-	---	-	---	-	---	1	0.6
Wildlife	-	---	-	---	-	---	-	---	1	2.8	1	1.4	1	0.6
Undecided	5	11.2	-	---	5	5.6	-	---	2	5.5	2	2.9	7	4.4
Total	45	100	45	100	90	100	34	100	36	100	70	100	160	100

between students at Tumaini and those at government schools is unknown. Tumaini students and government school students do have two things in common: a) they have completed primary school; and b) they are attending secondary school.

III. THE INSTRUCTIONAL UNITS

It had been decided during the planning stage that the programmed units of instruction to be used in this study would be adapted from units available in the United States. However, a search revealed that there were no suitable commercial programs. Several programs developed by various researchers were located and were adapted to create seven of the programmed instruction units used in this study. A total of twenty-two units were needed. The remaining fifteen units were developed by the investigator prior to the beginning of the experiment. The information contained in the units came from agricultural instructional units originally prepared for use in United States secondary school agriculture classes. The information was adapted to the Tanzanian locale by the investigator, who had previously managed an institution farm for two years and also had taught two years in Tanzania. (Appendix B contains copies of the programmed units.)

The topics for the instructional units were selected from the syllabus of instruction for secondary school agriculture in Tanzania. The units were developed as programmed textbooks in a vertical linear format. A combination mask and answer sheet was provided for use by the student. It permitted one new frame to be exposed at a time and the active written responses required from the students were recorded on it.

The same materials were taught to both Forms I and II. This was possible because the agricultural instruction the Form II students had experienced the previous year was social and political, not technical. The shortage of teachers also made it practical to teach the same material to both forms.

The twenty-two units of programmed instruction were developed according to the principles of programmed instruction. These units varied in length from thirty-six to seventy-eight frames. A comparison of the results of short and long programs has not shown marked differences and a number of comparisons are much better than an evaluation based on a single comparison (Kay and others, 1968, p. 124).

IV. THE DESIGN OF THE EXPERIMENT

A true experimental design was utilized to meet the objectives and test the hypotheses of this study. This was possible because the investigator could, as Ferguson (1971, p. 198) says he must:

(1) Select the values or categories of the independent variable to be compared;
(2) Select the subjects for the experiment;
(3) Apply the rules or procedures whereby subjects are assigned to the particular values or categories of the independent variable;
(4) Specify the observation or measurements to make on each subject.

A two-sample experiment of the Campbell and Stanley (1966, p. 25) posttest-only control group design was used. In a two-sample experiment such as this, the subjects are divided into two groups; one for treatment and one for control or for a second treatment (Kraft and van Eeden, 1968, p. 69). After treatment, both groups are observed. The observations are compared to determine if any differences resultfrom the differences in treatment.

It is necessary in such an experiment to insure that both groups are equal before the treatment so that any differences observed afterward can be ascribed to the difference in treatment, an aspect of interal validity. This could be done by pretesting the subjects and assigning them to the two experimental conditions on the basis of the pretest to insure that each group is matched or equal before the experiment. But as Champion (1970, p. 143) points out, "matching can pose a significant obstacle to any research design because there are always factors over which the investigator has little control."

The posttest-only control group design is a fully valid experimental design even though a pretest is not used because the two groups are equalized in another way (Campbell, 1957, p. 274). One way of achieving pre-experimental equation of groups is through randomization (Campbell and Stanley, 1966, p.2). Randomization eliminates the problem of selection bias by the investigator (Good, 1963, p. 457). At Stanley (1965, p. 286) points out, "randomization guarentees that, before the experiment begins, the means of the various conditions for any variable will differ only randomly. This randomization forms the basis for tests of statistical significance." Good (1963, p. 457) also emphasizes that randomization without a pretest is "the most adequate all-purpose assurance of lack of initial bias between groups."

Siegel (1956, pp. 61-62) suggests a second method of overcoming the difficulty. This, he says, can be done by using matched or otherwise related samples in a study.

But since it is difficult to match people it is preferable to use each subject as his own control. This is accomplished by exposing each subject to both treatments at different times.

The fact that a pretest is not used with the posttest-only control group experimental design was advantageous in this study. A pretest would have been a disadvantage for two reasons. First, it might have led the students to guess that an experiment was taking place by arousing their curiosity. Secondly, the pretest mighthave affected the results on the posttest by alerting the students toward certain topics and enhancing the learning of that information (Apter and Boorer, 1971, p. 125).

Internal Validity

Two kinds of validity are of concern in experimental design. The first kind, internal validity, is concerned with whether or not the experimental stimulus did, in fact, cause the difference in the specific instance. Internal validity is concerned with things which by themselves produce changes in the dependent variable and which might be mistaken for the results of the experimental variable. External validity is concerned with generalization of the results from the experiment to the population of which the experimental sample belongs.

Campbell and Stanley (1966) have described experimental design validity in detail. They state that both external and internal validity are needed to the greatest extent possible in an experiment. However, "internal validity is the prior and more indispensible consideration than is exernal validity" (Campbell, 1957, p. 282). Campbell and Stanley (1966, p. 8) state that "internal validity is assured with the posttest-only control group design."

External Validity

Campbell and Stanley (1966, pp. 5-6) identify four interaction effects which threaten external validity. They identify the first threat as the interaction of testing and the experimental treatment. This is the threat caused by a pretest. A pretest was not made in this experiment so there is no danger from this interaction effect on the posttest. There could, however, be an interaction effect on the retention test caused by the posttest.

The second interaction effect which threatens external validity is the interaction of selection and the experimental variable (Campbell and Stanley, 1966, p. 19). The selection referred to here is not that of assigning the subjects to experimental and control groups which is an aspect of internal validity. Rather it refers to the population from which these two groups were jointly selected. The amount of bias in the selection of the school for this experiment affects the external validity, or the extent to which the results may be generalized. Tumaini Secondary School may or may not be representative of secondary schools in Tanzania. The school may be representative of private secondary schools, but almost certainly is not representative of government secondary schools since the students in private schools failed to qualify for a government school. They must also possess the money necessary for the tuition at the private school. The greater the similarity between Tuamini and other schools, the less this interaction would occur.

The third Campbell and Stanley (1966, pp.20-22) interaction effect on external validity is called reactive arrangements. This is the threat to external validity posed by the artificiality of the experimental setting and knowledge by the subjects that they are participating in an experiment. This interaction effect can be prevented by disguising the research from the subjects. This factor should not affect the vaildity of this experiment for several reasons. First, the random assignment to streams was made before the students came to school. Upon their arrival they found thay had been assigned to a particular stream. This was the usual administrative practice, except that this time the assignment had been performed randomly by the investigator. Second, the students were not told that an experiment was being conducted and none, to the knowledge of the investigator, ever learned. The fact that one stream was taught by one method and the other stream by another method did not seem strange to the students since a shortage or teachers did exist and it was explained that using these two methods would ease that shortage. Finally, each stream was exposed to equal numbers of experimental and control treatments which made it possible foreach group to have similar experimental histories. The treatments were randomly assigned so the only possible interaction that could have resulted was that one group began with the control treatment, while the other group began with the experimental treatment.

The fourth and final interaction threat to external validity is what Campbell and Stanley (1966, p. 4) term multiple treatment interference. This is the hazard of giving multiple treatments to the same subject. Each group in this experiment was given twenty-two treatments, half underthe experimental condition and half under the control condition. This was done to help insure internal validity. The treatments were randomly assigned but there might have been a carryover effect depending on the sequence of methods experienced. Multiple treatment interference may have occurred, so it reduces the extent of generalization that can be made from the experimental results. On the other hand, it may not be a problem in this experiment since there were twenty-two units. The effects may not be as great as when only a few units are involved.

V. STATISTICAL ANALYSIS AND DECISION MAKING

An experiment is usually conducted to provide a basis for determining whether a particular hypothesis should be accepted or rejected. The whole procedure is often referred to as hypothesis testing. The experiment is only a means of obtaining information on which the decision about the hypothesis will be made. The purpose of the experiment in this study was to provide information which could be used to determine the effectiveness of programmed instruction as a teaching method in Tanzania. The statistical analysis and decision making steps followed in this study were those outlined by Siegel (1956, p. 6):

(1) State null hypothesis (H_o)
(2) Choose a statistical test (one which most closely approximates the conditions of research and whose measurement requirement is met by the measures used in the research)
(3) Specify a significance level (α), power ($1-\beta$) and a sample size (N)
(4) Find or assume the sampling distribution of the statistical test under H_o
(5) On the basis of b, c, and d above, define the region of rejection
(6) Compute the value of the statistical test, using the data obtained from the samples, use that value to decide whether to reject or not reject H_o

Null Hypothesis

The first step was to state the null hypothesis. The null hypothesis is the hypothesis under test and may be written in either two-tailed or one-tailed form. A two-tailed test would indicate only that a difference exists, not the direction of the difference. Ferguson (1971, p. 151) states that "there are few, if any, instances where the direction is not of interest." He believes that directional tests should be used more frequently.

The purpose of this study was to determine the effectiveness of the programmed instruction method by comparing it with the lecture-discussion method of instruction. It was decided that this would be determined by comparing the performance of students taught by these methods. Programmed instruction would be judged effective if student performance was better under that method than under the lecture-discussion method. A one-tailed test of the hypothesis was therefore appropriate for this study because the direction of difference is important, not just existence of a difference between the two methods.

The null hypothesis (H_0) is a hypothesis of no difference. It is usually formulated for the express purpose of being rejected. The alternative hypothesis (H_1) is the operational statement of the investigator's research hypothesis. It may be accepted if the null hypothesis is rejected (Siegel, 1956, p. 7). The null hypothesis is the one under test and "if the differences observed in the data have an extremely small possibility of having occurred by chance, then the investigator may be willing to reject the null hypothesis and accept the alternative possibility that the difference was due to differences in the treatment. The alternative hypothesis cannot be proven in terms of the data, but it does become more and more plausible as the null hypothesis becomesless and less." (Ferguson, 1971, p. 486).

The first hypothesis, in null form (H_0), in this study was: There is no statistical difference, in a Tanzanian secondary school, between the performance of students taught agriculture by programmed instruction and the performance of those taught by the lecture-discussion method.

The second hypothesis, in null form, was: There is not relationship between the performance of students taught by programmed instruction and differences in their sex, success in school, English language ability, and attitude toward the programmed instruction method.

The Statistical Test

The second step was to choose a statistical test. Siegel (1956, p. 18) points out that every statistical test has an associated model and a measurement requirement. Often the conditions of the model cannot be proven and must be assumed to be met. These are termed the assumptions of the test. The statistical test employed depends upon the nature of the population involved, the manner of sampling, the type of data collected, and on information about the population.

In this study, a statistical test was needed to determine the relationship between the performance results of the students taught by programmed instruction and those taught by lecture-discussion. The group which had been exposed to the experimental treatment (programmed instruction) was compared with another group which had experienced the control treatment (lecture-discussion). This required a two-sample statistical test.

The usual parametric statistical technique for analyzing data from two related samples is to apply a t-test to the difference scores (Siegel, 1956, p. 62). The t-test assumes: a) that the variable in the population from which the observations are drawn are distributed normally; and b) that there is a common variance in the population (Bradley, 1968, p. 23). However, in the setting of this study, it is difficult to justify these assumptions because there was no information available about the population variables prior to this study. It is not realistic to assume that these variables are distributed normally and that a common variable exists.

Conover (1971, p. 85) cites two reasons why "it is dangerous to use a statistical test in a situation where the assumptions of the test are not valid. First the data may result in the rejection of the null hypothesis not because the data indicate that the null hypothesis is false, but because the data indicate that one of the assumptions of the test is invalid. Hypothesis tests in general are sensitive detectors not only of false hypotheses but also of false assumptions in the model. The second danger is that sometimes the data indicate strongly that the null hypothesis is false, and a false assumption in the model is also affecting the data, but these two effects neutralize each other in the test, so that the test reveals nothing and the null hypothesis is accepted."

Bradley (1968, p. 9) emphasizes the danger of parametric methods because "it does not follow logically that approximate normality and homogeneity insure approximate validity of a test which assumes exact normality and exact homogeneity." Ferguson (1971, p. 517) cites another danger when using a one-tailed test. He says that "a one-tailed t-test is apparently more seriously affected by non-normality than is a two-tailed test." He (Ferguson, 1971, p. 321) goes on to state that when situations arise in experimental work where little is known about the population distribution of the dependent variable then nonparametric tests may be appropriately used.

Non parametric or distrubution-free methods provide tests which are independent of the shapes of the distribution from which the samples are drawn (Ferguson, 1971, p. 157).

Bradley (1968, P. 23) states that "the most common population assumption for nonparametric tests is that the population is continuously distributed. The continuity assumption is generally a sufficient, rather than a necessary condition, covering what are often more modest and easily satisfied necessary assumptions, which are sometimes highly insusceptible to violations. When the nonparametric assumption of continuous distribution is violated, both the fact and the degree of the violation tend to be readily apparent from the existence of tied scores (zero differences) in the obtained data. There is nothing so obvious when using parametric statistics."

Siegel (1956, p. vii) states that "the nonparametric techniques of hypothesis testing are uniquely suited to the data of the behavioral sciences because they do not assume that the scores under analysis were drawn from a normally distributed population." In fact the nonparametric tests for related samples do not require that all pairs be drawn from the same population (Siegel, 1956, p. 62). Populations can be whatever they are (Bradley, 1968, p. 12).

According to Conover (1971, p. 3), with nonparametric statistics "approximate solutions to exact problems are found, as opposed to the exact solution to approximate problems furnished by parametric statistics." The probability statements from most nonparametric statistical tests are exact probabilities. The accuracy of those statements does not depend on the shape of the population distribution (Siegel, 1956, p. 32). Another difference is that in many nonparametric procedures, neither the null hypothesis under test is formulated in terms of the parameters of the paren populations, nor are estimates of population parameters calculated (Ferguson, 1971, p. 322).

Nonparametric statistical procedures were chosen as the appropriate method to use for testing the hypothesis in this study. The next step was to choose a particular nonparametric procedure. The performance of the students in the study was measured at the end of each unit by multiple choice tests of the information presented in the unit. The test scores of all the students in each treatment group were combined. A mean was calculated. There were a total of twenty-two pairs of means.

The mean was selected as the appropriate measure of central tendency on which to make the statistical analysis for several reasons. The mean is an appropriate measure of central location for interval and ratio variables (Ferguson, 1971, p. 52). The arithmetic mean is the balance point of all the scores and it is easily calculated. Further, the effectiveness of programmed instruction as compared with other kinds of instruction can be evaluated according to Jacobs, Maier, and Stolurow (1966, p. 49) by comparing the mean level of outcome. The median, an alternative measure of central tendency, was considered. It was rejected in favor of the mean because the median is an ordinal statistic and would be appropriate in this study only if the distribution of the variables showed gross asymmetry (Ferguson, 1971, p. 53). The means were calculated using the formula:

$$\overline{X} = \frac{\Sigma X_i}{N}$$

The Wilcoxson Signed Ranks Test is the appropriate nonparametric procedure to use in a study such as this when the numerical value has meaning and a comparison is being made between two related groups (Conover, 1971, p. 206). However, the Wilcoxson test requires that the tests from which the means were generated be equivalent. The twenty-two unit tests in this study had varying numbers of questions and therefore the resulting means were not equivalent and the Wilcoxson test could not be used.

Sign Test

The sign test was selected for this study. It is a gross measure of the significance of difference. It does not take into account the magnitude of difference in the scores under different conditions (Champion, 1970, p. 165).

It is applicable to the case of two related samples when it is desired to establish that two treatments are different (Siegel, 1956, p. 68). It is useful for testing whether two populations have the same mean where the observations come in pairs with one element of each pair from each population (Conover, 1971, p. 121).

The assumptions for the sign test are:

(1) That the variable under consideration has a continuous distribution (Bradley, 1968, p. 167);

(2) That the two groups were equivalent before the test, that they either were randonly assigned to the treatment and control groups (Kraft and van Eeden, 1968, p. 124) or the subjects act as their own control in some type of before-and-after experimental design or succession of treatment conditions (Siegel, 1956, p. 68);

(3) That there is independent performance by the subjects on the post and retention tests in this experiment.

No assumptions are made about the form of the distribution of the differences and there is no assumption that all subjects were drawn from the same population.

In this study, if there is no difference between the two teaching methods in their effect on student performance:

(a) half of the time the experimental treatment should show a positive advantage over the control treatment; and (b) half of the time the control treatment should show a positive advantage over the experimental treatment. The theoretical probability that one is better than the other is fifty percent.

To determine which teaching method is better in this study the mean of the scores of the control group (lecture-discussion) was subtracted from the mean of the scores of the experimental group (programmed instruction) for each unit of instruction. If the result was positive (the experimental mean greater than the control mean) it was assigned a plus sign. If the result was negative (the control mean greater than the experimental mean) it was assigned a minus sign. The sign of the difference (plus or minus) is the only relevant information used to calculate the sign test statistic. The sign test procedure assumes that ties are impossible and that if they occur in a two-tailed test they should be disregarded (Conover, 1971, p. 123). However, in this experiment, the question of interest was one-tailed, whether the experimental method was better than the control method. Any ties which occurred were counted as minuses.

After the sign of the mean was determined for each of the twenty-two instructional units, the total number of plus signs was determined by counting. Since the sign test is a binomially distributed test with a probability of fifty percent, an equal number of plus and minus signs would be expected if: a) the two treatments were identical; and b) chance was the only determiner of which treatment had the higher mean.

The theoretical probability of obtaining a particular combination of plusses and minuses was determined by the binomial expansion rule using a probability of fifty percent (the probability of each sign) and the total number of trials (Marascuilo, 1971, p. 97). Each instructional unit was an experimental trial in this study. The resulting probability is that associated with the occurrence under the null hypothesis of a value as extreme as the observed value of the experimental condition (Siegel, 1956, p. 75). The probabilities obtained with the sign test are the ratio of the number of successful outcomes of an event to a finite number of possible outcomes (Bradley, 1968, p. 12).

The operational statement of the hypotheses may now be stated in terms of the probability of a plus for the experimental method over the control method (Conover, 1971, p. 122):

$$H_0: \; P(+) = P(-)$$

$$H_1: \; P(+) > P(-)$$

The null hypothesis is that the probability of a plus occurring (experimental mean greater than the control mean) is equal to the probability of a minus occurring (control mean greater than the experimental mean). The alternative hypothesis is that the probability of a plus occurring is greater than the probability of the occurrence of a minus.

Significance Level

The investigator, in the ideal situation, specifies the exact values of both the level of significance and type II error before he begins his research (Siegel, 1956, p. 89). These values determine the size of the sample (N) he needs for computing the chosen statistical test. The significance level is determined by first specifying all possible samples that could occur when the null hypothesis is true. Then a subset of the samples is selected which has a very small probability, if the null hypothesis is true, that a sample actually observed will be among them.

The significance level, power, sample size, and sampling distribution for this experiment were determined during the planning stage of the study. First the number of units (N) and the significance level (α) were determined by a trial and error expansion of the binomial formula:

$$\binom{N}{X} p^{x} q^{N-x}$$

Various levels of N (numbers of units) with the probability set at .50 were calculated until a reasonable combination of N and level of significance was discovered. The number of trials decided on was twenty-two. An expansion of the binomial formula with the number of trials set at twenty-two and the probability set at fifty percent was used to generate a binomial distribution. This is the sampling distribution for this study and from which the significance level and decision rule could be determined. The formula used was:

$$P\left[X = x \,\middle|\, \begin{matrix} P = \quad .50 \\ N = 22 \end{matrix}\right] = \binom{N}{X} \quad p^{x}q^{N-x}$$

This formula was used to generate the probability distribution by calculating the probability of each possible outcome (each possible combination of plusses and minuses) beginning with twenty-two plusses (x) out of twenty-two trials (N), then twenty-one plusses out of twenty-two trials (21 plusses and 1 minus) and so on. This was continued until the cumulative probability reached an acceptable significance level for the study. The calculation of probability in this manner results in an unconventional, but exact, level of significance (alpha level).

Table 11 shows the sampling distribution of the statistical test. This distribution is calculated in terms of the null hypothesis. Under the null hypothesis, the probability of a plus is fifty percent. The table, therefore, shows the distribution of the probability of committing a Type I error and falsely rejecting a true null hypothesis for various combinations of plusses and minuses. The table shows that if during twenty-two trials there are twenty-two plusses (the experimental method has a higher mean than the control method every time) the probability of committing a Type I error if the null hypothesis is rejected is .00000023. The probability of committing a Type I error for each combination of plusses and minuses is determined by cumulating the probability to that level. From Table 11 it is seen that by cumulating the probability of obtaining fifteen or more plusses out of twenty-two the total is .06587. This is the significance level selected for this study. (For comparison, the table also indicates the probability of obtaining fourteen plusses our of twenty-two.) The decision rule for rejecting the null hypothesis in this study is with alpha equalling 0.659, reject the null hypothesis if the number of plusses equals fifteen or more out of twenty-two trials.

Power

The power of a test is its probability of rejecting a specified false hypothesis. It is a procedure for comparing alternate procedures for testing hypotheses. It is the probability of rejecting the null hypothesis when that hypothesis is false. It is calculated by subtracting the

TABLE 11

The Probability Distribution Generated From the Binomial Formula When the Number of Trials is Twenty-Two and The Probability is Fifty Percent

N	x	P = .50
22	22	.00000023
22	21	.000005
22	20	.000055
22	19	.000368
22	18	.001737
22	17	.006254
22	16	.017493
22	15	.039958
22	14	(.075018)

N = the total number of trials

x = the number of plusses observed (experimental minus control)

$$P\left[X = 15, 16, 17, 18, 19, 20, 21, \text{ or } 22 \,\middle|\, \begin{matrix} P = .50 \\ N = 22 \end{matrix}\right] = .06587$$

Type II error from one ($1 - \beta$). Type II error is the failure to reject a false null hypothesis. The power of a statistical test depends on the level of significance, the alternative hypothesis (H_1), and the sample size (Ferguson, 1971, p. 322).

Power is calculated using the binomial formula in the same manner as was the level of significance. However, for power calculations, the alternative hypothesis (H_1) is the hypothesis of interest and the probability level selected is an arbitrary one. The probability distribution that results is the probability that the null hypothesis will be rejected if the experimental method is really better than the control method.

The probability level selected to calculate the power of the test statistic in this study was seventy-five percent. This indicates the probability of rejecting the null hypothesis if in reality the experimental condition is better than the control condition seventy-five percent of the time. The power distribution for this study was calculated from the formula:

$$P\left[X = x \,\middle|\, \begin{matrix} P = & .75 \\ N = & 22 \end{matrix}\right] = \binom{N}{x} p^x q^{N-x}$$

The resulting distribution is shown in Table 12. The probability is cumulated for the same number of plusses out of the total as was used for determining the level of

TABLE 12

The Probability Distrbution Generated from the Binomial Formula When the Number of Trials is Twenty-Two and The Probability is Seventy-Five Percent

N	x	P=.75
22	22	.00178
22	21	.01309
22	20	.04577
22	19	.10182
22	18	.16131
22	17	.19407
22	16	.17942
22	15	.13671

N = the total number of trials

x = the number of plusses observed (experimental minus control)

$$P\left[X = 15, 16, 17, 18, 19, 20, 21, \text{ or } 22 \;\middle|\; \begin{matrix} P = .75 \\ N = 22 \end{matrix}\right] = .83397$$

significance (15 out of 22). Table 12 shows that with a sample size of twenty-two and a significance level of .0659 that the power is .8340 when there is a seventy-five percent probability that the experimental method is actually better than the control method. This indicates that this statistical test is unbiased since the power is larger than the level of significance (Conover, 1971, p. 87).

V. PROCEDURES OF THE EXPERIMENT

All of the students in Forms I and II at Tuamini Secondary School during first term 1973 participated in the experiment. They were randomly assigned to the first two streams in each form by the investigator. The randomization was performed from a table of random numbers before the students arrived at school. The randomization was stratified according to sex.

Three of the students expected in Form II did not return to Tumaini. No adjustment was made for this. The assignment of subjects was not revised since it wasn't known until after the experiment had begun that those students would not return. It was assumed that there was a random pattern for not returning and no adjustment in the experiment was made. Eleven of the Form I students selected and randomly assigned did not appear. Their places were assumed by alternates who were placed in the streams as they appeared at school. This also was assumed to have occurred randomly.

The scores of eight students were excluded from the analysis of the data. Four of these were Form I students who joined the school after the middle of the term. The other four were Form II students who transferred to Tumaini from other schools and were not randomly assigned to their streams.

The order of presentation of the instructional units was randomly determined through the use of a table of random numbers as recommended by Good (1963, p. 457). Sequentially related units were assigned together as a group. Table 13 shows the sequence of presentation of the units and indicates those randomly assigned together. All of the units of instruction had been prepared for use before they were randomly sequenced. This eliminated possible bias due to sequence of preparation.

The two streams in each form were randomly assigned, using a table of numbers, to the experimental and control treatments for each instructional unit. These assignments are shown in Table 14. Each stream was randomly assigned to equal numbers of experimental and control treatments, eleven of each. The Form I and Form II agriculture classes met at the same time. The two streams (one from each form) randomly assigned to the control method, lecture-discussion, met together for their instruction in the dining hall. At the same time the two streams randomly assigned to the experimental method, programmed instruction, met together in classroom number six in another part of the school. During unit one, for example (Table 14), stream A of Form I and stream B of Form II met together in room six for instruction by programmed instruction. At the same time, stream B

TABLE 13

The Agricultural Instruction Units Taught at Tumaini Secondary School During First Term 1973; Those Randomized Together and the Order of Presentation

Randomized Group	Unit Number	Unit Title
1	1	Tyres for farm equipment
2	2	Raising dairy calves I
	3	Raising dairy calves II
	4	Raising dairy heifers and bulls
3	5	Caring for the sow and litter at farrowing time
4	6	Digestion in animals
5	7	Animal nutrition
	8	Feed characteristics
	9	Vitamins
	10	Minerals
6	11	Plant nutrition
	12	Land I
	13	Land II
7	14	Castrating, docking and dehorning
8	15	The cow's udder and how it functions
9	16	Small engines I
	17	Small engines II
10	18	Introduction to animal breeding
	19	Animal breeding, part II
11	20	Making and using concrete on the farm, part I
	21	Making and using concrete on the farm, part II
	22	Making and using concrete on the farm, part III

TABLE 14

The Randomly Assigned Treatments of the Form I and II Agriculture Classes at Tumaini Secondary School During First Term 1973

Unit Number	Form I		Form II	
	Stream A	Stream B	Stream A	Stream B
1	P*	L	L	P
2	L	P	P	L
3	L	P	P	L
4	P	L	L	P
5	L	P	P	L
6	L	P	L	P
7	P	L	L	P
8	L	P	L	P
9	L	P	P	L
10	P	L	P	L
11	L	P	P	L
12	P	L	L	P
13	P	L	L	P
14	P	L	P	L
15	P	L	L	P
16	P	L	P	L
17	L	P	L	P
18	L	P	P	L
19	L	P	L	P
20	L	P	L	P
21	P	L	P	L
22	P	L	P	L

*P = programmed instruction - the experimental method

L = lecture-duscussion - the control method of Form I and stream A of Form II met together in the dining hall for instruction by the lecture-duscussion method. The streams were reassigned according to the randomized schedule of treatments for each unit of instruction.

The agriculture classesmet for two consecutive forty minute class periods during each of the five school days per week. Identical information was presented to both treatment groups. The lecture-discussion classes were taught from the same information sources used to prepare the programmed instruction units. The two streams assigned to the control method (lecture-discussion) for each unit were taught by the investigator, an experienced teacher qualified to teach agriculture. The two streams assigned to the experimental method (programmed instruction) met together under the supervision of an experienced, qualified secondary school teacher; although not an agriculture teacher. It was necessary for a teacher not qualified to teach agriculture to supervise the programmed instruction and for the investigator to teach the lecture-discussion classes because no other teachers were available. No statistical calculations were made until after the experiment was complete in order to eliminate the possibility that the investigator would be influenced by early results.

At the beginning of the experiment the students were instructed on the use of the programmed materials. The investigator explained the use and purpose of the programmed method. A short practice unit, as recommended by Lysaught and Williams (1963, pp. 152-153), was used to familarize the students with the programmed instruction method. This was done to help the students adjust to the new method before reaching the subject matter units. (A copy is included in Appendix B.) At the beginning of each unit, the number of class periods allotted for that unit was announced to the students in both treatment groups. The time was specified so that the students would know when to expect the unit test and to enable those using the programmed units to pace themselves.

The lecture-discussion class was conducted in the traditional manner with the teacher presenting the material orally using the blackboard as an aid. The students were encouraged to ask questions and were called on to respond to questions asked by the teacher. The programmed instruction group received the instructional materials at the beginning of the class period. These were collected at the end of the period to insure that the control group did not see them. The students under the experimental conditions were permitted to make notes in addition to the responses made on the answer sheets which they were allowed to keep. The teacher was available in the classroom during the entire class period to answer questions and assist the students using the programmed materials.

The posttests were given to all students at the same time, on the class day following the completion of the unit. These were multiple choice tests that had been prepared before the experiment along with the programmed units. The number of questions varied with the length of the unit. The posttest marks were, as the students had been told, used to determine the grades for each student at the end of the term. Following the marking of the posttests, the students were permitted to look at them to see the results and to check the teacher's marking. The tests were then collected and not returned to the students again. No makeup tests were given.

A retention test was given four to six weeks following the posttest. Appendix C shows the dates of posttests and retention test and the time interval between them. Originally, the retention test was planned for six weeks following the posttest. However, this was impossible because of school holidays. Therefore, the four to six week schedule was adopted. In that way the retention tests could be scheduled around the holidays. The retention tests were given unannounced during regular class periods to all students at one time. The retention tests were given on an irregular schedule because of the four to six week interval. This made it unlikely that the students would be able to guess when one would occur. The students did not see the retention tests after they were marked.

Several students asked why the retention tests were given. They were told it was to see if they remembered anything. They did not have to study for them because the results would not affect their term grades. The retention test was the same test as the posttest. Lysaught and Williams (1963, p. 139) state that the same test can be used to insure equivalence of the two tests if given over a month apart.

VI. LIMITATIONS OF THE STUDY

The major limitation of this study is that the school where the experiment was conducted was not randomly selected from among all secondary schools in Tanzania. Neither was the experiment replicated at any other school. The reasons for this have been given previously. The students at Tumaini (the location of the study) are probably similar to students at other private secondary schools. They all failed to gain admission to government schools because their performance on the primary school leaving examination was inadequate. The second factor which they all have in commonis that they can afford to pay the fees which enable them to attend private school. This problem limits the generalizations which can be made from this study. The results cannot be logically generalized into a realm not represented in the study sample (Campbell and Stanley, 1966, p. 17). The generalizations from this study will be limited and restricted to the particular characteristics of the subjects sampled, the methods used, and the specific conditions of the experiment.

A second limitation was the active participation of the investigator in the experiment. He prepared the programmed instruction units and taught the lecture-discussion classes. There is, therefore, a possibility that unintentional researcher bias entered into the results. This was a fixed factor of the research and could not be avoided.

A third limitation of this study is that there was not control over the activities of the students outside the classrooms. The students taught under each of the two methods may have compared class notes, discussed the lessons, and studied together. This may have reduced the distinctiveness of each group's instruction by reducing the differences observed in the mean test scores and thereby blurring the results of the evaluation (Jacobs and others, 1966, p. 60). However, the actual method of instruction in the classroom was controlled and was distinct for each group.

One purpose of programmed instruction is to control the situation. If the students can cheat the control is not adequate. The use of a mask to expose only one new frame of the program at a time requires self-discipline on the part of the student for proper usage. This self-discipline was not always observed. The teacher of the programmed units did instruct the students in the proper use of the mask and the reasons why it was to their advantage to use it correctly. When improper usage was observed, the student was reminded to use it correctly. Improper usage could have affected the results of the experiment. A related problem, although not as obvious, could have affected the lecture-discussion classes. This is the problem of students failing to listen and participate in discussion. This could have affected the experimental results; but, like cheating, is something which could occur in a normal classroom situation.

A final problem, which may have affected the results of the experiment, was student absenteeism from class. Students were absent from class at various times. This was caused by truancy, assignment by school officials to punishment or other duties, and school activities. It was assumed that the absenteeism affected both experimental and control groups randomly, and therefore equally, so no adjustment was made.

CHAPTER IV

THE RESULTS:
ANALYSIS OF DATA AND HYPOTHESIS TESTING

The data collected in the experiment consisted of the students' posttest and retention test scores for each of the twenty-two units of agriculture instruction. The analysis of the data began with the calculation of the means for the experimental and control groups for each of the units of instruction. To determine the mean, the scores of all the students in each group were added together and then divided by the number of students. Then, for each unit of instruction (experimental trial), the control mean was subtracted from the experimental mean and the sign of the difference (+ or -) was determined. Finally, the number of plus signs was determined by counting.

The total number of plusses observed was the information needed to test the hypothesis of this study. The decision rule, which had been determined before the experiment, was: with alpha equalling .0659, reject the null hypothesis if the number of plusses equals or exceeds fifteen. Therefore, in each case, if the number of plusses was fourteen or less the null hypothesis was not rejected. If there were fifteen or more plusses the null hypothesis was rejected and the alternative hypothesis accepted because this indicated that the means of the experimental group exceeded the means of the control group a significant number of times at the .0659 level of significance.

Three groupings of the students participating in the experiment were tested under each hypothesis. One group was formed by combining the scores of the Form I and Form II students for an overall test of hypotheses. The other two groups were composed of the individual Forms, I and II. Means were calculated and the hypotheses tested for each of these groupings of students for both the post and retention tests. In the discussion which follows, programmed instruction and lecture-discussion are used instead of experimental method and control method.

I. HYPOTHESIS 1 - THE EFFECTIVENESS OF PROGRAMMED INSTRUCTION

The first hypothesis was that there is no significant difference in a Tanzanian secondary school between the performance of students taught agriculture by programmed instruction and the performance of those taught by the lecture-discussion method. The alternative or research hypothesis was that students taught by programmed instruction perform better than students taught by the lecture-discussion method. The test of this hypothesis provided an overall evaluation of programmed instruction as compared with the lecture-discussion method.

Hypothesis 1 - Posttests

The posttest results are shown in Table 15. (Appendix D contains the experimental trial means comparison for each statistical test.) When the scores for all students in Forms I and II were combined, the programmed instruction method had a higher mean than the lecture-discussion method twelve out of the twenty-two trials. The decision rule for rejecting the null hypothesis requires at least fifteen plusses so the null hypothesis could not be rejected.

However, when the forms were analyzed individually it was found that in Form I the programmed instruction method had a higher mean for fifteen of the twenty-two trials. This was sufficient, according to the decision rule, to reject

TABLE 15

Plusses Observed from the Comparison of the Experimental and Control Group Means of all Students

	Number of Plusses		
	All Students	Form I	Form II
Posttests	12	15*	11
Retention Tests	13	13	13

*Statistically significant when $\alpha = .0659$

the null hypothesis and accept the alternative hypothesis that there was a statistically significant difference between the means in favor of the programmed instruction method. The Form II results had eleven plusses, an equal division of success between the two methods, not enough to reject the null hypothesis.

Hypothesis 1 - Retention Tests

The results of the retention tests given four to six weeks after the posttests are also shown in Table 15. Identical results, thirteen plusses, were observed for all three groupings of students. This positive advantage for the programmed instruction method over the lecture-discussion method was not sufficient, according to the decision rule, to reject the null hypothesis.

The results of the testing of the first hypothesis, an overall comparison of the programmed instruction and lecture-discussion methods, indicates that Form I students performed statistically significantly better at posttest time when using programmed instruction than when taught by the lecture-discussion method. No advantage for either method was shown by Form II students at posttest time. None of the retention test results were statistically significant in the overall comparison of the two teaching methods. A positive numerical advantage is shown by both Form I and Form II students for programmed instruction, but is not sufficient to be statistically significant.

II. HYPOTHESIS 2 - STUDENT CHARACTERISTICS

The second hypothesis of this study was concerned with the relationship of selected student characteristics to the performance of students taught by programmed instruction. The hypothesis stated that there is no relationship between the performance of students taught by programmed instruction and differences in their sex, success in school, English language ability, and attitude toward the programmed instruction method. The alternative hypothesis was that the performance of students taught by programmed instruction is related to differences in their sex, success in school, English language ability, and attitude toward the programmed instruction method.

Sex

Sex - posttests. Sex was the first student characteristic analyzed. The scores were dicotomized according to the sex of the student and means calculated from them. The results of the posttest programmed instruction and lecture-discussion means comparison of the boys is shown in Table 16. There were twelve plusses when the scores of all the boys were combined, not sufficient to reject the null hypothesis. The Form I boys, as a separate group, had sixteen plusses which was a sufficient number to reject the null hypothesis. The Form II boys had thirteen plusses, insufficient to reject the null hypothesis.

TABLE 16

Plusses Observed from the Comparison of the Experimental and Control Group Means When the Students were Divided According to Sex

	Number of Plusses		
	Form I and II Combined	Form I	Form II
Posttests			
Boys	12	16*	13
Girls	14	15*	13
Retention Tests			
Boys	9	13	10
Girls	15*	13	14

*Statistically significant when $\alpha = .0659$

The same comparison for the girls is also shown in Table 16 and the results are similar to those obtained from the boys. The Form I girls had fifteen plusses which was sufficient to reject the null hypothesis. The Form II girls had thirteen plusses and the combined results of all girls had fourteen plusses, neither of which was sufficient to reject the null hypothesis.

These posttest results parallel those of the first hypothesis and indicate that the advantage for the programmed instruction method observed for the Form I students is distributed among both the boys and the girls. Similarly, the statistically non-significant results for Form II under the first hypothesis is not a factor affected by the sex of the student.

Sex - Retention Tests. The results of the comparison of the results of the retention test means for the boys is shown in Table 16. The results for three student groups, all boys and Forms I and II individually, indicated no statistically significant differences. There were nine plusses for the combined group, thirteen plusses for the Form I boys, and ten plusses for the Form II boys.

One statistically significant difference was observed in the results of the girls' retention tests as shown in Table 16. The combined group of all girls had fifteen plusses, sufficient for rejection of the null hypothesis. But the null hypothesis could not be rejected in the Form I group of girls with thirteen plusses nor in the Form II group of girls with fourteen plusses.

These results indicate that, when taught by programmed instruction, the girls performed better on the retention tests than did the boys. This is further supported by the fact that on the retention tests the girls in Forms I and II had higher numerical advantages for programmed instruction than did the boys. These results also indicate that, at retention test time, girls taught by programmed instruction tended to do better than girls taught by lecture-discussion.

Success in School

The relationship of the students' success in school and their performance under the programmed instruction method was assessed in two ways. The first assessment was made on the basis of the students' academic record in agriculture class. The second assessment was made on the basis of their academic rank in their form (grade). In both cases the students were divided into upper and lower class halves on the basis of their rank at the end of the school term during which the experiment had been conducted.

Agriculture class rank - posttests. The results of the comparison of the posttest means of the students who ranked academically in the upper half of their agriculture class is shown in Table 17. There were no statistically significant results. There were eleven plusses for the combined group, fourteen for Form I, and ten for Form II. None was high enough to reject the null hypothesis.

There was a difference in the results of the comparison made with the students who ranked academically in the lower one-half of their agriculture class (Table 17). The combined group had sixteen plusses, the Form I group fifteen plusses, and the Form II group sixteen plusses. In all three cases the null hypothesis could be rejected. This indicated that students who ranked in the lower half of their agriculture class performed statistically significantly better under the programmed instruction method than those under the lecture-discussion method.

Agriculture class rank - retention tests. The results of the retention test comparison of means is given in Table 17 for the students in both the upper half of their agriculture class and the lower half of the class. None of the six comparisons had sufficient plusses to reject the null hypothesis. The combined group in the upper half of the class had eleven plusses while the Form I upper half had twelve plusses

TABLE 17

Plusses Observed from the Comparison of Experimental and Control Group Means when the Students Were Divided According to Rank in Agriculture Class

	Number of Plusses		
	Forms I and II Combined	Form I	Form II
Posttests			
Upper half of agriculture class	11	14	10
Lower half of agriculture class	16*	15*	16*
Retention Tests			
Upper half of agriculture class	11	12	10
Lower half of agriculture class	14	12	13

*Statistically significant when $\alpha = .0659$.

and the Form II upper half had ten plusses. The lower half of the agriculture class (Table 17) had fourteen plusses for the combined group, twelve plusses for the Form I group, and thirteen plusses for the Form II group.

Agriculture class rank - discussion of results. These results of statistical tests made on the basis of rank in agriculture class show that it made no difference whether a student in the upper half of his agriculture class was taught by programmed instruction or by lecture-discussion. The test results,both post and retention, showed no statistically significant difference between the two methods. However, the method of instruction did make a difference for students who ranked in the lower half of their agriculture class. The students who were taught by programmed instruction had statistically significantly higher marks on the posttests than those taught by lecture-discussion in both Forms I and II. On the retention test, there was a numerical, but not statistically significant, advantage for the programmed instruction method. It appears that programmed instruction has definite advantages for the poorer student and no disadvantage for the better student.

Form rank - posttests. The second assessment of the relationship between programmed instruction and success in school was based on the academic rank of the students in their form. This rank was determined from a class standing determined by an average of their performance in all their classes at the end of the term during which they experiment was conducted.

The results of the comparison of the means of the posttests of students ranking in the upper half of their form is shown in Table 18. The combined comparison, Forms I and II together, resulted in fifteen plusses which was sufficient to reject the null hypothesis. The same is true in Form I; fifteen plusses resulted when the two methods were compared in that group and the null hypothesis was rejected. However, in Form II therewere only fourteen plusses, not sufficient to reject the null hypothesis.

Table 18 also shows the results of the comparison of posttest means between the two treatment methods for students ranking academically in the lower one-half of their form. The number of plusses in the combined group was sixteen, the Form I group also had sixteen, and the Form II group has seventeen. In all groups there were sufficient plusses to enable rejection of the null hypothesis.

These results indicate that Form I students taught by programmed instruction performed statistically significantly better on the posttests than when taught by lecture-discussion. It made no difference whether they ranked in the upper or

TABLE 18

Plusses Observed from the Comparison of Experimental and Control Group Means When the Students Were Divided According to Rank in Form

	Number of Plusses		
	Forms I and II Combined	Form I	Form II
Posttests			
Upper half of form	15*	15*	14
Lower half of form	16*	16*	17*
Retention Tests			
Upper half of form	8	13	10
Lower half of form	15*	13	14

*Statistically significant when α = .0659 lower half of their form. This is consistent with the overall results observed under the first hypothesis, that programmed instruction was the better method for Form I.

The posttest results for Form II are divided. There was no statistically significant difference in performance between the two teaching methods for Form II students who ranked in the upper half of their form. However, the Form II students ranking in the lower half of their form produced statistically significant results in favor of the programmed instruction method. The test of the first hypothesis had indicated that Form II students performed equally well under programmed instruction and lecture-discussion. The results here, however, indicate that this was true only for the better students, that the academically poorer Form II students performed better when taught by programmed instruction.

Form rank - retention tests. The results of the comparison of the means of the retention tests of the students who ranked in the upper half of their form is shown in Table 18. The combined group had eight plusses, the Form I group thirteen plusses, and the Form II group ten plusses. None was high enough to reject the null hypothesis.

Table 18 also shows the comparison of means of students who ranked academically in the lower half of their form. The overall comparison resulted in fifteen plusses which was sufficient to reject the null hypothesis. However, the Form I group had only thirteen plusses and the Form II group only fourteen plusses, neither of which was sufficient to reject the null hypothesis.

No statistically significant difference between the two teaching methods was observed at retention test time for students in either Form I or Form II who ranked in the academic upper half of their form. However, for students ranking in the lower half of their form, the programmed instruction method was superior. These statistically significant results for the combined Form I and II group and the numerical advantage for programmed instruction exhibited by the individual Form I and Form II groups again indicates that the programmed instruction method is superior to the lecture-discussion method for students who rank in the lower half of their form.

English Ability

English ability was another student characteristic which was analyzed to determine its relationship to student performance underprogrammed instruction. The rank of the student in his ENglish class at the end of the term during which the experiment was conducted was the criterion used to divide the students into upper and lower groups.

English ability - posttests. The results of the posstest means of students ranking in the upper half of their English classes is shown in Table 19. The combined group had nine plusses. Form I had fourteen plusses and Form II had eleven plusses. None was sufficient to reject the null hypothesis.

Different results occurred when the comparison of posttest means of those in the lower half of their English classes was made. There, as Table 19 shows, the combined group had eighteen plusses, the Form I group had seventeen plusses, and the Form II group had thirteen plusses. The results for the combined group and Form I group are sufficient to permit rejection of the null hypothesis. The Form II students in the lower half of their English class did produce a numerical advantage in favor of the programmed instruction method, but it was not sufficient for rejection of the null hypothesis.

English ability - retention tests. The results of the comparison of the means observed on the retention tests for those ranking in the upper half of their English class is included in Table 19. The combined group had eleven plusses, Form I fourteen plusses, and Form II eleven plusses. All were insufficient to reject the null hypothesis.

TABLE 19

Plusses Observed from the Comparison of Experimental and Control Group Means When the Students were Divided According to Rank in English Class

	Number of Plusses		
	Form I and II Combined	Form I	Form II
Posttests			
Upper half of English class	9	14	11
Lower half of English class	18*	17*	13
Retention tests			
Upper half of English class	11	14	11
Lower half of English class	13	13	13

*Statistically significant when α = .0659

The comparison of retention test means for the students in the lower half of their English classes is also shown in Table 19. Each of the three groups had thirteen plusses. This indicated a numerical advantage for programmed instruction, but was not sufficient to reject the null hypothesis.

English ability, as determined by rank in English class, appears to be related to students' performance under programmed instruction. Students with greater English ability, upper half of class, performed equally well (statistically) under both programmed instruction and lecture-discussion methods of instruction on both the post and retention tests. However, programmed instruction was the better method for students ranking in the lower half of their class. The Form I students in the lower half of their English class performed statistically significantly better on the posttests when taught by programmed instruction than when taught by lecture-discussion. The Form II students in the lower half of their English class had a posttest numerical advantage for the programmed instruction method. On the retention tests, the students of lower English ability, in both Forms I and II, produced results which were numerically although not statistically in favor of programmed instruction.

Teaching Method Preference

The students completed a questionnaire at the end of the experiment which included five questions about their preference of teaching method; programmed instruction or lecture-discussion. (See Appendix E for a copy of the questionnaire.) The students were divided into two preference groups, those preferring programmed instruction and those preferring lecture-discussion. If three or more of their responses to the five questions (numbers 1, 2, 4, 5, and 7) were programmed instruction, they were placed in the group preferring programmed instruction. Likewise, if three or more of their responses were lecture-discussion they were placed in that group. Table 20 shows the distribution of the students according to the treatment they preferred. Approximately one-third preferred programmed instruction and two-thirds preferred the lecture-discussion method.

Method preference - posttests. Table 21 shows the results of the comparison of the means of the group of students who preferred the programmed instruction method. The combined group had seventeen plusses and the Form I and Form II groups each had eighteen plusses. All three were sufficiently high enough to provide a basis for rejecting the null hypothesis. This indicated that the students who preferred the programmed instruction method performed

TABLE 20

The Teaching Method Preference Distribution of Form I and II Students

at Tumaini Secondary School at the End of First Term 1973

	Form I						Form II						Forms I & II Combined	
	Stream A		Stream B		Total		Stream A		Stream B		Total			
Preference	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Programmed Instruction	17	38.6	12	27.3	29	32.9	9	26.5	17	47.2	26	37.1	55	34.8
Lecture-Discussion	27	61.4	32	72.7	59	67.1	25	73.5	19	52.8	44	62.9	103	65.2
Total	44*	100	44*	100	88	100	34	100	36	100	70	100	158	100

*One student in each stream left school before this information was collected.

TABLE 21

Plusses Observed from the Comparison of Experimental and Control Group Means When the Students Were Divided According to Teaching Method Preference

	Number of Plusses		
	Forms I and II Combined	Form I	Form II
Posttests			
Preferred Programmed Instruction	17*	18*	18*
Preferred Lecture-Discussion	12	14	10
Retention Tests			
Preferred Programmed Instruction	15*	12	16*
Preferred Lecture-Discussion	12	12	9

*Statistically significant when $\alpha = .0659$

better under that method than under the lecture-discussion method.

The same comparison made on the posttest means of those who preferred the lecture-discussion method, Table 21, shows different results. The combined group had twelve plusses. The Form I group had fourteen plusses and the Form II group had ten plusses. None was sufficient to reject the null hypothesis.

Method preference - retention tests. The results of the comparison of means of the retention tests for those who preferred the programmed instruction method are shown in Table 21. The overall group had fifteen plusses and the Form II group had sixteen plusses. Both were sufficient to reject the null hypothesis. The null hypothesis could not be rejected on the basis of the twelve plusses observed in the Form I group.

Table 21 shows the results of the comparison of means of the group who preferred the lecture-discussion method. The combined group and the Form I group each had twelve plusses and the Form II group had nine plusses. None of the three was sufficiently high enough to reject the null hypothesis.

There results indicate a relationship exists between method preference and performance results. The students who indicated a preference for the lecture-discussion method exhibited no statistically significant difference between their performance when taught by programmed instruction and when taught by the lecture-discussion method. This was observed on both the post and retention tests.

On the other hand, students of both Form I and Form II who preferred the programmed instruction method achieved statistically significantly higher scores on the posttests when taught by programmed instruction than when taught by lecture-discussion. The retention test results were statistically significant in favor of programmed instruction for Form II students who preferred that method. The Form I retention test results numerically favored the programmed instruction method, but were not statistically significant.

IV. OTHER OBSERVATIONS

Thirty statistical comparisons of student characteristics and experimental results were made of the posttest means. Fifteen of those comparisons had significant results. In addition, twelve of the other comparisons had results in which there was an even or greater number of times that the mean of the programmed instruction group was higher than the mean of the lecture-discussion group. In the three remaining comparisons the mean of the lecture-discussion group was higher a greater number of times than the mean of the programmed instruction group.

Thirty statistical comparisons were also made of the student characteristics and experimental results from the retention test means. Four were statistically significant for the programmed instruction method. Twenty of the other comparisons had results in which there was an even or greater number of times that the means of the programmed instruction group were higher than the means of the lecture-discussion group. The remaining six comparisons had results in which the lecture-discussion means were higher than the programmed instruction means.

CHAPTER V

PROGRAMMED INSTRUCTION: EFFECTIVE OR NOT?

A short review of the problem and its background, the design of the experiment conducted to find an answer to the problem, and a summary of the experimental findings is included in the first part of this chapter. The conclusions arrived at as a result of the experiment are then presented. Finally, the implications of the findings and conclusions are made.

I. SUMMARY OF THE STUDY

The Problem

Is programmed instruction an effective method of teaching agriculture in a Tanzanian secondary school? This was the question for which the experiment conducted in this study attempted to provide an answer. The question developed out of the situation which existed in Tanzanian secondary education in 1972. At that time a reorganization of secondary schools was taking place which included the eventual introduction of an agricultural bias into almost one-third of the secondary schools in that nation.

The rapid expansion of agriculture into the secondary school curriculum, proposed in the reorganization plan, was slowed by several problems. These problems were created by the lack of teachers, the use of poorly qualified teachers, and the lack of teaching materials. A search for solutions to these problems indicated that programmed instruction might be useful.

The advocates of programmed instruction claim advantages for that method which would provide solutions to some of the problems observed in Tanzania. Programmed instruction could help make up for a lack of teachers because a larger group of students could be taught at one time than when using traditional teaching methods. Also, the use of programmed instruction eliminates much of the preparation time a teacher needs when using a traditional teaching method. This would permit a teacher to teach more classes.

Good programmed materials, although not a substitute for a teacher, would help alleviate problems caused by underqualified teachers. Expert preparation of materials would insure that all students recieved a minimum level of education. The preparation of programmed materials in Tanzania would insure that they were appropriate for that country. This would also provide a solution to the problem resulting from the lack of teaching materials.

The question about the effectiveness of programmed instruction in Tanzania then arose. There is a great deal of information about the use of programmed instruction in the United States, but nothing was found about its use in Tanzanian secondary schools. Reports of its use in other developing countries indicated that it might be a useful method for Tanzania. It was then decided to investigate the possibility of using programmed instruction in Tanzania.

The Experiment

An experiment with a posttest-only control group design was conducted to determine the effectiveness of programmed instruction in Tanzania. The location of the experiment, Tumaini Secondary School, was not randomly selected. This and the fact that Tumaini was a private school became the biggest limiting factors of the study.

Tumaini, at the time of the experiment, had entered the second year of a new agriculture syllabus. This meant that agriculture was taught to Form I and Form II students. All the students in these forms, boys and girls, participated in the experiment. The students were randomly assigned to the two streams in each form. These streams became the experimental and control groups for the experiment.

The experimental group was taught by programmed instruction; the control group by the lecture-discussion method traditionally used in Tanzania. The performance, as measured by a multiple-choice test of the material taught, of the students in the experimental group was compared with the performance of the students in the control goup to determine the effectiveness of programmed instruction. Posttests and retention tests were given. The experiment consisted of twenty-two trials. Each trial consisted of one unit of agriculture instruction.

The two streams of each form were randomly assigned to the two treatment methods for each experimental trial. This assignment was made with the condition that each stream experience each treatment an equal number of times. Each stream, therefore, served as the control group eleven times and as the experimental group eleven times.

The mean score of the students taught by programmed instruction was compared with the mean score of those taught by lecture-discussion for each unit of instruction. The results of the twenty-two experimental trial comparisons were statistically evaluated by a nonparametric statistical procedure, the sign test. A parametric statistical procedure was not used because the assumptions could not be justified in the setting of this study. The decision rule set for this study, before the experiment began, was: with alpha equalling .0659, reject the null hypothesis if, out of the twenty-two experimental trials, the unit test means of the students taught by programmed instruction exceeded the unit test means of the students taught by lecture-discussion fifteen or more times.

The Findings

This statistical procedure was utilized to test two hypotheses. The first hypothesis involved an overall comparison of the performance of students taught by programmed instruction with those taught by the lecture-discussion method. The null hypothesis was that the performance of students taught by programmed instruction would be no better than students taught by the lecture discussion method. The alternative hypothesis was that students would perform better when taught by programmed instruction than when taught by the lecture-discussion method.

The second hypothesis was concerned with the relationship between selected student characterisitcs and performance when taught by programmed instruction. The null hypothesis was that the performance of students taught by programmed instruction is not related to differences in their: sex, success in school, English language ability, and attitude toward the programmed instruction method. The alternative hypothesis was that the preformance of students taught by programmed instruction is related to differences in their: sex, success in school, English language ability, and attitude toward the programmed instruction method.

The results of the experiment were mixed. Neither hypothesis was fully supported nor completely rejected. Each hypothesis had some parts in which statistically significant results were observed and the null hypothesis could be rejcted and the alternative hypothesis accepted. Other parts of each hypothesis had results which were not statistically significant; for those parts the null hypothesis could not be rejected. A summary of the results of all the statistical comparisons made in testing these hypotheses is shown in Table 22.

The results of the test of the first hypothesis indicated that programmed instruction was a statistically significantly better method of instruction than lecture-discussion for Form I

TABLE 22

Results of Statistical Comparisons Between the Test Means of Students Taught by Programmed Instruction Versus Those Taught by Lecture-Discussion for Form I and II Agriculture Classes at Tumaini Secondary School, First Term 1973

Hypothesis	Group	Posttests			Retention Tests		
		Forms I & II	Form I	Form II	Forms I & II	Form I	Form II
1	All Students		X*				
2	Sex						
	Boys		X				
	Girls		X		X		
	Success in School I						
	Students ranking in upper half of agrilture class						
	Students ranking in lower half of agriculture class	X	X	X			
	Success in School II						
	Students ranking in upper half of form	X	X				
	Students ranking in lower half of form	X	X	X	X		
	English language abil.						
	Students ranking in upper half of English class						
	Students ranking in lower half of English class	X	X				
	Attitude toward programmed instr.						
	Students preferring programmed instr.	X	X	X	X		X
	Students preferring lecture-discussion						

*An X indicates a significant statistical difference (α = .0659) between the means in favor of those taught by programmed instruction.

students at posttest time. Four to six weeks after the posttest there was still a numerical advantage for the programmed instruction method, but the statistical significance had faded away. The Form II students produced results which indicated there was no statistically significant difference between their performance under the two methods of instruction.

Five subparts of the second hypothesis, which concerned the relationship between performance and selected student characteristics, were statistically tested separately. Sex of the student, the first subpart, was not a factor in posttest performance. The posttest results for the boys and girls of Form II were not significant, while the boys and girls of Form I produced statistically significant results in favor of programmed instruction. These results reflect those observed in the test of the first hypothesis, that programmed instruction was a statistically significantly better method for Form I students than was lecture-discussion.

The retention test analysis produced statistically significant results for the combined group of girls. This is confusing because neither the Form I nor Form II girls, as individual groups, produced statistically significant results. It indicates that the girls tended to perform better, at retention test time, when taught by programmed instruction than by lecture-discussion. It also means that the girls performed better than the boys when both were taught by programmed instruction.

The second and third subparts of the second hypothesis concerned success in school. The academically lower ranking students in both Form I and Form II achieved statistically significantly higher posttest marks when they used programmed instruction than when they were taught by lecture-discussion. This was observed when the comparison was made according to rank in agriculture class and when it was made according to rank in form. The statistical significance observed on the posttests diminished, so that at retention test time the only statistically significant results were for the combined Form I and II group who ranked in the lower half of their form.

English language ability, the fourth subpart of the second hypothesis, appeared to be related to performance in the experimentfor students of lower ability. The Form I students who ranked in the lower half of their English class achieved statistically significantly higher posttest results when taught by lecture-discussion. The Form II students in the lower half of their English class produced a numerical advantage for the programmed instruction method, but it was not statistically significant. At retention test time, the results, again, were not statistically significant for any student group.

The final subpart of the second hypothesis concerned the students' attitude toward programmed instruction. The Form I and Form II students who preferred the programmed instruction method achieved statistically significantly higher posttest marks when taught by programmed instruction than when taught by lecture-discussion. On the retention tests, the Form II students preferring programmed instruction produced statistically significant results for the programmed instruction method. The Form I students showed a numerical advantage for programmed instruction, but it was not statistically significant. The analysis of the test marks of the students who preferred the lecture-discussion method indicated that there was no statistically significant difference between their performance under the experimental methods on either the posttests or retention tests.

The overall finding of the study was that programmed instruction was as effective as the lecture discussion method and in some aspects more effective. Sixty-six comparisons of the means of the two teaching methods were made in this study. The results of fifty-one comparisons showed a numerical advantage for the programmed instruction method; twenty of which were statistically significant. Six comparisons had equal numerical results for the two methods. Only seven of the comparisons resulted in a numerical advantage for the lecture-discussion method.

II. CONCLUSIONS

The results of this study cannot technically be generalized outside the realm of the setting of the experiment because the location for the study was not randomly selected. But the results of this experiment can serve as a guide and indicator of what may be true in related areas. The similarity of Tumaini Secondary School students, the subjects of this study, to other secondary school students in Tanzania was not determined. However, the experience of the investigator indicates that the similarities are much greater than the differences. Tumaini students and other private school students had no known differences. The only known difference between private school and public school students was that the students in private schools had failed to be admitted to a public school; a difference based in a one-time primary school leaving examination. Completion of primary school and attendance at a secondary school were things which all secondary school students had in common and made them different from the general population of Tanzania.

The following conclusions seem logically drawn based on the results of the experiment in agriculture classes at Tumaini Secondary School and on the personal experience of the investigator:

1. Programmed instruction should be as effective a method in other private secondary schools in Tanzania as it was at Tumaini. The students in all Tanzanian private secondary schools have two common factors: a) they failed to qualify academically for public secondary school; and b) theyare able to pay the fees to attend a private school.
2. Programmed instruction would probably be an effective teaching method in public secondary schools.
3. Programmed instruction should be as effective in teaching factual information in other classes as it was in agriculture.
4. Programmed instruction must be effectively introduced to the students in order to obtain the best results.
5. The secondary school syllabus could be more effectively standardized throughout Tanzania with the use of programs adapted to or developed within the coutnry.
6. The problems of teacher shortage, use of underqualified teachers, and lack of material which hinder the development of agricultural secondary schools in

Tanzania, could be lessened by developing the suitable parts of the agriculture syllabus in a programmed format.

RECOMMENDATIONS

Given the above data and conclusions, the following recommendations are made for the implementation of programmed instruction in Tanzanian secondary schools:

1. Programmed instruction should be introduced into Tanzanian secondary schools whenever and wherever possible.
2. Programmed instruction should be experimentally tried in a public secondary school and in a non-agriculture subject matter area to demonstrate its wide application.
3. Ministry of National Education officials must make a commitment to furnish financial and staff resources needed to develop or adapt programs for Tanzania and to implement their use.
4. Teachers must be trained to insure that the programmed materials will be used effectively.

IMPLICATIONS

The implications of the development of programmed instruction as a valid teaching method in Tanzanian secondary schools would probably result in:

1. More students being taught by fewer teachers.
2. A faster rate of expansion for education.
3. A greater standardization of secondary education.
4. A faster rate of social and economic development for Tanzania.

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APPENDIX A

Beginning of Term Agriculture Class Questionnaire

FORMU YA MAELEZO

Somo la Kilimo

1. Jina lako ____________________

2. Mvulana au msichana ______________

3. Tarehe kuzaliwa ______________

4. Jaza jina la kijiji ____________________ la nyumba yako.
wilaya ____________________
mkoa ____________________
nchi ____________________

5. Makao yako (chagua moja): shamba ___, kijiji ___, kijiji cha
ujamaa ___, au miji _______.

6. Je, ni Mtanzania ______________

7. Jina la shule ya msingi ulipotoka ______________________
na anwani yake ______________________________

8. Mwaka uliofuzu darasa la saba ____________________

9. Kama mwanafunzi wa kidato cha pili, ulimaliza kidato cha kwanza
shule ya _____________________________

10. Kazi ya baba __________________________

11. Baba yako amemaliza darasa la gani la mwisho ________________

12. Kazi ya mama __________________________

13. Mama yako amemaliza darasa la gani la mwisho ________________

14. Una kaka wangapi ______

15. Una dada wangapi ______

16. Dini yako _______________

17. Kwa nini unasoma shule la sekondari? ______________________________
____

18. Je, unapenda kufana kazi ya shule? __________

19. Mna fugaji wanyama gani nyumbani: ngombe ___, mbuzi ___, kondoo ___,
punda ___, sungura ___

20. Mna fugaji ndege gani nyumbani: kuku ___, bata ___, njiwa ___,
bata mzinga ___

21. Je, mna tunza nyuki nyumbani? _____

22. Mna panda mimea gani nyumbani: mahindi ___, mtama ___, maharagwe ___,
kunde ___, pamba ___, korosho ___, karanga ___, mananasi ___, njugu ___,
miwa ___, maboga ___, na mengineyo kama _________, _________, _________.

23. Unapenda kufanya kazi gani baada ya kumaliza masomo yako? ____________
____

(English Translation)

Agriculture Class

1. Your name ______________
2. Boy or girl ______________
3. Date of birth ________________
4. Fill in the name of the village __________where your home is located. district__________ region __________ country __________
5. Where is your home located (choose one) farm ________, village ______, ujamaa village________, city ________
6. Are you a Tanzanian ____________
7. Name of the primary school you attended last ________ and its address ________
8. Year you finished standard seven __________
9. If you are in Form II, where did you finish Form I, _____
10. Father's occupation ____________
11. What was the last school grade your father finished ____
12. Mother's occupation ____________
13. What was the last school grade your mother finished ____
14. How many brothers do you have ________
15. How many sisters do you have _________
16. What is your religion ____________

17. Why are you studying at a secondary school __________

18. Do you like to do school work _______

19. What kinds of animals do you have at your home: Cattle ___, goats ______, sheep ______, donkeys ______, rabbits _______.

20. What kinds of birds do you have at your home: chickens ____, ducks _______, doves _______, turkeys _______.

21. Do you keep bees at your home? ______

22. What kinds of crops do you plant at your home: corn ____, millet/sorghum _____, beans ____, ground peas ____, cotton ____, cashew ____, peanuts ____, pineapple ____, peas ____, sugar cane ____, vegetables ____, and other such as ________, ________, ________.

23. What kind of work do you want to do after you finish your studies? ____

APPENDIX B

Programmed Learning Units in Agriculture

INTRODUCTION TO PROGRAMMED INSTRUCTION

INTRODUCTION TO PROGRAMMED INSTRUCTION

This is a programmed instruction unit to introduce you to programmed instruction.

In this unit you are to learn:
1. The usefulness of programmed instruction.
2. How to use a programmed lesson.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Introduction to
Programmed
Instruction

If you have not read the cover page, do so now, then proceed to frame 1.

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Name ______________________ Form ________

1. ______________

2. ______________

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8. ______________

9. ______________

10. ______________

11. ______________

12. ______________

13. ______________

Programmed	1. This term part of the agriculture class will be taught using programmed instruction. P______________ instruction will be used in some of the agriculture classes this term.
Programmed instruction	2. Programmed instruction is a type of teaching which is different from the kinds of teaching with which you are familar. P______ i________ is a new kind of teaching and learning method.
questions	3. In programmed instruction a student reads information much like he does from a regular textbook, but in programmed instruction each student is also required to answer questions after reading each piece of information. Students answer q_________ such as this when using programmed instruction.
frames	4. Each one of these spaces is called a frame. Each frame contains a small bit of the subject matter which the student is to learn. Small bits of information are contained in spaces called ____________.
students	5. This kind of leaning is called programmed instruction because the student is led from one small bit of information to another as he completes the frames in the order they are presented. It is important for the s_______ to complete the lesson in the proper sequence.
questions	6. Programmed instruction makes it possible for the student to progress gradually from small bits of simple information to more complex principles. Questions answered by the students are an important part of programmed learning. The q________ are an important part of programmed learning.

mask frame	7. In programmed learning, students read one frame at a time. A mask is used to cover other frames so as not to distract the attention of the student from the frame he is reading. Proper use of the m_______ is important so the student can concentrate on one f_______ at a time.
answer sheet (mask)	8. The mask also serves as an answer sheet upon which the student is required to write the answers to the questions which are asked in each frame. Answering questions helps the student learn the information he reads. Students answer questions on the ___________ in order to help learn the information in the lesson.
writing	9. Immediately after answering the question the studnet moves the mask down to see the correct answer. In this way he determines immediately whether his answer was right or wrong. The student moves the mask down after w_______ the answer to the question to see if it is correct.
frame	10. If the student has written the correct answer he moves on to read the information and answer the question in the next frame. If the student has written the correct answer to the question he moves on to the next f_______.
answers	11. If the student has written a wrong answer, he does not erase (rub out) his answer, rather he leaves the incorrect answer and beside it or over it he writes the correct answer. Incorrect a_________ are not erased.
test	12. When the student completes all the frames of a lesson he is given a short test to determine how much he has learned. How much a student has learned is determined by a short _______.

teacher	13. A teacher will be present when programmed instruction is being used. He will answer students' questions and help them use the programme. The student should ask the __________ for help when he has difficulty using programmed instruction.

Name ________________ Form ______

TEST

INTRODUCTION TO PROGRAMMED INSTRUCTION

UNDERLINE THE CORRECT ANSWER

1. A new type of teaching and learning method which we will use is ______.

   a. experiments
   b. lectures
   c. pictures
   d. programmed instruction
   e. textbooks

2. In this new kind of instruction students are required to write ______.

   a. answers to questions
   b. essays
   c. lessons
   d. long answers
   e. sentences

3. Small bits of information are contained in spaces called ______ in this type of instruction.

   a. boxes
   b. frames
   c. paragraphs
   d. sentences
   e. squares

4. When a student has difficulty using a programmed lesson he can get help from ______________.

   a. a textbook
   b. another student
   c. his father
   d. the headmaster
   e. the teacher

TUMAINI SECONDARY SCHOOL

TYRES FOR FARM EQUIPMENT

This is a programmed instruction unit on tyres for farm equipment.

In this unit you are to learn:

1. the parts of a tyre.
2. that there are several types of tyres.
3. the meaning of ply ratings, tyre grades and tyre sizes.
4. when to replace tyres.
5. how tyres should be stored.
6. the importance of proper inflation.
7. how drive wheel slippage can be reduced.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Tyres for Farm Equipment

If you have not read the cover page, do so now, then proceed to frame 1.

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– Cut –

Name __________ Form __________

1. __________
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18. __________
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25. __________
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31. __________
32. – –
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43. __________
44. – –
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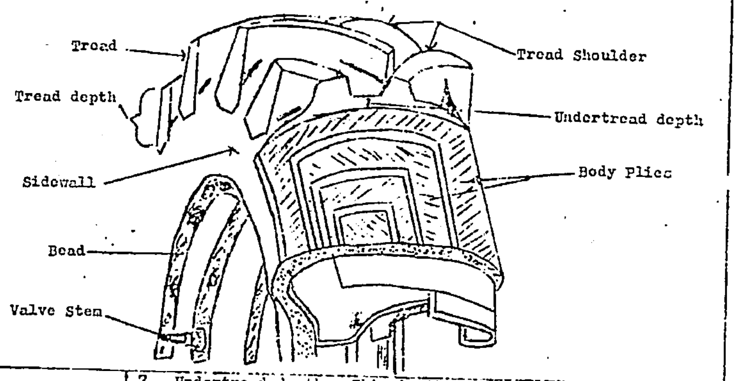
52. __________
53. __________
54. __________
55. __________
56. __________
57. __________
58. __________

rubber tyres	1. When a person thinks of modern tractors and wheeled farm implements, he immediately visualizes them on rubber tyres. It is hard, in fact, to name a wheeled farm implement that does not have rubber tyres. This has not always been true however. Wagons and other early farm equipment had wooden wheels first and later they had steel wheels. Most modern farm equipment have r___ t______.
tyres	2. Rubber tyres gradually replaced steel wheels on tractors also. Today, several types of tyres are needed on modern farms. To supply these needs, the tyre manufacturers provide a variety of specialized tyres for farm tractors and implements. Several kinds of _______ are needed on modern farms.
life	3. Therefore those who sell tyres must understand the construction of tyres, causes of tyre failure, what sizes mean, etc. in order to provide the best service to those who use tyres. The investment in tyres on a modern farm may amount to several thousand shillings. Those who operate farm equipment must know how to care for these tyres so they will give long service life. A knowledge of tyres is important to insure that they will have a long service l______.
- -	4. Construction of a Farm Tyre. The sectional view of a pneumatic tyre is shown in figure 1. The function of each of the essential parts is explained below.
tread	5. Tread. The tread is that portion of the tyre that contacts the road or ground surface. It has a tread pattern to provide traction for the particular conditions under which it is used. The tread pattern for a tyre used on highways is different than that of a tyre used in rice fields. The tread provides wear resistance and protects the body of the tyre. The ______ of a tyre provides traction and protects the body of the tyre.
tread shoulder tread depth	6. Tread Shoulder. The outer edges of the tread help provide stability, traction, and skid resistance. Tread Depth. The height of the tread ribs or cleats is called tread depth. The need for greater or less depth depends on the use of the tyre. The outer edge of the tread is the t____ s_______ while the t____ d_________ is the height of the tread ribs or cleats.

Fig. 1. Parts of a pneumatic tyre.



Sidewall Undertread depth	7. Undertread depth. This is the thickness of rubber from the lowest tread surface visible to the outside cord ply. Sidewall. This is the rubber covering between the shoulders and the beads. It protects the tyre body. The ______ protects the tyre body while the thickness of rubber between the lowest tread surface to the outside cord ply is the ______.
body ply bead	8. Body plies. These are the layers of rubber coated cord fabric that make up the body of the tyre. They give it structural strength. Bead. The high tensile steel wires that are insulated with rubber and fabric are called the bead. The bead is shaped to fit the rim of the wheel. The body plies are anchored around the beads. Each layer of rubber coated cord fabric is called a ______ and the bundle of wires to which the body plies are anchored is the ______.
inner tube	9. Air container. In tubeless tyres, the liner is vulcanized to the inner surface of the tyre and serves as an air container. In tube type tyres, an inner tube serves this purpose. The air container in a tube type tyre is called an i___ t_____.
rim valve stem	10. Valve stem. This is an outlet passage for the air, liquid, or dry ballast. It is an integral part of inner tubes but is a separate stem inserted into the rim for tubeless tyres. Rim. The rim is that part of the wheel that provides metal support for the tyre. The ______ is the part of the wheel that is in contact with the tyre and tube. The ______ is the air passage to the inside of the tyre and inner tube.

- -	11. Types of Agricultural Tyres There are many types of agricultural tyres and manufacturers apply various names to these tyres. The information in Table 1 will help a person select the best tyre for a job or the best tyre to use as a replacement. Other tyre types, besides those listed in Table 1, include industrial tractor, truck-bus, passenger car, tubeless, utility, and specials.
	Table 1. Industry tyre type Rear Tractor Regular Agricultural Cane and rice Industrial and sand Industrial - lug type Front Tractor Single rib tread Two-rib or triple tread Industrial rib Garden Tractor Regular tread Intermediate tread Shallow Implement Rib tread Moderate traction Traction tread Plough tail wheel Smooth tread
- -	12. Meaning of Ply Ratings, Tyre Grades and Tyre Sizes In order to purchase a replacement tyre of the size, quality, and type, that is matched for the job, a person needs to know something about ply ratings, grades, and tyre sizes.
ply rating	13. Ply ratings. At one time the exact number of plies of fabric or cord in a tyre was an indication of its strength. Now, other materials in addition to cotton are often used in tyres, thus making strength comparisons inaccurate when based on the number of plies. A "ply rating" is used to indicate the comparative strengths of tyres incorporating different fabric materials. The p___ r_____ indicates the comparative strength of a tyre.
ply	14. Briefly stated, this ply rating is used to identify a given tyre with its maximum recommended load when used in a specific type of service. It is an index of tyre strength and does not necessarily represent the number of cord plies in the tyre body. The higher the ply rating, the greater the load carrying capacity of the tyre. The higher the ______ rating, the stronger the tyre.
quality	15. Tyre grades. Tyre manufacturers normally produce more than one quality level of tyres. About the only common denominator for comparing tyre quality is the quality of tyres sold to farm equipment manufacturers for installation on new tractors and implements. All tyres are not of the same q_____.

quality	16. Compared to tyres produced for new vehicles, a manufacturer might produce other tyres of equal, better, or lower quality. There is no industry grade, level, or price. The "first line" or "top grade" tyre of one company might be of better quality or lower quality than the "top grade" of another company. The fact that the two tyres are similarly priced, does not guarantee that they are of similar quality. It is difficult to determine the q____ of tyres.
12 38	17. <u>Tyre sizes</u>. Extra wide base tyres are now used as regular rear tyres. They may be dual marked to show both the extra wide base and the old tyre marking. The widest permissible rim for a 12-38 tyre is 12 inches wide. On this rim, a 12-38 tyre measures about 13.6 inches in cross section and may be marked 13.6-38 or dual marked 13.6/12-38. The first number is the width in inches of the beads on the rim and the second number is the diameter of the rim in inches. A 12 - 38 tyre fits a rim which is _____ inches wide and _____ inches in diameter.
original	18. <u>Considerations when replacing tyres</u> When buying replacement tyres, try to buy the same type, size, and ply rating as those originally on the vehicle. In some instances, the service conditions, such as unusually severe service, special traction, or floatation requirements, may require a different type or a stronger tyre. Replacement tyres should be the same as the o____ tyres.
replaced	19. If a tyre is damaged beyond safe repair, replace it immediately. In many instances, choosing the proper time to replace a tyre becomes largely a matter of sound business judgment. Two factors to consider in making this decision are efficiency and risk. A tyre which is damaged beyond safe repair should be _____ immediately.
immediately	20. a. Is the tyre worn to the point where loss of traction (slippage) is costing the farmer extra fuel and loss of time? b. Is the tyre worn so that the farmer risks a failure in the field with loss of both time and the use of machinery when both are vitally important? If the answer to either of these questions is "Yes", then it is time to replace the tyre. Most tyre failures occur in the latter stages of their wear. Badly worn tyres should be replaced i________. before they fail completely.
more	21. A tyre with a low initial cost is not generally the least expensive in the long run. The tyre that will deliver maximum performance over a longer period of time usually costs less when you calculate costs on the basis of a cost-per-hour of operation. The lowest priced tyre may actually cost <u>more/less</u> on the basis of cost-per-hour of operation.

seller	22. When selecting replacement tyres, consider the performance of the previous tyre, service conditions, terrain, and loads. Consult with the tyre seller for reference data to match the tyre to the vehicle and the type of service. Handbooks that contain this data are everyday tools of good tyre sellers. Those who buy tyres should be able to depend on the s_______ for information on the kind of tyre to buy.
storage	23. <u>Storage of Tyres</u> The person who buys a new tyre wants it to look like a new tyre. To maintain new tyre appearance and condition, it is essential that the seller store and handle tractor and implement tyres properly before they are delivered to the buyer. After the tyres are purchased, their care and storage are just as important to insure long service life. Proper s______ of tyres is important.
cool dry dark	24. <u>Inside storage</u>. When tyres cannot be used promptly, and they must be stored for a considerable time, the ideal storage place is a cool, dry, dark location that is free from air currents. Moving air oxidizes or "ages" the rubber faster than still air. Keep the storage room as cool as possible, because low temperatures are not objectionable. High room temperatures (over 28°C) are detrimental and should be avoided. Tyres should be stored in a c_____, d_____, d_____ place.
deteriorate	25. Do not store tyres near boilers, furnaces, or other sources of heat. The storage areas should be free of electrical devices, such as motors, generators, switches, and welding equipment, which are sources of ozone. The tyres should not come in contact with petrol or lubricants. The fluids, solids, and vapors from these petroleum products are readily absorbed by the casing causing it to deteriorate. Heat, ozone, and petroleum products cause tyres to _____.
sunlight	26. Try to keep the storage room dark or at least free from direct sunlight. If there are windows in the storage room, apply a coat of blue paint to them. This will provide some indirect lighting in the daytime which will not be injurious. Direct s_____ is harmful to tyres.
water	27. <u>Outdoor storage</u>. Tyres in storage or transit must be protected from rain to prevent water from accumulating in the casing. This is very damaging and will cause premature failure. W_____ inside the tyre casing causes damage.

outdoors	28. Sun, heat, and exposure to weather in general will cause rubber to deteriorate, if tyres are stored outdoors for extended periods of time. One of the common effects of outdoor storage is the cracking or weather checking of the rubber on the tread or sidewalls of the tyre. Most manufacturers do not recommend outdoor storage of tyres. Tyres should not be stored o______.
0.7 (10 psi)	29. Mounted Tyres. If the tyres are mounted on rims and inflated, reduce the pressure to 0.7 ksc. (kilograms per square centimetre) (or 10 psi). If the tyres are stacked, place them on planking or boards to protect them from the ground or oily floors. Tyres which are inflated should be stored at ______ ksc.
tyres	30. If the tyres are mounted on vehicles, block the machine up, so the weight is off the tyres, and reduce inflation pressure to 0.7 ksc. When the machines cannot be blocked up, check inflation pressure frequently and maintain it at the proper level for the load on the tyres. If the machines are to be stored outdoors for any length of time, cover the tyres or remove the wheels and store them inside. When vehicles are stored, the ______ should be protected from the weather.
envelopes	31. Tyre envelopes can be made from waterproof jute reinforced paper. These are being successfully used by some companies to protect tyres against weathering on equipment stored outdoors. Tyre e__________ can be used for protecting tyres mounted on equipment in storage outdoors.
- -	32. To make an envelope, cut the paper to a length about twice the diameter of the tyre. Fold it over to bring the ends even, and staple along both edges to form an envelope open on one side. Slit one side, about half way to slip over the axle and then slip it over the tyre. If they are handled with reasonable care, the envelopes can be reused several time.
storage	33. Unmounted tyres. Lay a foundation of clean wood to protect the tyres from the soil or from dirty, oil soaked floors, or concrete. Store like sizes together. If necessary to pile different sizes together in the same stacks, make certain that the heavier and larger tyres are placed on the bottom of the pile. Tyres in s______ must be protected from dirty, oil soaked floors and from soil.

distorted	34. Larger tyres can be stored vertically in stalls. Shift the tyre position periodically to prevent flat spotting. Smaller tyres can be piled horizontally. Do not pile tyres so high that the bottom tyres are distorted. Tyres can be stored in piles as long as the bottom tyres do not become ______.
pressure	35. Importance of Proper Inflation Use of proper pressure is one of the most important factors in satisfactory performance and maintenance of tractor and implement tyres. Maintaining correct pressure is the key to long tyre life. Improper inflation pressure is a large contributor to tyre failure. Many kinds of fabric breaks that might ordinarily destroy a tyre can be avoided by frequent checking of pressure. Proper p________ is necessary for long tyre life.
underinflation overinflation	36. Underinflation (too little pressure) or overinflation (too much pressure) can ruin tyres in a hurry. Underinflation makes the tyre soft and will cause the sidewall areas of the tyre to flex abnormally, eventually causing breaks and separations in the cord body. Overinflation makes the tyre body rigid, reducing its resistance to impact and thus making it susceptible to fabric breaks. U______inflation and o____inflation are both harmful to tyres.
inflation	37. Tyre appearance. Even if one does not have a pressure gauge, it is possible to judge tyre inflation for general use by appearance. Always be alert for any tyre that appears too soft. An underinflated tyre is badly buckled in the body on the underside when a tractor is standing. The i__________ of a tyre can be estimated from its appearance.
inflated	38. An overinflated tyre has the tread bars off the ground at the outside edge. A properly inflated tyre has the entire length of the lower tread bar in contact with the ground, and there is a very slight buckling in the body of the tyre. If you view the tyre from the direction of travel, there will be a slight bulge at the bottom of the tyre. An underinflated tyre will have a large bulge in this area. A properly i_______ rear tractor tyre has the lowest tread bar in full contact with the ground.
gauge	39. Check inflation pressure frequently. Check inflation pressure every two or three weeks. Recommended inflation pressure based on total load on tyres should be used. For accuracy, use a special low-pressure gauge with one-kilogram gradations. Check the gauge against a new gauge occasionally for accuracy. Gauges may get out of order and incorrect readings will be made. Tyre pressure should be checked frequently with a ______.

bottom	40. Use a special inflation gauge to test tyres filled with water. To determine the true operating pressure for a water-filled tyre, the valve should be at the bottom of the tyre. Test tyres filled with water when they are cold and before the tractor is put into operation, because the pressure rises as the fluid becomes warm. Water-filled tyres should be pressure checked with the valve at the _______ of the tyre.
cold	41. A tyre that has sufficient pressure when it is hot may be underinflated when it cools. Any small loss of air from a liquid filled tyre makes a much greater decrease in pressure than if the tyre is filled 100 percent with air. Water-filled tyres should be pressure checked when they are c_______.
valve caps	42. Always replace the valve caps to prevent dirt from gettin into the valve and to prevent the loss of air in case the valve leaks. V___ c____ should be used to keep the valve clean and prevent air loss.
ploughing	43. Inflation adjustments. To be sure the pressure is correct for certain specific conditions, one may need to make certain adjustments. Ploughing causes a tilt to the tractor because one rear wheel is usually in the furrow. The pressure should be corrected to compensate for this tilt. Tyre pressure should be adjusted when a tractor is used for p_________.
- -	44. The tilt of the tractor causes a sidewise thrust of the weight against the tyre. This thrust, combined with the heavy pull of the plough, causes the inner sidewall of the tyre to buckle. This repeated flexing causes cord separation and a series of breaks on the inside of the sidewall area. When air or air and water are used, increase the pressure in the tyre on the furrow wheel to 2 kilograms greater than that in the land tyre, providing maximum recommended pressure is not exceeded.
increased	45. Adjust the plough hitch laterally so that the tyre does not need to crowd the furrow wall in order to plough a full width cut. The furrow-wheel tyre can usually be observed by the operator so he should notice whether or not the tyre is wrinkling or buckling. When ploughing, the pressure of the furrow-wheel tyre is i___________.

increased	46. Sidehill farming causes the rear tyres on each side of the tractor to alternately be on the down side. When air or air and water are used, it is necessary to increase the pressure in both rear tyres. When only one tyre is in the down position, it is only necessary to increase the pressure on the tyre in the down position. When operating a tractor on sidehills, the pressure of both rear tyres should be ______.
hand or foot	47. Hand pump or power pump. When only a few kilograms of air are needed to inflate tyres to the recommended pressure, use a hand or foot pump. For power pumping an air compressor, or a power take-off, or a spark-plug pump is satisfactory. A __________ pump should be used when only a small increase in tyre pressure is needed.
slippage	48. Reduction of Drive Wheel Slippage. Increased horsepower ratings of modern farm tractors have increased the problem of rear tyre slippage. Each tractor operator has different conditions under which he operates his tractor, and different implements and operations vary the amount of drawbar pull. A certain amount of slippage is normal but this should not exceed 16% for field operation or 5% on dry concrete pavement. A small amount of s________ is normal.
traction	49. The traction or pulling power which a tyre can exert is in proportion to the weight it carries. The greater the load on a tyre, the more tractive effort it can exert. T______ is the pulling power of a tyre.
weight	50. Increasing or decreasing inflation pressure will not increase traction and may ruin the tyres. For every 100 kilograms weight added to the rear of the tractor the average drawbar pull will be increased. The amount of increase depends on the type of surface. The drawbar pull can be increased by adding _______ to the rear of the tractor.

Table 2. The Effect of 100 Kg. Weight on Various Surfaces

Surface	Average Pull (Kg)
Concrete Road	66
Dry Clay	55
Sandy loam	50
Dry Sand	36
Green Lucerne	36

550	51. From this table it is obvious that, in order to pull a certain drawbar load, more weight must be added to the rear tyres on dry sand than for other surfaces. A 1000 kilogram tractor can exert, on the average, a pull of ______ kilograms on dry clay.
weight	52. When extra drawbar pull is required, the preferred way to get it is through the addition of weight to the rear wheels of the tractor, up to the maximum carrying capacity of the tyres. The pressure of the tyres must be adjusted to take care of the additional weight. To increase drawbar pull, w______ is added to the rear wheels of the tractor.
liquid	53. Liquid weighting increases traction. Some manufacturers claim that 50 kilograms of extra drawbar pull is gained for each 100 kilograms of added rear-wheel weight, but table 2 indicates that the surface type affects the traction. One way of increasing the weight is to add ______ to the tyres.
calcium chloride	54. Calcium chloride is the most common material for liquid weighting. It does not have any harmful effects on the tyre carcass, tube, or valve stem. It is comparatively inexpensive, readily available, and is 30 percent heavier than water. C______ c______ is the most often used material for liquid weighting of tractor tyres.
valve level	55. A fill of 75 percent or valve level is recommended for liquid weighting. There are several reasons for this. a) An air chamber is necessary to maintain the pneumatic principle in the tyre. b) Liquid solutions cannot be compressed, so if the tube is completely filled with liquid, it cannot absorb shock, and has little or no bruise resistance. The tyre should be filled with liquid only to v___ l______, when the valve is at the top of the tyre.
75	56. Ploughing or disking usually requires 75 percent maximum weighting, because of the need for extreme traction. A tractor used exclusively for cultivating, light implement work, or chore work may require less weighting Heavy work like ploughing usually requires ______ percent weighting.

dry	57. Dry ballast has been in use for several years but it has not received the wholehearted endorsement by tyre manufacturers for several reasons. One of the major problems with dry ballast is the difficulty of maintaining proper inflation pressure. It is often difficult to maintain proper tyre pressure when using _______ ballast.
liquid	58. The pressure loss is due to the problem of keeping an air-tight seal in the valve because the ballast materials keep the valve from functioning properly. The loss of inflation causes early tyre failures. Other difficulties include problems of adding and removing ballast and those connected with repairing tyres. Most people prefer _______ ballast over dry ballast.

The information in this unit is based on VAS unit 3031 of the Vocational Agricultural Service of the College of Agriculture, University of Illinois.

Name ____________ Form _____

TEST

TYRES FOR FARM EQUIPMENT

UNDERLINE THE CORRECT ANSWER

1. The ______ is the portion of the tyre which contacts the road or ground surface.

   a. bead
   2. ply
   3. rim
   4. tube
   5. tread

2. The ______ is the outlet passage for air from inside the tyre.

   a. bead
   b. cord
   c. innertube
   d. rim
   e. valve stem

3. The ply rating is an indication of the ______ of a tyre.

   a. price
   b. shape
   c. size
   d. strength
   e. quality

4. A tyre marked 12-38 will fit a rim which is ______ inches wide.

   a. 6
   b. 12
   c. 19
   d. 38
   e. 50

5. Tyres should be replaced when ____________.

   a. the tread is half worn away
   b. the tread shoulder touches the ground
   c. the tyre pressure becomes too great
   d. they are five years old
   e. they are worn enough to cause excessive slippage

6. Unmounted tyres should be stored in a ______ place.

   a. cool, damp, dark
   b. cool, damp, light
   c. cool, dry, dark
   d. warm, damp, dark
   e. warm, dry, light

7. Exposure to or contact with ______ will not cause tyres to deteriorate.

   a. concrete
   b. ozone
   c. petrol
   d. rain
   e. sun

P.T.O.

8. Overinflation is bad for a tyre because ______.

   a. it may cause the tractor to tip over.
   b. it becomes too heavy
   c. its impact resistance is reduced
   d. its traction is increased to a dangerous level
   e. the sidewalls then flex abnormally

9. When ploughing, the pressure in the rear furrow-wheel of the tractor should be ______ the other rear wheel.

   a. greater than
   b. less than
   c. the same as

10. The drawbar pull of a tractor can be increased by ______.

   a. adding weight to the rear wheels
   b. greasing the tyre treads
   c. increasing tyre slippage
   d. overinflating the tyres
   e. underinflating the tyres

11. The most common material used for liquid weighting of tyres is ______.

   a. mercury
   b. petrol
   c. water
   d. water and calcium chloride
   e. water and sand

12. A tyre should be filled to ______ percent of its capacity when using liquid weighting.

   a. 25
   b. 50
   c. 75
   d. 90
   e. 100

13. The most important factor in obtaining a long service life from tyres is ______.

   a. daily inspection
   b. maintaining correct inflation pressure
   c. proper storage
   d. regular cleaning
   e. regular use

14. The ______ is the part of a tyre containing wires which anchor the body plies.

   a. bead
   b. rim
   c. tread
   d. tube
   e. valve

TUMAINI SECONDARY SCHOOL

RAISING DAIRY CALVES I

This is a programmed instruction unit on raising dairy calves.

In this unit you are to learn:

1. the care of cows at calving time.
2. the care of new-born calves.
3. three methods of feeding dairy calves:
    - a. limited whole-milk and dry-calf-starter method.
    - b. whole-milk method.
    - c. skimmilk method.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Raising Dairy Calves I

If you have not read the cover page, do so now, then proceed to frame 1.

-Cut-

- Cut -

Name __________ Form __________

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62. - -

63. __________

64. __________

65. __________

66. __________

67. __________

68. __________

69. __________
____

purchasing replacements raising calves	1. Improvement in the inherent producing ability of a dairy herd may be accomplished through either purchasing replacements or raising calves. The most certain way of improving the ability of the herd is to breed the cows to sires of known high-transmitting ability, and to produce calves that may be used as replacements. The producing ability of a dairy herd may be improved by __________ or __________.
four	2. Dairy cooperative records show that the annual herd-replacement rate is about 20 percent. Not all the calves that are born will live, develop, or breed satisfactorily, so about one-third as many heifer calves need to be raised each year as there are cows in the herd. When selection is possible, keep only calves from the best cows. An ujamaa village with a herd of twelve dairy cows needs to raise ________ heifer calves each year for herd replacement.
foetus	3. Care of the Cow at Calving Time. Nearly two-thirds of the development of the foetus, or unborn calf, is during the last three months of the gestation period. While the foetal requirements for growth are not large, there is a direct relation between the feeding of the dam and the development of the foetus and the vigour and thriftiness of the newborn calf. A cow must be fed well if her f________ is to develop well.
colostrum	4. The nutritive value of the colostrum (the first milk) is influenced by the ration fed prior to calving. The ration of the dam must be adequate in phosphorous, calcium, vitamins A and D, protein, and energy. To supply these requirements, feed high-quality feeds, especially good hay. c________ is the first milk a cow produces after calving.
6 to 8	5. It is important to dry off cows six to eight weeks before they are due to freshen and to condition them properly for freshening and for production during the next lactation. Feed the dry cow all the good-quality mixed or legume hay she will eat if good-quality pasture is not available. Cows should be dried off _____ to _____ weeks before they are due to calve.
concentrate	6. Good-quality hay or pasture is not only an economical source of total digestible nutrients and of protein, but furnishes vitamins A and D, calcium, and most of the other minerals needed. The dry cow also needs to be fed enough low-protein concentrates to build up a reserve of body fat. A dry cow should be fed both roughage (hay or pasture) and a low-protein c__________.

1.75 to 2.8	7. A mixture of 600 kilograms of cereal grains, 300 kilograms of wheat bran, and 100 kilograms of soybean meal makes a good concentrate ration for the dry cow. Usually from 0.25 0.4 kilogram of concentrate is needed daily per 50 kilograms of body weight to get cows in desirable condition. Free access to water and salt is also necessary. A dry cow weighing 350 kilograms needs from ____ to _____ kilograms of concentrate daily.
laxative	8. Additional amounts of wheat bran, molasses, or other laxative feeds may be substituted for all or part of the concentrate mixture a few days before and after freshening. A l_______ feed may be used just before and after freshening.
freshening (calving)	9. A few days before the cow is due to freshen, stable her in a roomy, well-beded box stall. It is a good practice to thoroughly clean and disinfect the maternity stall each time it is used. A small pasture near the barn, and away from the herd also makes a good place for cows to freshen during warm dry weather. A cow should be put into a special stall or pasture for f__________.
283	10. The normal gestation period for cows is 283 days. Signs of approaching freshening include a sinking and loosening of the ligaments around the tail head, filling of the udder and teats with colostrum, and a restless nervous disposition on the part of the cow. Most cows give birth to their calves without difficulty, but it is good practice for a person to be on hand to render aid if necessary. The gestation period for cows is ______ days.
front feet	11. In normal calving, the calf's front feet appear first with the head on the front legs. Usually the calf is born within an hour after delivery starts. If the cow seems to be having difficulty, examine her to see if the calf is too large to come through her pelvis or is in an abnormal position. If the calf is not in a normal position, a person may have to push it back into the uterus and straighten it. A calf is normally born with the _____________ appearing first.
pulling	12. If the position is normal, assistance, if needed, can be given by pulling on the calf when the cow strains. A veterinary officer may be required if the farmer is inexperienced or the delivery is complicated. Care must be taken to see that the cow does not become chilled. A cow may be assisted in calving by p_________ on the calf if the position of the calf is normal.

dry cloth or bag	13. Care of the Newborn Calf. Early management. Usually a cow begins to lick the calf immediately after birth. This not only helps to dry the calf, but helps to start respiration and improves circulation. In cool damp weather it may be desirable to rub the calf briskly with a dry cloth or burlap feed bag. A calf may be wiped off with a _______ following its birth.
navel	14. It may also be necessary sometimes to start respiration artificially in the newborn calf. Be certain that the fetal or mucous membranes do not cover the nostrils and prevent the calf from breathing. Disinfect the calf's navel cord with tincture of iodine soon after birth, to prevent infections from entering the body through this channel. The calf's n_____ should be disinfected soon after birth.
nurse	15. Within a short time after birth, the calf is usually strong enough to stand and nurse. If it is too weak to stand up and nurse in an hour or two, it shuld be helped to nurse. A calf should start to n_____ soon after birth.
colostrum	16. Feeding the young calf. The first milk given by a cow after the birth of a calf is colostrum. It provides essential food for the calf and starts the digestive system to function. Colostrum also helps to protect the calf from diseases. It is high in vitamin A, although the amount varies. A calf is usually born with small reserves of this vitamin; yet, it must be obtained from some source if proper growth is to be made. A calf must get the c______ as its first food in order to begin growing properly.
2 or 3	17. If for any reason the calf does not get colostrum give it a vitamin A supplement. Because of the importance of getting the calf off to a good start, leave the calf with its mother for the first two or three days after birth. The calf should stay with its mother for the first _______ days.
overfeed	18. Feed any surplus colostrum to the other calves rather than throw it away. While the calf is still on the cow, be sure it does not overfeed. If the cow comes into her milk very rapidly, allow the calf to nurse only at certain intervals. After the calf is taken from its mother it is taught to drink from a pail. A calf nursing from its mother should be watched so it does not o_______.

pail	19. It is not too difficult to teach a hungry calf to drink from a pail. A good procedure is to back the calf into a corner and straddle its neck. Dip one or two fingers in the warm milk, then allow the calf to suck the fingers as its head is drawn down gradually into the pail. As the calf's head is drawn down, its mouth comes in contact with the milk. A calf can easily be taught to drink from a p______.
- -	20. When the calf's mouth comes in contact with the milk, it is sucked up between the fingers. The fingers can then be withdrawn from the calf's mouth. After one or two such lessons, the calf will usually drink without coaxing. Gulping the milk may cause digestive disturbances.
overfeeding	21. If possible, when pail feeding is started, give the calf its mother's milk for several days. Be sure that the calf is not fed too heavily on milk, especially during the first month. Overfeeding may cause digestive upsets followed by scours. A calf will usually do better if kept slightly hungry. Over________ is bad for a calf.
2.8	22. A good rule to follow in feeding milk is not to exceed 10 percent of the calf's body weight in kilograms of milk per day. This will be from 2 to 3.5 kilograms for the calf each day during the first few days, depending upon the breed and size of the calf. A calf which weighs 28 kilograms should receive ____ kilograms of milk per day.
twice (two times)	23. A common procedure is to feed a calf milk twice a day. Some dairymen, however, prefer to feed milk three times a day until the calf has a good start. This may be advisable for calves that are weak or small at birth. Calves normally need to be fed milk ____ a day.
milk	24. The digestive tract of a young calf is undeveloped so it must be fed chiefly on milk and on concentrated feeds high in digestible nutrients and relatively low in fibre for the first few weeks. The digestive tract, however, changes rapidly and becomes especially adapted to handle hay and other roughages. For the first few weeks, the calf's digestive tract can utilize only ______ and a small amount of concentrates.

cleanliness	25. Sanitary precautions. Any successful program for raising strong, healthy calves must include good sanitation. Cleanliness is one of the first essentials. Wash all feeding pails thoroughly and sterilize them after each feeding, just the same as other dairy equipment. Dirty pails and contaminated milk are frequent causes of common calf scours. c__________ is very important in keeping calves healthy.
regular	26. Regularity in calf feeding is always important. Weigh the milk at each feeding, and make all changes gradually. Best results are obtained when fresh milk is fed at a uniform temperature of from ~~70~~ 35°C. to ~~73~~ 38°C. Calves should be fed at r__________ intervals.
cleaned	27. Calf pens should be kept clean, dry, and well-bedded at all times. Proper ventilation and freedom from drafts and dampness is essential for healthy calves. The mangers and feed boxes must be kept clean. Regular cleaning of the feed box will prevent the calf from eating moldy or contaminated feed. Calf pens need to be c________ regularly.
3 to 4	28. Some Satisfactory Feeding Schedules for Calves. Most schedules for dairy calves include whole milk during the first few weeks. Following this period, the procedure used is generally determined by the method of marketing milk or cream from the farm. On the fluid-milk markets, whole milk is often too expensive to feed, except for the first few weeks. Calves need whole milk for the first _____ to _____ weeks of their lives.
Skimmilk	29. When fluid milk is sold, dairymen frequently use milk replacers which are mixed with warm water and fed. In other areas where cream is the product sold from the farm, the skimmilk left is an excellent feed for calves. S__________ is an excellent feed for calves.
calf	30. Success or failure with any of the methods of raising calves depends largely upon the skill and judgment of the feeder and his ability as a dairyman. A great deal of common sense and judgment must be used along with any suggested rules or schedules. Keep in mind, therefore, that the following feeding schedules are intended only as guides. Each calf needs to be fed and managed as an individual. Feeding schedules must be adjusted to each individual c________.

milk

31. **Limited Whole-milk and Dry-calf-starter Method.** This method of feeding is economical, and the care and labour required in feeding are reduced to a minimum. After the first 7 - 10 weeks, feed all of the feeds in dry form, thus eliminating much of the labour connected with pail feeding.

With this method, calves of small breeds receive no m____ after they are 10 weeks old.

--

32. While the calves may not be so fat and sleek as they are when more milk is fed, this method is effective in producing thrifty calves that are above normal in size with large body capacity. Daily feeding schedules for a typical calf are shown in Figure 1.

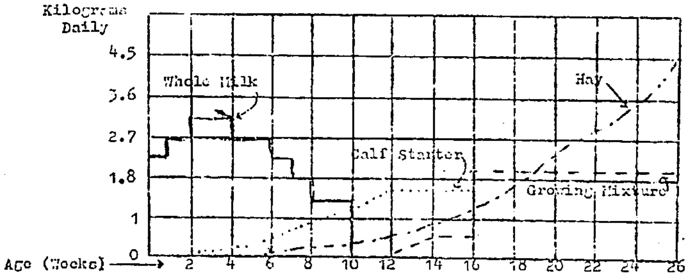

Figure 1. This feeding schedule, for the dry-calf starter method of feeding calves should be used only as a guide. Feed each calf according to its individual needs.

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33. **Whole Milk.** The total amount of whole milk allowed each calf should be approximately 160 kilograms. Leave the calf with its mother for two or three days and then teach it to drink from a pail. A suggested daily milk-feeding schedule is given in Table 1. As shown, the calves of smaller breeds are weaned at 10 weeks and those of larger breeds at the end of seven weeks.

Table 1. Daily Milk-Feeding Schedule

Age	Large Breeds	Small Breeds
	Kilograms of milk	Kilograms of milk
1 to 3 days	with cow	with cow
4 to 7 days	3.6	2.3
Second week	4.0	2.7
Third week	4.5	3.1
Fourth week	4.0	3.1
Fifth week	3.1	2.7
Sixth week	2.7	2.7
Seventh week	1.8	2.3
Eighth week	-	1.8
Ninth week	-	1.4
Tenth week	-	1.4

one	34. **Dry Calf Starter.** Feed the dry starter at the beginning of the second week. To give the calf a taste of the starter, rub a little into the calf's mouth, especially after each feeding of milk. Putting fresh starter in the feed box each day also helps to increase consumption. Be careful to feed each day approximately the amount the calf will clean up. Dry calf starter is first fed when the calf is _____ week old.
12 to 14	35. Calves differ greatly in their eating habits. Some readily eat large amounts of starter while others are slower to accept it. Feed each calf all of the starter it will eat until a daily maximum of 1.8 kilograms is reached for the larger breeds and 1.6 kilograms for the smaller breeds. For a majority of calves, this amount is reached at about 12 to 14 weeks of age. During the first ____ to ____ weeks calves should be fed as much dry calf starter as they will eat.
dry pellets	36. There are some commercial calf starters on the market. Some of these are sold in the form of dry meal, some in pellets and others as a mixture of meal and pellets. Some calves may prefer a starter in the meal form while others take more readily to pellets. Experiments show no particular advantage to either types of starter or to a mixture of meal and pellets. If a commercial starter is used follow the manufacturer's directions as closely as possible. Commercial calf starters may be in the form ~~of~~ d___ meal or p_____.
- -	37. In experiments on different starters and methods of feeding them, no one starter has proved to be consistently better than others. On the basis of some of these investigations, a home-made mixture that has given good results is as follows: Ground maize (yellow) — 50 percent (by weight) Ground oats — 20 percent Soybean meal — 27½ percent Steamed bonemeal — 1½ percent Salt — 1 percent
water	38. **Water.** Calves should have free access to clean, fresh water at all times after they are about three weeks of age. This is especially important with the dry-starter system because the amount of milk fed is relatively small, and young, growing animals have a high water requirement. After three weeks of age, calves need free access to w________.
growing	39. **Grain mixture.** When a calf reaches a maximum consumption of from 1.6 to 1.8 kilograms of calf starter, or at about 12 to 14 weeks of age, the feed can be gradually changed over to a growing or fitting mixture. After the starter mixture a calf changes to a g________ mixture.

--	40. The following mixture is commonly recommended as a growing mixture: 28% Ground maize 30% Ground oats 30% Wheat bran 10% Soybean or linseed meal 1% Salt 1% Steamed bonemeal, or dicalcium phosphate
16	41. This mixture contains about 14 to 16 percent total protein. If one uses a 16 percent protein mixture for the dairy herd, there is no reason why the same mixture is not satisfactory for calves. In fact, if nonlegume hay is fed, a 16 or 18 percent protein-grain mixture is likely to give better results than one lower in protein. The grain mixture fed for growth should contain at least ______ percent total protein.
16	42. A calf should be on the growing mixture and completely off the starter mixture at about 16 weeks of age. Feed about 2.3 kilograms daily to a calf of a larger breed and about 2 kilograms daily for calves of the smaller breeds. If the calves begin to lay on excess fat the amounts fed should be reduced. Keep salt before the calves at all times. A calf should be receiving only the growing mixture after _____ weeks of age.
hay pasture	43. Hay and Pasture. For best results from any calf-feeding program, and especially the dry-starter method, it is essential to give calves free access to high-quality hay or pasture. Any variety of hay that was cut early and cured in such a way to preserve the leaves and green colour makes good calf hay. Legume hay is entirely satisfactory.. Calves need free access to high-quality h___ or p_____.
soft pliable	44. Second-cutting hay from a mixture of legumes and grasses that is soft and pliable is ideal. In addition to the carotene, vitamin D, and calcium furnished in good hay, heavy hay consumption develops the middles of calves and increases their capacity for roughages. The hay or pasture fed to calves should be s___ and p___.
hay pasture	45. In the calf-starter experiments, it has been noted that the growth rates and physical condition of the calves have varied directly with the quality of hay fed. When high-quality hay was used, far better results were obtained with the same starter formulas than was true when it was necessary to use low-quality hay. The deficiencies in poor hay or pasture cannot be made up satisfactorily in the starter formula. There is no substitute for high quality h___ or p_____.

second	46. Feed hay or grass as soon as the calf will eat it, usually about the second week. Allow calf all of the hay or grass it will eat. More hay will be eaten if fresh hay is put into the rack each day. To get the best results, feed the hay in racks rather than on the floor. A calf should be given hay or grass about the _____ week.
--	47. Amounts of feed required. The amount of feed eaten varies greatly between individual calves, but the following are approximate amounts required to raise a calf up to six months of age: Whole milk 160 kilograms Calf starter 90 to 135 kilograms Growing mixture 90 to 135 kilograms Hay 225 to 325 kilograms
--	48. Growth rates to be expected. Large breed heifer calves, fed according to the dry-starter program should gain about 0.7 kilogram per day up to six months of age and those of the smaller breeds should gain from 0.5 to 0.6 kilogram.
whole milk	49. Whole-milk Method. When price permits the feeding of milk longer than the first few weeks, the whole-milk method gives excellent results. Whole milk is the natural food for calves and is the best single food. The best single food for calves is ________.
milk	50. Calves raised on liberal quantities of whole milk usually are fatter and smoother than the calves raised on other methods. Care needs to be taken, however, not to feed too much milk as this may limit both the amount of hay or grass eaten and proper development of the animal. Feeding too much m____ is not good for calves.
5.5 to 6.4	51. Follow the same milk-feeding schedule for the first three weeks as for the limited-whole-milk dry-calf-starter system. After this, increase the whole milk gradually up to a maximum of 5.5 to 6.4 kilograms per day. With the whole-milk method, the amount of milk fed is gradually increased to _____ to _____ kilograms per day.

ground	52. Usually, a calf will start to eat some grain by the end of the second week. The young calf can eat the second week. The young calf can eat whole oats or coarsely cracked maize or other grains as readily as it will a mixture of finely-ground feeds. As the calf gets older, it will not chew feed so thoroughly as at a younger age; therefore, all concentrates should be ground. Grains for young calves need not be finely g______.
overfat	53. The growing and fitting mixture is satisfactory right from the beginning with the whole-milk method. Enough of this mixture should be fed each day until the calf is eating about 1.5 kilograms. Too much grain mixture limits the amount of hay or grass a calf will eat. Take care to keep the calf growing at all times but prevent an overfat condition. Calves should be prevented from becoming o__________.
pasture hay	54. High-quality pasture or hay is as essential with this method as it is with the dry-starter system. Allow the calf all the leafy, find stemmed hay it will eat. Sufficient p_____ or h_____ for the calf is very important with the whole-milk method of raising calves.
nurse	55. Use of nurse cow. Somedairymen prefer to feed whole milk to their calves by the use of a nurse cow. With this plan of feeding, there is less work than with pail feeding, and there seems to be fewer calf troubles, especially scours. Calves raised on this system are often fatter and sleeker in appearance than are pail-fed calves. A n____-cow is a cow which is used to feed several calves.
nurse cow	56. The calves can be weaned at from 7 to 10 weeks of age and raised on a dry starter or left on the cow for three to four months and fed a simple grain mix and hay as with the whole-milk method. It is possible, therefore, for a cow to raise several groups of calves in one lactation. Bull calves grown for veal are most satisfactorily raised on the nurse cow. A n____ c______ can be used with either the limited whole-milk or whole-milk method of raising calves.
--	57. One nurse cow can handle several calves, depending upon her production. Enough calves should be placed on the cow so that each calf will get about 4.5 to 5.5 kilograms os milk each day.

skimmilk

58. Skimmilk Method.
When skimmilk is readily available on farms, the whole-milk and skimmilk method of raising calves is satisfactory. Leave the calf with its mother for two or three days and then feed whole milk during the first two weeks as described for the dry-starter method.

A third method of raising calves is the s_____ method.

third

59. By the third week gradually replace the whole milk with skimmilk. About a week is needed for the change, replacing about ½ kilogram of whole milk with an equal amount of skimmilk. After the third week, increase the amount of skimmilk 6.5 to 7.5 kilograms per day, depending upon the growth and size of the calf. It may be desirable to continue feeding whole milk longer than three weeks if calves are weak or unthrifty.

Skimmilk gradually replaces whole milk during the ______ week in this method.

16

60. With a limited amount of skimmilk, one may reduce the amount gradually when the calf is about 16 weeks of age until milk feeding is discontinued entirely. It is possible however, to continue skimmilk feeding until the calf is about six months old.

The skimmilk may be discontinued after the calf reaches ______ weeks of age.

\- -

61. A suggested daily feeding schedule for a dairy calf on the whole-milk--skimmilk system is given in Table 2.

Table 2. A Daily Feeding Schedule--Whole Milk and Skimmilk Method

Age of calf	Large Breeds		Small Breeds	
	Whole milk Kilograms	Skimmilk Kilograms	Whole milk Kilograms	Skimmilk Kilograms
1 to 3 days	With Cow	- - -	With Cow	- - -
4 to 7 days	3.6	- - -	2.3	- - -
Second week	4.0	- - -	2.7	- - -
Third week	4.5 to 0	0 to 4.5	3.1 to 0	0 to 3.1
Fourth week	- - -	4.5 to 5.4	- - -	3.6 to 4.0
Fifth week	- - -	5.4 to 6.3	- - -	4.5 to 5.4
Sixth to 16 weeks	- - -	6.3 to 7.2	- - -	5.4 to 6.3

Grain

62. Feed skimmilk when it is fresh and at a uniform temperature of from 35 to 38°C. If purchased away from the farm, pasteurize it before feeding it. Allow the calf all of the high-quality hay it will eat. Provide a simple grain mixture as described previously and feed in the same way as with the whole-milk method.

G_______ must also be fed with the skimmilk method.

Dried	63. Dried Skimmilk. When fresh skimmilk is not available, dried skimmilk (defatted dry milk solids) is a satisfactory feed for calves. Whether or not a person uses it will depend upon the cost of powdered skimmilk in comparison with the cost of milk substitutes and dry calf starters. D______ skimmilk can be used in place of fresh skimmilk.
9	64. Powdered skimmilk is prepared for feeding by mixing 1 kilogram with 9 kilograms of warm water. Mix it fresh at each feeding and feed it in the same manner and amounts as liquid skimmilk. Powdered skimmilk is mixed in a proportion, by weight, of 1 part to _____ parts water.
replacer	65. Milk substitutes. Where commercial milk replacers are available they can be used to replace milk in the calf's ration at 10 days or 2 weeks of age. The manufacturer's directions should be followed when using. At first calves raised on milk replacers do not look as thrifty as calves raised on milk, but later they compare favorably in growth and development. A commercial substitute for milk for calves is known as a milk r____________.
Silage	66. Experimental results show that good-quality maize or grass-legume silage may be fed along with liberal amounts of calf starter after calves are 6 to 8 weeks of age. If too much silage is fed, however, the amount of hay eaten may be reduced and good-quality hay is more valuable for young calves than maize silage. S________, in limited amounts, is a good feed for calves.
6	67. Pasture. Pasture grass is an excellent feed; however, calves under six months of age should not have to depend on it for all their nourishment. Calves often receive a setback during their first season on pasture because they cannot get enough feed to produce satisfactory growth. Pasture by itself cannot provide proper nourishment for calves under _____ months of age.
pasture	68. Make any change to pasture gradually and continue to feed some grain and hay until calves are able to gather enough grass to meet their needs. Early pasture grass is rich in protein and carotene, both of which are essential for the calf. In addition, when a calf is out on pasture it will get plenty of vitamin D from the sun. A calf must be gradually changed to p_______ from its former feed.

shade water	69. Shade and water are always essential in the pasture lot. Be sure to furnish some shelter to calves on pasture during the heat of the day and make some provision for protection from flies. S_____ and w_______ must be provided for calves pasture.

The information in this unit is based on VAS unit 1021 of the Vocational Agricultural Service of the College of Agriculture, University of Illinois.

Name ____________ Form ____

TEST

RAISING DAIRY CALVES I

UNDERLINE THE CORRECT ANSWER

1. A dairy farm which has 21 cows in its herd should raise _____ heifer calves each year as replacements.

   a. 3
   b. 7
   c. 10
   d. 15
   e. 21

2. Cows should be dried off ________ before they are due to freshen.

   a. 2 weeks
   b. 1 month
   c. 2 months
   d. 3 months
   e. 4 months

3. A dry cow needs to have free access to ____________________.

   a. concentrate and water
   b. hay and concentrate
   c. salt and concentrate
   d. salt and water
   e. vitamins and hay

4. The normal gestation period for cows is ____ days.

   a. 201
   b. 237
   c. 248
   d. 270
   e. 283

5. The first milk given by a cow after the birth of a calf is __________.

   a. cheese
   b. colostrum
   c. dried milk
   d. skim milk
   e. whole milk

6. A good rule to follow in feeding milk is not to exceed _______ percent of the calf's body weight in kilograms of milk per day.

   a. 1
   b. 5
   c. 10
   d. 15
   e. 20

7. Calves are usually fed milk ________ per day.

   a. one time
   b. two times
   c. three times
   d. four times
   e. five times

P.T.O.

8. Dairy calves should be allowed to nurse their mothors for ________ and then be trained to drink from a pail.

   a. 1 day
   b. 2 or 3 days
   c. 1 week
   d. 2 weeks
   e. 1 month

9. A calf on a whole-milk and dry-calf-starter method of feeding should start eating the dry-calf-starter when it is _____ weeks old.

   a. 2
   b. 4
   c. 6
   d. 8
   e. 10

10. Calves of small dairy breeds receiving whole milk are normally weaned when they are ______ weeks old.

    a. 2
    b. 4
    c. 6
    d. 8
    e. 10

11. Calves should not have to depend upon pasture for all of their nourishment until they are over ________ old.

    a. 4 months
    b. 6 months
    c. 10 months
    d. 1 year
    e. 1½ years

12. In normal calving, the calf's __________ appear (s) first.

    a. back feet
    b. front feet
    c. head
    d. rump
    e. tail

13. A very young calf cannot be fed grass or hay because ________________.

    a. grass and hay are low in vitamin A
    b. grass and hay have low amounts of fibre
    c. it does not have any teeth
    d. its digestive tract is underdeveloped
    e. its stomach is soft.

14. Silage may be fed to calves after they are ______ weeks old.

    a. 3 to 4
    b. 6 to 8
    c. 10 to 12
    d. 14 to 15
    e. 16 to 18

TUMAINI SECONDARY SCHOOL

RAISING DAIRY CALVES II

This is a programmed instruction unit on raising dairy calves. It is a continuation of the previous unit.

In this unit you are to learn:

1. the minerals and vitamins needed by calves.
2. the importance of good housing.
3. the management of calves in marking, dehorning, removing extra teats, and foot care.
4. the prevention and control of common calf ailments.
5. about vaccinations, fluke, worm, and tick control.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Raising Dairy
Calves II

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minerals	1. **Minerals and Vitamins Needed by Calves.** Minerals. Calves that get a good start on milk, calf starter, and grain and legume hay or pasture generally receive plenty of minerals, except common salt. Legumes are rich in calcium and milk is rich in both calcium and phosphourous. Calves that get a good ration including salt usually receive plenty of m_______.
phosphourous	2. The supply of phosphourous is usually sufficient even after the calves are weaned, if a farmer feeds a grain mixture containing such protein supplements as wheat bran, wheat pollards, soybean meal or linseed meal. If the grain mixture is made up largely of cereal grains, add a phosphourous supplement such as steamed bonemeal or dicalcium phosphate. Cereal grains contain a low amount of p_______.
common salt	3. To meet the needs of calves and heifers, keep common salt before them at all times. When there is any danger of an iodine deficiency, use iodized salt. A deficiency of iodine will cause goiter. If the farmer believes that a mineral supplement is needed in addition to salt, the following is suggested: 50% iodized salt 50% steamed bonemeal or dicalcium phosphate Calves need to have free access to ________.
A D	4. Vitamins. Of the many vitamins, only vitamin A and D seem to have practical significance in calf feeding. Others are apparently needed by calves but are usually provided in sufficient amounts in the regular feeds or are manufactured in the calf's body. Vitamins ___ and ___ are the only vitamins of concern in calf feeding.
A	5. Vitamin A is essential for satisfactory growth and maintenance of good health, and may be helpful in building up resistance to diseases and bacterial infections. The calf is born with little reserve supply of vitamin A. The amount of vitamin A in the colostrum and normal milk depends largely upon the ration of the cow. A calf needs vitamin ____ in his ration because it is born with only a small reserve of it.
A	6. The amount of vitamin A in milk is usually adequate to meet the calf's need. If for any reason a calf does not get colostrum or is taken off milk at an early age, be sure to include a vitamin - A supplement in its ration. Young calves not getting milk should receive vitamin A until they are eating 1 to 1½ kilograms of good, green, leafy hay or pasture grass each day. If a calf does not get colostrum he should receive a vitamin ____ supplmont.

2	7. Vitamin A feeding oil or concentrates are usually available. If the oil is used, add about 2 teaspoonsful daily to the ration for the first six weeks. Practically all of the dry starters, calf meals, and milk substitutes which can be bought contain sources of vitamin A. ____ spoonsful of vitamin A feeding oil is given to a calf each day for the first 6 weeks.
carotene	8. Among the natural feeds for calves, good, green, fine-stemmed, leafy hay is the best source of carotene which is converted by the calf to vitamin A. Pasture grass is high in carotene which furnishes plenty of vitamin A for those calves that are old enough to be turned on pasture. Silage from maize or hay crops is also an excellent source of carotene. A calf can convert c______ into vitamin A.
rickets	9. An ample supply of vitamin D is needed in calf rations to prevent rickets. Sometimes calves that are making good growth may have mild cases of rickets as shown by a characteristic sag in the top line just back of the withers, a slight hump in the loin, and some stiffness in the joints. Rickets are most likely to occur when calves are still on milk and not yet eating significant amounts of hay. A lack of vitamin D in the ration causes r______.
D	10. Experiments show that 1 kilogram per head daily of sun-cured hay provides enough vitamin D to meet the calf's requirements. The calf, therefore, should be induced to eat high-quality hay as early as possible. Calves that eat large quantities of sun-cured hay will not have rickets. Sun-cured hay provides vitamin ____ to calves which do not go outside.
D	11. Calves and heifers will get plenty of vitamin D when they are out in the sun, therefore any consideration of supplementary vitamin D should be a consideration only when calves are confined inside a building. If calves have rickets or if they are kept inside and fed poor-quality hay, then add a vitamin D supplement to the ration. Calves outside normally get plenty of vitamin ____ from the sun.
cod-liver irradiated yeast	12. One kilogram of cod-liver oil for each 1000 kilograms of calf starter, or its equivalent of vitamin D in irradiated yeast, may be used to supply supplementary vitamin D. C____ oil or i____ y______ can be fed as a vitamin D supplement to calves.

A D	13. Other vitamins. Large-scale experiments have not shown any particular value in supplying properly fed young calves with any of the vitamins other than A and D mentioned already. ____ and ___ are the only vitamins which calves may need to be fed.
vitamins	14. Older calves and cows have the ability to synthesize the important B-complex vitamins in the rumen. Information is lacking for practical recommendations for adding any of these vitamins to the ration of calves at one or two weeks of age when the rumen may not be functioning. Milk and other feeds given early in life will furnish the B vitamins needed. Calves which get their mother's milk and are out in the sun receive all the v_____ they need.
management	15. Housing and Management of Calves. Proper housing and management are most important for raising healthy calves. Without good management, no feeding schedule gives satisfactory results. M________ is very important in raising calves satisfactorily.
quarters	16. Quarters. Clean, well-lighted, properly ventilated quarters, free from drafts and dampness are essential in any good calf-raising program. These requirements can be met without expensive and elaborate barns. Calves need good q____________.
Individual	17. Individual pens with solid partitions between them are best for young calves. The solid partition prevents drafts from striking the calves, and common calf diseases can be controlled more easily because the calf has no contact with other calves. Such a system also prevents calves from sucking each other. I_________ pens are the best for young calves.
1.3 2	18. A satisfactory pen should not be less than 1.3 by 2 metres in size. A slatted gate allows good air circulation. Supply each pen with a hay rack, a feed box, and a water bowl or a place for a pail of water. Individual calf pens should be at least ___ by ____ metres in size.

size	19. Keep the calves in the individual pens until they are from 8 to 12 weeks of age, or until they have been weaned from milk, if the calf-starter method of feeding is followed. After this they can be grouped according to size in larger pens. After weaning, calves can be grouped by _____ in larger pens.
sucking	20. If a farmer does not or cannot have individual pens, it is highly desirable to provide ties or stanchions along one side of the pen for calves at feeding time. Inexpensive stanchion arrangements are entirely satisfactory. With this method, more calves can be kept in a given amount of space and prevent them from sucking one another after their feeding of milk. Calves should be prevented from s______ one another.
bedding	21. Supply adequate amounts of clean, dry bedding at all times. Usually it is better, however, not to remove the bedding each day. Add enough bedding to keep the pen dry, as the litter that accumulates generates heat and provides a warmer bed than if the pens were thoroughly cleaned each day. When the calves are removed, thoroughly clean and disinfect the pens before any new calves are put in. Calf pens need an adequate supply of b_________.
exercise sunshine	22. Exercise. Allow calves plenty of exercise and sunshine. If tie stalls are used, turn the calves out in exercise lots or pens regularly after they are a couple of months of age. Exercise lots should be well drained. Calves need plenty of e______ and s______.
shade	23. During the hot months of the year, be sure to provide shade in the exercise lots. In extremely hot weather, a farmer may want to exercise the calves only early in the morning and late in the afternoon and keep them in the barn during the heat of the day. Calves need s______ so they don't get overheated when it is hot.
identified	24. Marking for identification. It is necessary to identify properly and record all calves. This is essential for proved sire records and for selection and culling programs. Calves can be tattooed in the ears for identification. Eartags are used in many herds. Some dairymen put a strap or chain around the calf's neck with a numbered tag attached. Calves need to be i________ in order to keep proper records.

dehorned	25. Dehorning. There is no good reason to leave horns on dairy cattle. Some dairymen think it improves the appearance of their cattle, but hornless cattle are not discriminated against in any of the major cattle shows or sales. If horns on all cows were removed, there would be fewer udder and body injuries. Dairy cattle should be d________ to prevent injury to other animals.
calves	26. The best time to remove horns is when the calves are about one or two weeks of age, or as soon as the horn buttons can be distinctly felt. The two most common methods are the use of caustic potash and the use of special irons for burning the horn button. These procedures if carried out properly when the calf is young leaves a good, smooth poll that is much better in appearance than if the horns are cut or sawed off after the animal reaches maturity. Dairy animals should be dehorned while they are c______.
teats	27. Removing extra teats. Sometimes heifer calves are born with extra teats. Later, these detract from the appearance of the udder and at times interfere with milking. They can be easily removed at birth or before a year of age with a pair of sharp scissors. Disinfect the cut area with tincture of iodine or other antiseptic. A veterinary officer should be consulted if the extra teats are attached to one of the regular teats or are hard to distinguish from the regular teats. Extra t_____ should be removed before the calf is a year old.
feet	28. Care of the feet. When calves and heifers are confined in pens or stanchions, the feet grow faster than they are worn off. Frequently the toes get long and turn up. This makes it impossible for the animal to stand or walk properly and may cause weak pasterns and crooked legs. Trim the toes back to a normal shape with a wood chisel or hoof clippers. Use a wood rasp to level the bottom of the toes. ________ which do not wear down properly need to be trimmed off periodically.
lead	29. Teach calves to lead. Dairy breeders who show or consign cattle to sales want to train their calves to lead, stand, and pose. A well-trained animal is easier to handle when it has to be moved and it shows to better advantage in the show or sales ring. One of the best ways to do this is to tie the calf with a rope halter to a wall or a post a few times until it learns that it is useless to try to escape. Then it may be taught to lead more easily. Calves which are to be taken to shows must be taught to ________.
prevent control	30. Prevention and control of common calf ailments. Calf losses during early life sometimes run as high as 20 percent. Many of these losses in calves result from digestive disturbances that precede pneumonia. Some diseases of calves are contagious and result in high mortality. Others may result in a severe setback in the calf's growth and development. It is important to p_____ and c______ common calf ailments to prevent the death of calves.

gestation	31. With a true appreciation of calf losses, it is generally possible to reduce them by better housing, management, sanitation, and by improved feeding practices. Improved feeding of the dam during the latter part of the gestation period may be beneficial in promoting good health in the early life of a calf. A calf is more likely to be healthy if its dam is well fed during the g_______ period.
sickness	32. If a farmer watches his animals closely, he will detect any sickness promptly. Early detection helps to prevent the spread of an infectious disease and permits prompt treatment. To be successful in raising calves, he needs to have some knowledge of calf diseases and of practical measures for their control. A good farmer needs to observe his animals closely to detect any _________ promptly.
disease	33. Every good dairyman or herdsman should have the advice of a competent veterinary officer in adopting sanitation and disease-prevention programs. Regular veterinary service in this way helps materially to maintain a healthy calf herd. A veterinary officer's advice is very helpful in preventing __________.
white common	34. Scours. Scours is one of the most common ailments of young calves. It includes all conditions in which there are frequent loose evacuations of the bowels. It is difficult to distinguish between white scours, apparently due to an infection, and common scours which may result from other causes. There are two types of scours; ______ scours and ________ scours.
white	35. White scours affects calves chiefly in the first one to three days of life. It is commonly termed infectious and is fatal in a large proportion of cases. There is a marked looseness of the bowels, with the feces being very thin, grayish white in colour, and very foul smelling. Preventive measures are extremely important as little can be done once the calf is infected. ______ scours is very serious and prevention is more important than trying to cure it.
common	36. Common scours is an indication, or a result, of an upset digestive system. It may result from many causes. One of the most common is overfeeding of milk, especially during the first few weeks. Other causes may include irregularities in the time of feeding, amount fed, and the temperature of milk. Overfeeding may cause _______ scours.

common	37. Sudden changes in feeding, such as a change from whole milk to skimmilk or from sweet to sour milk, dirty feed pails, and very high fat content of milk may cause scours. Cold, damp, and dirty quarters may help to lower the calf's resistance and thus make it more susceptible to digestive upsets. An upset digestive system can cause _____ scours.
isolated	38. With the first sign of scours, immediately try to find the cause and correct the condition. Usually it can be corrected by proper feeding and management. Isolate infected calves. Calves with scours must be i_______ from healthy calves.
milk	39. Many different remedies have been used in treating scours. The most common in the past has been to reduce the milk by one-half or more and move to correct any faults in regularity, in temperature of milk, and in sanitation. The first step in treating scours is to reduce the ____ fed by one-half or more.
- -	40. The reduction in milk is often followed with a physic of 30 to 60 millilitres of castor oil in 0.25 litre of warm milk. A few hours later the calf can be fed about one-half teacup of a mixture of 3 parts of mineral oil and 1 part bismuth subnitrate mixed with a small quantity of milk. As soon as some improvement occurs in the condition of the calf, discontinue this mixture and gradually bring the calf back onto full feed.
Limewater	41. Another home remedy frequently used is to give the calf some limewater. It may be fed in the milk at the rate of 1 part limewater to 3 parts milk. The limewater used should be the clear fluid obtained after the slacked lime has settled. L______ may also be used as a treatment for common scours.
Sulfa	42. In recent years, the most effective treatment for scours has been to use certain of the sulfa drugs. These should be given to calves upon the advice and recommendations of a veterinary officer. Along with good management practices, these drugs help to prevent scours in calves. _______ drugs are effective in treating common scours.

vitamins	43. Certain antibiotics are helpful in preventing scours. Some people use vitamin pills or capsules in an attempt to prevent calf ailments, including scours. However, supplementary vitamins do not take the place of good feeding and management practices nor have they proven to be of any value in preventing common scours. Feeding extra v______ will not help to prevent common scours.
pneumonia colds	44. Pneumonia. Colds and pneumonia are frequent in dairy calves. They often follow common scours and cause great losses to dairy farmers each year. Pneumonia is more likely to develop in calves kept in damp, poorly ventilated and drafty quarters in cool damp climates than those that are well housed. P______ and c_____ are common calf diseases in cool damp climates.
pneumonia	45. The symptoms of pneumonia are coughing and rapid breathing, followed by a high temperature. There may be a lack of appetite. Pneumonia may be of an infectious nature and spread to other calves. Therefore, isolate the affected calf, if possible, in a clean, dry, well-ventilated stall. New born calves should not be introduced into the general calf quarters if pneumonia is present in some of the calves. Calves with __________ should be isolated from healthy calves.
sulfa	46. The most effective treatment is to use one of the sulfa drugs. Sulfamerazine and sulfamethazine have been used quite successfully, especially in the early stages of pneumonia. Other drugs or medicines may be helpful and should be used as prescribed by a veterinary officer. ______ drugs are commonly used to treat pneumonia in calves.
Lice	47. Lice. Lice are a rather common problem on dairy farms, especially when animals are confined to pens or stalls. They cause discomfort to the animals, produce a rough, unthrifty appearance, and prevent proper growth of the animals. Skin injury may be induced because of constant rubbing. _____ are an insect pest of dairy cattle.
- -	48. There are commercial louse powders on the market. The most effective ones contain either ½-percent rotenone or 10 percent sabadilla seed. Any powder that is used should be applied to all parts of the animal. It takes about 100 grams for each animal. Be sure to cover the legs, the inside of the ears, the wrinkles along the neck, and the area around the head.

ticks	49. Treat all animals in the herd, not just a few obviously lousy ones. Repeat any treatment in 10 to 15 days to kill the lice which hatch out following the initial treatment. Where animals are reularly dipped or sprayed for ticks, the control of lice is obtained at the same time. Lice are not a problem when cattle are regularly treated for _______.
liver fluke	50. Worms and liver flukes present a great danger to calves and heifers. Liver flukes are prevalent in swampy areas. An infected animal usually has a rough skin, and generally has an unhealthy appearance. There are drugs available which can effectively eliminate liver flukes. They should be used in consultation with a veterinary officer. The l f ______ is a parasite of cattle found in swampy areas.
phenothiazine	51. Cattle infected with stomach and intestinal round worms can show the following symptoms: depression, progressive loss in condition, anemia, lack of appetite, and scours usually of a persistant nature with fluid droppings of a dark colour. In chronic cases, emaciation follows and the calves develop a rough coat. Round worms are treated by giving cattle three doses of phenothiazine each year. Roundworms are treated with ________.
brucellosis rinderpest	52. Vaccinations. All heifers should be vaccinated against brucellosis (contagious abortion) before they are one year old. When rinderpest is present they should be inoculated against the disease when they are about eight months old. These injections should be made only by a veterinary officer. Calves should be vaccinated for _______ and ________ during their first year.
disease	53. Ticks. Ticks transmit several serious cattle diseases. Among these are East Coast Fever, red-water, anaplasmosis, and heartwater. Various measures suxh as grass burning and cultivation of land have been recommended for the control of ticks but their destruction on the cattle by the application of chemical substances is still the most practical and effective method. This is usually acheived by dipping or spraying. Ticks are dangerous to cattle because they can transmit d_______ to them.
dip	54. Dipping is carried out by moving cattle through a tank containing a water solution of chemicals toxic to ticks. It is important that the tank be deep enough so that cattle submerge completely when they jump in. Another important consideration is that the strength of the dipping solution must be maintained at the proper strength. The common method of dealing with cattle ticks is to d_____ the cattle every 5 to 7 days.

arsenic	55. For many years, arsenic was the most common active ingredient of dipping solutions. Arsenical solutions were very effective and are still used extensively even though they have some disadvantages. It is highly toxic so care must be used so the dipping solution does not become too strong and when the tank is cleaned it must be disposed of carefully to prevent pollution of food and water. The most common chemical used in dipping has been ______.
resistance	56. A further disadvantage of arsenic is that strains of ticks in certain places developed a resistance to arsenic but the introduction of new synthetic insecticides such as benzene hexachloride, toxaphene and chlordane have reduced the problem. It is recommended that the type of chemical used be changed periodically to reduce the possibility of the development of resistant strains of ticks. Some ticks have developed a r______ to certain dip chemicals.
spray race	57. Instead of dipping, some farmers use a cattle spray race. Cattle are driven through it and inside they are exposed to a dense spray delivered under pressure from a system of specially placed pipes. The used spray solution drains to a small reservoir from which it is circulated by a pump operated by a small engine or a tractor. Rather than dipping, tick control can also be acheived by use of a s____ r______.
spraying dressing	58. Other methods of tick control include hand spraying and hand dressing. Hand spraying can give satisfactory results when carried out by an experienced and conscientious operator but it is generally impractable where large numbers of animals are involved. Ticks can also be controlled by hand _____ and hand ______.
Hand	59. Hand dressing involves the application of dip washes or greasy compounds, such as used engine oil to control ticks. It is commonly used to control outbreaks of disease in isolated areas where spraying or dipping facilities do not exist. It is a time-consuming task and not economical on the large scale as a normal routine for tick control. H_____ dressing to control ticks is seldom used.

The information in this unit is based on VAS unit 1021 of the Vocational Agricultural Service of the College of Agriculture, University of Illinois.

Name ____________ Form ____
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TEST

RAISING DAIRY CALVES II

UNDERLINE THE CORRECT ANSWER

1. _______ is the only mineral necessary to feed to calves receiving a a normal ration.

    a. bonemeal
    b. dicalcium phosphate
    c. iodine
    d. phosphourous
    e. salt

2. Calves do not need to be fed a vitamin A supplement if they ________.

    a. are fed their mother's milk
    b. are out in the sun every day
    c. are vaccinated
    d. eat plenty of grain
    e. exercise at least an hour per day.

3. The best source of vitamin A for calves is ______.

    a. green grass
    b. irradiated yeast
    c. silage
    d. the sun
    e. water

4. Young calves should be prevented from __________.

    a. eating hay
    b. eating salt
    c. getting exercise
    d. going outside
    e. sucking each other

5. Calves can be permently marked for identification purposes by any of the following methods except ___________.

    a. branding
    b. cutting marks in the hair
    c. eartags
    d. ear tattooing
    e. neck chain with tag

6. Calves should be dehorned to ____________.

    a. help prevent disease
    b. increase milk production
    c. make them look better
    d. make them more comfortable
    e. reduce injuries to other animals

7. Dehorning of young calves is commonly done with ________.

    a. caustic potash
    b. a pair of scissors
    c. a piece of wire
    d. a pinchers
    e. a saw

P.T.O.

8. Extra (more than four) teats on a calf ____________.

   a. are an advantage during milking
   b. means she will be a high milk producer
   c. should be left undisturbed
   d. should be removed
   e. will cause mastitis

9. Calves confined in pens or stanchions sometimes need ____________.

   a. a bath
   b. dry skimmilk
   c. rickets
   d. their hair cut
   e. their toes trimmed

10. ________ is usually the result of an upset digestive system.

   a. anemia
   b. common scours
   c. East Coast Fever
   d. pneumonia
   e. white scours

11. Phenothiazine given three times per year gives adequate control of ____.

   a. heartwater
   b. liver flukes
   c. rickets
   d. roundworms
   e. trypanosomiasis

12. Calves should be vaccinated for __________ during their first year.

   a. anemia and brucellosis
   b. anemia and East-Coast-Fever
   c. brucellosis and rinderpest
   d. East-Coast-Fever and rinderpest
   e. rinderpest and anemia

13. Cattle are dipped or sprayed regularly to control __________.

   a. lice
   b. liver flukes
   c. pneumonia
   d. ticks
   e. tsetse flies

TUMAINI SECONDARY SCHOOL

RAISING DAIRY HEIFERS AND BULLS

This is a programmed instruction unit on raising dairy heifers and bulls.

In this unit you are to learn:

1. the feeding of dairy heifers.
2. the housing of dairy heifers.
3. breeding and freshening practices.
4. the feeding and care of the young dairy bull.
5. about the common parasites and diseases infecting dairy heifers and bulls.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Raising Dairy
Heifers and
Bulls

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340	1. If heifers and young bulls are to reach their ideal size and capacity as two-year-olds, they must be fed and cared for so they will grow rapidly and continuously from birth. An average daily gain of 0.6 kilograms for large dairy breeds like Holstein-Fresian, 0.55 kilograms for medium dairy breeds such as Guernseys and Ayrshires, and 0.45 kilogram for small dairy breeds like Jerseys is needed to meet the growth standards at 2 years of age shown in Figure 1. (page 3) A heifer of a large dairy breed should weigh at least ____ kilograms before being bred.
273	2. Estimating weights. The weight of a dairy heifer or bull can be fairly accurately estimated by measuring the heart girth, if scales are not available. The animal should be measured when it is standing squarely on all four legs and is holding its head in a normal position. The tape should be drawn snugly around the animal's body just behind the front legs. The weight for each measurement may be obtained from Table 1. (page 3) A calf that has a heart girth measurement of 150 centimetres weighs ______ kilograms.
Hay	3. Feeding the Dairy Heifer. Dry Season Feeding. Hay. Free access to good-quality mixed or legume hay in racks or mangers is the most important part of a dry season feeding program for dairy heifers. Good-quality hay is a low-cost source of total digestable nutrients and most of the protein, minerals, and vitamins needed for rapid growth. Heifers eat about 1 kilogram of good hay, or its equivalent in silage and other roughage, each day for about 40 kilograms of liveweight. ____ is the most important factor in feeding during the dry season.
Silage	4. Silage. Yearling heifers may be fed liberal amounts of maize or hay-crop silage during the dry season. The amounts to feed will be determined somewhat by the supply of silagein relation to hay and other available roughages. ________ may be fed to heifers over one year old.
40	5. Approximately one kilogram of silage each day for each 40 kilograms of liveweight is usually enough. For a majority of heifers, this amounts to 7 to 9 kilograms per day along with hay. Heifers normally require about one kilogram of silage each day for each _______ kilograms of liveweight.
concentrates	6. Some concentrates are usually needed in addition to hay and silage to properly balance the ration and to supply enough nutrients for rapid growth. The protein needed in the concentrate mixture depends on the kind, amount, and quality of roughage eaten. Feed a concentrate mixture containing from 12 to 14 percent total protein with legume hay, 16 percent with mixed hay, and 18 percent with grass hay. Heifers usually need some c_____ in addition to hay and silage during the dry season.

- -	7. In general the same concentrate mixture used for the milking cows will be satisfactory for calves and heifers after they are 4 months of age. Suggested amounts of grain to feed each day according to the size of heifers and the quality of roughage are given in Table. (page 3)
pasture	8. Feeding on Pasture. Good pasture is the lowest-cost source of nutrients for growing heifers. Heifers may be started gradually on pasture at 5 or 6 months of age, but they should not be expected to depend entirely on pasture until they are close to a year of age. Heifers can not obtain their total nutrient requirements from p_______ until after they are a year old.
Heifers	9. A pasture near the barn where young heifers can be fed hay in racks and some supplementary grain make an ideal arrangement for heifers under one year of age. Yearling heifers will make satisfactory growth on excellent pasture without additional concentrates. High quality wet season pasture includes both tall-growing legumes and grasses such as lucerne and Rhodes grass. Heifers need fully as good pasture for rapid growth as milking cows do to produce well. H_______ need good quality pastures.
grain	10. It is poor economy to put older heifers out on poor pastures. When good pasture is not available, give heifers free access to hay, maize silage, or hay crop silage in racks or in bunks in the barnyard or pasture. Some grain will also need to be fed, in addition to supplementary roughage, if pastures are poor. If pastures are poor, hay or other roughages and g_____ must be fed.
water	11. Water. Heifers need plenty of clean fresh water at all times. Water in the pastures is especially desirable. If running streams or springs are not available, provide other sources of water. Heifers graze better if water is available at all times in the pasture than if they have to walk a long distance for it or are watered only once or twice daily. Heifers need plenty of clean fresh _______ at all times.
salt	12. Minerals. Heifers on pasture need free access to salt, and a mineral mixture is often advisable because they usually are fed little or no grain. A pasture mineral box with a roof to keep it dry is easily constructed. Salt can be put in one side and a mineral mixture in the other. Heifers on pasture need free access to s_____.

Figure 1. Heifers that are well-grown can be bred at the size and age shown.

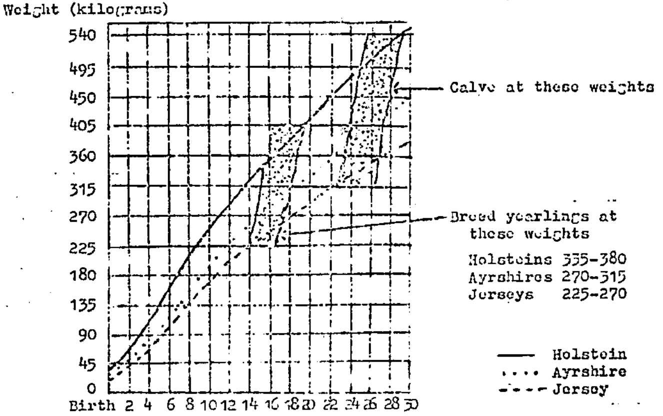

Table 1. Estimating Weights of Dairy Cattle from Heart-Girth Measurements

Heart girth centimetres	Weight kilos	Heart girth centimetres	Weight kilos	Heart girth centimetres	Weight kilos
66	36	122	159	178	434
69	38	124	168	180	462
71	40	127	177	183	482
74	43	130	186	185	500
76	45	132	195	188	519
79	49	135	205	190	539
81	53	137	215	193	558
84	58	140	225	195	578
86	62	142	237	198	599
89	67	145	248	201	620
91	71	147	261	203	640
94	76	150	273	206	661
97	81	152	287	208	682
99	86	155	301	211	702
102	94	157	315	213	723
104	101	160	329	216	744
107	108	163	345	218	765
109	116	165	360	222	785
112	124	168	376	224	806
114	132	170	392	227	827
117	141	173	409	229	847
119	150	175	426	232	868

Table 2. Kilograms of Concentrates to Feed Dairy Heifers

Liveweight of heifers	Quality of roughage*		
	Good	Fair	Poor**
135 kilograms	2.3	2.7	3.2
180 kilograms	1.8	2.7	3.6
225 kilograms	1.4	2.7	4.0
270 kilograms to 2 months before freshening	.9	2.7	4.0
Last two months before freshening	2.7	3.6	4.5

*Good. Liberal feeding of good-quality, leafy, green hay that was cut early, with or without silage. Fair. Usual or average quality hay showing some loss of colour and leaves due to late cutting or weather damage; limited amount of silage. Poor. Late cut mature hay or hay badly weather damaged; little or no good quality roughage.

**Heavy rates of grain feeding will not entirely make up the deficiencies of poor quality roughage.

4½ to 5½	13. Housing for heifers. Pen stabling. The pen or loose-stabling method of housing heifers is very efficient from the labour standpoint and has the advantage that roughage can be self-fed in racks. In fact, the essential shelter requirements, namely protection from wind and rain can be met with a low-cost pole-type structure. Allow from 4½ to 5½ square metres of floor space per head. Heifers, kept in pens, each need ____ to ____ square metres of floor space.
size age	14. The ceiling should be at least two metres high. It is best to divide the stable into several pens so that heifers of a similar size and age can be penned off together. Sixty centimetres of rack and grain-feeding space are needed per head. A combination feed alley and manger between every two pens makes a satisfactory arrangement. Heifers should be kept in pens with others of similar s____ and a____.
exercise	15. Exercise Yard. A well-drained exercise yard is needed with either pen stabling or when the heifers are tied. Heifers that are allowed free access to outdoor exercise have better appetites, develop straighter and stronger legs, and keep their feet worn down to normal shape. It is also easier to detect when they are in heat. Sunlight is an additional source of vitamin D. Heifers need daily outdoor e________.
weight	16. Breeding and Freshening Practices. Breeding. The age and size at which heifers should be bred are shown in Figure 1. For example, a large breed like Holstein-Fresian may be bred anytime after they weigh 335 kilograms. Small breeds like Jersey may be bred when they weigh 225 kilograms. Heifers should be bred after they have reached a certain minimum w______.
rainy	17. Cows which freshen at the beginning of the rains produce more milk than do cows that freshen during the dry season. Breeding must be planned and controlled to insure that freshing occurs during the rains. It is easier to breed heifers for rainy season freshening than it is to change the freshening cycle of older cows. Cows should freshen during the _____ season.
freshening	18. Freshening. Two months before a heifer is due to freshen with her first calf, she should be placed with the milking herd so that she becomes accustomed to the other cows in the herd and to the milking routine. Handled in this manner, she will be easier to train into good milking habits. Heifers should join the milking herd about two months before f______.

ration	19. At the same time the heifer needs to be conditioned properly for freshening. Usually from 2½ to 4½ kilograms of fitting concentrate ration in addition to high-quality hay or pasture are needed to get heifers in the desired physical condition. Heifers need to receive a special r____ in order to be properly conditioned for freshening.
milking	20. Heifers are likely to develop more congestion in the udder at freshening time than older cows. In unusually severe cases of udder congestion you may need to start milking heifers a few days to a week before they freshen. Once milking is started, however, it must be continued and the udder completely milked out at each milking. If heifers develop udder congestion, m____ may be started before freshening.
milk	21. Training to milk. The life-long milking habits of a cow are usually determined by the way she is trained to milk at her first freshening. The heifer should be treated with kindness and gentleness at milking time. Heifers need to be trained to m____.
3 to 4	22. If machine milking is to be used, start the heifer out on the machine and train her for rapid milking. Massage the udder with a warm cloth wrung out of warm water to stimulate milk let down. Apply the teat cups in about one-half minute. Remove the machine in 3 or 4 minutes or as soon as the udder is milked out. Strip by machine and never prolong hand stripping. Milking by machine should take only about ___ to ___ minutes per cow.
6	23. Feeding and Raising the Young Dairy Bull. The same methods of feeding, care, and management outlined for dairy heifers apply to dairy bulls under six months of age. Bulls begin to show evidence of masculinity and sexual maturity at about six months of age and should then be separated from open heifers to prevent unwanted matings. Bull and heifer calves should be separated when they are about ____ months of age.
Bulls	24. From this age on bulls tend to grow more rapidly than heifers and need slightly more feed, especially concentrates. Most dairymen like to see their future herd sires well grown and properly developed, so liberal feeding of growing bulls is desirable. B____ should be fed well so they develop properly.

½ ¼	25. As bulls approach maturity, feed ½ kilogram of good-quality hay or its equivalent and about ¼ kilogram of concentrates each day per 50 kilograms of live weight to maintain good breeding condition. Bulls need ____ kilogram of hay and ___ kilogram of concentrate per 50 kilograms of liveweight each day.
ring	26. Bulls, especially of the European breeds, often become dangerous and hard to handle. They can be easily controlled if a ring is placed in the nose and then led with a staff. Bulls can best be controlled by a r____ in the nose.
one	27. Bulls may be used for light breeding service when they are about a year of age. Limit the yearling bull to 12 to 15 services the first year to prevent the danger of lower fertility later on. A bull may be first used for breeding when it is ____ year old.
Bulls	28. The use of a safety stall and breeding rack for older bulls is highly desirable and often necessary. Therefore, it is a good idea to train a young bull to use a breeding rack and to house him in a safety bull pen. There is no such thing as a gentle or safe bull. B_____ should always be treated as dangerous animals.
Internal parasites	29. Parasites and Diseases. Internal parasites. Calves and heifers are subject to infection with intestinal parasites. Animals with a heavy infestation of parasites may show a general unthrifty condition, a rough hair coat, poor appetite, loss of weight, and usually a bloody diarrhea. Pneumonia often develops. I__ p____ are harmful to cattle.
management sanitation	30. Spread of these parasites from one animal to another is by the ingestion of eggs or young parasites that contaminate the feed and bedding. Some of the newer sulfa drugs may be helpful in treating certain types of intestinal parasites, but careful management and sanitation go a long way toward prevention. Good m_____ and s_____ help prevent infestation by parasites.

pastures	31. Large numbers of calves confined in small lots are often heavily infested. Young calves often become infected in pasture or exercise lots. Segregation of calves and heifers by ages is helpful. Also keeping calves under six months of age off pasture is a good practice. Young calves usually become infected with parasites which are picked up on p____.
roundworms flukes tapeworms	32. The common worm parasites are broadly classified into three groups: roundworms, flukes, and tapeworms. Worms are very common in Tanzania and one rarely examines an animal which does not harbour at least a few species. They occur in most parts of the body. Worm parasites do not multiply within the host animal. Therefore the number of worms found in an animal is a direct result of the number of organisms which invaded the body. Three groups of worms found in cattle are: r____, f____, and t____.
roundworms	33. Roundworms living in the digestive tract are responsible for greater losses than those found in other organs. A number of general principles apply to all the gastro-intestinal worms. This group of worms includes such species as a reddish worm with a twisted appearance found in the abomasum, while worms which produce nodules are found in the large bowel, thread-like worms are found in the intestines, and the blood-sucking hookworms are found in the small intestine. Many kinds of r____ can live in the digestive tract.
digestive system	34. The life cycle of these worms have certain features in common. The adult females, living in the digestive system of their host, lay large numbers of eggs. The eggs reach the exterior in the faeces and then they must undergo further development before becoming capable of infecting another animal. The fact that eggs require some time outside the host before becoming infective is most important in the formulation of control measures. Roundworms lay their eggs in the d____ s____ of the host.
Dryness	35. After being voided by the host, development proceeds provided the temperature, humidity and availability of oxygen are favourable. Some species are more sensitive to the environment than others, but dryness is undoubtly the most lethal factor to all. D____ is harmfull to roundworm eggs.
eggs, larvae	36. The host animal becomes infected by eating infective eggs or larvae in the feed or water. Hookworms are also capable of penetrating the skin. After entering the body, they may migrate around the body, but all species eventually settle down in the stomach or intestines where they grow to maturity, mate, and begin to lay eggs. Cattle get infected with roundworms by eating their e____ or ____.

Roundworms	37. The symtoms of roundworm infestation varies with the species of parasite. In general most cases show a progressive loss of condition with or without diarrhoea, and productive efficiency is reduced. As the parasites increase, weight is lost, the body loses its fat and bony structures become prominent, the flesh becomes watery and swellings may appear under the jaw and near the brisket. Finally the animal becomes emaciated and so weak it is unable to rise. R______ can cause the death of cattle.
Roundworms	38. Generally, control measures should be directed towards limiting the number of worms an animal has by preventing worm eggs or larvae to accumulate on the ground. Worms are capable of producing an enormous number of eggs so that if infected animals are confined in small pastures it would become so infected that the animals kept there would eventually die from worm infestations. ________ eggs and larvae should not be allowed to accumulate on the ground.
roundworms	39. Since about a minimum of three days is required for voided eggs to develop into infective larvae, cattle with heavy infestations of worms can be run with others if they are moved to clean ground every three days. With heavy stocking the cattle should be moved to a new pasture at intervals of a few days. Rotational grazing is one method of ______ control.
rested	40. The weather conditions affect how long a pasture must be rested before it is safe to use for grazing again. When it is wet and when there is no excessively dense stocking of cattle, pastures are usually safe after two to three months. During the dry season only two to three weeks is necessary to reduce the infective larvae to a safe level. The weather determines how long a pasture should be r____ to reduce the danger from roundworms.
anthelmintic	41. When rotational grazing can not be fully used to control roundworms anthelmintic drug treatments are necessary. Maximum benefits from these treatments are obtained if they are administered when cattle are only lightly infected and when the weather is dry so that the eggs and larvae on the ground are greatly reduced. Roundworms can be treated with a_______ drugs.
pasture	42. In warm humid areas it may be necessary to treat cattle every six to eight weeks. It is usually best to rotate the kind of drug used each time for better control. Anthelmintic drugs include phenothiazine, copper sulphate, carbon tetrachloride and arsenicals. When anthelmintic drugs are used it is very important that all animals are treated at the same time and then they should be moved immediately to a clean pasture. After treating cattle for roundworms, they should be moved to a clean p______.

Flukes	43. Flukes. Fluke infections are found in all animals in the tropics. All the flukes use snails as intermediate hosts for the completion of their life cycle. Most fluke diseases are associated with marshy places, lakes, and rivers where snails are found. F____ are dependent on snails for part of their life cycle.
water	44. Liver flukes are the most common kind and their control applies to other kinds also. The eggs are laid by adult flukes living in the bile ducts. These pass out in the faeces and if they reach water a motile organism hatches out in about ten days. Fluke eggs must reach w____ to hatch.
eating drinking	45. These organisms find a snail and penetrate its tissues. There it multiplies asexually and about six weeks later a great number of organisms (cercaciae) emerge. These organisms are very active and swim around searching for a place, such as grass, on which to encyst. Cattle are infected by eating grass or by drinking water containing these organisms. Cattle become infected with flukes by e____ grass or d____ water containing the organisms.
number	46. The effect of flukes on the animal depends on the number of flukes present and the state of resistance of the animal. Generally, infected cattle lose condition, production drops in the case of dairy cows, anemia develops, and watery swellings may develop on the body. Death can occur from severe infestations of flukes. The effect on an animal of flukes depends on the n____ of parasites in the animal.
snails snails anthelmintic	47. Control of flukes can be done in three ways. The cattle can be kept away from places where snails exist. The number of snails may be reduced by treating infested water with copper sulphate, but this is very difficult and the snails return soon after treatment. A third method is to give the animals regular anthelmintic treatments of drugs such as carbon tetrachloride or hexachlorethane. Control of flukes is by keeping cattle away from s____, killing the s____, or by giving a____ drugs.
man	48. Tapeworms. A wide variety of tapeworms occurs in all animals. Most of those in the adult stage seldom cause serious disease in cattle. The problem of importance is that tapeworms which infect man use cattle as an intermediate host. Tapeworms are important because they can infect m____.

beef	49. Cattle become infected by eating the tapeworm eggs passed in human faeces. The eggs develop into white cysts 5 to 12 millimetres in diameter. These cysts are found in the muscle tissue of cattle. Man becomes infected by eating ripe cysts in improperly cooked beef. Man gets infected by tapeworms by eating improperly cooked ________.
human	50. Tapeworm infestations are common in Tanzania and are responsible for great losses through condemnation or special treatment of affected carcasses. Control is largely a measure of preventing humans defecating on pasture, avoiding the use of human manure and sewage on the land, and insuring that the people who handle the cattle eat properly cooked meat. Tapeworm infestations of cattle can be prevented by preventing cattle from contacting h_____ faeces.
Brucellosis	51. <u>Vaccination for brucellosis</u>. Brucellosis, Bang's disease, or contagious abortion in cattle is a costly disease. Dead and weak calves at birth, many abortions, breeding troubles, and lower milk production are the result. Fortunately, brucellosis can now be controlled and these losses reduced. B__________ is a serious cattle disease.
6 12	52. A program of calf vaccination and blood testing is available in most areas. It is advisable to have calves vaccinated between the ages of six and twelve months. The vaccination is not complete and everlasting protection but it is highly preventive and practical. Usually all dairy calves should be vaccinated against this disease. Calves should be vaccinated for brucellosis when they are between _____ and _____ months of age.

The information in this unit is based on VAS unit 1022 of the Vocational Agricultural Service of the College of Agriculture, University of Illinois.

Name ______________ Form ____
Date ___________

TEST

RAISING DAIRY HEIFERS AND BULLS

UNDERLINE THE CORRECT ANSWER

1. If scales are not available, the weight of a dairy heifer or bull may be estimated by __________________.

   a. lifting the animal
   b. looking at the animal
   c. measuring the heart girth and converting to kilograms with a table
   d. measuring the length and multiplying by three
   e. measuring the neck and comparing with a table

2. The lowest-cost source of nutrients for growing heifers is _________.

   a. concentrates
   b. hay
   c. minerals
   d. pasture
   e. water

3. Heifers need water ____________.

   a. once every two days
   b. once per day
   c. twice per day
   d. three times per day
   e. available at all times

4. Heifers can depend entirely on pasture for their feed after they are __________ old.

   a. one month
   b. three months
   c. six months
   d. one year
   e. two years

5. When heifers are kept in pens, about ______ square metres of floor space should be allowed for each heifer.

   a. 1
   b. 3
   c. 5
   d. 7
   e. 10

6. Heifers usually need to be fed some ______ in addition to hay and silage during the dry season.

   a. bedding
   b. concentrates
   c. dry mature grass
   d. straw
   e. tree leaves

7. Heifers should be bred after they have reached a certain _________.

   a. age
   b. daily amount of feed consumption
   c. size
   d. time of the year
   e. weight

P.T.O.

8. Heifers should begin to be fed concentrates about ______ before freshening.

a. 1 week
b. 2 weeks
c. 1 month
d. 1½ months
e. 2 months

9. Milking by machine should take only about ______ per cow.

a. 1 minute
b. 3 minutes
c. 5 minutes
d. 10 minutes
e. 15 minutes

10. Calves usually become infected with parasites which they get from ______.

a. concentrates
b. hay
c. insects
d. other animals
e. pastures

11. ________ are parasites commonly found in the digestive tract of cattle.

a. flukes
b. lice
c. ticks
d. tsetse flies
e. worms

12. Flukes can be controlled by keeping cattle away from _________.

a. cattle with flukes
b. dirty pastures
c. rats
d. snails
e. water

13. Tapeworms in cattle are important because they ___________.

a. eat the food of cattle
b. infect man
c. kill cattle
d. live in the blood
e. make cattle sick

14. __________ is a serious disease of cattle which can be prevented by vaccination of the cattle.

a. Brucocellosis
b. Mastitis
c. Roundworms
d. Smallpox
e. Tapeworms

15. Bulls can best be controlled by __________.

a. cutting off their horns
b. feeding good hay
c. putting a ring in the nose
d. tying a rope around the neck
e. tying the rear feet together

TUMAINI SECONDARY SCHOOL

CARING FOR THE SOW AND LITTER AT FARROWING TIME

This is a programmed instruction unit on caring for the sow and litter at farrowing time.

In this unit you are to learn:

1. the kinds of common farrowing units.
2. how the farrowing unit should be prepared.
3. how the sow should be prepared for farrowing.
4. the care that should be given to the sow at farrowing time.
5. the care little pigs need at farrowing time.
6. the special care needed by orphan pigs and large litters.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Caring for the
Sow and Litter
at Farrowing
Time

If you have not
read the cover
page, do so now,
then proceed to
frame 1.

- Cut -

- Cut -

Name ______________________ Form ________

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1

farrowing unit	1. Preparation of the Farrowing Unit. The farrowing unit may be a farrowing house, pen, or stall. Its main purpose is to provide clean, comfortable quarters for the sow and litter. The place where a sow gives birth to its young is called a f____ u______.
farrowing unit	2. To be comfortable, the quarters should provide proper ventilation, warmth, and freedom from drafts, diseases, parasites, and dust. This in turn demands that the construction be tight enough to prevent drafts and leaking of rain and be made of materials that can be thoroughly cleaned and disinfected before the farrowing season. The f___ u______ must be clean and dry.
Farrowing stalls	3. Using farrowing stalls (figure 1). Farrowing stalls save space and help prevent the sow from crushing the pigs. Where they are practical, they are recommended over farrowing pens with guard rails. The stalls reduce somewhat the need for attending sows at farrowing. ________________ are individual stalls in which the sows are placed for farrowing.

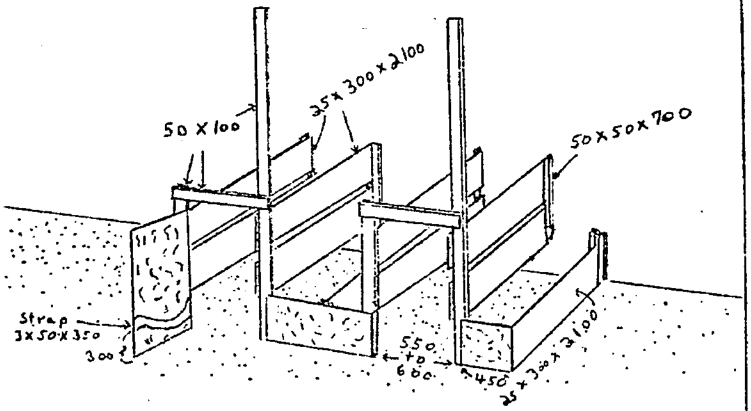

Figure 1. Farrowing stalls save space and help prevent the sow from crushing pigs. (Dimensions are in millimetres.)

farrowing stalls	4. A good herdsman can save more pigs by being present at farrowing, but many hog producers who formerly "lived" with the sows at farrowing time, now place the sows in farrowing stalls to farrow unattended except for routine checks or assistance when it is needed. Sows need little attention at farrowing time if they are in _________.
outside	5. Sows in farrowing stalls can be fed and watered in the stall or can be turned out twice a day to a pen or feeding platform provided with a self-feeder and automatic waterer. Turning the sow out reduces the amount of labour needed for cleaning manure out of the farrowing stall area, gives the sow exercise, and is preferred over feeding in the stall unless equipment is well adapted for stall feeding. It is best to feed the sow o________ the farrowing stall.
pigs	6. Use stalls that are about 75 centimetres wide and 2 to 2½ metres long, the dimensions depending upon the size and condition of the sows. The bottom of the partitions should be about 30 centimetres off the floor, so the pigs can move into a heated area between the stalls. The main purpose of farrowing stalls is to prevent the sow from crushing the little _______.
guard rails	7. Using farrowing pens. While farrowing stalls are generally recommended over farrowing pens, there are still situations where the stalls might be impractical. Where this is true, the farrowing pen may be the best method to use. It should be at least 2 X 2½ metres for gilts and 2½ X 2½ metres for sows. The pen should be equipped with guard rails and a heat source. A farrowing pen needs to be equipped with ________ to protect the little pigs.
disinfected	8. Scrubbing and disinfecting. Several days before the farrowing season starts, or the sow is confined if using individual houses, thoroughly scrub and disinfect the farrowing unit. A thorough cleaning of the pen or house will be necessary before scrubbing can be done successfully. Clean the pen by scraping loose any dirt or manure on the floor and walls and sweeping it out as well as possible. The farrowing unit must be completely cleaned and d______ before use.
sprayer	9. Use a steam cleaner or a high pressure sprayer, if possible to clean the farrowing unit. If a power sprayer is used, the addition of an alkaline detergent will help with the cleaning. A high pressure ______ is very useful in cleaning a farrowing unit.

lye	10. The unit can also be scrubbed with boiling lye water (½ kilogram of lye to 140 litres of water) and a stiff broom or brush. If lye is used, goggles and rubber gloves should be worn to avoid getting caustic burns. Boiling _____ water is a good disinfectant for a farrowing unit.
water	11. With either system of scrubbing, clean until all dirt and foreign material have been removed. Rinse the cleaned surfaces with clean water to remove any soap or detergent still remaining. After scrubbing, the unit must be rinsed with clean ___________.
Fumigation	12. Fumigation. If there has been any problem with scours and the house is tight enough, it is wise to fumigate before farrowing time to kill the disease organisms. To fumigate a building, the following steps are recommended: a. Tightly seal all doors and windows. b. Moisten the floor with water about 15 minutes before fumigation. F_____ is a method of killing disease producing organisms.
formaldehyde potassium permanganate	13. c. Figure the number of cubic metres of air space in the building (length X width X height). d. For each 170 cubic metres of air space, use 4.5 litres of formaldehyde and 1 kilogram of potassium permanganate. e. Place the formaldehyde in two or three pans, equally spaced down the centre of the house. The chemicals needed for this fumigation are _______ and ________.
24	14. f. Divide the potassium permanganate, and starting at the back of the house and moving rapidly along, drop the potassium permanganate into the pans, and get out of the house immediately. g. Leave the building closed for 24 hours. h. After the 24-hour period, open the doors and air the inside thoroughly. The fumigation gases are allowed to remain in the house for _____ hours.
idle	15. If possible let the fumigated house stand idle for a week before moving hogs in again. These sanitation breaks help to prevent the buildup of disease. The danger of disease can be lessened if the house is left i_____ for certain periods and not used continuously.

crushing	16. Installing guard rails or fenders. Guard rails or fenders to prevent the sow from crushing the pigs against the walls should be used in individual houses or farrowing pens. Make them out of timbers 50mm X 100mm or larger: or pipe, placed about 20 centimetres from the floor and 20 to 25 centimetres out from the wall. The purpose of guard rails is to prevent the sow from ________ the pigs.
20 20-25	17. The rails may be fastened to the walls by such methods as nailing, hinging so they can be moved up out of the way, or nailing temporarily so that after a week or two they can be removed to allow additional floor space. The method of fastening to the wall is of little importance as long as they are constructed solidly enough to stand the stress and strain they will receive. The guard rails are put about _____ cm above the floor and _____ to _____ cm out from the walls.
bedding	18. Bedding. After the house is thoroughly dry but before the sow is moved in, bed it with a good absorbent, such as cut wheat straw, shredded maize stover, leaves, or sawdust, that is dry and will lie close to the floor. As a rule, if the weather isn't too severe, a very thin covering on the bare floor is all that is necessary. The floor of the farrowing house should be covered with good absorbent __________.
30	19. Heating. In cold weather some kind of artificial heat should be provided for the pigs. This may be provided by a stove, lantern or electric heater in the house, or by a heated tub, barrel, or box. Heat lamps are generally used with farrowing stalls. Adjust the heat at the floor to about 30°C. (85°F) at farrowing time. This can be reduced to 22°C (70°F) by three weeks of age and discontinued after 4 or 5 weeks. Pigs need a temperature of ________°C. at farrowing time.
brooder	20. In farrowing pens, the electric pig brooder (figure 2) is a good means of providing heat if electricity is available. To make a pig brooder, build a partition across a corner of the house or pen, about 25 or 30 centimetres above the floor. An electric pig b________ is a good means of providing heat for pigs.
50	21. In the brooder, hang a heat lamp from some type of support so the bulb and reflector is back of the partition and about 50 centimetres above the floor. A 150 watt bulb is sufficient. The electric heat lamp should be hung ____ centimetres above the floor.

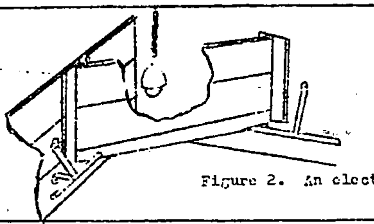

Figure 2. An electric pig brooder.

hover	22. A hover, a platform across a corner of the house about 30 centimetres above the floor, is sufficient if the weather is not too cold. The low "ceiling" of the hover helps prevent drafts on the pigs and gives them a better chance to keep themselves warm than if they are huddled together. A pig ________ provides sufficient warmth for most areas of Tanzania.
Stoves kerosene lanterns	23. Where electricity is not available, heat may be supplied in the house or pen by a stove or kerosene lantern. The fire hazard, however, is a problem and should be taken into consideration before using. ______ and ______ may be used as heat sources where electricity is not available.
tub barrel box	24. The use of a heated tub, barrel, or box for the pigs may save many newborn pigs during very cold weather. A bottle of hot water, heated bricks or sand, or warm bags or cloths may serve as a source of heat. In very cold weather the pigs may be kept in a _____, _______, or ______ which is kept warm by heated materials.
breeding	25. Preparation of the Sow for Farrowing. Farrowing time is a critical period in swine production. The breeding dates of the sows provide the information so that the day of farrowing can be closely foretold and preparations made for the arrival of the pigs. The b_____ dates of sows must be known so preparations for farrowing can be made.
warm soapy water	26. Washing. About a week before the end of the gestation period, wash the sow with warm soapy water. Give special attention to the udder and teats to remove any dirt or filth that might be harbouring disease germs or worm eggs. A mild disinfectant applied at this time to rid the sow of lice and mites is also advisable. The sow should be washed with _________ one week before farrowing.

one

27. Put the sow in the cleaned farrowing pen or stall so she will be come accustomed to the new quarters. This should tend to quiet her and make her better satisfied. If she is too nervous, brushing her daily is an effective way to quiet her.

The sow should be put into the farrowing unit _____ week before she is to farrow.

quiet

28. Keep the sow as quiet as possible during this time so that if she needs help in farrowing, she will not be so wild and nervous and can be more easily approached.

It is important to keep the sow _____ before she farrows.

ration
3

29. **Feeding.** Sows should be fed a special ration starting three days before farrowing and continuing through lactation. An example is given in the next frame. They are either turned out for an hour, morning and night, to a self-feeder containing the ration, or have access to feed in a small self feeder in the stalls.

Sows need to be fed a special r_____ starting _____ days before farrowing and continuing until the pigs are weaned.

Self-fed Ration for Sows

Ground shelled maize, k.	1,550	Vitamins	
Soybean meal (44%), k.	400	Riboflavin, gm.	2.2
Steamed bone meal or dicalcium phosphate, k.	20	Pantothenic acid, gm.	11
Ground limestone, k.	20	Niacin, gm.	33
Trace mineral salt with zinc, k.	10	Choline, gm.	200
		Vitamin A, million units	6.6
		Vitamin D, million units	.66
		Vitamin B12, mg.	35.2
		Antibiotics, gm	44

bran

30. If the sows are hand fed, cut back the feed by about 1 kilogram and add a litre of wheat bran to each sow's ration when she is put into the farrowing house. If they had been self-fed a mixed ration, add one-fourth wheat bran to it and hand-feed it.

Wheat _____ is added to the sow's ration before farrowing.

- -

31. Another alternative is to mix and hand feed the following ration from the time the sow goes into the farrowing pen until a week after farrowing.

300	kilos ground shelled maize
300	kilos ground millet or ground rice
300	kilos wheat bran
100	kilos drylot sow supplement
1,000	kilos

farrow	32. <u>Care of the Sow at Farrowing Time.</u> When the sow is about to farrow, there are certain indications that foretell the probable time. The usual signs are restlessness and a filling of the udder and teats. When she begins carrying straw or arranging her bed, she may be expected to farrow within twelve hours. Restlessness, filling of udder and teats, and carrying straw are signs that a sow will soon ______.
farrowing	33. If the sow has taken plenty of exercise, has been properly fed, and is in a strong condition, she will seldom need any help at farrowing time; nevertheless a close watch should be maintained. It is important that a sow or gilt needing help gets it at the right time. Sows should be watched closely at ______ time.
turned	34. If a pig lodges at the pelvic bones, it usually dies in 30 to 60 minutes, if it remains there two or three hours, the next pig following it will be dead; and if it lodges 24 hours, the remainder of the litter will have perished. As soon as it is seen that continued labour is of no avail, the pigs should be turned so that normal birth may result. A pig that lodges at the pelvic bones must be ______ so it can be born.
breathe	35. If the sow still has trouble, it may be necessary to pull the pigs through the pelvis or call a veterinary officer for assistance. As the sow is farrowing, assist the newborn pigs if necessary to free themselves from the enveloping membrane and start to breathe. Newborn pigs sometimes need help to start to b______.
breathing	36. If the pig isn't breathing, first see that the mouth and nostrils are clean of mucus or slime, then blow into its mouth and nostrils and at the same time rub its chest. Sometimes working the fore and hind legs at regular intervals and shaking or gently slapping the pig on the side of its head will start it breathing. As long as the heart continues to beat the efforts are not hopeless, but the chances of survival are slim if the pig doesn't start breathing within a few minutes. A pig needs to start ______ within a few minutes of birth.
nurse	37. The instinct to nurse should be satisfied as soon after birth as possible. Weak pigs should be helped to a teat. The first milk of the mother acts as a laxative, stimulating the functions of digestion and helping to eliminate the accumulations of the digestive tract. It is believed also that it temporarily immunizes the pig against certain germ infections. Pigs should begin to n____ as soon after birth as possible.

dry	38. If the farrowing unit is cold, rub the pigs dry with a cloth or burlap bag and keep them warm. If an electric brooder or heat lamp is used, put the pigs under it immediately after the first nursing. Pigs should be rubbed _____ after birth if it is cold.
warm	39. Otherwise they may be kept warm by placing them in a basket in which a bottle of warm water has been placed, or by wrapping them up and taking them into a warm room. Don't under any circumstances let the pigs become chilled. Pigs must be kept w______.
farrowing	40. Feeding the Sow after Farrowing. Continue to feed the sow after farrowing just as she was fed previous to farrowing. The ration mentioned in frame 29 can be fed until weaning time. If the sows are hand-fed, continue the farrowing ration for a few days and then return to full regular feed within a week to 10 days after farrowing. The sow needs an adequate ration after f________ to insure a good supply of milk for the pigs.
navel	41. Care of the Little Pigs. Soon after the pigs are born, dip the navel stub in a strong tincture of iodine solution (15 percent) or use straight Lugol's solution. The ______ of new born pigs should be disinfected immediately.
needle	42. The needle teeth or temporary tusks of newborn pigs are sometimes long and sharp. They are of very little benefit to the pigs and may be removed if the pigs fight excessively. The n_____ teeth of pigs may be removed if the pigs fight excessively
needle	43. If the teeth do not cut into the pig's upper lip, cut the udder of the sow, or lacerate the noses of other pigs while tussling for a place to nurse, it is best not to clip them. If they do cause trouble, clip only the tips with small nippers. Be careful not to injure the gums, as this provides a source of infection which may result in later difficulties. N_____ teeth should not be cut unless they cause trouble.

bull	44. Bull nose, an enlarged sore nose, is caused by filth-borne bacteria which may be present on unwashed sows or in unscrubbed farrowing quarters. Treatment consists of cleaning the nose thoroughly and painting it with iodine. When the swelling softens, it may be lanced and washed out with a disinfectant. B____ nose is caused by dirty farrowing quarters.
Anemia	45. Anemia often occurs in little pigs that are confined in a pen off the ground and receive no feed other than the milk of the sow. The external symptoms are thumping of the sides, paleness of the skin, loss in flesh, and roughness of the hair. Pigs so affected may die within a few days. A________ is caused by a lack of minerals in a pig's ration.
Iron-dextrose	46. Anemia can be prevented by any of four different ways: a. By injecting iron-dextrose in the hip muscle. Follow the manufacturer's recommendation as to size and number of injections. __________ injections can prevent baby pig anemia.
copper iron	47. b. By swabbing the sow's udder once a day with a saturated solution of copperas, made by dissolving ½ kilogram of copperas in 3½ litres of hot water. c. By treating each pig with special iron pills or solutions. They may be obtained from veterinary officers or farm supply shops. The use of c______ and i_____ solutions is another method of preventing anemia in pigs.
sod	48. d. By placing some fresh sod in the pen so the pigs can get to it. The pigs can usually get enough iron from the dirt and sod to prevent the deficiency. The simpliest method of preventing baby pig anemia is to place s____ in their pen.
Hypoglyremia	49. Weak or chilled pigs sometimes develop a conditon called hypoglyremia (baby pig disease) because their blood sugar supply has been depleted. Symptoms are shivering, dullness, and a lack of desire to nurse. They tend to wander away from the litter and burrow under the bedding. H________ is a condition which may develop when pigs become weak or chilled.

sugar	50. Many of the affected pigs die within 24 hours after the first symptoms appear. Some of these pigs will respond to an under-the-skin injection of 5 to 10 cc. of a sterile 10-40 percent glucose solution, or to 1 to 2 spoonsful of sugar syrup diluted with enough water that it can be fed with a spoon. If the pigs respond, treat them every hour until they can nurse successfully. Hypoglycemia can sometimes be treated by giving the pigs s______ water.
tails	51. Sometimes the tails of little pigs become sore at the base, dry up, and slough off. This is caused by a bacterial condition usually associated with damp bedding and infection in the pen. The _____ of pigs sometimes drop off because of an infection caused by dirty conditions.
cleanliness	52. This condition can be treated and prevented by smearing the tails with vaseline, adding clean dry bedding to the pen, and letting in as much sunshine as possible. Pigs on pasture are seldom bothered. C_______ is a major factor in preventing the infection which causes pigs' tails to drop off.
ears	53. Pigs must be marked for identification if good production records are to be maintained. The most preferred method is to cut a V-shaped notch in the ear with a special tool or knife. The number of notches and their location is used in making a number code. Notching the _____ of pigs is one way of marking them for identification.
- -	54. Even up litters by transferring the strongest pigs from large litters to small litters. The sow will usually accept foster pigs if you put all the pigs to be left with one sow together in a tub or box for about an hour. Pigs can be transferred from one sow to another more easily in farrowing stalls than in farrowing pens.
cow's milk	55. Care of Large Litters and Orphan Pigs. If the little pigs cannot be put with another sow, hand feed the orphans whole cow's milk. Some farmers feed the milk with a bottle and teat, but many prefer feeding in a shallow pan right from the start. An orphan pig should be fed c__m_____.

pan	56. When feeding in a pan, use enough milk to cover the pig's mouth when its nose is in the bottom of the pan. Push the pig's nose into the milk for a few seconds. This bathes the tongue and the pig gets some milk whether it wants to or not. A lesson or two of this kind is generally all that is necessary before the pig will drink of its own accord. Pigs can be fed milk from an open p____.
3 or 4	57. Feed the pig every 3 or 4 hours for the first few weeks. Althogh good results have been obtained by feeding pigs 3 times a day right from the beginning, it is generally better if they are fed more often at first. At first, orphan pigs should be fed every _____ hours.
milk	58. Milk may be supplemented with grain, shelled maize, and ground green lucerne hay or pasture as soon as the pigs will eat them. Make the change gradually, and increase the amount as fast as the pigs get used to the feed. As pigs get older the amount of ______ should be gradually reduced and grains and hay gradually increased.

This unit is based on the information contained in VAS unit 1037 of the Vocational Agricultural Service of the College of Agriculture, University of Illinois.

Name ________________ Form ____ Date____

TEST

CARING FOR THE SOW AND LITTER AT FARROWING TIME

UNDERLINE THE CORRECT ANSWER

1. The main reason for using guard rails in a farrowing pen is _______.

   a. to keep the pigs clean
   b. to keep the pigs warm
   c. to keep the sow from standing up
   d. to prevent the pigs from being crushed
   e. to protect the farmer

2. A recommended disinfectant for cleaning the farrowing house before use is ___.

   a. boiling lye water
   b. Dettol
   c. formaldehyde
   d. pure water
   e. warm soapy water

3. Guard rails should be placed about ______ above the floor.

   a. 2 centimetres
   b. 5 centimetres
   c. 20 centimetres
   d. 45 centimetres
   e. 70 centimetres

4. ____________ is a good bedding material for a farrowing pen.

   a. Dry grass
   b. Fresh grass
   c. Maize cobs
   d. Maize stalks
   e. Sawdust

5. The recommended temperature for newborn pigs is ______.

   a. 20°C.
   b. 25°C.
   c. 30°C.
   d. 35°C.
   e. 40°C.

6. _________ is one sign that a sow is about to farrow.

   a. Saliva dripping from the mouth
   b. Teats filling with milk
   c. Much drinking of water
   d. Not eating
   e. Sleepiness

7. A pig hover is a structure __________.

   a. for caring for orphan pigs.
   b. to feed pigs.
   c. to keep pigs warm.
   d. to keep the sow while farrowing.
   e. for washing the sow.

8. The navel of pigs should be ______ soon after birth.

   a. burned
   b. cut off
   c. disinfected
   d. measured
   e. tied with string

9. The box-like structure about 75 centimetres wide and 2 to 2½ metres long into which sows are put for farrowing is called a ____________.

   a. farrowing house
   b. farrowing hover
   c. farrowing pen
   d. farrowing platform
   e. farrowing stall

10. The process of using a poisonous gas to kill disease organisms in a farrowing house is called _______.

   a. airing
   b. fumigation
   c. gassing
   d. scrubbing
   e. washing

11. A sow should be washed with warm soapy water _______.

   a. one day before farrowing
   b. one week before farrowing
   c. one month before farrowing
   d. while she is farrowing
   e. one day after farrowing

12. _______ is often added to a sow's ration just before and during farrowing.

   a. Dry grass
   b. Limestone
   c. Maize cobs
   d. Water
   e. Wheat bran

13. During farrowing a pig that lodges at the pelvic bones of the sow _______.

   a. always dies
   b. is not a problem
   c. is usually a male
   d. should be left at least 6 hours before turning
   e. should be turned immediately

14. A new born pig needs to begin nursing as soon after birth as possible because the first milk __________.

   a. contains antibiotics
   b. helps prevent disease
   c. helps the pig begin breathing
   d. is rich in minerals
   e. prevents bull nose

15. One of the easiest ways of preventing baby pig anemia is to provide the pigs with _________.

   a. cow's milk
   b. fresh sod
   c. hay
   d. maize cobs
   e. salt

16. Pigs are usually marked for identification purposes by ___________.

   a. cutting notches in their ears
   b. cutting their tails
   c. painting numbers on their sides
   d. putting tags in their ears
   e. removal of certain teeth

17. An orphan pig may be fed ________ as a substitute for his mother's milk.

   a. copperas
   b. cow's milk
   c. lucerne meal
   d. maize meal in water
   e. a sugar solution

TUMAINI SECONDARY SCHOOL

DIGESTION IN ANIMALS

This is a programmed instruction unit on Digestion in Animals.

In this unit you are to learn:

1. The parts of the animal digestive system.
2. The digestion that occurs in the mouth.
3. The digestion that occurs in the stomach.
4. The digestion that occurs in the small intestine.
5. The digestion that occurs in the large intestine.
6. The role of enzymes and bacteria in digestion.
7. How absorption of digested foodstuffs occurs.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Digestion in
Animals

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

Name ____________ Form ______

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digestion	1. Digestion in animals is the process of breaking down feeds into their various constituents and those into such forms as can be absorbed by the blood and used by the cells. Breaking down feeds in animals is called ______.
false	2. In general, digestion is accomplished with the aid of teeth, enzymes, hydrochloric acid, bile, and the churning, squeezing action of muscles of the stomach. Digestion takes place only in the stomach - true or false?
enzymes	3. Although chewing of the feed and churning and squeezing the chewed-up mass are quite necessary in the digestion process, enzymes in general do most of the actual digesting. Most digestion is done by ______.
enzymes	4. Enzymes, such as those found in saliva of the mouth, gastric juice, or intestinal juice of the small intestine are organic catalysts which can break down other organic compounds without themselves being changed or used up. Organic catalysts which aid digestion are called ______.
nutrient	5. Each of the enzymes, however, acts on only one of the nutrients; such as protein, carbohydrates or fats. Each enzyme can act on only one kind of ______.
digestive system	6. The digestive system consists of the organs of chewing and digesting of the feed, passage of the feed through the animal body, and the excretion of the unabsorbed residue. Digestion takes place in the ______ ______.

oesophagus or gullet	7. Generally the system is considered only as the alimentary canal and the accessory organs of digestion. The alimentary canal includes the mouth, oesophagus, stomach, small intestine and large intestine. (See figure 1.) The oesophagus or gullet is the tube-like passage from the mouth to the stomach. The ______ connects the mouth to the stomach.

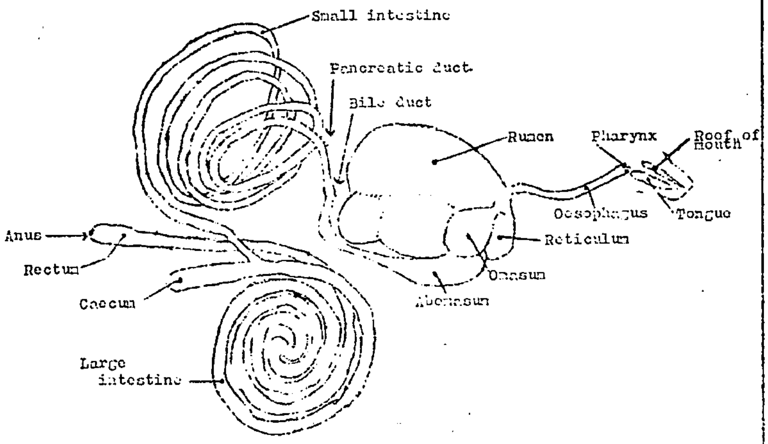
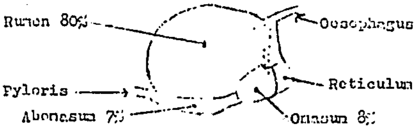


Figure 1. The digestive tract of a ruminant, including the mouth, oesophagus, stomach, small intestine, and large intestine.

Ruminants	8. The stomach of a horse or pig is similar in shape to that of a human. The capacity of a horse's stomach is 12 - 18 litres and that of a pig 6 - 9 litres. The stomach of ruminants or cud chewing animals (cattle and sheep) is much larger than that of nonruminants. __________ are cud chewing animals.
4 rumen reticulum omasum abomasum	9. The stomach of ruminants is divided into four divisions as follows: the rumen, the reticulum, the omasum, and the abomasum. (See figure 2.) The capacity of the cattle's stomach is 100 to 140 litres in small animals and 160 to 240 litres in large animals. The stomach of a ruminant has _____ divisions which are the ______, ________, ________, and _______.

	 Figure 2. The four divisions of a ruminant stomach are as shown.
rumen	10. The rumen, which makes up about 80 percent of the capacity of the stomach, is where roughages are broken down, and essential vitamins and proteins are synthesized by micro-organisms that live there. The ________ is the largest division of a ruminant stomach.
small intestine	11. The small intestine (where most digestion is completed and most absorption takes place) is a long folded tube attached to the lower end of the stomach. In cows it is about 40 metres long and holds about 75 litres; in sheep it is about 24 metres long and holds about 12 litres. Most digestion takes place in the ______ _______.
small intestine	12. The large intestine is attached to the lower end of the small intestine. It is larger in diameter, but much shorter than the small intestine. In the cow it is about 10 metres long and has a capacity of 35 to 45 litres. In sheep it is about 5 metres long with a capacity of 8 litres. During digestion, food passes from the stomach into the _______ ________.
mouth	13. There is an elongated sack or bag at the junction of the large intestine to the small intestine called the caecum. In most animals the caecum is relatively small, but in some animals like horses and rabbits it is large. This helps them to digest large amounts of roughages like cattle, even though they have simple stomachs. Digestion begins in the m______ of animals.
liver	14. The liver produces the bile, which is stored in the gall bladder and later emptied into the upper part of the small intestine. The liver is the largest gland in the animal body. Bile is produced by the ________.

liver pancreas	15. The pancreas, located along the upper part of the small intestine, secretes the pancreatic juice used in the digestion process in the small intestine. Two body organs which secrete digestive juices are the _____ and the _______.
tongue teeth salivary glands	16. The accessory organs of the digestive system are the teeth, tongue, salivary glands, liver and pancreas. The first three are found in the mouth. The teeth are used for tearing up the food, and the tongue assists in directing the food to the throat for swallowing. The ______, ________, and _________ are found in the mouth.
saliva	17. The salivary glands, located under the lower jaw and under the ears, produce the saliva used for digestion in the mouth. The salivary glands produce _______.
poultry	18. The digestive system of poultry is similar in principle to that of other animals and yet has many differences too. (See figure 3, page 5.) One of the differences is that food passes into the crop for temporary storage before reaching the stomach. Here the food is softened by saliva that was swallowed with the food and by secretions from the crop wall. The digestive system of p________ is somewhat different from other animals
gizzard	19. Another difference is that after passing through the stomach, the food enters the gizzard or muscular stomach. Its walls consist of large, red, thick, powerful muscles and its lining is a thick horny epithelium. The gizzard crushes food particles and mixes them with digestive juices of the stomach. The _______ grinds food in the digestive system of the chicken.
ceca	20. A third difference is that chickens have ceca which are two blind pouches, about 18 centimetres long, attached to the small intestine where it empties into the large intestine. The function of the ceca is unknown. They are usually filled with soft, pasty, undigested food. The _______ are a pair of pouches whose function is unknown.

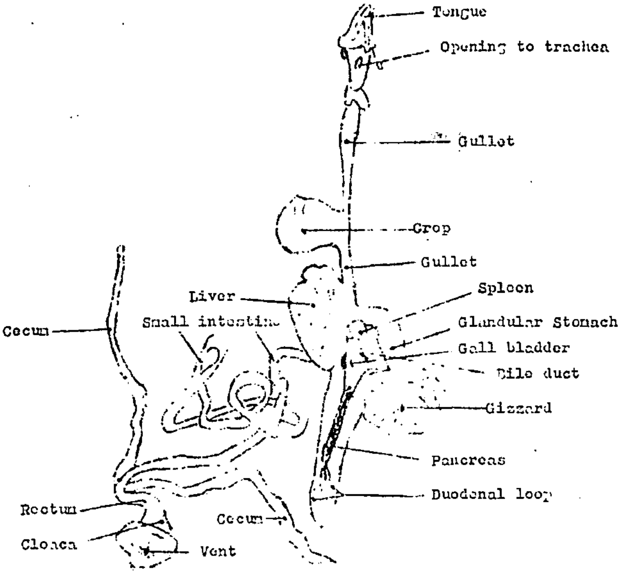


Figure 3. The alimentary tract of a chicken is similar to other animals.

cloaca	21. A fourth difference is that at the connection of the large intestine to the vent is an enlarged portion called the cloaca. It carries all fecal material from the large intestine, eggs from the oviduct, and urine from the kidneys that are eliminated through the vent. The end of the alimentary canal in poultry has a common passage for faeces, urine, and eggs called the ______.
Chewing	22. The first step of digestion is the breaking, cutting, and tearing up of the feed by the chewing process in the mouth. Here the feedstuffs are also thoroughly mixed with saliva. C ________ is the first process in digestion.
saliva	23. The saliva assists in the chewing and swallowing processes, stimulates the nerves of taste, and in ruminants assists in rumination (chewing of the cud). Feed is mixed with ______ while being chewed.

enzyme	24. Saliva is slightly alkaline in reaction and in most animals contains the enzyme "salivary amylase" which changes some starch to maltose or malt sugar. Salivary amylase acts only in a slightly alkaline solution and is destroyed by even a weak acid solution. Saliva contains an ______ which digests some starch.
Ruminants	25. The ruminants only partially chew their food at first, but later return it to the mouth for further chewing or rumination. About 7 or 8 hours of a ruminant's day is spent in "chewing its cud". R________ return food to the mouth in the process of rumination.
Gastric juice	26. As soon as the masticated (chewed) food enters the stomach, gastric juice, secreted by glands in the walls of the stomach, begins to flow. _______ ________ is secreted by glands in the stomach walls.
acid	27. Gastric juice contains 0.2-0.5 percent hydrochloric acid, which when mixed with the food stops all action of the salivary amylase. Gastric juice is ______ in reaction.
Pepsin	28. Next the enzymes in the gastric juice; pepsin, rennin, and gastric lipase, begin to act on the food stuffs. Pepsin acts on the protein of the food and breaks them down into proteoses and peptones. P______ is an enzyme in gastric juice which acts on protein.
Renin	29. Rennin curdles the casein of milk, thus preventing it from passing on through undigested. _________ is not an enzyme.

Gastric lipase	30. Gastric lipase acts on emulsified fats and splits them into glycerol and fatty acids. However, most of the fats going into the stomach are not emulsified, so gastric lipase does very little in the digestion process. __________ __________ does little to fats in the stomach because they are mostly not emulsified.
small intestine	31. Soon after the masticated feed enters the stomach, the muscular walls set up a churning, squeezing action. The pushes the liquid portion of the feed on into the small intestine and leaves the solid portion in the stomach for further action by the gastric juice. The muscles of the stomach walls cause the liquid in the stomach to pass into the _____ ________.
rumen	32. The digestion in the stomach of ruminant animals is quite different from that of non-ruminants. As the feed is swallowed by ruminants, the solid part, which is only partially chewed, passes into the rumen while the liquid part passes into the reticulum, on through the omasum, and into the abomasum or true stomach. Solid feed swallowed by ruminants passes into the ____________.
Bacteria	33. While in the rumen, the feed is thoroughly mixed and partially broken down by bacterial action and a slow churning movement. This feed is later taken back to the mouth and rechewed. ________ help to break down feed in the rumen.
mouth	34. When it is swallowed the second time, it will go back to the rumen if it still isn't chewed thoroughly enough. If it has been thoroughly chewed, it will pass into the reticulum and on into the omasum or may pass directly into the omasum from the oesophagus. Feed passes from the rumen to the _______ for further chewing.
bacteria	35. The bacterial action in the rumen releases considerable carbon dioxide and methane gases. These are useless to the animal and must be excreted through the digestive tract. Gases are formed by _______ in the rumen.

Bloat	36. If the gases form faster than they can be removed from the body, as happens sometimes when an animal eats a large amount of fresh grass or legumes, the animal bloats. B______ is caused by too much gas forming in the rumen.
reticulum	37. The liquid and some of the fine particles of the feed accumulate in the reticulum before being passed into the omasum. Some of the liquid portion of the feed from the reticulum is also used to moisten the feed from the rumen as it is returned to the mouth for rumination. After being swallowed, liquid goes first to the ______ in ruminants.
- -	38. The omasum receives its food from the rumen, reticulum, or directly from the oesophagus. The latter is usually true only after the feed has gone back to the mouth for rumination.
omasum	39. The feed in the omasum is crushed and ground by the squeezing, rasping action of the horny muscular walls. The feed is always dry in this compartment as the liquid portion is squeezed out immediately and forced into the abomasum. Feed in the ______ is always dry.
abomasum	40. In the abomasum the feed is mixed with gastric juice, and digestion, as explained for the simple-stomached animals, is carried on. Digestion in the ______ is similar to digestion in the stomach of non-ruminants.
Chyme	41. After digestion in the mouth and stomach, the food materials are an acid, semifluid, gray, pulpy mass when they enter the small intestine. This feed mass is called "chyme". C______ is the material which passes from the stomach into the small intestine.

pancreatic juice bile intestinal juice	42. Chyme is mixed with three digestive juices soon after leaving the stomach. They are the pancreatic juice, bile, and intestinal juice. These are alkaline in nature and immediately stop peptic digestion, which required an acid condition. Write the names of the three digestive juices which mix with the chyme after entering the small intestine.
4 trypsin pancreatic amylase pancreatic lipase maltase	43. Pancreatic juice, secreted by the pancreas contains the enzymes trypsin, pancreatic amylase, pancreatic lipase, and small amounts of maltase. Pancreatic juice contains _____ enzymes. They are _______, _________, ___________, and ________.
amino acids	44. Trypsin acts on the proteins not broken up by pepsin and breaks down some of the proteosis and peptones to peptids. Each of the protein compounds in the digestion process is a progressively simpler combination of amino acids than the ones ahead of it. Proteins are broken down into ______ _______ by enzymes.
starch	45. Pancreatic amylase changes the starch of the food that was not acted on by salivary amylase to maltose. In general the pancreatic amylase does the greater share of the digesting of starches because it is present in a larger amount and has a longer time to act than the salivary amylase. Pancreatic amylase changes _______ to maltose.
lipase	46. Lipase breaks down the fats of the food into fatty acids and glycerol. The fatty acids then combine with the alkaline salts of the pancreatic juice and bile to form soluble bile salts. Fats are broken down by the enzyme l_______.
maltase	47. Maltase acts on the sugar maltose and changes it into a simpler sugar, glucose. Maltose is changed to glucose by the enzyme ________.

liver	48. The bile is a yellowish-green, alkaline, very bitter liquid secreted by the liver and stored in the gall bladder in all animals except the horse. Bile is produced by the ________.
bile	49. Bile contains no enzymes, but acts as a solvent of fats and fatty acids and aids in their digestion and absorption Its presence also increases the activity of the enzyme, lipase. No enzymes are contained in b______.
4 erepsin sucrase maltase lactase	50. The intestinal juice is secreted by small glands in the walls of the upper and middle part of the small intestine. It contains the enzymes erepsin, sucrase, maltase, and lactase. Intestinal juice contains ______ enzymes. They are ________, __________, _________, and _________.
Erepsin	51. Erepsin finishes breaking down the proteosis and peptones produced by the action of pepsin and trypsin, into amino acids. It is in a much larger quantity in the intestinal juice than in the pancreatic juice. E_____ is the final enzyme that acts on proteins.
enzymes	52. Sucrase, maltase, and lactase all act on various starches and sugars, breaking them down to the simple sugars, glucose and galactose. Sucrase, maltase, and lactase are ________.
large intestine	53. Although most of the digestion is done by the time the feed is through the small intestine, there is always a certain amount of undigested and unabsorbed material passing into the large intestine. The enzymes of the small intestine continue their action for awhile in the large intestine. Most digestion occurs before feed reaches the _____ _____.

bacteria	54. Much digestion in the large intestine, especially of crude fibre and the undigested proteins is carried on by bacterial action. This creates many gases which give the faeces their offensive odor. Digestion in the large intestine is aided by ________.
Faeces	55. The remaining undigested, unabsorbed food materials, remains of the digestive juices, living and dead bacteria, and dead cells from the walls of the digestive tract are passed out as faeces of the animal. F______ are the waste products of the digestion process.
absorption	56. Absorption is the process by which the digested foodstuffs are taken into the blood and lymph streams for distribution to the body cells and tissues. Digested food passes into the blood and lymph by a__________.
small intestine	57. Most of the digested food materials are absorbed from the small intestine and the remainder from the large intestine. Most absorption takes place in the _____ ________.
Villi	58. The walls of the small intestine are lined with a large number of small cone - or club-shaped projections, called villi. Each villus contains a lymph vessel and a network of blood capillaries. V______ line the inside of the small intestine.
liver	59. The digested proteins (amino-acids), starches and sugars (glucose, fructose, and galactose), and crude fibre (short chained fatty acids) are absorbed by the blood capillaries, passed through the liver, and into the general circulation of the blood. All digested food absorbed by the blood passes through the l______.

lymphatic system	60. The digested fats (soaps and glycerol) are recombined into fats again and are absorbed into the lymph vessels, carried in the lymphatic system, and emptied into the circulatory system through the thoracic duct in the lower part of the neck. The ______ ______ carries digested fats from the place of absorption to the blood system.
small intestine	61. Water and dissolved mineral matter are absorbed into the blood stream through the villi. The villi are located in the ______ ______.
large intestine	62. Absorption from the large intestine is made directly into the blood stream in capillaries in the walls. Absorption does not take place through villi in the ______ ______.

Table 1. Summary of Digestion Process

Organ	Digestive Juice	Enzyme	Action
Mouth	Saliva	Salivary amylase	Changes some starch to maltose or malt sugar
Stomach	Gastric juice	Hydrochloric acid	Stops salivary amylase action
		Pepsin	Changes some proteins to proteosis and peptones
		Rennin	Curds the casein of milk
		Gastric lipase	Splits some fats into glycerol and fatty acids
Small intestine	Pancreatic juice	Trypsin	Changes more proteins to proteosis and peptones and some proteosis and peptones to peptids
		Pancreatic amylase	Changes remaining starches to maltose
		Pancreatic lipase	Splits remaining fats into glycerol to form soap
	Bile		Mixes with fatty acids and glycerol to form soap
	Intestinal juice	Erepsin	Breaks down remaining proteins, proteosis, peptones, and peptids to amino acids.
		Maltase	Changes maltose to glucose
		Sucrase	Changes sucrose or cane sugar into simple sugars, glucose, and fructose
		Lactase	Splits lactose or milk sugar into simple sugars, glucose, and galactose

This unit is based on the information contained in VAS unit 1026 of the VAS of the College of Agr., Univ. of Illinois.

Name ____________________ Form ________
Date ______________

TEST

DIGESTION IN ANIMALS

UNDERLINE THE CORRECT ANSWER

1. ____________ in animals is the process of breaking down feeds into forms which can be used by the body cells.

   a. absorption
   b. digestion
   c. mastication
   d. rumination
   e. salivation

2. The stomach of a ruminant is divided into _____ divisions.

   a. one
   b. two
   c. three
   d. four
   e. five

3. The _________ makes up about 80 percent of a ruminant's stomach.

   a. abomasum
   b. caecum
   c. omasum
   d. reticulum
   e. rumen

4. Most digestion is completed and most absorption takes place in the ___________.

   a. caecum
   b. large intestine
   c. oesophagus
   d. small intestine
   e. stomach

5. Digestion takes place in the ________________.

   a. alimentary canal
   b. circulatory system
   c. gullet
   d. liver
   e. ~~liver~~ spleen

6. Micro-organisms that live in the rumen synthesize ________ and _________. (Choose two answers)

   a. carbohydrates
   b. fats
   c. minerals
   d. proteins
   e. vitamins

7. In poultry, the ________ crushes food particles and mixes them with digestive juices of the stomach.

   a. caecum
   b. crop
   c. gullet
   d. gizzard
   e. liver

8. Digestion begins in the ______.

a. large intestine
b. mouth
c. oesophagus
d. small intestine
e. stomach

9. ________ in general do most of the actual digesting.

a. Bacteria
b. Enzymes
c. Gastric juices
d. Pancreatic juices
e. Salivary juices

10. The alimentary canal includes the ______ and the ______. (Choose two answers.)

a. gall bladder
b. liver
c. mouth
d. pancreas
e. stomach

11. The three digestive juices; ______, ________, and ______ are mixed with the food in the small intestine. (Choose three answers.)

a. bile
b. gastric juice
c. hydrochloric acid
d. intestinal juice
e. pancreatic juice
f. saliva

12. Digestion of crude fibre and undigested proteins is carried out by __________ in the large intestine.

a. bacteria
b. bile
c. enzymes
d. gastric juice
e. pancreatic juice

13. _________ is the process by which the digested foodstuffs are taken into the blood system for distribution to the body cells.

a. absorption
b. digestion
c. diffusion
d. dissolution
e. mastication

14. The walls of the small intestine are lined with a large number of small cone or club-shaped projections called _________.

a. caeca
b. enzymes
c. glands
d. nodules
e. villi

TUMAINI SECONDARY SCHOOL

ANIMAL NUTRITION

This is a programmed instruction unit on animal nutrition.

In this unit you are to learn:

1. the main composition of plants and animals.
2. the nutritional requirements of animals.
3. the different groups of animal nutrients and their need by animals.
4. some practical rules of thumb for feeding livestock.
5. the Pearson Square Method of finding the proportion or percentage of two (or more) feeds which, when mixed together, will furnish a desired percent protein.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Animal Nutrition

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

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Animal nutrition, continued

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Name ____________________ Form _____

46. ______ to ______

47. - -

48. ______ to ______

49. ______ to ______

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55. ______________

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56. - -

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58. - -

59. - -

60. ____

____

Water carbohydrates (organic matter) ash	1. Plants and animals are composed of (1) water, (2) organic matter, and (3) mineral matter or ash. Organic matter is composed of carbon united with hydrogen and oxygen and, in some cases, nitrogen and other chemical elements. Mineral matter is neither animal nor vegetable; it is an inorganic homogeneous substance. Plants and animals are composed of ________, ________, and ________.
¾	2. Carbohydrates make up about three-fourths of all the dry matter in plants, and they are the chief source of energy and heat for animals. Carbohydrates are composed of carbon, hydrogen, and oxygen. Carbohydrates form about ________ of all dry matter in plants.
(1) water (2) carbohydrates (3) mineral matter or ash	3. Plants and animals are composed of (1) ________, (2) ________, and (3) ________.
carbohydrates	4. Animal nutritional requirements are most conveniently spoken of as requirements for maintenance, growth, fattening, production, and reproduction. ________ are the chief source of heat and energy for animals.
maintain	5. To sustain life with no loss or gain of weight requires sufficient feed to m________ the animal.
growth	6. In addition to a maintenance ration, an animal requires additional food to put on weight and increase in muscle and bone. This is called a g________ requirement.

fattening	7. Increased fat deposition is obtained by satisfying a requirement for f______________.
production	8. The nutrients to provide milk and wool are called the requirements for p____________.
reproduction	9. The required feed nutrients needed for an animal to produce young are called requirements for r________.
maintenance growth production fattening reproduction	10. The nutrient requirements are classified by the functions of ____________, ____________, ____________, ______________, and ____________.
no	11. A nutrient is any compound or group of compounds having similar chemical composition that aids in the support of life. Is maize a nutrient?
nutrient	12. A compound or group of compounds having similar chemical composition that aids in the support of life is called a ____________.

carbohydrates proteins fats minerals vitamins	13. The different groups of nutrients are carbohydrates, proteins, fats, minerals, and vitamins. Copy these.
carbohydrates	14. Carbohydrates are the starches, cellulose, and sugars. __________ make up ¾ of all dry matter of plants.
carbohydrates	15. Feeds high in carbohydrates are the grains and their by-products such as maize, oats, barley, wheat pollards, and wheat bran, and the fibre portions of roughages. These grains and their by-products are high in ________.
carbohydrates fats minerals vitamins proteins	16. The different groups of nutrients are __________, __________, ______________, ________, and __________.
protein	17. Proteins are compounds made up of amino acids. Proteins are particularly important nutrients needed for growth. Compounds made up of amino acids and important for growth are __________. The kind and quality of protein is fully as important as the amount.
protein	18. The common protein supplements are soybean meal, cottonseed meal, linseed meal, tankage, meat and bone scraps, fishmeal and dried skimmilk. All common feeds contain some ________ but not to the extent that those listed here do.

amino acids	19. Proteins are very complex substances, made up of 24 or more different amino acids. In the digestion of food the proteins are split into these amino acids which are absorbed from the digestive system and enter the blood stream. ______ ________ are the component parts of protein.
fats	20. Fats in the formsof esters of fatty acids and glycerol are the high-energy compounds of feeds. They are also the carriers of many of the vitamins present in feeds. _______ are the high-energy compounds of feeds.
blood stream	21. Minerals are the major elements of bones and teeth and a vital part of main tissues, organs, and the body's enzyme system, as well as the soft tissues and the fluids of the body. The amino acids are absorbed by the animal body through the ________ ________.
minerals	22. Calcium, phosphorous, sodium, chlorine, potassium, sulfur, magnesium, iron, iodine, copper, cobalt, zinc, manganese, molybdenum, florine, and arsenic are ___________ that are essential for, or affect in some way, livestock feeding.
proteins.	23. __________ are made up of amino acids and are furnished in adequate supplemental forms in cottonseed meal and fishmeal.
amino acids	24. Proteins are made up of _______ ___________ and are particularly important to meet the growth requirements.

protein growth maintenance reproduction	25.	Young animals require the nutrient p________ to meet g________ requirements. Mature cattle need nutrients to maintain the same weight. This is a m________ requirement. Bred cattle require an additional r________ requirement.
growth maintenance production	26.	A fattening ration must satisfy g________, m________, and p________ requirements of the animal.
carbohydrates	27.	C________ includes starches, sugars, and cellulose.
fats	28.	________ supply 2.25 times as much energy as carbohydrates. Fats aid in absorption from food of Vitamin A and may help in the absorption of calcium.
organic	29.	Vitamins are trace organic nutrients. Essential vitamins to livestock feeding are: A, D, E, K, Thiamin or B_1, niacin or nicotinic acid, B_{12}, and C or ascorbic acid, choline pyridoxin, biotin, and folic acid. Vitamins are trace ________ nutrients.
green forage crops	30.	One of the most important facts in livestock production is that all green forage crops are rich in most of the vitamins required by farm animals. The only exception seems to be Vitamin D and Vitamin B_{12}. Vitamin D and Vitamin B_{12} are not supplied by ________ ________ ________.

Vitamins	31. Water and oxygen provided inadequately, or inconveniently, may affect the performance of livestock. ________ are trace organic nutrients and must be considered in the balancing of rations.
maintenance growth fattening production reproduction	32. The nutrient requirements are classified by functions as ________, ________, ________, ________, and ________.
proteins minerals carbohydrates fats vitamins	33. The different groups of nutrients are ________, ________, ________, ________, and ________.
oxygen water	34. O________ and w________ are essential for successful performance of livestock but are not expensive to provide in most cases.
maintenance	35. The body can be kept at a constant weight and temperature when carrying on only such activities as digestion, heartbeat, and breathing by providing a m________ ration. The energy-producing nutrients (carbohydrates and fats) along with small amounts of protein, minerals, and vitamins fulfill this requirement.
proteins minerals vitamins water	36. Animals need proteins, minerals, vitamins, and water for growth, so feeds that are relatively high in these nutrients should be fed. A young growing animal suffers sooner and much more seriously from nutritive deficiencies than does a mature animal. Animals need ________, ________, ________, and ________ for growth. Proteins are most commonly limiting in a growth ration.

carbohydrates fats	37. Carbohydrates and fats are required for fattening. Little or no protein is necessary, but any extra protein in the ration that is not used otherwise can be used by the body for fattening. Proteins are generally more expensive, however, than carbohydrates and fats. __________ and __________ are more economical for fattening purposes than the protein feeds. The purpose of fattening is to cause "marbling" in the lean meat (deposition of fat in the lean meat) and a covering of fat over the carcass.
false	38. The nutrients that are needed for production vary according to the type of production. Milk is high in calcium, protein, and phosphorous, and feeds for milk cows should be high in these elements. All production requirements are the same. True or false?
- - -	39. Eggs are rich in protein, fats, minerals, vitamins, and water. Feeds high in these nutrients need to be fed to laying hens.
calcium phosphorous	40. Milk production requires feeds high in the minerals __________ and __________.
nutrition	41. The fertility of breeding stock is dependent on adequate nutrition levels. Small and weak litters of pigs and poor hatchability in poultry result from inadequate rations. Flushing of swine and sheep are two examples of the importance of adequate __________ to fertility of breeding stock.
vitamins	42. Breeding herds or flocks should be provided a liberal supply of protein, minerals, and vitamins. Liberal supplies of proteins, minerals and __________ are necessary to maintain high fertility.

24	43. A ration is the amount of feed allowed an animal during a 24-hour day. If a ration contains all the nutrients in proportion and amounts necessary for proper nourishment, the ration is said to be balanced. A ration is the amount of feed allowed an animal during a _______-hour period.
balanced	44. A good ration in addition to containing nutrients in the proper amounts should (1) be as economical as possible, (2) not be harmful to the animal, (3) should be palatable, and (4) be in the proper proportion. A ration that agrees with the above requirements is said to be a b________ ration.
2 3 1	45. The following are some practical "rules of thumb" for feeding livestock. For beef cattle maintenance, feed approximately 2 kilograms of air dry roughage for every 100 kilograms of liveweight. If silage is used, then substitute 3 kilograms of silage for 1 kilogram of air dry roughage. Protein and mineral supplements may have to be added to the hay or silage rations. A rule of thumb ration of roughage for beef cattle would be _____ kilograms per 100 kilograms of liveweight. If silage is used, substitute _____ kilograms of silage for each _____ kilograms of air dry roughage.
1 2	46. For beef cattle fattening, feed approximately ¾ to 1 kilogram of air dry roughage and 2 kilograms of concentrate per 100 kilograms liveweight to cattle on full feed. The ratio of roughage to concentrate is _____ to _____.
- -	47. For dairy cattle feed 2 kilograms of air dry roughage per 100 kilograms of liveweight and concentrate as follows: Milk breeds, feed 1 kilogram concentrate for every 3 kilograms milk produced. Dual purpose breeds, feed 1 kilogram concentrate for every 4 kilograms of milk produced.
1 3	48. Milk breeds of cattle require a ratio of concentrate to milk of ______ to ______.

1 4	49. Dual purpose breeds of cattle require a ratio of grain to milk of _______ to ______.
3	50. For sheep maintenance, feed 3 kilograms roughage per 100 kilograms liveweight and supplement with proteins and minerals if needed. Ratio of roughage to 100 kilograms liveweight is _______ kilograms per 100 kilograms liveweight for sheep.
1½ 2 100	51. For sheep fattening feed 1½ kilograms roughage and 2 kilograms of concentrate per 100 kilograms liveweight. The sheep fattening ratio is _____ kilograms roughage to _______ kilograms concentrate to ________ kilograms of liveweight.
- -	52. For bred sows and gilts. If self-feeding, provide enough ground roughage to furnish 12-15% fibre. Approximately 1/3 roughage, such as ground legume hay or maize cobs; 1/3 wheat; and 1/3 maize supplemented (barley may be substituted for maize) with protein, minerals, and vitamins will be satisfactory. Control the gain in weight by changing the proportion of roughage to concentrate. More concentrate results in more gain and vice versa.
concentrate roughage	53. To reduce gain, reduce _____________ and increase _________ proportionately, in bred gilts and sows.
12 15	54. If self feeding sows and gilts, feed enough roughage to provide _______ to _______ % fibre.

roughage wheat maize or barley	55. Bred sows and gilts should be fed 1/3 ____________, 1/3 ____________, and 1/3 __________ with proper supplements.

56. The Pearson Square Method of balancing rations is used to simplify, and systematize the procedure.

To find the proportion or percentages of two feeds which, when mixed together, will furnish the desired percent of protein (or any other nutrient) use the square as follows:

Calculate the amount of maize (10% crude protein) and soyabean oil meal (50% crude protein) that will be needed to furnish 10 kilograms of a mixture containing 20% crude protein.

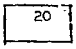
1. Draw a square with lines connecting opposite corners.

2. In the centre of the square, enter the crude protein percentage desired in the mixture.

3. At the left-hand corners of the square, write the materials mixed together and their crude-protein content.

Maize 10

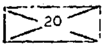
Cotton seed meal 50



4. Subtract along the diagonals, the smaller from the larger, and place the difference at the opposite end of the diagonals. Thus 20 minus 10 is 10, and 50 minus 20 is 30.

Maize 10 30

Cottonseed meal 50 10



The 30 then becomes the parts of maize required in the ration and the 10, the parts of soybean meal.

Maize	10		30
		20	
Cottonseed meal	50		10
			40 total parts

5. To find the percentage of each feed in the desired mixture, divide the parts of <u>each</u> by the <u>total</u> parts.

Maize 30 ÷ 40 x 100 = 75%

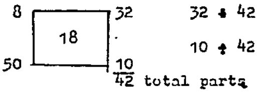
Cottonseed meal 10 ÷ 40 x 100 = 25%

6. Since we want 10 kilograms of the mixture, mix (10 kg. x 75%) 7.5 kg. of maize with (10 kg. x 25%) 2.5 kg. of cottonseed meal.

57. Calculate, using the Pearson Square, the amount of wheat (8% crude protein) and soyabean oil meal (50% crude protein) that will be needed to furnish 100 kilograms of a mixture containing 18% crude protein.

Wheat

Soyabean meal



32 ÷ 42 = 76 parts or 76% wheat

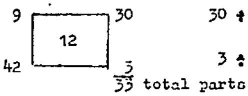
10 ÷ 42 = 24 parts or 24% soyabean oil meal

The 100 kilogram mixture should be made up of 76 kilograms of wheat and 24 kilograms of soyabean oil meal.

58. Calculate, using the Pearson Square, the amount of wheat (9% protein) and cottonseed cake (42% protein) that will be needed to furnish 100 kilograms of a mixture containing 12% protein.

Wheat

Cottonseed cake



30 ÷ 33 = 90.9 parts or 90.9% wheat

3 ÷ 33 = 9.1 parts or 9.1% cottonseed cake

The 100 kilogram mixture should be made up of 90.9 kilograms of wheat and 9.1 kilograms of cottonseed cake.

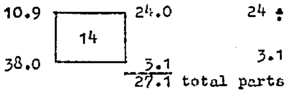
59. Suppose you plan to use 20% wheat at 10.5% protein, 40% barley at 9% protein and 40% mill run at 13% protein. You will supplement this grain ration with a 38% protein supplement. You require a 14% mix. Solve using the Pearson Square for 100 kilograms of feed.

Wheat = .105 x 20 = 2.10 Barley = .09 x40 = 3.60 Mill run = .13 x 40 = 5.20

2.1 + 3.6 + 5.2 = 10.9% protein in the mixture of wheat, barley, and mill run at the percentages given.

mix

supplement



24 ÷ 27.1 = 88.6 parts or 88.6% "mix"

3.1 ÷ 27.1 = 11.4 parts or 11.4% protein supplement

The 100 kilogram mixture should be made up of 88.6 kilograms of mixed grain and 11.4 kilograms of protein supplement.

Sufficient nutrients in a 24-hour period in proportion to requirements of the animal.	60. The key to profitable livestock feeding is to feed a balanced ration. Define such a ration.

This unit is based on a similar one prepared by Gilbert Long of the College of Education at Washington State University, Pullman, Washington.

Name ________________ Form _____
Date _______________

TEST

ANIMAL NUTRITION

UNDERLINE THE CORRECT ANSWER

1. Animals require nutrients to sustain life with no loss or gain of weight. This is called ______.

a. fattening
b. growth
c. maintenance
d. production

2. __________ are the chief sources of heat and energy for animals.

a. Carbohydrates
b. Fats
c. Minerals
d. Proteins

3. The nutrients to provide milk and wool are called the requirement for ____.

a. fattening
b. growth
c. production
d. reproduction

4. ___________ include starches, sugars, and cellulose.

a. Carbohydrates
b. Fats
c. Minerals
d. Proteins

5. Feeds that are high in ______ include maize, oats, barley, and wheat pollards.

a. carbohydrates
b. fats
c. minerals
d. protein

6. The kind and quality of _______ are fully as important as the amounts.

a. carbohydrates
b. fats
c. minerals
d. proteins

7. _________ are the high energy compounds of feeds.

a. Calcium
b. Carbohydrates
c. Minerals
d. Proteins

8. _________ are essential minerals for feeding livestock. (Choose 2 answers.)

a. Gold
b. Manganese
c. Platinum
d. Silver
e. Sodium

9. Fats supply ______ times as much heat energy as do carbohydrates.

a. 2.00
b. 2.25
c. 2.50
d. 2.75

10. ___________ requirements vary according to what is created for "sale" by the animal (milk, wool, meat, eggs, etc.).

a. Growth
b. Maintenance
c. Production
d. Reproduction

11. A(n) ______ is the amount of feed nutrients in the proper proportion for a 24-hour period.

    a. adequate supply
    b. balanced ration
    c. increment
    d. ration

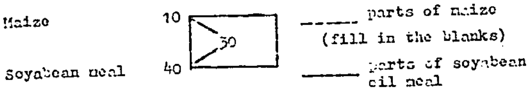
12. ________ are common protein supplement feeds. (Choose <u>two</u> answers.)

    a. Barley
    b. Bone meal
    c. Cottonseed meal
    d. Maize
    e. Oats
    f. Soyabean meal

13. To reduce gain of bred sows or gilts, feed more ______ and less _______. (Choose <u>two</u> answers.)

    a. grain
    b. minerals
    c. protein
    d. roughage
    e. vitamins

14.



    a. 10 parts maize
    b. 70 parts maize
    c. 10 parts soyabean meal
    d. 70 parts soyabean meal

(underline <u>two</u> answers)

TUMAINI SECONDARY SCHOOL

FEED CHARACTERISTICS

This is a programmed instruction unit on feed characteristics.

In this unit you are to learn:

1. to classify feeds into the following groups:
   - a. total digestible nutrients
   - b. net energy
   - c. concentrates
   - d. protein supplements (animal and plant)
   - e. roughages
   - f. legumes and non-legumes forage quality.
2. Energy value as a measure of feeding value.
3. Maintenance and production-feed requirements.
4. The importance of forage testing as an economic tool for efficient feeding of livestock.
5. The method of matching forage-test information with grain requirements for dairy cattle.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Feed Characteristics

If you have not read the cover page, do so now, then proceed to frame 1.

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54. ____________
55. ____________
56. ____________
57. ___1. ___2. ___3. ___4. ___5. ___6. ___7.
58. ____________
59. ____________
60. See frames 48 & 49.

- -	1. Livestock foods are generally classified according to the amount of total digestible nutrients (TDN) they provide, or according to the amount of specific nutrients they furnish in the ration.
Roughages	2. Feeds that contain relatively large amounts of fibre or non-digestible material are called roughages. __________ contain large amounts of fibre..
fibre	3. Concentrates are feeds that have a comparatively high digestibility, and are high energy foods. Concentrates are relatively low in f________. They include all grains and many by-products of grains and animals, such as wheat pollards, tankage, and cottonseed oil meal.
grains	4. Concentrates include all g_____ such as wheat, maize, oats, and barley.
concentrate	5. Tankage is a protein supplement as is cottonseed oil meal because it has 20 percent or more protein. Wheat is a ____________.
concentrates	6. Protein concentrates may be classified as a subdivision of concentrates. They contain 20 or more percent protein. ______________ have a comparatively high digestibility.

20	7. Protein concentrates contain ______ or more percent protein.
Animal	8. Protein concentrates are derived from either animal or vegetable substances. Proteins derived from animal or animal by-products are high quality protein feeds valuable for poultry and swine. They are more expensive than plant proteins. ______ proteins are high quality proteins.
vegetable or plant animal	9. Vegetable or plant proteins are found in the by-products of plants. Soyabean oil meal, linseed oil meal, cottonseed meal, and groundnut oil meal are ______ protein concentrates. Tankage, meat scraps and fish meal are ______ protein concentrates.
animal	10. The ruminant-stomached livestock are fed vegetable proteins because ______ proteins are more expensive and are not essential feed stuffs for ruminant animals. They synthesize their own protein "quality proteins" whereas swine and poultry connot.
protein	11. Cottonseed oil meal, soyabean oil meal, and linseed oil meal have in excess of 20 percent protein and are classified as ______ supplements.
grains or high energy feeds	12. The grains are the best source of energy for the common feed stuffs and they have the best fattening value. Maize and wheat are examples of ______.

non-legume	13. Roughages are divided into legume and non-legume. Legumes are plants that have the ability to use nitrogen which they take from the air. Legumes are higher in protein than are ________ roughages.
Grains	14. Grains and roughages vary considerably in nutrient values depending upon variety, stage of maturity, soil fertility, where grown, methods of harvesting, and length of time in storage. ________ and roughages vary considerably in nutrient value.
- -	15. The manufacturing process determines to some extent the values of feeds. Therefore, average composition of various feeds is often used when planning livestock rations. This is true regarding grains, but forage testing is done chemically and will be discussed later in this program.
important	16. It is (important, unimportant)((choose one)) for the farmer feeding home grown feeds to have a chemical analysis made of his feed because of the variability of these feeds.
- -	17. The energy value of a feed is a very good criteria of its feeding value. Energy losses occur through undigested material in the feeds, energy losses in the urea, energy lost (in small amounts) in the combustible gases, and energy lost in the various processes of chewing, digesting, and assimilating food.
less than	18. The animal can be likened to an automobile. There is (less than, nearly perfect, perfect) efficiency in utilization of the "fuel".

- -	25. For purposes of balancing rations, we must know (1) the nutrient requirement of the animal, and (2) the nutrient content of the feed. Crude protein and energy are the measurements that we use primarily for the nutrient content of the feed (T.D.N.)
- -	26. Net energy is measured as NEm or net energy for maintenance, and NEp or net energy for production. For example: Crude Protein — TDN — NE (m, p) Lucerne — 15 — 50 — 34 — 24 The net energy value of lucerne for maintenance is higher than the energy value for production. This is characteristically true as the maintenance ration must be satisfied before the production requirement is met.
net energy maintenance net energy production production maintenance energy T.D.N.	27. NEm stands for ____________. NEp stands for ____________. Net energy is calculated in terms of ____________ requirements and ____________ requirements. ____________ is a more sensitive indicator of feeding values than is ____________.
- -	28. Maintenance feed requirements furnish the nutrients to provide neither gain nor loss of weight, plus normal nutritional health. The production requirement is the requirement for wool and milk or fat above the maintenance requirement.
seven	29. Livestock require about seven times as much energy as protein in their diets. There is a considerably greater difference between the net energy value of a high grade concentrate and that of a dry roughage than there is between the percentages of total digestible nutrients furnished by the same feed. Livestock require ________ times as much energy as protein.
- -	30. Dent maize of Grade No. 1 supplies 180 therms of net energy per 100 kilograms, while timothy hay, all analysis, furnishes but 82 therms, or only 46 percent as much. However, timothy hay has about 60 percent as much digestible nutrients as does maize. It has 49.1 percent total digestible nutrients, in comparison with 81.9 percent of No. 1 dent maize.

- -	31. Net Energy Therms — TDN % Dent Maize — Grade No. 1 — 180 — 81.9 Timothy Hay — All Analysis — 82 — 49.1 82 is 36% of 180 49.1 is 60% of 81.9
- -	32. The net energy figures are no meaningful than the TDN (total digestibel nutrients) figures in most cases when balancing feed rations.
Forages grains	33. The nutrient requirements of dairy cattle are satisfied largely by forages and grains. F________ make up 60-80 percent of the total nutrients and G________ the other 20-40 percent of the nutrients for dairy cattle.
low	34. The protein in the grain mixture should complement the protein supplied by the forage. The grain, of course, is the primary energy feed. A high protein hay would require a _______ protein grain.
- -	35. A poor quality hay may require a high protein grain costing as much as Shs. 105 more per 1000 kilograms. Some forage tests have resulted in a range of 2.8-14.9% protein for grass hay and 10.6-24% for legume hay.
errors	36. These quality differences demonstrate differences in harvesting, climate, soils, and variety of seed. Using average values of forages when balancing the protein level in grain mixtures leads to large (advantages, errors).

- -	37. Visual estimates of forage quality, as are sometimes used for grading of hay, are often in error. Erros as much as 5 percent in crude protein and 9 percent TDN (total digestible nutrients) are made by trained individuals.
- -	38. The case for forage testing is based upon the relation between the chemical composition of a forage and its feeding value for animals. As a plant matures, its digestibility decreases and its protein content declines. Chemically these changes are reflected by an increase in crude fibre (and lignin) and by a decrease in crude protein. This is the basis of forage testing. Hays that are weathered also show an increase in fibre and a decrease in protein since soluble nutrients are washed out by rain and leaves are lost during harvest.
declines increases fibre protein	39. As a plant matures its digestibility d________. As a plant matures, crude fibre content i________. Weathered hay shows an increase in f________ and a decrease in p________. Weathered hay loses Vitamin A in large amounts, but does not lose a like amount of energy unless the hay molds.
less	40. As digestibility of a feed declines and its crude fibre content increases, the value of this particular feed becomes ________.
fibre protein	41. Forage testing tests for the amount of crude f________, and, therefore, crude p________.
15	42. Hay varies with the way in which it is grown, cured, and stored. Soils, climate, and variety of plant also affect quality of hay. There are often differendes in quality within the same field due to weather changes during harvest. A representative sample is, therefore, important (15% approximately). To sample a 5,000 kilogram unit of hay one should take at least (5, 12, 15) core samples from different places.

1	43. The purpose of forage testing is to ________. (Choose one.) (1) Establish an accurate feed value for roughage. (2) Establish an accurate feed value for the concentrate fed. (3) Determine how much an animal requires to produce at a certain level.
- -	44. The single most important step in forage testing is sampling. Fifteen cores (drill samples) should be taken from one lot of forage. Samples from one bale vary as much as 1.8 percent protein. Bales in a lorryload vary as much as 6.5 percent protein.
15	45. ________ core samples should be taken from each lot of forage. Samples should be taken each time a change in feed is noticed; for example, change from first cutting to second cutting.
- -	46. We said that we try to balance protein content of our fora by the grain we purchase or mix. In general, we expect our hay to follow the following averages: Remember a forage test is the only accurate method - the table below is here for use as an example only.
- -	47. Average Crude Protein (moisture free) Brome Grass . . . . 7% Ladino Clover. . . . . 18% Lucerne . . . . 16% Red Clover . . . . 9% Oat Forage . . . . 7% Orchard Grass. . . . . 8% Timothy . . . . 5% Maize Silage 5%

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48 and 49. The following table will tell you what percent of protein grain to feed with your forage.

% Crude Protein in Forage	% Crude Protein Needed in Grain Mix
2.0 - 3.3	20
3.4 - 4.5	19
4.6 - 5.6	18
5.7 - 6.8	17
6.9 - 7.9	16
8.0 - 9.1	15
9.2 -10.2	14
10.3 -11.4	13
11.5 -12.5	12
12.6 -13.7	11
13.8 +	10

15%
11%

50. What percent protein grain would you feed if your forage tested 8.3% on a dry matter basis? (See above table.)

And if the forage tested 13.2%

- -

51. Many cases where high quality forage is fed require only 10-12% crude protein in the grain mix (as per table.) When this occurs economical grain mix may be fed which does not include a protein supplement. Such mixtures as steamedrolled barley, barley-oats, or barley-mill run combinations which contain 1% steamed bone-meal or dicalcium phosphate and 1% iodized or trace mineralized salt are good feeds.

does not

52. A high quality forage (does, does not) require a grain mix containing a protein supplement.

- -

53. How can we establish how much grain and hay to feed each cow? We need to know what her individual nutrient requirements are. This is determined by her production. Tables are available to conveniently arrive at the correct amounts.

forage	54. The basis for an economical feeding system for dairy cows is ________ testing.
are not	55. High quality lucerne hay requires a mixture of home grown grains plus 1% steamed bonemeal and 1% salt, iodized or trace mineralized. Protein supplements (are, are not) necessary with this kind of forage.
Shs. 4,410.00	56. Through forage testing it was found that a dairy farmer needed 10% protein grain rather than the 13% protein grain he had been feeding. This resulted in a saving of Shs. 35.00 per 1,000 kilograms of grain. Over a 10 month period, feeding 60 cows at an average of 7 kilograms per animal per day, the farmer saved Shs. ____.
2,3,5 - A 1,4,6,7 - P	57. Label the plant derived protein supplements with a P, and the animal derived protein supplements with an A. ______ 1. Soyabean oil meal ______ 2. Tankage ______ 3. Meat scraps ______ 4. Cottonseed oil meal ______ 5. Fish meal ______ 6. Linseed oil meal ______ 7. Groundnut oil meal
animal	58. (Plant proteins or Animal proteins) are higher quality proteins and are more expensive.
concentrate	59. Barley, wheat, and pollards are (protein supplements, concentrates).

See frames 48-49	60. Suppose a forage test indicated a 16% crude protein hay. What percent protein grain is necessary?

This unit is based on a similar one prepared by Gilbert Long of the College of Education at Washington State University, Pullman, Washington.

Name ________________ Form _____
Date ________

TEST

FEED CHARACTERISTICS

UNDERLINE THE CORRECT ANSWER

1. Livestock feeds are generally classified according to the amount of _______ they provide.
   - a. availability
   - b. colour
   - c. net energy available
   - d. nutrients not fat
   - e. total digestible nutrients

2. Feeds that contain relatively large amounts of _______ are called roughages.
   - a. ash
   - b. fibre
   - c. lignin
   - d. minerals
   - e. protein

3. Feeds that contain relatively small amounts of ______ are called concentrates.
   - a. carbohydrates
   - b. fibre
   - c. minerals
   - d. protein
   - e. water

4. _________ are feeds that have a comparatively high digestibility.
   - a. Concentrates
   - b. Legumes
   - c. Protein
   - d. Roughages
   - e. Total digestible nutrients

5. ___________ are feeds that have a comparatively low digestibility.
   - a. Carbohydrates
   - b. Concentrates
   - c. Minerals
   - d. Protein
   - e. Roughages

6. Protein supplements contain ______ or more percent protein.
   - a. 10
   - b. 15
   - c. 20
   - d. 30
   - e. 40

7. Tankage is classified as a _____.
   - a. concentrate
   - b. feed additive
   - c. lowfibre feed
   - d. protein supplement
   - e. vitamin

8. Protein supplements originate from ______ or ______. (Choose 2 answers.)
   - a. animals
   - b. cereals
   - c. fibrous
   - d. minerals
   - e. plants

9. Fish meal is ____________.
   - a. an animal derivitive protein supplement
   - b. a carbohydrate substitute
   - c. a little used protein supplement
   - d. a plant derivitive protein supplement
   - e. an unpalatable feed.

10. The _____ derivitive proteins are the best quality proteins of the common protein supplements.

a. animal
b. enzyme
c. mineral
d. plant
e. vegetable

11. The small grains are __________.

a. concentrates
b. high fibre feeds
c. low energy feeds
d. protein supplements
e. roughages

12. Feeds ______ depending upon such things as variety, soil fertility, where grown, methods of harvesting, stage of maturity, and length of time in storage.

a. do not vary
b. vary
c. vary but do so in no particular order

13. The _____ determines to some extent the quality of the feed.

a. distribution methods
b. manufacturing process
c. price
d. quantity
e. weight

14. _______ losses occur through chewing, digesting, assimilation of feed, and losses through undigested material in the feeds.

a. Amino acid
b. Energy
c. Mineral
d. Protein
e. Time

15. The _________ represents the amount of energy available for productive purposes, such as growth.

a. energy value
b. net energy value
c. net production value
d. real income value
e. total digestible energy

16. For purposes of balancing rations we must know the _______ and the ______. (Choose 2 answers.)

a. cost of the feeds
b. nutrient content of the feed
c. nutrient requirements of the animal
d. preferences of the owner
e. type of feeding system used

17. ___________ is only partially digestible (75-85%).

a. A carbohydrate
b. Crude protein
c. Digestible protein
d. Energy
e. A mineral

18. Net energy requirements are broken down into requirements for _________ and ___________. (Choose 2 answers.)

a. digestion
b. growth
c. maintenance
d. production
e. therms

19. Livestock require about ______ times as much energy as protein.

a. 3
b. 4
c. 5
d. 7
e. 12

20. NEp stands for ________.

a. net energy
b. net energy for production
c. net energy potential
d. net energy power
e. new energy production

21. The value of a feed ______ as digestibility decreases and crude fibre increases.

a. decreases
b. increases
c. stays the same

22. Ruminant stomached animals are fed ________ protein feeds because the higher quality animal derivitive proteins are unnecessary and, generally, more expensive.

a. energy
b. plant
c. T.D.N.
d. total digestible
e. unusual

23. The single most important step in forage testing is ______.

a. accurate size samples
b. a large sample
c. a proportional sample
d. a small sample
e. a useful sample

24. Roughages are divided into ________ and ________. (Choose 2 answers.)

a. concentrates
b. fibres
c. grains
d. legumes
e. non-legumes

TUMAINI SECONDARY SCHOOL

VITAMINS

This is a programmed instruction unit on vitamins.

In this unit you are to learn:

1. The importance of vitamins to animal nutrition.
2. What vitamins are.
3. Which vitamins are essential to animal nutrition.
4. How the individual vitamins are provided to livestock.
5. What anti-vitamins are.
6. Symptoms of vitamin deficiency.
7. Which vitamins are commonly deficient within particular classes of livestock.
8. The importance of vitamins to reproduction.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
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Vitamins

If you have not read the cover page, do so now, then proceed to frame 1.

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vitamins	1. Much of our modern efficiency in feeding livestock, particularly swine and poultry, can be attributed to the rapid succession of discoveries concerning vitamins. Research concerning ________ has increased the efficiency of animal production and has made possible the prevention of serious diseases.
- -	2. Previous to 1911 vitamins were unknown. The vitamins that are known are not related chemically to each other, as are proteins, fats or the carbohydrates. The function of the vitamins are also entirely different from each other.
vitamins	3. The ________ are grouped together because each vitamin is organic in nature and because in many cases it is a nutritive essential required only in an exceedingly small amount.
Vitamins	4. Some vitamins are needed by only a few species of animals. Others are required by all species, but there is no need for a supply in the feed. This is because an adequate supply is synthesized, either in the body tissues or by bacteria in the digestive tract. __________ are grouped together because they are organic in nature.
vitamin A carotene	5. Vitamin A is required by all animals and can be made only from carotene contained in plants. Animals must, therefore, receive in their food an adequate supply of ________ or ________.
carotene	6. The knowledge concerning the different amounts of each vitamin in various feeds is limited compared with our knowledge of the ordinary nutrients. Vitamin A is found in the form of ________ in many plants. Animals cannot synthesize this vitamin.

A	7. All green forage crops are rich in most of the vitamins required by farm animals. Animals are not able to produce Vitamin ______. It must be in their feed.
forage	8. Green __________ crops are a rich source of vitamins. These crops provide vitamins (and minerals) in proportion to the leafiness of the plant.
- -	9. The exception to the preceeding statement is lack of Vitamin D and Vitamin B_{12}. These two vitamins, D and B_{12}, are not plentiful in green forage crops.
- -	10. Swine and poultry on good pasture do not seem to need Vitamin B_{12} even though pasture is not a good provider of Vitamin B_{12}. Vitamin D is supplied by sunlight.
D D, B_{12}	11. Hay and other dry forage cured in the sun supply vitamin _______. Pasture is not a good source of vitamins ______ and _____.
forages vitamins and minerals	12. Green forages supply undiscovered vitamins as indicated by the fact that sows on dry lot fed a seemingly balanced diet are unable to reproduce until supplied with green ________. Legumes have more leaves than grasses and are richer in v__________ and m_________.

D	13. A study of vitamins is not complete without some mention of the antivitamins. Antivitamins are substances that prevent the action of the vitamin or even destroy it. The sun supplies vitamin ______ to animals directly and indirectly through hay.
A	14. Vitamin _______ must be included in an animals' feed in the form of carotene. This vitamin is essential for maintenance of mature animals and in greater amounts for growth, reproduction, and lactation.
carotene	15. The so-called "cottonseed-meal poisoning", produced when cattle are fed for lengthy periods on such a ration as cottonseed meal and cottonseed hulls, is due primarily to the lack of Vitamin A. Vitamin A is found in plants as c________.
Vitamin A	16. Severe losses of vitamin A occur through oxidation during hay making or long storage periods. Hay stored a year or longer has little or no vitamin A feed value. "Cottonseed-meal poisoning" is caused primarily by a shortage of __________. Rain on drying hay results in severe losses of vitamin A. Energy losses occur if molding occurs.
Antivitamins A	17. The cereal grains with the exception of yellow maize are very low in vitamin A. _________ are substances that prevent the action of vitamins or even destroy them. Severe losses of vitamin ______ occur during the hay making process due to the drying action of the sun (oxidation).
A	18. Adequate vitamin D is necessary for the proper assimilation and use of calcium and phosphorous and the development of good bones and teeth. Vitamin D is needed especially during growth. Much less Vitamin D is necessary for maintenance of mature animals. The cereal grains, with yellow maize the one exception, are low in vitamin ________.

calcium phosphorous	19. Poultry need more vitamin D in their rations than do other farm stock, especially for egg production. Vitamin D is necessary for the proper assimilation of the minerals ________ and ________.
Poultry D	20. ________ need more vitamin D than do other livestock. The assimilation of calcium and phospherous is tied to adequate amounts of vitamin ______.
growth	21. Deficiency of vitamin D causes rickets. Less severe deficiencies retard growth and produce a weak skeleton. Vitamin D is needed especially during ________.
rickets	22. A deficiency of vitamin D in mature fowls causes thin-shelled eggs, decreased egg production, and lowered hatchability. Deficiency of vitamin D causes r________.
A	23. When dairy cows, beef cattle, or sheep receive ordinary rations that include satisfactory roughage, no attention need generally be given to the B-complex vitamins because of the synthesis of these vitamins in the rumen. The cereal grains are low in vitamin except for yellow maize.
vitamin D	24. Swine need the B-complex vitamins in their feed because there is little synthesis of them in their digestive tracts. Their requirements are met by pasture during the growing season and good well-cured legume hay when not on pasture. Thin shelled eggs may be caused by a deficiency of _____.

synthesize or produce	25. Sheep, beef, and dairy cattle ________ the B-complex vitamins in the rumen.
swine	26. Forms of yeast such as brewers dried yeast are sometimes used as a B-complex vitamin supplement. ________ do not synthesize B-complex vitamins in their digestive tracts and, for this reason, must receive adequate B-complex vitamins in their food.
Riboflavin	27. Riboflavin or Vitamin B_2 is required in large amounts for poultry. Milk and dairy by-products such as dried skim milk, dried butter milk, and dried whey are especially rich in riboflavin. They are valuable poultry feeds. ________ is vitamin B_2.
yeasts riboflavin milk products	28. ____________ are sometimes used as B-complex vitamin supplements. Vitamin B_2 or ____________ is supplied in good amounts by m______ p________.
rich	29. Niacin or nicotinic acid is a B-complex vitamin that is necessary for all animals. Ruminants synthesize their own supply. Humans, dogs, swine, and poultry require a supply in their food. Milk and dairy products are a _______ source of riboflavin.
Ruminants humans dogs, swine, or poultry	30. Dried yeast, rice polish, rice bran, wheat bran, groundnut oil meal, and green forage and pasture crops are rich in the vitamin niacin. Good quality hay supplies a fair amount, while maize, grain, oats, rye, and dairy by-products have a rather low content. __________ synthesize their own supply of niacin; __________ do not.

rich Ruminants humans, dogs swine, or poultry	31. Vitamin E is necessary for reproduction in poultry, rats, and perhaps some other animals. "Stiff lamb disease," can be prevented or cured by vitamin E. A deficiency of vitamin E seems to be the cause of "white muscle disease" also. Green forage is ______ in niacin. __________ synthesize their own supply of niacin, __________ do not.
reproduction	32. A lack of vitamin E/in poultry feeds causes the disease encephalomalacia, or "crazy chick disease". A prolonged lack causes lowered hatchability of eggs and sterility of males. Vitamin E is necessary for r__________ in poultry.
E	33. Deficiency of vitamin ______ seems to cause "white muscle disease". "Stiff lamb disease" can be cured by this vitamin. Crazy chick disease is caused by a deficiency of this vitamin.
vitamin C	34. Only human beings, monkeys, and guinea pigs lack the ability to synthesize ascorbic acid (vitamin C). Sailors in early history suffered from a deficiency of __________ ________.
vitamin C	35. A deficiency of vitamin C (ascorbic acid) in man, monkeys, or guinea pigs causes scurvy. The symptoms are loosening of the teeth, inflammation of the gums, hemorrhages, brittleness of the bones, slow healing of wounds, and loss of vigor. Slow healing of wounds is a symptom of a deficiency of ____________.
scurvy	36. A deficiency of vitamin C evidenced by loosening of the teeth is a sign of _________.

This unit is based on a similar one prepared by Gilbert Long of the College of [illegible]

Name ______________ Form _____
Date ______________

TEST

VITAMINS

UNDERLINE THE CORRECT ANSWER

1. The chemical make-up and functions of vitamins are ____________.
   - a. different from each other
   - b. similar but distinct
   - c. similar to each other
2. Vitamin ________ is required by all animals and must be present in the feeds.
   - a. A
   - b. B
   - c. B_{12}
   - d. C
   - e. D
3. Research in vitamins is ____________.
   - a. easy
   - b. economical
   - c. extensive
   - d. limited
   - e. questionable
4. So called "cottonseed meal poisoning" is really a deficiency of vitamin ___.
   - a. A
   - b. B_{12}
   - c. C
   - d. D
   - e. F
5. Severe losses of vitamin _______ occur through oxidation during hay making or long storage periods.
   - a. A.
   - b. B_2
   - c. B_{12}
   - d. D
   - e. E
6. Adequate vitamin D is necessary for the proper assimilation and use of the minerals _________ and __________. (Choose two answers.)
   - a. calcium
   - b. iron
   - c. manganese
   - d. magnesium
   - e. phosphorous
   - f. zinc
7. Poultry need more vitamin ______ in their rations than do other farm stock, especially for egg production.
   - a. A
   - b. B
   - c. C
   - d. D
   - e. E
8. Deficiency of vitamin _________ causes rickets.
   - a. A
   - b. B
   - c. B_2
   - d. B_{12}
   - e. D

9. Swine need ________ because they do not synthesize it in their digestive tracts as sheep, beef, and dairy cattle do.

   a. Vitamin A
   b. Vitamin B-complex
   c. Vitamin C
   d. Vitamin D
   e. Vitamin F

10. All green forages are ______ sources of vitamins.

   a. expensive
   b. inadequate
   c. moderate
   d. poor
   e. rich

11. A deficiency of vitamin ________ accompanied by loosening of the teeth is evidence of scurvy.

   a. A
   b. B_2
   c. B_{12}
   d. C
   e. D

12. An ________ prevents the actions of vitamins or kills the vitamins.

   a. antibiotic
   b. antidote
   c. antivitamin
   d. exovitamin
   e. killer vitamin

13. Vitamin ______ is necessary for reproduction in poultry, rats, and perhaps some other animals.

   a. A
   b. C
   c. D
   d. E
   e. G

14. Lack of vitamin ______ seems to cause "white muscle disease."

   a. A
   b. C
   c. D
   d. E
   e. K

15. Slow healing wounds are symptomatic of a deficiency of vitamin ________.

   a. A
   b. B_{12}
   c. C
   d. D
   e. K

TUMAINI SECONDARY SCHOOL

MINERALS

This is a programed instruction unit on feed characteristics.

In this unit you are to learn:

1. the importance of minerals for animal growth and reproduction.
2. which minerals are required.
3. which functions minerals perform in the body.
4. what adequate mineral nutrition depends on.
5. symptoms of mineral deficiencies.
6. classification of minerals as major or minor elements.
7. salt deficiency symptoms.
8. symptoms of deficiency for the major and minor elements.
9. specific mineral information for common feeds for different classes of livestock.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Minerals

If you have not read the cover page, do so now, then proceed to frame 1.

-Cut-

-Cut-

Name ______________________ Form ________

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Revision

A. ________
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46. ____________
47. ____________
48. - -

Minerals	1. A ration containing an abundance of protein, carbohydrates, and fat without minerals will generally result in the death of an animal sooner than if no food at all is given. ___________ are necessary for many body processes including growth and reproduction.
15	2. Fifteen separate and distinct mineral elements are known to be required by animals. Some of the important functions they perform in the body are: (1) they contribute to the body structure, particularly the bones and teeth, (2) they aid in muscular activities, in the reproduction processes, and in lactation and egg production, and (3) they promote digestion of food, repair the body tissues in maintenance, formation of new tissue in growth, and liberation of energy for muscular work and activity and the production of heat. ________ minerals are known to be required by animals.
minerals	3. Adequate mineral nutrition is dependent on: (1) a sufficient intake of each required element, (2) presence of the elements in forms biologically available to animals, (3) a suitable balance between each of the elements, and (4) adequate supply and balance of other nutrient factors. Sufficient energy and vitamins in balance with other nutrients are necessary to insure adequate absorption of available ___________.
3 2 and 3 1 and 4	4. We must know the type of ration and the form in which the mineral is fed based upon item ___ listed in frame 3 above. Fertilizer elements added to a deficient soil might result in a deficiency of a mineral element previously adequate in the feed ration and probably adequately supplied now. This condition could be explained by ____ and ____ listed in frame 3. Irrigation may wash away soluble minerals such as calcium. Calcium might become deficient because of ______ and/or ______ listed in frame 3.
- -	5. When supplementing rations, only those minerals that are deficient need be added. As necessary as minerals are, an oversupply can reduce performance or in some cases even be toxic. As an example, cobalt is most essential yet when as little as 12 ppm (.1 gram/day) is fed, digestion of roughage is reduced. Consequently, cattle feeders cannot operate on the theory that if a small amount of mineral is good three times this level would be better. Indiscriminate use of minerals may be expensive in cost and in reducing performance.
False	6. Mineral deficiencies may be so slight as to be hardly noticeable or acute enough to cause death. Correct feeding practices must include feeding of the minerals that the animal needs. Nothing is gained in adding a mineral to a ration in which enough of that mineral is already included. Extra minerals fed as "insurance" are an economical supplement to feed. True or False?

False	7. Mineral deficiencies that are not severe enough to result in visible symptoms may represent an economic loss because of reduced growth and inefficient feed utilization. Therefore, mineral deficiencies may result in an exonomic loss before they are serious enough to cause visible symptoms. Mineral deficiencies are important only if deficiency symptoms can be observed. <u>True or False?</u>
calcium phosphorus potassium sodium sulfur chlorine magnesium False	8. The essential elements are usually classied as either major or minor. The essential <u>major</u> elements are calcium, phosphorus, potassium, sodium, <u>sulfur</u>, chlorine, and magnesium. The essential major elements are: c______, p______, p______, s______, s______, c______, and m______. Mineral supplements should be added to rations according to the theory "if a little is good, a lot is better". True or False?
iron zinc copper iodine manganese cobalt selenium molybdenum fluorine	9. The <u>minor</u> or <u>trace</u> elements usually considered as essential are iron, zinc, copper, iodine, manganese, cobalt, selenum, molybdenum, and fluorine. Write these names on your answer sheet. You should become familiar with them. In addition to these elements known to be required, an animal's body may contain 20 to 30 additional different elements in trace amounts. Some of them may one day prove to be essential.

10. In order to supply the correct amount of minerals, it is necessary first to know the mineral composition of the feeds. Knowing this, one can add the correct minerals and amounts as needed. Some commonly used cattle feeds have the following approximate mineral compositions:

	Calcium %	Phosphorus %	Salt (Sodium) %	Salt (Chlorine) %	Copper MG/K.	Iodine	Cobalt
Lucerne	1.50	0.25	.13	.37	1-1.5	b	b
Wheat	0.06	0.35	.06	.15	.5-1[a]	b	b
Cottonseed cake	0.23	1.12	b	b	5.0	b	b
Maize silage (dry matter basis)	0.35	0.23	.01	.05	0.3	b	b

a. Estimated
b. Not present, in amounts too small to be detected or contents not known.

If you were feeding a ration composed as follows:

Lucerne	20%
Cottonseed cake	30%
Wheat	50%

It would contain approximately 0.40 percent calcium, 0.46 percent phosphorus, 0.21 percent salt and 9.5 mg copper per kilogram. Such a ration is inadequate in iodine, copper, and salt. It will be readily observed that adequate calcium is present. There is enough phosphorus, if it is all available. In this case phosphorus supplementation would be good insurance.

cannot	11. Studies at one university indicate that animals at 20 locations were fed rations containing an adequate amount of most minerals with the exception of copper. Certain by-product feeds are exceptionally low in one or more minerals, and a deficiency proportional to the amount of the by-product fed might occur. Also, when rapid gains are expected the stress is likely to increase the requirements over that normally needed for many of the minerals. General recommendations of mineral supplements for all rations (can or cannot) be made with assurance, for a whole country.
feed lot operations. False May cause imbalance and thereby cause a deficiency	12. Mineral deficiency will be more likely with a (feed lot operation or cow and calf operation). Extra minerals fed liberally as "insurance" are an economical supplement to a ration. True or False? Why or why not?
sodium and chlorine or salt	13. Sodium and chlorine combined as sodium chloride is common salt. The symptoms of a salt deficiency are, an intense craving for salt, rapid weight loss, lusterless eyes, and in the case of dairy cattle, diminished milk production. A rapid weight loss can be symptomatic of a ________ deficiency in cattle.
salt	14. Calves and sheep require 7 to 14 grams of salt per day, while high producing cows may require as much as 75 grams. Salt may be included in the swine ration (½ to 1 percent) but generally it is advisable to supply animals free choice also. Block salt should not be depended upon as the lone supply of salt for average to high producing dairy cattle. Lusterless eyes, rapid loss of weight and diminished milk production are symptoms of ________ deficiency.
kill or make sick	15. Animals that have not had salt for some time should not be given free access to it because they may eat enough to cause digestive disturbances or even death. They should be given small quantities daily until the craving has largely disappeared. Animals with a craving for salt based upon a lengthy deficiency may eat enough to ________ if given free access to large amounts of it.
regulating body processes	16. Phosphorus also is found primarily in the bones and teeth. About 80 percent of it is used for structural purposes. Like calcium, it is important in bone formation, but this is not its most important function since it is vitally concerned in regulating various body processes. Protein, fat, and carbohydrates cannot be used by the animal in the absence of phosphorus. This compound serves at least 14 different functions in the body. Phosphorus is primarily important for (bone formation or regulating body processes).

- -	17. Potassium has received renewed interest in the last few years. Deficiency symptoms may range from barely noticeable to acute. Slightly reduced feed intake or performance may go unnoticed. A minor stiffness, especially in the front joints that could be mistaken for decease, weather, or effects of age, may actually be due to insufficient potassium intake. One possible reason for a higher incidence of these problems is that rations have been changed to include more feedstuffs with lower potassium content. Most cereal and animal products are, at best, only marginal in potassium content and these ingredients comprise the major part of today's rations for rapidly growing and fattening cattle.
is not	13. One example of comparative availability of minerals is that of calcium. It has been shown that the calcium contained in milk is much more readily available for absorption than is the calcium in other foods. But, even if the calcium available for absorption is high, unless there is a proper ratio of calcium and phosphorus and Vitamin D, the absorption cannot be fulfilled and the calcium will pass through the body and be excreted. Adequate supply of a mineral (is or is not) a guarantee of adequate absorption by the animal.
phosphorus	19. Symptoms of a phosphorus deficiency are stiffness and soreness of the joints, listlessness and lack of appetite, and even a depraved appetite causing the animal to eat dirt, or chew bones or wood. Thus rate of growth and production are affected. Lack of ________ can affect rate of growth and production.
moderate poor	20. Feeds are classed as phosphorus poor, moderate, or rich. Most legume hays are moderate in phosphorus while the grass hays are poor. If the dry matter of the feed contains less than .2 percent, it is classed as phosphorus poor; between .2 percent and .5 percent, as moderate amount; and more than .5 percent, as phosphorus rich. Lucerne is ________ in phosphorus. Grass hay is _______ in phosphorus.
moderate poor	21. The cereal grains are moderate in phosphorus while whole cottonseed, silage, and early green pastures are poor. The cereal grains are _______ in phosphorus while whole cottonseed, silage, and early green pastures are ________.
rich	22. Wheat bran, cotton seed meal, skimmilk and linseed meal are rich in phosphorus. Wheat bran, cotton seed meal, and skimmilk are _______ in phosphorus.

TABLE 1

PHOSPHORUS

Poor Dry -.2%	Moderate Dry .2 - .5%	Rich Dry +.5%
Grass Hay	Legume hay	Wheat Bran
Mature, weathered hay	Cereal grains	Cottonseed meal
Silage		Skimmilk
Early Green Pasture		

TABLE 2

CALCIUM

Poor	Moderate	Rich
Cereal grains	Bluegrass pasture	Lucerne hay
legume feeds	Cottonseed oil meal	Red clover hay
Grass hay	Soybean oil meal	Ladino clover hay
	Sorghum stalks	Tankage
	Maize silage	Meat scraps
	Fodder	Fish meal
		Milk products

Dicalcium phosphate	23. Rations poor in phosphorus should be supplemented with steamed bone meal, dicalcium phosphate, or defluorinated rock phosphate. Dicalcium phosphate is generally preferred but any one of the three materials will supply phosphorus in a satisfactory form, especially if it doesn't contain fluorine. It becomes a matter of convenience to make available steamed bonemeal and salt in two containers One container to contain salt, the other to contain 2/3 salt and 1/3 dicalcium phosphate or steamed bonemeal. ________ is the supplement generally preferred as a source of phosphorus.
calcium	24. Calcium deficiencies result in weakening of the bones, lameness and even fractures. Less serious symptoms include slow growth, poor condition or unsatisfactory milk production. Bones are composed largely of phosphorus and ________.

gypsum (calcium sulphate), lime	25. An excess of calcium will often decrease absorption of zinc and manganese. What plant fertilizer additive adds calcium to the soil? Calcium is the major mineral in the body. About 99 percent of this mineral is found in the bones and teeth while the remaining 1 percent is in the soft tissue. Since calcium is used largely for structural purposes it is needed in greater amounts for younger animals than for feed lot cattle. Calcium has other functions in the body such as blood clotting.
rich poor moderate	26. Calcium poor feeds include cereal grains, and their by-products, legume seeds and all grass hay grown on acid soils. Calcium in moderate amounts is supplied by bluegrass pasture, cottonseed meal, soybean meal, all grass hay grown on non-acid soils, dried fodder, and maize silage. Calcium rich feeds include lucerne hay, red clover hay, ladino clover hay, tankage, meat scraps, fish meal, and milk products. Lucerne hay and tankage are calcium _____ feeds. The cereal grains are _____ in calcium and ______ in phosphorus.
limestone, ground oyster shell, steamed bonemeal, dicalcium phosphate	27. Calcium supplements include good grade limestone, dicalcium phosphate, ground oystershell, or steamed bonemeal. Vitamin D, furnished by direct sun rays enables an animal to make better use of the calcium available to it. ___________ is a good calcium supplement.
poor poor moderate rich rich moderate	Practice Revision. Use Tables 1 and 2. A. Grass hay grown on acid soil is _______ in calcium and _______ in phosphorus. B. Cottonseed meal is _______ in phosphorus and _______ in calcium. C. Ladino hay is a calcium ______ feed and a _______ source of phosphorus.
calcium phosphorus	28. Fattening hogs require no additional calcium or phosphorus if fed enough tankage, fishmeal, or milk by-products to balance the protein needs of the ration. Soybean meal used as a protein supplement requires additional finely ground limestone or bonemeal fed free choice. Fattening hogs require no additional c________ or p________ if fed enough tankage, fishmeal, or milk by-products to balance the protein needs of the ration.
milk	29. Beef Cattle. More calcium and phosphorus is needed by young calves than by older cattle. Nursing calves or calves getting skimmilk need no extra calcium. Should the soil of their pasture be deficient in phosphorus, dicalcium phosphate should be made available. Phosphorus is more of a problem than calcium and dicalcium phosphate has a good balance of calcium and phosphorus. _______ is an adequate source of calcium for young calves.

anemia	30. Anemia in animals results from a deficiency of iron. It is recognizable by paleness of the skin and especially membranes of the mouth. Thumps in suckling pigs is also an indication of anemia. The problem usually is limited to pigs kept on concrete or wooden floors with no access to soil and calves, and to lambs or colts kept too long on milk as their only feed. Milk is deficient in iron. A deficiency of iron results in ________.
iodine	31. Iodine is necessary for the formation of thyroxine which is a hormone of the thyroid gland. When a deficiency of iodine exists, the gland enlarges in an effort to provide more thyroxine. ________ is necessary for the formation of thyroxine.
iodized salt iodine	32. Iodized salt with stabilized iodine added is a good way to provide iodine. Iodine deficiency in sheep results in the birth of weak, dead or woolless young. Stabilized __________ is a good way to provide ________.
copper	33. Copper deficiency may exist as a primary deficiency or in combination with cobalt and possibly iron deficiencies. Copper deficiency seems to be associated with anemia. Anemia is recognizable by paleness of the skin and especially the membranes of the mouth. _______ deficiency may exist as a primary deficiency or in combination with cobalt and possible iron deficiencies.
copper	34. Animals suffering from inadequate copper intake appear to be unable to absorb iron at a normal rate, and a defect in hemoglobin synthesis exists. Symptoms of copper deficiency in young lambs are muscular incoordination with partial paralysis of the hindquarters. A defect in hemoglobin synthesis may result from a __________ deficiency preventing absorption of adequate iron.
vitamin B_{12}	35. The important function of cobalt in sheep nutrition is to promote synthesis of vitamin B_{12} in the rumen. Cobalt deficiency causes a loss of appetite, lack of thrift, weakness, anemia and a decrease in fertility and in milk and wool production. Cobalt functions in the rumen to promote synthesis of ________.

sulfur	36. Sulfur is essential in livestock diets. It functions in the synthesis of sulfur containing amino acids in the rumen and certain other sulfur compounds of the body. Mature grass and grass hays are sometimes low in sulfur and may not furnish adequate amounts for optimum animal performance. ______ functions in the synthesis of some amino acids in the rumen.
manganese	37. The symptoms of manganese deficiency are poor hatchability of the eggs in the laying flock and slipped tendons in growing chickens. Rations containing wheat or wheat products or a small amount of manganese sulfate will generally prevent the trouble. A deficiency in m_______ does affect hatchability of eggs and causes slipped tendons in growing chickens.
salt	38. Tankage, milk by-products or fishmeal fed to boars in large enough amounts to balance their protein needs satisfies the mineral needs except for salt. ______ is the only mineral not adequately supplied to boars when protein requirements are satisfied with tankage, milk by-products or fishmeal.
sunshine	39. Calves in confinement sometimes get rickets. Feeding a well-balanced ration made up of grain and sun-cured legume hay, and access to sunlight will prevent rickets and cure it in its early stages. Plenty of ______ will help prevent rickets.
Dicalcium phosphate	40. Cows nursing calves on early season pasture may need calcium added to their ration. Dicalcium phosphate is a good form to use. Good legume hay fed at the rate of 3 kilograms daily with other roughage should provide enough calcium but phosphorus may be lacking. __________ _______ is a good source of phosphorus.
ground limestone or dicalcium phosphate	41. Bulls fed mixed hay and grain during the dry season need no mineral supplement other than salt. If no legume hay is fed, calcium should be supplied by ground limestone, free choice or dicalcium phosphate. Bulls on pasture and grain, or bulls on grass hay should be supplied with __________ __________.

pasture legume hay	42. Supplementary minerals are not necessary for young dairy cattle on pasture or legume hay except for salt. It is good practice to keep dicalcium phosphate available to them, however. High producing cows in the early stages of lactation may need additional calcium and phosphorus. Supplementary minerals are **not** necessary for young dairy cattle on __________ or __________ except for salt.
ground limestone steamed bonemeal or decalcium phosphate phosphorus phosphoros	43. Producing dairy cattle not receiving legume hay should be furnished ground limestone or steamed bonemeal. These may be mixed with the grain at the rate of 1 to 2 kilograms for each 100 kilograms of grain mixture, or for cows on pasture a mixture consisting of equal parts bonemeal or dicalcium phosphate, limestone, and salt may be supplied in feeders to which the cattle have free access. Dairy cattle not on legume hay should receive ______ or __________. Dairy cattle fed grass hays are generally deficient in ________. This can be remedied usually by feeding supplements high in ________________.
loose	44. Salt should be available at all times. Swine cannot eat enough block salt to get all that they need, so loose salt should be fed in the ration or free choice. Brood sows and pigs not running on pasture should be self-fed sun-cured legume hay to provide calcium and vitamins A and D. This is especially true during the dry season when pastures are not available. Salt should be provided for swine in the _____ form.
Legume, Iron, copper (Note: Iron injection or solu solution painted on the udder or iron sulfate or ferrous sulfate is an alternative.)	45. L______ hay is needed to provide calcium and vitamins A and D for brood sows and pigs not on pastures. It is impossible to give lactating sow the feeds that will enable her to furnish enough iron and copper in her milk to prevent anemia in her pigs. For this reason young pigs kept on concrete or wooden floors should have _______ and ________ provided.
manganese	46. Poor hatchability of the eggs in a laying flock and slipped tendons in growing chickens result from manganese deficiency. Wheat and wheat products or 120 to 150 grams per 1000 kilograms of manganese sulfate will generally prevent the trouble. Slipped tendons in growing chickens result from _________ deficiency. Manganese deficiencies are common only in the poultry industry.
no	47. Now that you are aware of mineral deficiencies to be concerned about, answer this question again. Should extra minerals be fed as "insurance" to maximize profits?

- -	48. With the increasing usage of irrigation, mineral supplements will become more necessary. Some of the important minerals are soluble and will become deficient because of irrigation. Commercial fertilization has the effect of adding minerals to the soil. In some cases this could bring about a poor balance of minerals. In other cases the fertilizer elements will compensate for losses through irrigation.

This unit is based on a similar one prepared by Gilbert Long of the College of Education at the University of Washington, Pullman, Washington.

Name ________________ Form ____
Date __________

TEST

MINERALS

UNDERLINE THE CORRECT ANSWER

1. A ration containing an abundance of protein, carbohydrates, and fat, without minerals will generally result in the death of an animal ________ than if no food at all is given.
   - a. at the same time
   - b. sooner
   - c. later
2. Extra minerals fed as "insurance" ________ an economical supplement to feed.
   - a. are
   - b. are not
3. Mineral deficiencies are important only if deficiency symptoms can be observed.
   - a. True
   - b. False
4. Block salt ______ be depended upon as a lone supply of salt for average to high producing dairy cattle.
   - a. should
   - b. should not
5. Animals with a craving for salt based upon a lengthy deficiency may eat enough to __________.
   - a. catch up on their requirements
   - b. cause bloat
   - c. cause constipation
   - d. injure themselves
   - e. require none for a period of time
6. Lucerne is classed as ________ in phosphorus.
   - a. moderate
   - b. poor
   - c. rich
7. Plenty of ________ will help prevent rickets.
   - a. exercise
   - b. lucerne hay
   - c. milk
   - d. protein
   - e. sunlight
8. ________ cannot get enough block salt to satisfy their requirements.
   - a. Cattle
   - b. Goats
   - c. Horses
   - d. Sheep
   - e. Swine
9. _________ is a good source of calcium.
   - a. Bonemeal
   - b. Dicalcium phosphate
   - c. Ground limestone
   - d. Meat scraps
   - e. Sodium chloride
   - f. Tankage
10. An animal needs phosphorus for all of the following except ________.
    - a. bone formation
    - b. necessary for usage of fat by animal
    - c. necessary for usage of protein by animal
    - d. prevention of rickets
    - e. regulating body processes

11. Mineral deficiencies ______ economic losses even though deficiency symptoms are not visibly apparent.

    a. can cause
    b. cannot cause

12. Anemia in animals results from a deficiency of __________.

    a. cobalt
    b. iron
    c. lead
    d. salt
    e. water

13. ____________ is necessary for the formation of thyroxine, a hormone of the thyroid gland.

    a. Cobalt
    b. Iodine
    c. Iron
    d. Manganese
    e. Salt

14. Slipped tendons in growing chickens result from _______ deficiency.

    a. calcium
    b. cobalt
    c. iron
    d. manganese
    e. mangesium

15. Match the following materials with the minerals they provide:

a. iron sulfate	______ calcium
b. oystershell	______ salt
c. sodium chloride	______ iron

16. _____________ or __________ are good sources of calcium and phosphorus. (Choose two answers).

    a. dicalcium phosphate
    b. iron sulfate
    c. oystershell
    d. steamed bone meal
    e. vitamin A
    f. vitamin D

17. ___________ animals have the greatest need for minerals such as calcium and phosphorus.

    a. Aged
    b. Mature
    c. Young

TUMAINI SECONDARY SCHOOL

PLANT NUTRITION

This is a programmed instruction unit on feed characteristics.

In this unit you are to learn:

1. chemical elements necessary for plant growth, grouped by:
   - a. sources of air, water and soil.
   - b. major and minor elements.
   - c. primary plant feeds.
   - d. secondary plant foods.
2. Functions of nitrogen, phosphorus, and potash for growth and maturity of plants and resistance to disease.
3. The function of the "carrier" material in commercial fertilizers.
4. The importance of chemical soil tests to establish fertilizer needs.
5. The plant processes; photosynthesis, transpiration, and respiration.
6. Barnyard manure as a source of nutrients to the soil.
7. Green manure crops.
8. Commercial fertilizer labeling.
9. The nitrogen cycle.
10. The carbon-nitrogen ratio.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side-do not erase your incorrect answer.

Plant Nutrition

If you have not read the information panel, do so now, then proceed to frame 1.

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Plant Nutrition
continued

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Name ____________________ Form ______

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Revision

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_____ iron
_____ copper
_____ calcium
_____ boron
_____ zinc
_____ sulfur
_____ molybdenum
_____ magnesium
_____ manganese

carbon hydrogen oxygen	1. Fourteen elements have been recognized as being necessary for plant growth. Three from air and water are carbon, hydrogen, and oxygen. These elements account for over 90 percent of the total weight of the plant. The three elements furnished by air and water are ________, ________, ________.
oxygen hydrogen carbon	2. The atmosphere provides c________, h________, and o________ to plants.
nitrogen	3. Nitrogen is taken from the air by certain groups of bacteria. The nitrogen assimilated by these organisms undergoes a change before it is used by higher plants. Certain groups of bacteria remove ______ from the air.
nitrogen	4. The bacteria taking nitrogen from the air may be associated with most, if not all, legumes. Leguminous plants are nitrogen-fixing plants. Non-legumes do not fix ________.
oxygen hydrogen carbon	5. The nitrogen which is taken from the air by bacteria is combined in the soil to make soluble compounds before it can ordinarily be used by higher plants. Therefore, it is ordinarily stated that 3 elements come from air and water. The three from air and water (other than nitrogen) are ________, ________, and ______.
nitrogen phosphoric acid potash	6. Twelve elements are provided by the soil. Nitrogen, phosphoric acid, and potash are known as "primary plant foods" and are needed by plants in relatively large amounts and have long been recognized as those most likely to be deficient in soils. Copy them in the answer space.

calcium sulfur magnesium	7. Calcium, sulfur, and magnesium are secondary plant foods. These secondary plant foods are usually needed in relatively large amounts. Copy them in the answer space.
nitrogen phosphoric acid potash calcium sulfur magnesium	8. ________, __________, and _________ are "primary plant foods". __________, __________, and ___________ are "secondary plant foods".
iron manganese copper zinc boron molybdenum	9. Iron, manganese, copper, zinc, boron, and molybdenum are usually called the "rarer elements" or "minor plant foods". They are needed in minute amounts but are essential. Copy them in the answer space.
iron manganese copper zinc boron molybdenum	10. Continuing research is studying some eleven other mineral elements. However, _________, __________, __________, __________, ___________, and ____________ are the "rarer elements" proven to be essential to plant growth.
growth maturity	11. Nitrogen functions to increase growth and defer maturity. It produces a good leaf and stem development and gives to the plant that luxurious dark-green colour which is so desirable in growing crops. Nitrogen increases g_______ and defers m_________.
nitrogen	12. No matter how much phosphoric acid and potash there may be in the soil, the crops can use only quantities in proportion to the growth of the plants, and the growth of the plants will be in proportion to the n______ in the soil.

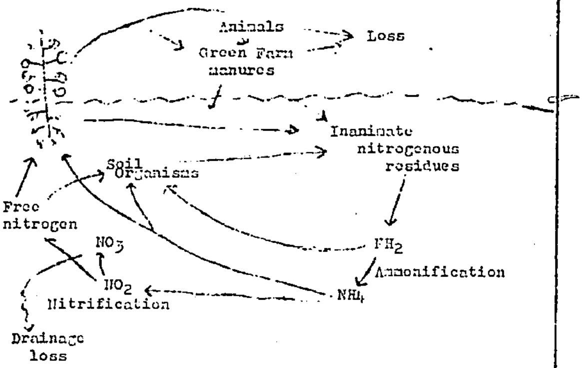
phosphoric acid	13. Phosphoric acid hastens maturity of crops and aids in transferring substances from the stalk, leaves, and other growing parts to the seed, making the grains plump and full. __________ __________ increases the proportion of grain to straw and also stimulates root development in young plants.
phosphoric acid	14. ________ ________ hastens the maturity of crops. Potash appears to aid the plants resisting certain diseases. An insufficiency of potash results in the early ripening or dying of the stems and leaves of plants while the seeds or fruit are still immature.
potash carbon hydrogen oxygen	15. ________ appears to aid plants in resisting certain diseases. ________, ________, and ________ are elements furnished by air and water. They make up 90 percent of the weight of the plant.
nitrogen potash phosphoric acid	16. The term "carrier" is used to indicate the material in which the plant nutrient is found. For instance, sodium nitrate, superphosphate, and potassium sulfate are carriers of the "primary plant foods"; __________, __________, and ________.
carrier	17. The term c________ is used to indicate the material in which the plant nutrient is found. Chemical soil tests have been developed to determine which fertilizer elements are less than adequate in a particular soil.
less	18. Soil type has a marked effect on the results of fertilizer applied to soils having the same chemical test result. Clay soils are usually richer in plant nutrients than sandy soils. Sandy soils leach badly compared to clay soils. Certain chemical forms of a fertilizer elements are more quickly available and are more soluble than other forms. A sandy loam is ________ rich in plant nutrients than a silty clay loam.

clay sandy	19. Chemical soil tests are important to a fertilization program. A field trial based upon the chemical tests results can definitely establish the rate of fertilizer application by applying the amounts of fertilizer indicated by the chemical test to growing crops and by measuring the differences in crop yield. _________ soils do not leach as badly as do _______ soils, and, therefore, do not lose nutrients as quickly.
amendment	20. Lime is called a soil "amendment" rather than a fertilizer, as it does not carry nitrogen, phosphoric acid or potash. The acidity of the soil determines the kinds of crops that can be grown on a soil. Lime is a soil ____________.
photosynthesis	21. Some knowledge of plant processes are important to the growth and nutrition of crops. Photosynthesis is the process by which green plants combine carbon dioxide and water in the presence of sunlight, to form carbohydrates. P____________ results in formation of carbohydrates.
- -	22. Plants need a certain amount of water in carrying on their physiological processes. However, only a small percentage of the water that is absorbed by the root hairs and passes upward to the leaves is used in these processes. The remainder evaporates through the stomata as water vapour. This process is called transpiration.
Respiration	23. Respiration unlike photosynthesis, which is limited to certain cells in the leaves, takes place in every living cell. Respiration is a destructive process by which food is destroyed with a consequent release of energy, intake of oxygen and outgo of carbon dioxide and water. R________ results in release of carbon dioxide and water.
Transpiration Respiration	24. _________ is the process of absorption of water by the root hairs, and movement up through the stems, to the leaves. _________ is the process involving release of energy, intake of oxygen and outgo of carbon dioxide and water.

Physical texture chemical fertility	25. Two soil characteristics equally important as limitations to plant growth are the physical texture and structure of the soil and the chemical fertility of the soil. __________ and ______ are important soil characteristics to plant growth.
- -	26. Barnyard manure is valuable for its nutrient elements and for its organic matter content so beneficial to the physical structure of the soil. Manure is not a well-balanced fertilizer. It is low in phosphoric acid and relatively high in nitrogen and potash. Addition of phosphourous to manure adds much to its value.
organic matter phosphoric acid	27. Barnyard manure is valuable for its nutrient elements and for its o________ m_________ content. Manure is low in ____________.
green manure crop	28. A green manure crop is one used for ploughing into the soil, whether planted for that purpose or not. For supplying organic matter to the soil, the g_______ _______________ that will produce the most growth in the time available should be chosen.
(1) (2)	29. Fertilizers are made up of two major groups: (1) Manures or organic amendments, and (2) Commercial fertilizers. Group I includes barnyard manures, green manures, crop residues and wastes that are ploughed under for enrichment of the soil. Group II includes fertilizers produced commercially and sold singly or in combination. A compost of leaves is (group 1 or group 2). Calcium nitrate is (group 1 or group 2).
- -	30. The mixed fertilizers are commonly referred to by a series of numbers such as 0 - 10 - 10, 5 - 10 - 20, etc. The first number stands for the percentage of nitrogen; the second number, available phosphoric acid; and the third number, the water soluble potash. 10 - 20 - 30 stands for 10 kilograms of nitrogen, 20 kilograms of phosphate, and 30 kilograms of potash in a 100 kilogram bag.

15 40 10	31. 10 - 40 - 15 stands for ______ kilograms potash, ______ kilograms phosphoric acid, and ______ kilograms nitrogen. (Assume a 100 kilogram container.)
nitrogen phosphorus potash	32. 20 - 10 - 5 stands for 20 kilograms ____________, 10 kilograms ___________, and 5 kilograms _________. (Assume a 100 kilogram container.)
- -	33. A crop rotation is any plan that is followed whereby one crop follows another. Usually one thinks of a well-planned program when referring to a crop rotation.
- -	34. Some advantages of crop rotation are: 1. Maintains fertility of the soil. The same crop grown successively uses more of one nutrient than of the other. 2. Disease, weeds and insects are more easily controlled. 3. Labour is distributed to better advantage. 4. Legumes aid in maintaining soil fertility through nitrogen fixation. 5. Erosion control is promoted through preservation of organic matter by proper rotation. 6. Diversification spreads the financial risk.
	35. Can you think of any suggestions why any of the above might be true? List them.
crop rotation	36. A fundamental approach to _____ _____ includes cash crop, cultivated crop, legume or hay crop (poorer quality soils would require more than one year in this last category).

- -	37. Nitrogen in the soil is soluble and easily lost to drainage. Nitrogen has a rapid effect on plant growth. Such a potent nutrient element should not only be conserved but also regulated. Some of the intake and outgo of nitrogen can be controlled by man; some is beyond man's control.
soluble	38. Nitrogen is s______ and easily lost to drainage.
20 12 15	39. The nitrogen income of arable soils is derived from such materials as crop residues, green manures, farm manures, commercial fertilizers, and ammonium and nitrate salts brought down by precipitation. In addition, there is fixation of atmospheric nitrogen. 12 - 20 - 15 stands for ______ kilograms of phosphorous ______ kilograms of nitrogen ______ kilograms of potassium (Assume a 100 kilogram container)
- -	40. The outgo of nitrogen is due to crop removal, to drainage, to erosion, to loss in a gaseous condition, both elemental and ammonia, and to unavailable forms of nitrogen.
nitrogen	41. ______ has a rapid effect on plant growth.
crop residue, green manures, commercial fertilizer, ammonium and nitate salts by precipitation crop removal, drainage, erosion, gaseous losses	42. One form of nitrogen income is ______. One form of nitrogen outgo is ______.

- -	43. Much of the nitrogen added to the soil undergoes many transformations before it is removed. NH4 (ammonium) changes to NO2 (nitrate). This nitrate form is either used by microorganisms and higher plants, or is removed in drainage or volatilization. And so the cycle goes on and on.
- -	44. Study the nitrogen cycle. 
income outgo	45. Crop residue is considered nitrogen (outgo, income). Drainage is considered nitrogen (outgo, income).
low	46. A close relationship exists between the organic matter and nitrogen contents of soils. This ratio of carbon to nitrogen in the organic matter of the plough furrow slice ranges from 8:1 to 15:1. This ratio controls the available nitrogen, total organic matter, and rate of organic decay. The relationship is called the carbon-nitrogen ratio. Green manure crops have a (low, high) ratio of carbon to nitrogen.
- -	47. Competition for available nitrogen results when residues having a high C:N ratio are added to the soil (straw at 90:1 carbon to nitrogen ratio for example). When a high carbon residue is added to a soil having a narrow C:N ratio, the demand for nitrate nitrogen becomes so great by the microorganisms rapidly decomposing the organic matter that little nitrate nitrogen is available for higher plants. This slows growth of plants.

a	48. A practical example would be the ploughing under of wheat straw and planting a crop. Unless the nitrogen content is high the new crop will lack optimum nitrogen for growth. Commercial fertilizer in correct amounts will hasten decomposition of organic matter and release the nitrate nitrogen for the new crop. Moisture often limits the amount of fertilizer useable as a maximum amount. Farmers should (a. add commercial nitrogen or b. burn stubble) to keep the C:N ratio low for a new growing crop.
30:1	49. 30 parts carbon to 1 part nitrogen is a ration of _____:______ carbon to nitrogen.
- -	50. Most important to the farmer is whether additions of fertilizers result in a profitable increase in production. This can be determined by field trials.
field trials	51. The amounts of fertilizer providing the best economic return can best be determined by chemical tests followed by f________ t________.
- -	52. Farming is applied science. This program illustrates this. A farmer needs to make use of chemical tests, resource people, and the scientific method in his farming enterprise.
nitrogen phosphoric acid potash calcium, sulfur, and magnesium are secondary plant foods, the rest are rarer elements	Revision: The primary plant foods are _____, _____ _____ and _______. Choose the secondary plant foods by placing the letter "S" in front of them and the "rarer elements" by putting an "R" in front of them. _____ iron _____ copper _____ calcium _____ boron _____ zinc _____ sulfur _____ molybdenum _____ magnesium _____ manganese

This unit is based on a similar one prepared by Gilbert Long of the College of Education at the University of Washington, Pullman, Washington.

Name ________________ Form _____
Date ______________

TEST

PLANT NUTRITION

UNDERLINE THE CORRECT ANSWER

1. Water and air furnish three elements for plant growth. They are _____, _____, and ______. (Choose 3 answers.)

   a. carbon
   b. copper
   c. hydrogen
   d. manganese
   e. oxygen
   f. phosphoric acid
   h. zinc

2. _________ is taken from the air by certain groups of bacteria. It is available to plants through these bacteria.

   a. Calcium
   b. Carbon
   c. Nitrogen
   d. Oxygen
   e. Phosphorous

3. Which three are known as primary plant foods? (Choose 3 answers.)

   a. carbon
   b. iron
   c. nitrogen
   d. phosphoric acid
   e. potash
   f. zinc

4. _________ functions to increase growth and slow up maturity.

   a. Calcium
   b. Lead
   c. Nitrogen
   d. Oxygen
   e. Phosphorous

5. _________ hastens maturity of crops.

   a. Calcium
   b. Nitrogen
   c. Phosphoric acid
   d. Potash
   e. Sulphur

6. _________ appears to aid plants in resisting certain diseases.

   a. Gypsum
   b. Nitrogen
   c. Phosphoric acid
   d. Phosphorous
   e. Potash

7. The term _________ is used to indicate the material in which the plant nutrient is found in commercial fertilizers.

   a. carrier
   b. conveyer
   c. dryer
   d. host
   e. surplus

8. 12-15-7 stands for a commercial fertilizer mixture of 12% _____, 15% _____, and 7% ________. (Choose 3 answers.)

   a. calcium
   b. lime
   c. nitrogen
   d. phosphoric acid
   e. potash
   f. sulfur

9. __________ is the process resulting in production of carbohydrates.

a. Digestion
b. Photosynthesis
c. Respiration
d. Transpiration
e. Transportation

10. __________ is the process of absorption of water by root hairs, movement up through the stems, to the leaves. The remainder of the water is lost by evaporation through the stomata.

a. Perspiration
b. Photosynthesis
c. Respiration
d. Transpiration
e. Transportation

11. __________ is a destructive process by which food is destroyed, with a consequent release of energy, intake of oxygen, and outgo of carbon dioxide and water.

a. Exhalation
b. Osmosis
c. Photosynthesis
d. Respiration
e. Transpiration

12. Barnyard manure is valuable for its nutrient elements and for its ______.

a. calcium
b. nitrogen
c. organic matter
d. phosphoric acid
e. salt

13. One type of __________ includes a cash crop, a cultivated crop, and a legume or hay crop.

a. a carbon cycle
b. crop rotation
c. nitrification
d. nutrition
e. soil erosion

14. ____________ in the soil is soluble and easily lost to drainage.

a. Iron
b. Nitrogen
c. Phosphoric acid
d. Potash
e. Sulfur

15. The relationship between nitrogen and carbon is called the ________.

a. carbon-nitrogen equivalent
b. carbon-nitrogen ratio
c. nitrogen-carbon ratio
d. nitrogen cycle
e. potash cycle

16. __________ is most readily available and in larger amounts for microorganisms and plant growth.

a. N, nitrogen
b. NaCl, salt
c. NH_4, ammonium
d. NO_2, nitrite
e. NO_3, nitrate

TUMAINI SECONDARY SCHOOL

LAND I

This is a programmed instruction unit on land.

In this unit you are to learn:

1. why land is classified.
2. how the following are used in classifying land:
    a. soil depth.
    b. soil profile.
    c. soil surface texture.
    d. soil permeability.
    e. soil colour.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Land I

If you have not read the cover page, do so now, then proceed to frame 1.

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-cut-

Name ____________________ Form ________

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REVISION

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B. ____________

C. ____________

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E. ____________

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Land I
continued

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Name ______________________ Form _______

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- -	1. Before you start the program, you should read the instruction sheet. If you have not already done so, read the instruction sheet now. If you have read it, proceed to frame 2.
capability	2. For the most hazard free land usage we classify our soils into "ability to produce" groups, or land capability classes. The eight capability classes are divided according to their c________.
classify	3. Just as a doctor checks pulse and temperature of a patient before classifying the sickness, so do we learn to check the seven symptoms of our land before attempting to c_______ it.
seven	4. We look for ______ factors or symptoms before classifying the land and recommending certain crop usage for it.
classifying or classification	5. The reason for c_________ of land is to make the best use of the land. We wish to gain the biggest return from our investment without permanent loss of the soil or its fertility.
factors or symptoms	6. Efficient classification of the land will require a detailed knowledge of the seven __________s.

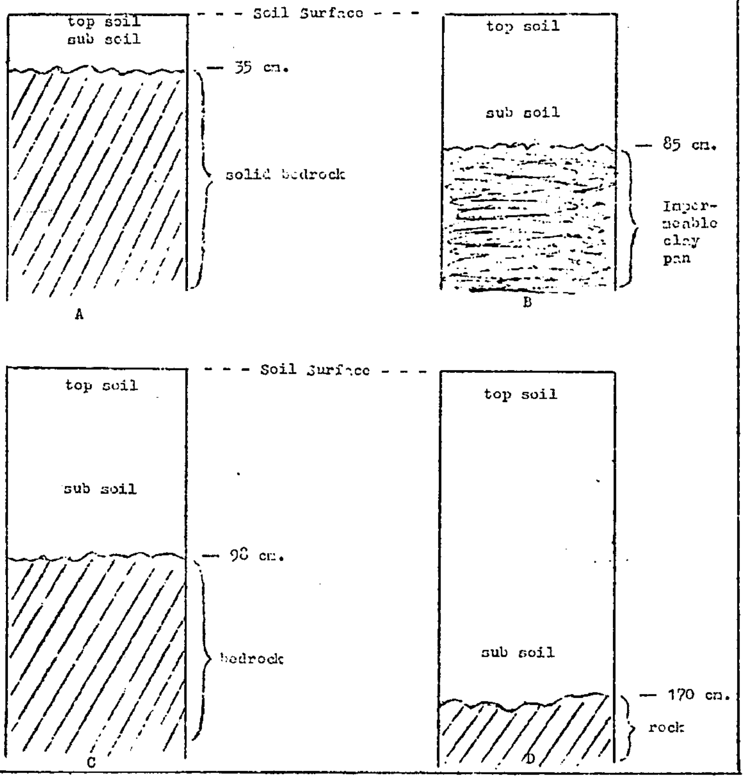
depth	7. Soil depth is the first factor we will consider in detail. Soil d_____ is determined by the depth of penetration of roots and moisture.
moisture or root	8. Soil depth may be measured by either ________ or _________ penetration.
soil depth	9. We classify soils as very shallow, shallow, moderately deep, deep, or very deep. These are the divisions or categories of _____________.
-	10. Soil depths are separated by centimetres as follows: 0 - 25 centimetres - very shallow 25 - 50 centimetres - shallow 50 - 90 centimetres - moderately deep 90 - 150 centimetres - deep 150 centimetres or more - very deep Copy the soil depths
deep	11. Deep soils are from 90 - 150 centimetres deep. Lucerne roots found at 135 centimetres depth is an indication of a ________ soil.
moisture or roots	12. Very deep soils can be identified by evidence of ________ or ___________ at 150 centimetres or deeper.

25	13. Very shallow soils are less than 25 centimetres deep. Shallow soils are from ________ to 50 centimetres deep.
90	14. Moderately deep soils are from 50 to 90 centimetres deep. Deep soils are from ________ to 150 centimetres deep.
150	15. Very deep soils are ________ centimetres or deeper.
25	16. Very shallow soils are less than ________ centimetres deep.
50 90	17. Moderately deep soils are _____ to _____ centimetres deep.
25 50	18. Shallow soils are from _____ to _____ centimetres deep.

90 150 150	19. Deep soils are from _____ to ______ centimetres deep. Very deep soils are _______ centimetres deep or more.
0 - 25 Shallow 50 - 90 90 - 150 Very deep -- 150 or over	20. If you answer the following questions correctly, move on to frame 21. Otherwise, turn back to frame 11 for revision. Very shallow --- ___ to ___ cm. __________ --- 10 to 20 cm. Moderately deep --- ___ to ___ cm. Deep --- ___ to ___ cm. ______ ______ --- ___ to ___ cm.

SOIL PROFILES

Diagrams of vertical profiles showing depths of soils.



shallow	Refer to information panel, page 4 to answer frames 21 - 24. 21. The depth of soil profile "A" would be classified as ________.
moderately deep	22. The depth of soil profile "B" would be classified as ________.
deep	23. The classification would be ________ for soil profile "C".
very deep	24. Soil profile "D" would be classified as ________.
moderately deep	25. Failure to find evidence of moisture or roots deeper than 55 centimetres would indicate ________ soil depth.
surface texture	Next read the information panel on soil surface texture on page 6. 26. Soil ______ ________ refers to the composition of the important top 15 centimetres of soil - the root zone.

Soil surface texture is classified according to the proportion of sand, silt, and clay that make up the soil mass.

The size of individual particles of soil influences the ability of the soil to absorb and store water and air.

After looking at and feeling the soil, we can then classify the surface texture as:

Fine - "Clayey" soils that feel sticky or slick to the touch.

Medium - "silty" soils that feel smooth or "floury" to the touch.

Coarse - "very sandy" soils that feel gritty or abrasive to the touch.

by looking at it and feeling it	27. Texture of clothing is sometimes referred to as "coarse". We speak of soils as fine, medium, or coarse textured. We are referring to a 15 centimetre layer. How would you decide whether a soil were fine, medium, or coarse?
soil surface texture	28. Perhaps a series of different sized sieves would work to determine s______ ________ t______.
fine, medium, or coarse	29. Sieves are used in the laboratory, but are awkward for field use. Field men learn to determine soil surface texture by moistening it and rubbing it between the thumb and forefinger. In this way they can determine if the soil surface texture is _______, _______, or _______.
sand, silt, clay	30. Soils are composed of ________, ________, and ________; the individual parts being called particles.

particle	31. ________ size determines ability of the soil to hold air and water.
air water	32. Particle size influences the ability of the soil to absorb and store ________ and ________.
coarse	33. Sandy soils feel abrasive and "gritty" to the touch. Sandy soils have a c______ texture.
coarse	34. Coarse soils are predominately sand with some silt and clay. Desert soils are usually ________ in texture due to large proportions of sand.
fine	35. Soils having enough clay to feel "slick" and "sticky" have a f_____ texture.
sticky or slick	36. Fine textured soils feel ______ to the touch.

gritty	37. Coarse textured soil feels ______ to the touch.
medium	38. Soils with a large quantity of silt that feel <u>smooth</u> and <u>floury</u> are classified as having a m________ texture.
silt	39. Medium textured soils are composed predominantly of ________. They feel smooth and "floury" to the touch.
smooth or floury	40. Medium textured soils feel ______ to the touch.
a - fine b - coarse c - medium	41. a. ________ textured soils feel sticky. b. ________ textured soils feel gritty. c. ________ textured soils feel smooth and floury.
fine - sticky medium - smooth or floury coarse - gritty	42. List the classifications of soil surface texture and indicate how they feel.

soil surface texture	43. The purpose of this classification is to accurately field test a soil as to its ______ ______ ______.
particles	44. The individual parts of these soils are called soil ________, the size of which determines the ability of the soil to hold air and water.
sand, silt, clay	45. Soil is composed of varying proportions of ________, ________, and ________.
25	REVISION A. Very shallow soils are 0 to ________ centimetres deep.
25 - 50	B. Shallow soils are _____ to _____ centimetres deep.
Moderately deep	C. ______ ______ soils are 50 to 90 centimetres deep.

deep 90 to 150	D. ______ soils are ______ to ______ centimetres deep.
150	E. Very deep soils are greater than ______ centimetres deep.
roots moisture	F. Soil depth is the effective depth that ______ and ______ can penetrate.
	Fine soils characterized by a sticky feeling when moist are chemically fertile but are often a problem physically. They are either too hard for adequate moisture penetration or too moist and sticky to disc and cultivate for seedbed preparation. Soil surface texture is an important consideration in land classification for hazard free land usage.
sand, silt, clay	G. Soil is composed of varying proportions of ______, ______, and ______.
fine medium coarse	H. Depending upon the proportions of sand, silt, and clay, we speak of soils in the three textural categories of ______, ______, and ______.

	The next section of this program will consider the effects of fine, medium, and coarse textured soils on the movement of air and water through the entire profile (depth) of the soil.

Soil permeability refers to the rate of movement of air and water through the subsoil. Soils may be placed into relative permeability classes through studies of structure, texture, cracking, density and other features. Structure refers to the arrangement of soil particles into granules, clods, columns, or crumbs. We classify permeability as:

Limiting - soils which have dense, heavy clay or clay pan subsoils. Soils under this classification feel sticky and plastic, have the appearance of putty, press out thin between the fingers without crumbling when wet.

Adequate - granular clay loam or silt loam subsoils. Soils with strata cracks usually running perpendicular to the surface. This type of soil is ideal for most agricultural purposes since the water, air, and plant roots can penetrate easily. Yet the soil column is firm and stable.

Excessive- sandy, coarse subsoils through which water and air move freely.

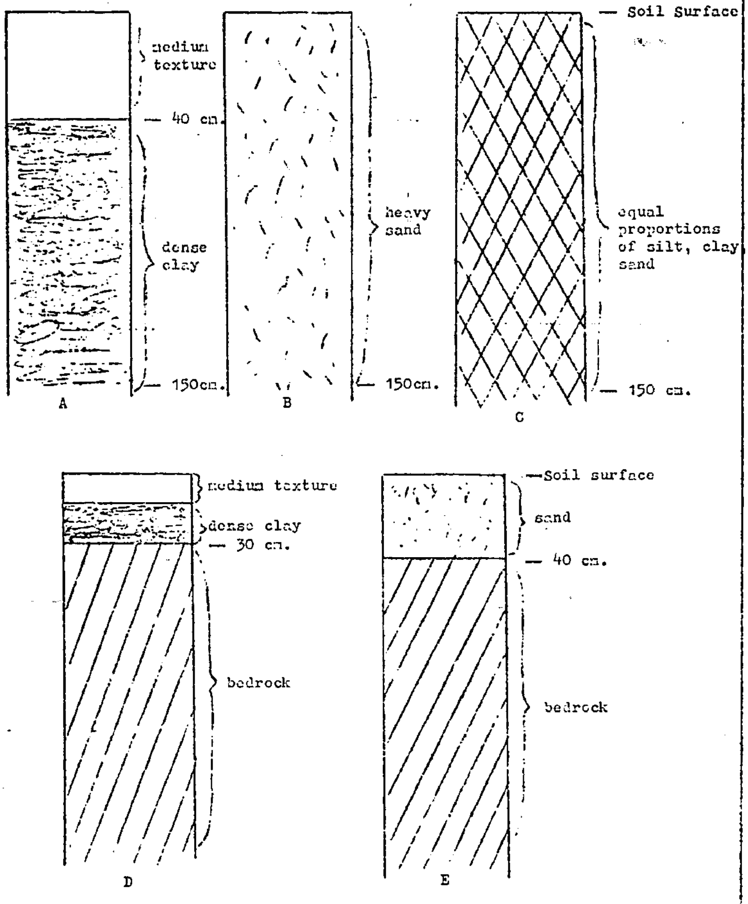
soil permeability	46. Soil depth, you will recall, was important as it affects the amount of moisture available to crops. Soil permeability refers to the rate of movement of air and water through the subsoil. How well excess moisture drains through the soil profile is a function of s_______ p________.
permeability	47. Soils may be placed into relative _____ classes through studies of structure, texture, cracking, density, and other features.
moisture air	48. Structure of the soil profile is determined by the "clumping" of individual particles. This affects the movement of ______ and _______ through the entire soil profile. For our system of classification, we will divide soil permeability into limiting, adequate, or excessive.

limiting	49. Soils that have dense clays in their subsoil would limit movement of water through the profile. We would classify their permeability as ________.
clay	50. A common example of a soil profile having limiting permeability is one having a heavy layer of ________ in the subsoil.
adequate	51. A medium texture soil throughout the profile would result in ________ permeability.
smooth or floury	52. A soil profile having adequate permeability would feel ________ to the touch throughout the profile.
excessive	53. A deep sandy soil would have excessive drainage of water through the profile. The permeability of this soil would be ________.
sand	54. A soil having excessive permeability would consist largely of ________.

surface texture	55. Permeability pertains to the effective depth of a soil and not to the surface 15 centimetres as does soil ________ ________.
permeability	56. A dense subsoil of a putty-like consistency would be classified as having limiting ________ that would limit water movement through the soil. Obviously a narrow horizontal band of soil of a particular texture can result in a limiting permeability.
excessive permeability	57. A soil that is excessively drained because of a sandy, coarse subsoil has ________ ________.
limiting permeability	58. Very slow movement of air and moisture through the soil indicates ________ ________.
adequate permeability	59. A satisfactory movement of air and moisture through the soil is called ________ ________.
a - limiting b - adequate c - excessive	60. The three classifications of permeability are ________, ________, and ________.

SOIL PROFILES

Diagrams of vertical profiles showing permeability



limiting	Refer to information above to answer frames 61 - 65. 61. Profile "A" demonstrates _________ permeability.

excessive	62. Profile "B" is an example of _______ permeability.
adequate	63. Profile "C" is an example of _______ permeability.
limiting	64. "D" profile demonstrates _________ permeability.
excessive	65. "E" profile demonstrates _______ permeability.
light medium dark dark	66. Soil colour is a rather subtle clue to the history of a particular soil. Soil colour is divided into three divisions: light, medium dark, and dark. Write the three colour divisions on the answer sheet.
high	67. Dark soil is nearly black and is usually (high - low) in inherent fertility.

dark	68. Soil with a high inherent fertility level is usually classified as having a ________ colour.
medium	69. Medium dark soil has a moderate level of inherent fertility. Dark gray to light brown soils indicate a ________ dark colour.
medium	70. Medium dark soil has a (high - medium - low) level of inherent fertility.
light	71. A low or very low inherent fertility is indicated by a ________ colour.
low	72. Light gray to pale brown surface soils usually have a ________ inherent fertility level.
soil fertility	73. Soil colour is not always a reliable clue to inherent fertility. Soil colour may or may not indicate inherent s________ f________.

dark medium dark light	74. Soil colour is divided into three divisions. They are ____________, ________ _________, and ____________.
a - medium b - low c - high	75. List the probable inherent fertility level indicated by each of the following soil colours: a. medium dark - __________ b. light - ________________ c. dark - _________________

This unit is based on a similar one prepared by Gilbert Long of the College of Education at the University of Washington, Pullman, Washington.

Name ________________ Form _____
Date ________________

TEST

LAND I

UNDERLINE THE CORRECT ANSWER

1. Soil depth is the effective depth that roots and ______ can penetrate the soil.

   a. moisture
   b. a post hole digger
   c. a shallow rooted plant
   d. a plough
   e. worms

2. Soil permeability refers to the rate of movement of ______ and _______ through the soil. (Choose 2 answers.)

   a. air
   b. fertilizer
   c. moisture
   d. ploughs
   e. roots

3. Soils that feel "sticky" when moist are ______ textured soils.

   a. coarse
   b. fine
   c. loam
   d. medium
   e. silt

4. "Silty" or "loamy" textured soils are _________.

   a. coarse
   b. heavy
   c. medium
   d. fine
   e. soft

5. Land that is very deep is greater than ________ centimetres deep.

   a. 10
   b. 70
   c. 100
   d. 125
   e. 150

6. The individual parts of soil are called soil __________.

   a. clumps
   b. conglomerates
   c. dirt
   d. particles
   e. pieces

7. A common example of a soil profile having limiting permeability is one having a heavy layer of _________ in the subsoil.

   a. clay
   b. minerals
   c. nutrients
   d. sand
   e. stones

8. Soil surface texture is classified as fine, medium, or ________.

   a. coarse
   b. hard
   c. loam
   d. rough
   e. silt

9. The mineral ingrediants of soil are of three sizes; sand, silt, and ______.

   a. clay
   b. fine
   c. gravel
   d. humus
   e. loam

10. A soil having excessive permeability would consist largely of ______.

    a. clay
    b. humus
    c. loam
    d. sand
    e. silt

11. Soil with a high inherent fertility level is usually classified as having a ______ colour.

    a. black
    b. dark
    c. green
    d. light
    e. medium dark

TUMAINI SECONDARY SCHOOL

LAND II

This is a programmed instruction unit which continues the instruction began in Land I.

In this unit you are to learn:

1. how the following are used in classifying land:
   a. slope.
   b. soil drainage.
   c. erosion.
2. what pH is and its effect on plant growth.
3. the characteristics of each of the land classifications.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Land II

If you have not read the information panel, do so now, then proceed to frame 1.

-cut-

-cut-

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Land II
continued

- cut -

- cut -

Name ____________________ Form ________

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60. ____________

61. ____________

62. ____________

63. ____________

Slope. Slope is very important because it influences the rate at which water runs over the soil. This runoff is one of the causes of erosion. Slope also influences the way in which the land can be farmed. Slope is expressed by the number of metres of fall in each 100 linear metres. Slope ranges vary widely in different areas. For instance, land with 8 to 12 metres fall per 100 linear metres might be considered steep or very steep in some climates and soil conditions. It might be considered only moderately sloping under other conditions of less intensive climatic conditions. The following will give an idea of the manner in which slope ranges are expressed:

(2% means 2 metres fall per 100 linear metres of distance.)

Nearly level

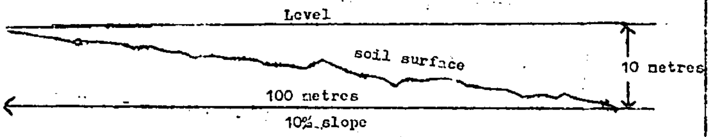
Gently sloping

Moderately sloping

Strongly sloping

Steep

Very steep



slope	If you have not read the above information panel on soil slope, do so now. 1. Slope is important as it directly influences water run off and erosion. __________ is expressed as the number of metres of fall per 100 linear metres of "run".
nearly level gently sloping moderately sloping strongly sloping steep very steep	2. Slope ranges are expressed as nearly level, gently sloping, moderately sloping, strongly sloping, steep, and very steep. Write the slope ranges in the answer box.
2	3. Two percent fall means __________ metres fall per 100 linear metres.

slope	4. Erosion is partially caused by water runoff, which is due to percent of ______. The slope of the land is the major influence on erosion.
level sloping sloping steep	5. Slope is divided into six categories. They are nearly ______, gently ______, moderately ______, strongly sloping, steep, and very ______.
nearly gently moderately strongly steep very	6. The six categories of slope are: ______ level, ______ sloping, ______ sloping, ______ sloping, ______, and ______ steep.
nearly level gently sloping moderately sloping strongly sloping steep very steep	7. List the six categories of slope.
nearly level gently sloping	8. If you answered frame number 7 without error, well done! Go to frame 11. Otherwise, continue with this frame. Very little erosion might be expected due to a n______ l______ slope or a g______ s______ land.
moderately sloping strongly sloping steep very steep	9. Greater degrees of erosion might be expected on slopes ranging from m______ s______, to s______ s______, to ______ to ______ ______.

nearly level gently sloping moderately sloping strongly sloping steep very steep	10. The six categories of slope are:

Soil drainage. How rapidly or slowly the land drains after heavy rains. Land subject to overflow by streams is less attractive to the farmer than higher-lying well drained land. Flat slopes that drain slowly are less desirable than those that drain moderately well. Similarly, gravelly or sandy soils that are excessively drained and droughty are less desirable than those with moderate drainage. These classifications may be used:

Limiting - water is removed so slowly that the soil remains wet for a large part of the time.

Adequate - this is normal drainage, no water problems.

Excessive - water is removed in an excessive amount and rate, causing droughty conditions.

soil drainage	11. Soil drainage is a function (result) of soil permeability and slope. How rapidly or slowly the land drains after heavy rain is called ________ ________.
soil drainage	12. ________ ________, the result of vertical movement of moisture through, and lateral movement across, the land is classified as limiting, adequate, or excessive.
limiting adequate excessive	13. You will notice that permeability and soil drainage are described by the same terms: ________, ________, or ________.

limiting	14. With limiting soil drainage, water is removed so slowly that the soil remains wet for a large part of the time. Swampy lands would have ________ drainage.
adequate	15. Adequate drainage is normal drainage with no water problems. A soil with adequate permeability and no slope problem will probably have ________ soil drainage.
limiting	16. A heavy clay subsoil and a "flat" slope might indicate ________ soil drainage.
adequate	17. A medium textured soil profile (topsoil and subsoil) with an even, moderate slope will probably have ________ soil drainage.
excessive	18. A soil profile that is coarse textured will probably have ________ soil drainage.
adequate	19. A fine surface texture with a medium texture subsoil will probably have ________ soil drainage. Soil drainage is a function of water movement through the soil (permeability) and across the soil surface (slope).

limiting adequate excessive	20. Soil drainage is classified as ________, ________, and ________.

Erosion. The loss of soil by the effects of water and wind is called erosion. Excessive accumulation of soil particles and sand due to the force of wind is also evidence of erosion.

The percentage of erosion can be measured by comparing the depth of topsoil at the field site with topsoil in a nearby protected area where no erosion has occurred.

None to slight erosion - nearly all the original topsoil remains, or less than 25% of topsoil lost by erosion; no gullies which cannot be crossed by farm machinery.

Moderate erosion - the top several centimetres may be lost, 25% to 75% of topsoil lost by erosion, without frequent uncrossable gullies.

Severe erosion - the topsoil being farmed is less than a plough depth and the result is a mixture of topsoil and subsoil, or more than 75% of topsoil lost by erosion with occasional uncrossable gullies.

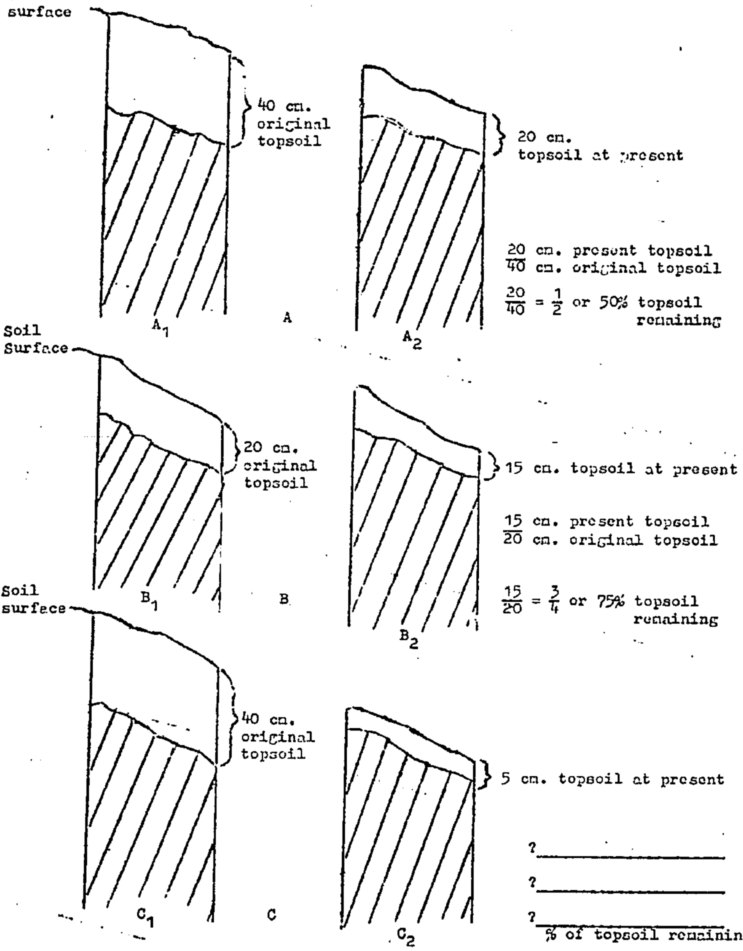
erosion	21. The loss ob soil by the effects of water and wind is called ________.
wind and water	22. Erosion by ________ and ________ is evidenced by an accumulation of soil particles and sand, examples being the sand dunes of the desert and river deltas. These "accumulations" are materials which have been transported by wind or water from one place to another.
erosion	23. The extent of ________ is measured from the amount of <u>original</u> topsoil as opposed to the amount of topsoil present <u>now</u>.

none to slight moderate severe	24. Erosion terms, such as none to slight, moderate, and severe erosion are based on the percentage of erosion. Copy these three terms in the answer frame.
none to slight	25. Less than 25 percent loss of topsoil is called ______ to ______ erosion.
moderate	26. From 25 percent to 75 percent of topsoil loss is defined as ______ erosion.
severe erosion	27. When the topsoil being farmed is less than plough depth or when more than 75 percent is lost by erosion, we call this ______ ______.
none to slight moderate severe	28. For purposes of classification and correct technical language, then, we speak of erosion as (0-25%) ______ to ______, (25-75%) ______, or (greater than 75%) ______.
none to slight - 0-25%; moderate - 25-75%; severe - greater than 75%.	29. The percentage of loss of topsoil determines which category of erosion a soil "fits". Now list the three divisions <u>and</u> their percentages.

original present (or terms which mean the same)	30. To calculate percentage of erosion, one must know the depth of ______ topsoil as opposed to the amount of ______ topsoil.

SOIL PROFILES

Diagrams of vertical profiles showing % of erosion



$\frac{20}{40}$ cm. present topsoil / cm. original topsoil

$\frac{20}{40} = \frac{1}{2}$ or 50% topsoil remaining

$\frac{15}{20}$ cm. present topsoil / cm. original topsoil

$\frac{15}{20} = \frac{3}{4}$ or 75% topsoil remaining

?____________

?____________

?____________ % of topsoil remaining

moderate	31. Refer to information panel on page 7 to answer frames 31-34. Soil profile "A" (A_1 and A_2) would be classified as ________ erosion.
none to slight	32. Soil profiles "B" (B_1 and B_2) would be classified as ________ erosion.
severe	33. Soil profiles "C" (C_1 and C_2) would be classified as ________ erosion.
50%	34. Given 50 cm. of original topsoil and 25 cm. of topsoil now evident, what percent loss of erosion would this be?
66% moderate	35. Given 21 cm. of original topsoil and 14 cm. now present, the percent of loss is ________ and the category of erosion is ________.
I	36. Land used best for cultivated crops are land classes I, II, and III. Land classes II and III are best used in rotation to maintain a relatively high organic matter content. Land class IV is grouped with cultivable land classes also. Land class ________ can be cultivated every year with relatively small risk.

I	37. Land class IV is best used for hay or pasture with an occasional cultivated crop possible. Land class VI is best used for range. A maize crop every yea r is economically sound on land class ______ soil. Land classes I, II, III, and IV can be cultivated. Land classes VI, VII, and VIII are not cultivated because of extreme hazards.
VI	38. Land class VII soil is best used for range and woodland and land class VIII for recreation and wildlife. Land suitable for grazing cattle is classified as land class ______.
VIII	39. Land most suited for parks is classified as land class ______.
I	40. The best land capability class a soil with moderate permeability can be assigned is land class ______.
I	41. The maximum land capability class that can be assigned to a soil with a light coloured surface soil is ______.
increases	42. The texture of a soil affects its water holding capacity. As the soil particle size decreases the water holding capacity ______.

b - more fertilizer, because the soil drains rapidly	43. A coarse textured soil will probably requre (a) less fertilizer, (b) more fertilizer, (c) tile drains. (choose one).
b - aggregates; (organic matter encourages aggregation of soil.)	44. Structure of a soil refers to how individual soil particles are grouped together to form (a) organic matter, (b) aggregates, (c) clay. (choose one).
IV, III, I	45. The maximum land capacity class of: a shallow soil is ________, a moderately deep soil ________, a deep soil ________.
IV	46. The maximum capability class of severely eroded soil is land class ________.
II	47. The maximum land class of a moderately eroded soil is land class ________.
V or VI (V - where this class is used)	48. The maximum land capability class of a soil with limited surface drainage is land class ________. Field practice is necessary as well as study of detailed land class description to master correct assignment of a soil to a land class.

c	49. Single grain structure is associated with soils high in (a) silt, (b) clay, or (c) sand. (choose one).
permeability	50. The ease with which water moves through the soil is referred to as ________.
climate	51. Climate is important because it influences the kinds of crops that can be grown on a soil. The most important factor of climate to crop response is rainfall. ________ influences the kinds of crops that can be grown on a soil.
climate	52. Extremely low rainfall, or too short a period of good rainfall for crop maturity are definite limitations of ________.
- -	53. These low rainfall areas are found in various parts of the country. Other areas which normally receive adequate rainfall sometimes receive inadequate amounts to bring crops to maturity.
climate	54. ________ is limiting where there is inadequate rainfall to provide a growing season of at least 120 days.

climate	55. Adequate __________ is represented by a growing season greater than 120 days, and no climatic problems.
	56. Stoniness refers to the relative proportion of stones in or on the soil. They have an important bearing on soil use because of their interference with the use of agricultural machinery.
non-stony	57. We classify non-stony as no stones or too few to interfere with tillage. The word is __________.
	58. We classify land as stony if there are sufficient stones to make all use of machinery impracticable except for very light machinery or hand tools for pasture improvement.
	59. pH is an expression used to measure the acidity or alkalinity of a soil. This is determined by the use of chemical indicators applied to the soil with resulting colours compared to a colour chart of known determinations. pH is important because all plants grow within a certain reaction range. Some plants will grow best in slightly acid soils, but will not grow in alkaline soil. Different plants grow best in a slightly alkaline soil. If we know the pH of a soil we know what type of plant will grow best in that pH range. We classify pH on a scale of 0-14 as follows: Acid-below 6.6; Neutral-6.6-7.3; Alkaline above 7.4
pH	60. __________ is a measure of a soil's acidity or neutrality or alkalinity.

acid	61. Soils below a pH of 6.6 are ________.
7.4	62. Soils with a pH above ________ are alkaline.
neutral	63. Soils with a pH between 6.6 and 7.3 are ________.

This unit is based on a similar one prepared by Gilbert Long of the College of Education at the University of Washington, Pullman, Washington.

LAND JUDGING SCORE CARD

Name or Number ____________________

Field Number ____________________

INVENTORY OF LAND FACTORS
Part I

Indicate your answer by an X in the proper square.

EFFECTIVE DEPTH

- Very Deep . . . . (____)
- Deep . . . . (____)
- Moderately deep . . . . . . (____)
- Shallow . . . . (____)
- Very Shallow . . . . (____)

SURFACE TEXTURE

- Fine . . . . (____)
- Medium . . . . (____)
- Coarse . . . . (____)

PERMEABILITY

- Limiting . . . . (____)
- Adequate . . . . (____)
- Excessive . . . . (____)

SLOPE

- Nearly level . . . . (____)
- Gently sloping . . . . (____)
- Moderately sloping . . . . . (____)
- Strongly sloping . . . . . . (____)
- Steep . . . . (____)
- Very Steep . . . . (____)

SURFACE DRAINAGE

- Limiting . . . . (____)
- Adequate . . . . (____)
- Excessive . . . . (____)

EROSION

- None to slight . . . . (____)
- Moderate erosion . . . . . . (____)
- Severe erosion . . . . (____)

CLIMATE

- Limiting . . . . (____)
- Adequate . . . . (____)

STONINESS

- Non-stony . . . . (____)
- Stony . . . . (____)

RECOMMENDATIONS
Part II

Recommendations for best land use. (Select One)

- Cultivated . . . . (____)
- Hay or pasture . . . . (____)
- Range . . . . (____)
- Woodland . . . . (____)
- Wildlife, Watershed, & Recreation . . . . (____)

CLASSIFICATION

Indicate by an X the major limiting factors or problems to be considered in selecting the proper land classification.

- Depth . . . . (____)
- Surface texture . . . . (____)
- Permeability . . . . (____)
- Colour . . . . (____)
- Slope . . . . (____)
- Surface drainage . . . . (____)
- Erosion . . . . (____)
- Climate . . . . (____)
- Stoniness . . . . (____)

LAND CAPABILITY CLASS
(Circle One)

I II III IV V VI VII VIII

Name ______________ Form _____
Date ______________

TEST

LAND II

UNDERLINE THE CORRECT ANSWER

1. Land classes suitable for cultivation are _____, _________, _________, and _________. (Choose 4 answers.)

   a. I
   b. II
   c. III
   d. IV
   e. VI
   f. VII
   g. VIII

2. Land classes not suitable for cultivation are ______, ________, and _______. (Choose 3 answers.)

   a. I
   b. II
   c. III
   d. IV
   e. VI
   f. VII
   g. VIII

3. Land slope is defined as the number of metres fall per ________.

   a. 10 metres
   b. 100 metres
   c. 25 metres
   d. 1,000 metres
   e. 50 metres

4. __________ is the major influence for rate of water run-off.

   a. Cover
   b. Flexibility
   c. Permeability
   d. Slope
   e. Soil drainage

5. Soil ________ refers to how rapidly the land drains after heavy rains.

   a. drainage
   b. length of life
   c. permeability
   d. slope
   e. texture

6. Moderate erosion is a loss of topsoil between __________ percent.

   a. 10-20
   b. 15-30
   c. 25-75
   d. 30-60
   e. 50-90

7. The acidity or alkalinity (sweetness) of a soil are measured in terms of _________.

   a. bH
   b. cation exchange
   c. pH
   d. sourness
   e. taste

8. Land that can be used regularly for crops in a good rotation but needs intensive treatment and is subject to severe limitations in use for crop land is land class ________.

a. I
b. III
c. IV
d. VI
e. VIII

9. The ______ of the land is the major influence on erosion.

a. depth
b. fortility
c. slope
d. soil drainage
e. texture

10. The loss of soil by the effects of water and wind is called _________.

a. alluvium
8 b. conservation
c. drainage
d. erosion
e. fertility

11. A maize crop can be grown every year on land in land class _______.

a. I only
b. I and II
c. I, II, and III
d. II only
e. I, II, III, and IV

TUMAINI SECONDARY SCHOOL

CASTRATING, DOCKING, AND DEHORNING

This is a programmed instruction unit in castrating, docking, and dehorning.

In this unit you are to learn:

1. methods of castrating pigs.
2. methods of castrating cattle.
3. methods of castrating sheep.
4. methods of docking lambs.
5. methods of dehorning cattle.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Castrating,
Docking and
Dehorning

If you have not read the cover page, do so now, then proceed to frame 1.

- cut -

- cut -

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Castration	1. Castration is the operation of removing the testicles or sex glands of animals. _________ is the removal of the testicles of animals.
testicles ovaries	2. The name is used by some to include the removal of the testicles from the male and the ovaries of the female. Commonly, however, the term spaying is used when referring to the removal of the ovaries and castration for the removal of testicles. Castration is the removal of ______ and spaying is the removal of the ________.
improve meat quality prevent indiscriminate breeding Prevent development of sexal ordors in meat	3. The object of castration is to improve the quality of meat, to prevent indiscriminate breeding, and to prevent the development of sexual odors and flavors, which occur in the meat of the uncastrated male hog or sheep. Animals are castrated to ________, __________, and ______________.
stags	4. Males which are castrated after they have developed mature sexual characteristics are classified on the market as "stags". The strong sexual odors become modified and usually disappear within one or two months after castration. Males castrated after reaching sexual maturity are called ________________.
castration	5. It is best, however, to perform castration at an early age, long before sexual maturity. The earlier it is done, the less shock will be experience by the animal and the less its development will be interrupted. ____________ should be done before sexual maturity.
castration	6. As a result of castration, the characteristic sex features fail to develop and the animal becomes more refined or feminine in nature. The sex features of a male fail to develop after ______.

castrated	7. Male pigs may be castrated any time between a few days and a few months of age. However, most breeders like to operate when the pigs are young enough that the wounds will be entirely healed before weaning time. Pigs are usually ________ at an early age.
- -	8. At an early age the pigs are easily handled, and heal faster than they do at an older age. Complications, which sometimes happen at later ages, are not so liable to occur either. When the operation is performed as late as four or five months of age, breeding frequently results among the young animals of the herd.
2-3	9. Castration before weaning time (preferably 2 to 3 weeks of age), then is a good practice for the pig grower to follow. Pigs should be castrated when they are ______ weeks old.
- -	10. Castration of pigs may be performed successfully at any season of the year. When possible, clear, warm days should be selected for the operation, and cool damp weather avoided.
disinfected	11. Preparation for castration includes confining the pigs to a clean, well-bedded pen or lot. If the pigs are clean, it is not necessary to wash the scrotum with a disinfectant. If the pigs are dirty, the scrotum should be ________ before castration.
soap and water	12. If quite dirty, they should be washed with soap and water or a mild antiseptic solution. Avoid irritating disinfectants because they are painful to the cut surface and often cause rubbing of the wounds, resulting in injury to the parts. A good disinfectant to use before castration is ____________________.

2	13. To perform the operation, have an assistant hold the pig on its back or side on the floor or table, or by the hind legs with the body and head between the knees. Castration of pigs requires at least _____ people.
- -	14. If the animal is lying on its side, remove the lower testicle first. Make the incision parallel to and about 1 centimetre from the line or raphe. This incision should pass through the skin near the lower end of the testicle and through the testicular covering into the body of the testicle itself.
incision	15. A common mistake is to cut too high on the scrotum. Unless the incision is properly made, it is impossible for the wound to drain properly when the pig is standing or running around. The _______ must be made correctly to insure that the wound can drain properly.
cord	16. Following the incision slip the testicle out through its membranes and cut the attachments except the cord. Then pull the cord until it breaks and comes out. Remove the second testicle in a similar manner. The ______ of the testicle should not be cut, but pulled until it breaks.
tied	17. When castrating older boars, special means of holding the animal are necessary Roping the feet and throwing the animal on its back or side is generally the easiest. Older pigs must be ______ down for castration.
bleeding	18. Perform the operation in the same manner as on small pigs, the only precaution being the prevention of excessive bleeding. Excessive __________ must be prevented when castrating older boars.

scraped (cut)	19. It is advisable to tie a ligature tightly around the cord before cutting it. The cord on matured animals should not be pulled in two as in young animals but should be scraped in two with a sharp knife. The cord on older boars must be ________ in two rather than pulled apart.
dressed	20. It is not necessary to apply a dressing of any kind to the wounds for purposes of disinfection. A dressing is objectionable because it interferes with the quick healing process which usually results. Castration wounds should not be ________.
- -	21. The lymph and blood serum which escape at the edges of the wound contain sufficient germicidal properties to take care of ordinary exposure.
infected	22. In some instances, it may be necessary to apply pine tar as a protection against flies. In a properly performed operation with a clean, sharp knife, only little swelling or discharge will follow. If the wounds should become infected, treat them like other infected wounds, using such disinfectants and dressings as may be necessary. Castration wounds need to be treated only if they become ___________.
rupture	23. The castrating of ruptured pigs (scrotal hernia) requires special care. Since the intestine has already slipped through the canal into the scrotum, it must be worked back into the abdomen.
- -	24. The intestine is returned into the abdomen after making the incision by holding the pig up by the hind legs and working the intestine down with the fingers. The testicle may then be removed, but the thin membrane should be carefully sewed or sutured with silk thread to close the cavity completely and prevent the escape of the intestines.

testicle	25. The castrating of ridgelings has to be done through the side. A ridgeling is an animal in which the ________ remains in the body cavity.
removed	26. Since the testicle or testicles that remain in the body cavity are never fertile, most breeders do not bother with removing them. Such testicles may or may not cause masculine characteristics to appear. Testicles which remain in the body cavity are usually not ________.
1 to 4	27. For economic reasons all bull calves not required for breeding in cattle herds should be castrated at an early age. Castration is best done when calves are from 1 to 4 months of age. Bull calves should be castrated when they are ________ months old.
castrate	28. Many recommend that the operation be performed when the calf is only a few days old, claiming that less pain and less blood will result than if done later. The testicles of very young calves, however, are so small and soft that it is often difficult to distinguish them from the surrounding tissue. It is difficult to c________ very young bull calves.
- -	29. Also, occasionally, the testicles do not descend into the scrotum until several days after birth. The castration of older animals is attended with more risk, but seldom do complications develop if the operation is properly performed.
weather	30. Castration should be done when weather conditions are the most favorable, neither too hot nor too cold. Good w________ conditions are important for castration.

tied, held, or fastened	31. When performing the castration operation, the calf may be thrown and tied, or fastened in some type of a "squeeze". The calf must be firmly ______ for the castration operation.
drainage	32. If thrown, remove the bottom testicle first by slitting the far side of the scrotum parallel to the median line. The incision should be made over the side of the testicle, and from the top one-third to the lower end of the scrotum to permit proper drainage. It is important that the incision made for castration is correct so that proper ________ can occur.
- -	33. A common method is to grasp the lower end of the scrotum, pull it out tightly, and cut off the lower-one-third, exposing the ends of both testicles. Remove one testicle at a time.
median one-third	34. Do this by pulling or pressing it out of the scrotum, slitting the covering membrane, and severing the cord, allowing two or three inches of the cord to remain on the testicle. The scrotum may be slit parallel to the _______ line on each side or the lower _____ of the scrotum cut off to remove the testicles.
antiseptic	35. Perform the operation with clean instruments and sanitary conditions. First scrub your hands, knife, and scrotum with a sponge or piece of absorbent cotton saturated with a weak antiseptic solution. An _______ solution is used to help prevent infection from the operation.
standing	36. To castrate a standing animal, stand close against the left side, face the rear, and with the left hand draw the scrotum back between the hind legs. With this method the animal should be tied securely with a short rope or lead. In other respects perform the operation in the same manner as when the animal has been thrown. Cattle may be castrated either while s_________ or after being thrown.

observed	37. After castration make sure that the incisions are sufficiently large and low to afford proper drainage. Hold calves in a clean pen or lot for observation for a few hours until all danger of excessive bleeding is past. After castration cattle should be o______ for several hours to insure that they do not bleed too much.
flies	38. Only if there is danger of flies should anything be put on the wounds. Then a repellent such as pinetar should be used. Observe the calves for a few days for unnecessary swelling. Nothing should be put on the castration wounds unless ______ are present and then a repellent can be used.
cords	39. Bloodless castration is practiced by many breeders. This calls for a special type clamp or instrument which crushes each cord separately an inch or two above the testicle. The Burdizzo emasculatome is such an instrument. Calves may be castrated by crushing the ______ of the testicles with a special instrument.
crushed	40. This type of castration is satisfactory if properly done, but if a cord is incompletely crushed, a "slip" will develop. The cords must be completely ______ or castration is not completed and a slip occurs.
bleeding skin	41. To perform the operation, work the cord to one side of the scrotum and place it between the jaws of the emasculatome and crush. With no break in the skin of the scrotum and no external bleeding, this method has an important advantage where flies are troublesome. The advantage of an emasculatome is that there is no b______ or breaking of the s______.
eslatrator	42. Another instrument used for castrating calves, without the loss of blood, is the elastrator. It is a pincer-like tool used to place a strong elastic band around the scrotum, well above the testicles. Use of the e______ is another method of bloodless castration.

blood	43. This band shuts off all circulation of blood, causing the scrotum to slough off in about a month, leaving the groin region perfectly smooth. With the elastrator, a strong rubber band is used to cut off ______ circulation which causes the scrotum to dry up and fall off.
- -	44. Castration with the knife is generally recommeded over the two "bloodless" castration methods described.
7 to 14	45. Ram lambs (sheep) should be castrated when they are 7 to 14 days old. Choose a bright day; do not castrate lambs on a damp, chilly, or rainy day. Sheep should be castrated at ______ days of age.
excited	46. Select from the flock all lambs that are to be castrated and fence them off so they can be caught without too much excitement. Place them in a clean stall or pen after the operation is performed. The lambs should be e______ as little as possible before castration.
testicles cords	47. Castration may be done by either of two methods. In one you remove the testicles by operation, while in the other you pinch the cords, causing the testicles to shrivel up, due to lack of nourishment. Removing of the testicles is by far the more common practice. The two methods of castration are: removing the ______ and pinching the ______.
- -	48. To perform the operation, hold the lamb on its rump with its hind legs wide apart. Cut off the lower third of the scrotum and with the left hand squeeze the testicles down. Next grasp the testicles firmly between the thumb and fingers of the right hand and pull them out with the adhering cords.

disfectant	49. The work should be done quickly but not roughly, and the testicles and adhering cords should be drawn out with a steady pull. The wound should then be treated with one of the sulfa ointments, a weak carbolic solution, or lysol preparation. Castration wounds of lambs should be treated with a d__________.
bleeding	50. If the lambs are more than three weeks old before the operation is performed, do not pull the cords out but scrape them in two, back of the testicle, with a knife. The scraping is done to prevent excessive bleeding. Castration of older lambs is more difficult because excessive __________ may occur.
Burdizzo (emasculatome)	51. A bloodless method of castration is performed with special pinchers called Burdizzos or emasculatome. The cord just back of each testicle is pinched one at a time so some scrotum is left unclamped for circulation. Lambs can be bloodlessly castrated with the ________.
infection	52. This type of castration does away with all danger of infection, but unless very carefully done, may produce some "slips" in which castration is not accomplished. Bloodless castration has the advantage that all danger of i________ is eliminate.
Elastration	53. The elastrator may also be used for sheep. The rubber band cuts off all blood supply causing the scrotum and testicles to slough off in a few weeks. Care must be taken to be sure that both the testicles are below the rubber band when it is applied. E__________ is another method of bloodless castration.
tail	54. The docking of lambs is practiced because the tail is of no benefit to the animal and the presence is injurious because of the filth which accumulates around and beneath it. Docking means removal of the _______.

clean	55. Moreover, lambs are more attractive and look deeper in the leg and twist if the tail is docked. Females with full-length tails often fail to breed. The main purpose of docking is to help keep the animal c________.
docking	56. If you will use care, you can dock and castrate lambs at the same time. If both operations are performed at the same time, you save labour as the lambs will have to be caught only once. Lambs should be docked when they are 7 to 14 days old. Castration and ________ can be done at the same time.
- -	57. One of the most satisfactory methods of docking is with the emasculatome emasculator. If crushes the tail toward the body as it cuts the tail away from the body so that there is usually little loss of blood. Use tincture of iodine or some other disinfectant on the tail stub.
knife emasculator elastrator	58. A recent method of docking, widely used in some places, is the use of the elastrator to place a tight rubber band over the base of the tail. Three instruments that can be used for docking are __________, __________, and __________.
- -	59. With the elastrator, the tail will drop off in 3 or 4 weeks time. If used in hot weather, some odor is present after a week or two, which may attract blow flies. The tail should be cut off with a knife at this point.
sears sterilizes	60. Hot docking irons may also be used. Heat the pinchers or chisel to a cherry-red heat, not hotter, and sear off the tail 2 to 4 centimetres from the body. This sears the blood vessels and sterilizes the wound by the heat. Docking with a hot iron ______ the blood vessels and ________ the wound.

- -	61. If docking with a hot iron in warm weather, some fly repellent may be necessary. Watch the lambs for a few days to see that they are recovering satisfactorily.
2 to 4	62. Docking is sometimes done with a knife, especially in small flocks. With a knife, feel on the underside of the tail to locate the joint to be cut (2 to 4 centimetres from the body). Make the cut from the underside toward the top or wooly side. The tail should be docked ______ centimetres from the body.
cord red-hot iron	63. If the tail bleeds too much, tie a piece of cord tightly around it or touch the cut end lightly with a red-hot iron. If you use the cord, remove it in a few hours to keep the tail stub from sloughing off. Excessive bleeding after docking can be treated by tying a _____ around it or touching the end with a ______________.
Dehorning	64. Horns on commercial cattle are extremely objectionable. The losses from burised carcasses and damaged hides are so great on slaughter cattle shipped to market that horned cattle often sell for 8 to 12 percent less than if they were polled or dehorned. D________ helps to prevent loss to slaughter cattle from bruises.
	65. Horns are also objectionalbe on the farm, especially in feedlots. Timid weak animals are forced away from feed and shelter by strong, horned ones.
polled	66. Dehorning may be done in one of several ways. The use of a pure (homozygous) polled bull is one way favoured by many commercial producers. A "pure" polled bull will sire nothing but hornless calves even when used on horned cows. One way of obtaining polled calves is to use a pure p_________ bull.

caustic soda caustic potash	67. Chemicals are often used for dehorning young calves. Those generally used are caustic soda or caustic potash. For best results use this when the calf is 3 to 10 days old. Dehorning can be done with a chemical such as _______ or __________.
- -	68. First, when using chemicals, clip the hair away from the budding horn. Then rub the area with a rough substance, such as a maize cob until the skin shows signs of irritation. Then with the dehorning paste applicator, apply enough paste directly unto the horn button to cover it completely with a thin layer.
3 to 10	69. Take care not to put on too much or touch anything except the horn button. Beginners often place a ring of vaseline, lard, or other grease around the horn so as to avoid buring more than the desired spot. A scab will form in a few days which later drops off leaving the skin smooth. Dehorning with chemicals should be done when calves are _________ days old.
heat	70. An electrical dehorner is sometimes used instead of chemicals on young calves. To use it, heat the iron to the proper temperature, fit it over the horn button, and hold it firmly against the head until the horn tissue has been destroyed. An electrical dehorner destroys the horn tissue with h___________.
1 to 2	71. Because they are more painful and require more time than chemicals, electrical dehorners are not commonly used on young calves, but are used on calves 1 to 2 months old. They should not be used on calves over 2 months of age. Electrical dehorners should be used on calves ________ months of age.
mechanical	72. Mechanical dehorners of various kinds are used on cattle when they get past the baby-calf stage. A small calf dehorner called a "gouge" can be used successfully on a calf from 1 to 3 months of age. M__________ dehorners are used on older calves and cattle.

- -	73. From 3 months up to about 10 months, a mechanical dehorner with half-round cutting blades has proven best. Beyond this age mechanical clippers or a saw is generally used.
using pure polled bull, chemicals, electrical dehorner, mechanical dehorner	74. Ordinarily, about ½ to 1 centimetre of flesh and hair should be cut off at the base of the horn in order to insure a smooth head. A good fly repellent, such as pine tar should be used around the wound, if flies are present. The four main ways of dehorning cattle are: __________, __________, __________, and __________.

The information in this unit was taken from the University of Illinois VAS unit 1032.

Name ____________________ Form ______
Date ____________________

TEST

Castrating, Docking, and Dehorning

UNDERLINE THE CORRECT ANSWER

1. Castration is an operation to remove the ________ of animals.

   a. horns
   b. ovaries
   c. penis
   d. tails
   e. testicles

2. Castration is performed on animals to __________ and ________. (Choose 2 answers)

   a. help keep the animal clean
   b. improve the quality of meat
   c. meet religious requirements
   d. prevent indiscriminate breeding
   e. prevent injury to other animals

3. When should animals be castrated?

   a. after reaching sexual maturity
   b. at an early age
   c. just before slaughter
   d. at birth
   e. can be done at any time

4. An animal which has not been correctly or completely castrated is known as a_____________.

   a. boar
   b. bull
   c. ram
   d. slip
   e. stag

5. Pigs should be castrated when they are _________ old.

   a. 1 day
   b. 2-3 weeks
   c. 10-12 weeks
   d. 5 months old
   e. 1 year

6. After castration, animals should be kept in clean surroundings to prevent __________.

   a. bleeding
   b. breeding
   c. emasculation
   d. infection
   e. pain

7. When castrating with a knife, it is important that the scrotum be cut correctly so that proper _______ of the wound will occur.

   a. bleeding
   b. docking
   c. draining
   d. infection
   e. swelling

8. When castrating young pigs, the cord should be ________.

   a. cut with a scissors
   b. cut with a knife
   c. pulled until it breaks
   d. smashed with a stone
   e. tied with a string

9. Bloodless castration of cattle can be done with a ________ or a ________. (Choose 2 answers.)

   a. Burdizzo emasculatome
   b. elastrator
   c. knife
   d. razor blade
   e. scissors

10. Bloodless castration is advantageous when ___________.

    a. flies are troublesome
    b. it is cold
    c. ridgelings are castrated
    d. the animals are very old
    e. there is no danger of infection

11. Docking is an operation to remove the ______ of sheep.

    a. horns
    b. ovaries
    c. penis
    d. tails
    e. testicles

12. Sheep are docked to _________.

    a. keep them clean
    b. meet religious requirements
    c. prevent breeding
    d. prevent injury to other animals
    e. prevent pain

13. Sheep should be docked ______ from the body.

    a. 1-2 millimetres
    b. 2-4 centimetres
    c. 10-12 centimetres
    d. 40-50 centimetres
    e. 75-80 centimetres

14. Cattle are dehorned to _________.

    a. keep them clean
    b. meet religious requirements
    c. prevent breeding
    d. prevent injury to other animals
    e. prevent pain

15. Dehorning chemicals such as caustic potash should be used when the animal is ________ old.

    a. 3-10 days
    b. 25-30 days
    c. 2 months
    d. 6 months
    e. 1 year

16. Electrical dehorners should <u>not</u> be used on animals over _______ of age.

    a. 2 weeks
    b. 1 month
    c. 2 months
    d. 4 months
    e. 10 months

17. Sheep should be castrated when they are ______ old.

    a. 1-2 days
    b. 7-14 days
    c. 1 month
    d. 2- 3 months
    e. 6-8 months

18. Cattle should be castrated when they are _______ old.

    a. 1 week
    b. 1-4 months
    c. 10-12 months
    d. 1 year
    e. 2 years

19. One way of preventing horns is to use a _______ bull who will produce only hornless calves.

    a. castrated
    b. dehorned
    c. grade
    d. heterozygous polled
    e. homozygous polled

TUMAINI SECONDARY SCHOOL

THE COW'S UDDER AND HOW IT FUNCTIONS

This is a programmed instruction unit in the cow's udder and how it functions.

In this unit you are to learn:

1. the parts of the udder.
2. how milk is secreted in the udder.
3. how milk is carried to the teats.
4. the parts of the teat.
5. how a cow lets down her milk.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

The Cow's Udder
and How it
Functions

-cut-

-cut-

Name ______________________ Form __________

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udder	1. Since most dairy cows are kept on farms for the primary purpose of producing milk, the udder is an important part of their anatomy. That is where the various milk constituents are taken from the blood and manufactured into milk. Milk is manufactured in the cow's __________.
bag sack	2. One look at the outside of a cow's udder at milking time leaves one with the impression that the udder is a large bag or sack that is used to hold the milk until milking time after it has been manufactured somewhere else. A cross section of an udder, however shows it is not hollow like a bag or sack, but instead is full of tubes, connective tissue, and such. An udder is not just an empty b_____ or s_________.
milking	3. A further study shows the milk does not move far from where it is manufactured until it is "let down" by the cow at milking time. The milk is not held in a large hollow bag but in a large number of very small openings scattered throughout the udder. Milk is held in small openings until m_______ time.
4	4. <u>Parts of the Udder.</u> The udder is made up of four separate and distinct glands or quarters. The front and rear quarters are separated by a rather fine membrane, while the right and left halves are separated by a very distinct wall. (Fig. 1). The cow's udder is made up of _____ separate quarters.

Fig. 1. The udder is divided into halves by a central supporting membrane and quarters by a very fine membrane.

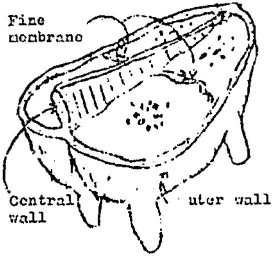
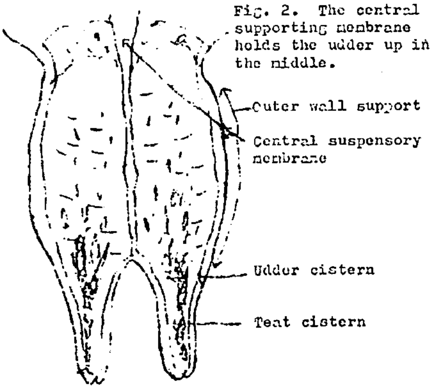


Fig. 2. The central supporting membrane holds the udder up in the middle.



central suspensory membrane	5. The centre wall is an elastic suspensory membrane and acts as the main support of the udder (Fig. 2). The udder is further supported by membranes passing up the two outer sides which are attached to the abdominal wall. The main support of the udder is given by the c___ s___ m___.
connective	6. Spaced at intervals, throughout each quarter, are web-like connective tissues which support the various parts of the milk-secreting gland of that quarter (Fig. 3). If the secretory tissue did not have support, it would be much like a big bag of jelly. C______ tissue supports the various parts of the milk-secreting gland.
shrinks	7. Also if the udder had more connective tissue than is necessary, it would be quite large and still not have much secreting tissue. That is why the size of the udder does not indicate production but does limit it. An udder that shrinks away and becomes quite flabby after milking indicates the presence of much secretory tissue with only fine connective tissue. An udder with much secretory tissue s______ greatly after milking.

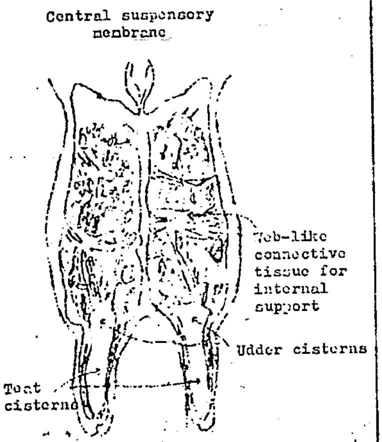


Fig. 3. Web-like connective tissues criss-cross the interior of the quarter and support the ducts and secretory cells.

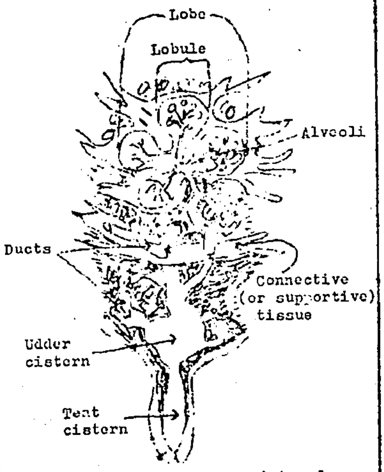


Fig. 4. Each quarter consists of many lobes, which are divided into lobules and many alveoli.

lobules	8. Each quarter is divided in a large number of divisions called lobes. Each lobe is drained by a single duct. The lobes in turn are divided into many lobules, each of which is drained by a duct leading to the main lobar duct (Fig. 4). Lobes are divided into many l________.
connective	9. Both the lobes and lobules are surrounded and supported by connective tissue membrane. This is part of the hammock-like membrane that supports the gland tissue of the udder. The lobes and lobules are supported by ________ tissue.
epithelial alveoli	10. A lobule is made up of a large number of alveoli, spherical structures with a wall made up of a single layer of epithelial cells, which manufacture or secrete the milk (Fig. 5). Each alveolus is connected by a duct to a holding space within the lobule and is connected to the interlobular duct. Milk is secreted by e________ cells located in the a________.

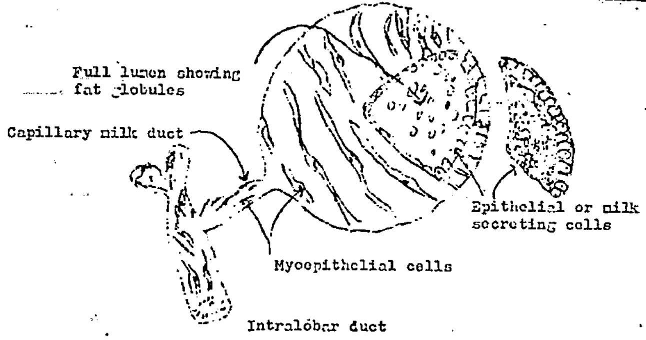


Fig. 5. An alveolus is a hollow, shperical structure where the milk is made.

myoepithelical	11. Completely surrounding an alveolus are groups of fibres, called myoepithelial cells, which have the ability to contract or shorten when they are stimulated. These act much like rubber bands which stretch out as the alveolus fills up with milk and contract, forcing out the milk, when the cow is timulated to "let down" her milk. The m__________ cells, when stimulated, contract to force the milk out of the alveoli.

blood	12. Surrounding each alveolus is a network of tiny capillaries which carry blood to the base of the epithelial cells. The materials in the blood that are used in milk production pass out of the capillaries and are taken up by the cells and manufactured into the various constituents of milk, such as fat, sugar, and protein. The b______ transports the materials needed for making milk to the alveoli.
- -	13. When one stops to realize that the udder manufactures about 5 kilograms of solids daily, one can appreciate what a terrific job these millions of alveoli are performing. This requires the passage of 400 to 500 litres of blood for each kilogram of milk.
epithelial	14. Milk Secretion in the Udder. If one examines an individual epithelial secreting cell, he will find that it goes through a definite process of milk formation. The cell absorbs the milk-making materials from the blood and makes it into milk. The e______ cell absorbs the materials for milk-making from the blood.
lumen	15. The cell then enlarges with the contained milk substances and one or more large fat globules. It then discharges the milk into the hollow central part (the lumen) of the alveolus. This is accomplished by the upper end of the cell opening up and letting the fat globule and milk pass out into the holding space or hollow cavity of the alveoli (Fig. 6). The epithelial cells discharge the milk into the l______ of the alveolus.

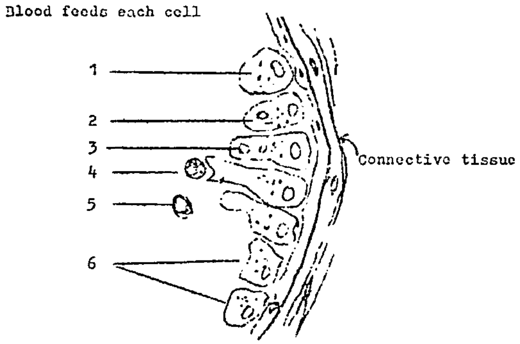


Fig. 6. The different stages of milk secretion are: 1. milk making material enters from blood stream, 2. fat globule begins to form, 3. fat globule getting larger, 4 & 5. fat globule breaking away from secretory cell, and 6. flattened cells caused by milk filling up the alveolus.

15 20	16. These manufacturing cells go through many cycles of secretion and discharge of milk into the alveolus during the periods between milkings. It is believed that an individual cell may fill up and discharge its contents in a period of 15 or 20 minutes. If milk secretion and discharge continue, the cavity of the alveolus gradually fills up with milk as though it were a balloon. The milk-making cells fill up and discharge milk about every ______ to ______ minutes.
alveoli	17. The diameter of the alveolus may increase four or five times before the pressure reaches a point where milk manufacture begins to slow up as the milk within the alveolus increases, it flows out through the tiny duct into the duct system which has larger and larger holding spaces as the size of the ducts increases toward the lower regions of the udder. The secretion of milk slows up as the a______ fill up and create pressure on the secreting cells.
- -	18. Usually the milk pressure in the udder will reach a level of 25 to 30 mm. of mercury during the interval between milkings. As this degree of pressure is attained, the tiny capillaries carrying the blood to the surface of the alveolus become partially or totally collapsed, thus shutting off the blood supply for further milk making. This explains why the production per hour is greater over a short interval than over a longer interval.
ducts	19. <u>How Milk is Carried to the Teats.</u> The duct system in the udder has been mentioned previously. It connects each individual alveolus to the openings between the connective tissue. These openings or ducts branch into larger and larger openings as they continue downward through each quarter. The alveoli are connected by d________.
cistern	20. The ducts finally empty into a single large opening, called the gland cistern, above each teat and into the cistern of the teat. The ducts tend to branch out like limbs of a tree as they progress upward through the quarter. At every point of branching there is a constriction (Fig. 7). The single large opening above the teat is called the gland ________.
constriction	21. Therefore, there is a tubular system which is far from being of uniform size. The milk which drains out of the alveoli is more or less stopped at each fork of the branch. These small openings keep the milk inside the glandular part of the udder and keep it from draining down into the cisterns by gravity as the cow moves about between milkings. The c__________ in the ducts prevent the milk from draining down into the cisterns.

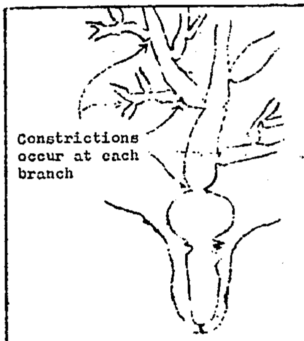


Fig. 7. Constrictions at each branch of the duct system prevent milk from leaking into the teat and lower udder as fast as it is manufactured.

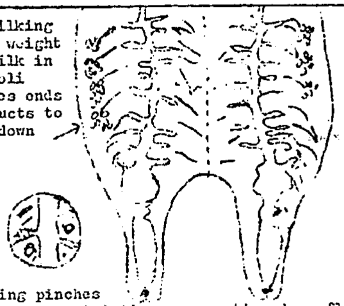


Fig. 8. The lobes, as they fill with milk, sag with the extra weight, pinching off the ducts and thus prevent further flow of milk into the ducts

ducts

22. These branches often extend laterally as well as vertically. Since each duct is suspended by connective tissue, the increasing weight of the milk in the outer areas of the quarter have a tendency to cause the ducts to sag down and pinch off the opening and further prevent the flow of milk in the ducts at these points of suspension (Fig. 8).

The sagging of the alveoli tends to pinch off the opening of the d_______.

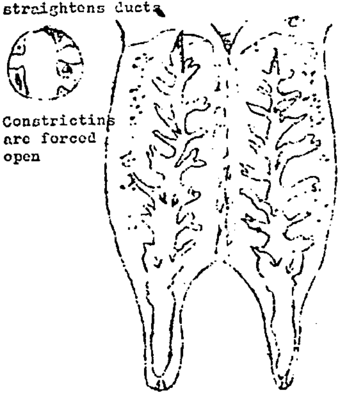


Fig. 9. A cow's let-down action squeezes the alveoli and shortens and straightens the ducts. Allowing the milk to pass out into larger ducts.

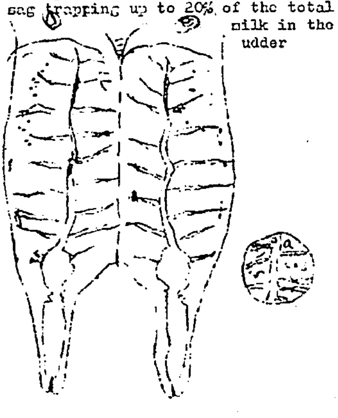
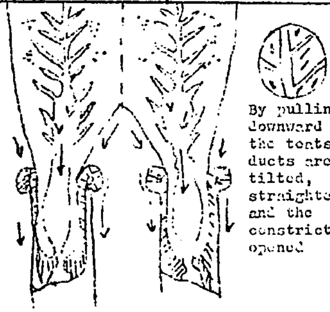


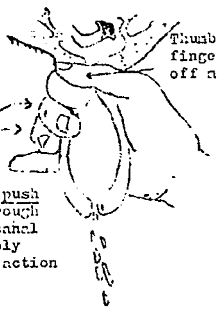
Fig. 10. As the milk is removed, there is a gradual collapse of the duct system, trapping some of the milk in the ducts and alveoli.

smooth myoepithelial	23. When a cow lets down her milk, she puts a squeeze on all of the gland areas. At the same time the ducts are contracted by smooth muscles and myoepithelial cells along their walls which tend to straighten them out at their points of suspension and constriction as well as to enlarge the bore and thus aid in the flow of milk downward to the cistern (Fig. 9). Milk is squeezed out of the ducts by contraction of ________ muscles and __________ cells.
20	24. In the early part of the milking process, there is so much rigidity of these ducts that the milk flows out as a result of the pressure built up throughout the udder. But as the milk is removed there is a tendency for a gradual collapse of the duct system. This tends to close the constrictions and again let the lateral sections of the ducts and glands sag (Fig. 10). Up to ______ percent of the milk is trapped in the ducts when they shrink and sag.
downward	25. When this happens some of the milk is left in the smaller ducts and alveoli. This milk can be removed by a downward motion of the teat cups of the milking machine. The pull on the teats cause a pull on the entire cistern and duct system. During the last stage of milking, the teat cups of the milking machine should be pulled d__________.
- -	26. This stretches the ducts and straightens them out, giving them a downward pitch for better draining (Fig. 11) Then with the release of the downward pull, the recoil and upward massaging action tend to widen and shorten the ducts, thus hastening the forward and downward flow of milk.



By pulling downward on the teats, ducts are tilted, straightened and the constrictions opened

Fig. 11. The downward pull of the teat cups straightens the ducts and squeezes the alveoli causing the trapped milk to again move toward the teats.



Thumb and finger pinch off milk

Fingers push milk through streak canal and supply massage action

Fig. 12. In hand milking you squeeze out a teat full at a time.

streak canal	27. The Parts of the Teat. The first structure of importance at the bottom of the teat is the opening, called the "streak canal". Normally this canal is always closed, except when pressure opens it or when erosion or injury prevents its closing. The opening at the end of the teat is called the s ______ c ______.
sphincter	28. The closing apparatus, called the sphincter, consists of a group of band-like smooth muscles that are normally constricted and thus keep the streak canal closed. The s ________ muscle keeps the streak canal closed.
vacuum	29. When hand pressure is applied to milk in the upper part of the teat and the teat is squeezed downward, the milk forces the streak canal open and passes through it (Fig. 12). The same result may be accomplished by applying negative pressure (vacuum) at the base, as in a calf sucking or in machine milking (Fig. 13). Milk can be squeezed through the streak canal or be withdrawn by applying a v ______ at the base.

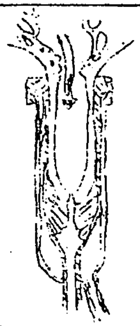


Fig. 13. In machine milking or calf sucking the milk is sucked out of the teat with a vacuum action.

sphincter	30. The rate of milking depends largely on the ease with which the resistance of the rubber band-like spincter muscles are overcome and the canal opened to its widest capacity. A fast milking cow has s ________ muscles which have less resistance than slow milking cows.

bacteria	31. One function of the streak canal is to keep bacteria from gaining entrance into the teat. For this reason some dairy farmers claim that easy milking cows are more susceptible to mastitis than hard milkers, but as yet there is insufficient evidence to prove it. The streak canal prevents b________ from entering the teat.
more	32. Teats vary in size and shape; front teats usually being larger than the rear. The rear quarters, however, usually have more capacity for milk than the front quarters. The rear quarters of the udder usually have more-less capacity for milk than the front quarters.
size	33. With wider use of milking machines, the adaptability of the cow's udder and teats to machine milking is a factor to be considered. For hand milking, the most serious defect of the teat is insufficient size to properly grasp and easily milk. Tight sphinctered teats make the job of hand milking slow and hard. The s_____ of the teats is the most important factor for hand milking.
udder	34. For machine milking, teats too widely spaced, as they are on poorly shaped udders, are more difficult to milk, because of the difficulty of distributing the tension on each quarter. This is necessary to keep all of the milk ducts open for free milk flow, particularly in the last one or two minutes of milking. A well shaped u________ is important for machine milking.
30 to 45	35. Above the streak canal, the cow's teat widens out into a cavity that holds 30 to 45 millilitres of milk. Though the thickness of the teat wall is fairly uniform, the shape and size of the cavities varies. The teat cistern holds ______ to ________ millitres of milk.
mastitis	36. The membrane lining the cistern of the teat may be either smooth or have pouches or folds. These pouches probably hold milk during the interval between milkings, and if mastitis organisms are present, the pouches serve as a retainer or trap from which they can spread upward into the udder. M________ is a bacterial infection of the udder.

milk	37. The walls of the teats contain a great many arteries and veins. As long as the teat is massaged during milking, either by hand or by action of the teat cups, the teat cistern remains open and allows milk to pass through easily. The teat needs to be massaged during milking to permit m____ to pass through freely.
teat udder	38. The top of the teat, or the point where the cistern of the teat joins the cistern of the quarter, is separated from the gland by a constriction in the form of an annular (cricoid) fold, 2 to 6 millimetres in thickness. Usually this opening into the teat is large enough that milk can pass through it as fast as it can be milked out (Fig. 14). The t____ cistern and u_____ cistern are separated by an annular fold.

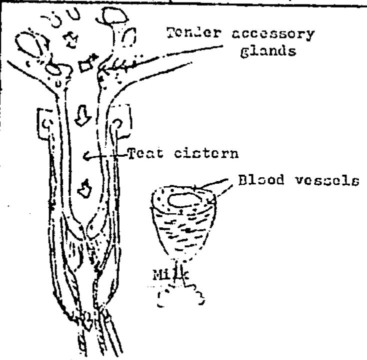


Fig. 14. Teat cups work best when held down to normal position on the teats.

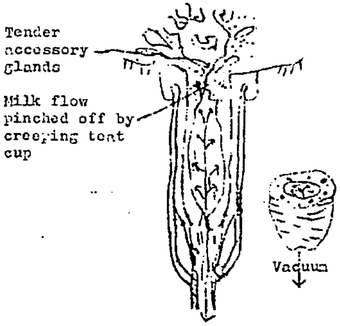


Fig. 15. Teat cups that are allowed to creep tend to pinch off the opening and stop the milk flow.

- -	39. Toward the end of milking, the withdrawal of the milk and the gradual relaxation of the gland causes the udder and teat to shrink and become slack. At this time the vacuum of a milking machine pulls the teat deeper into the teat cup. As the teat cup "creeps" up nearer the floor of the udder, it tends to pinch off the opening from the gland to the teat cistern and thus stop the milk flow (Fig 15).
creep	40. The greater the natural constriction is at this point, the easier and the sooner a "creeping" teat cup will pinch off the opening. When this happens, the teat cup assembly of the milking machine should be gently but firmly pulled downward to open the teat cistern to milk flow. Continuous creeping of the cups will cause an irritation and may cause injury or mastitis. The teat cups of a milking machine should not be allowed to c____ up.

stimulated

41. How a Cow "Lets Down" Her Milk.

When a cow is stimulated, either by washing or rubbing the udder as one prepares it for milking (Fig. 16), her cooperation is shown by a swelling and tenseness of the teats.

A cow must be s________ to let down her milk.

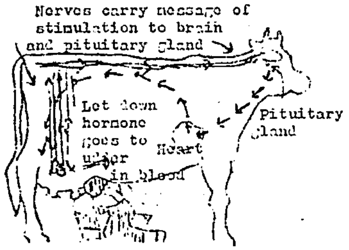


Fig. 16. The pituitary gland, stimulated by washing or rubbing of the udder, discharges the "milk-let-down" hormone into the blood stream which causes the contraction of the muscle-like cells around the alveoli.

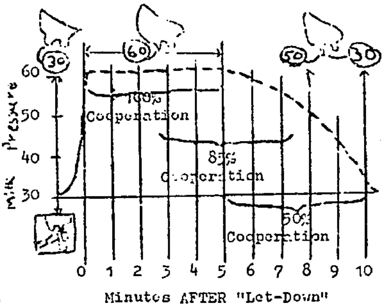


Fig. 17. A cow should be milked between 1 and 5 minutes after washing or rubbing the udder. The cow can not give complete cooperation before or after.

pressure

42. A pressure gauge connected to a milk tube inserted in a teat will show a great increase in milk pressure. Within minutes after stimulation, the milk pressure doubles (Fig. 17). This rise in milk pressure is due to "let-down" or forcing down of the milk already accumulated in the udder.

Milk let-down causes the p________ of milk in the udder to increase.

pituitary

43. For a cow to let down her milk, the stimulation is carried by nerves to the brain, then to a small endocrine gland called the pituitary, which hangs down like a small tomato from the base of the brain (Fig. 16).

The stimulation of the udder is carried to the p________ gland by the nerves.

milk-let-down

44. The nerve impulse causes the pituitary to discharge a chemical substance, called a hormone into the blood stream. This hormone is called the "milk-let-down" hormone, because it flows through the blood stream to the cow's udder and causes the contraction of the tiny muscle-like cells (myoepithelium) around the alveoli.

The pituitary gland produces the ____________ hormone which causes the myoepithelium to contract.

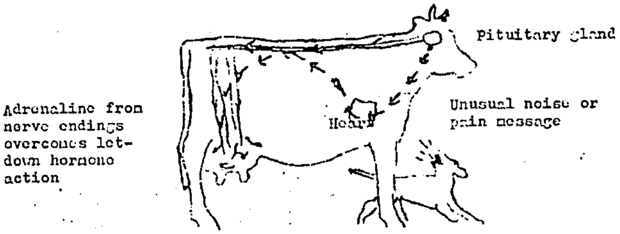


Fig. 18. If the cow is frightened or in pain, an adrenalin-like substance is released into the blood stream. It causes a contraction of the small blood vessels and prevents the "let-down" hormone from acting on the alveoli.

alveoli	45. The contraction of these fibre-like cells is similar to the action of a hand squeezing the bulb of a syringe. Every one of the millions of alveoli are thus individually squeezed shut and the pressure of the milk is almost doubled. The hormone causes each a______ to squeeze out its milk.
5	46. The hormone continues to circulate in the blood of the cow. After a few minutes it is gradually inactivated and the contraction of the muscle-like fibres is lost. Milk not harvested while the hormone is acting on the udder will not be obtained. A cow should be finished milking within ______ minutes after stimulation.
let down	47. If a cow becomes excited, nervous, afraid, or suffers pain (Fig. 18), her sympathetic nervous system goes into action and an adrenalin-like sybstance is released into the blood stream. As it is pumped to all parts of the udder in the blood it causes contraction of the small blood vessels and prevents the "let-down" hormone from reaching the alveoli. The l________ hormone is counteracted by a material released into the blood if the cow becomes frightened or excited.
decrease	48. The greater the fright the larger is the amount of adrenalin and the greater is the inhibition of let down. For best possible production, one should take special precautions to see that a cow is properly stimulated and has no cause to be nervous or scared at milking time. Pain, excitement, or fright cause a(n) increase-decrease in milk production.

let-down	49. A cow has no voluntary control over the let-down hormone in her body and should not be held responsible for her lack of let-down reaction under unfavorable conditions. The milking environment must be pleasant in order for the ____________ hormone to be completely effective.

The information in this unit was taken from the University of Illinois VAS unit 1025.

Name ____________________ Form ______
Date ____________________

TEST

The Cow's Udder and How it Functions

UNDERLINE THE CORRECT ANSWER

1. A cow's udder is divided into ______ distinct glands.
   - a. 1
   - b. 2
   - c. 3
   - d. 4
   - e. 5
   - f. 6

2. The __________ are spherical structures with a wall made up of a single layer of epithelial cells which manufacture the milk.
   - a. alveoli
   - b. cisterns
   - c. lobules
   - d. membranes
   - e. udders

3. The milk secreting epithelial cells absorb the milk-making materials from the __________.
   - a. blood
   - b. ducts
   - c. hormones
   - d. lobes
   - e. lumen

4. Milk is carried from the individual milk secreting parts of each gland to the teat by a system of __________.
   - a. alveoli
   - b. connective tissue
   - c. ducts
   - d. lobes
   - e. membranes

5. The __________ is a large opening in the centre of the teat into which the milk drains.
   - a. canal
   - b. cistern
   - c. duct
   - d. gland
   - e. quarter

6. When using a milking machine, the teat cups should be pulled down at the end of the milking period to __________.
   - a. massage the teats
   - b. release trapped milk
   - c. protect the connective tissue
   - d. protect the machine
   - e. stimulate the cow

7. The __________ is the opening at the bottom of the teat.
   - a. central duct
   - b. lumen
   - c. sphincter
   - d. streak canal
   - e. teat cistern

8. A milking machine removes milk from the teat by __________.
   - a. applying a vacuum to the end of the teat
   - b. applying pressure to the end of the teat
   - c. massaging the end of the teat
   - d. squeezing the teat
   - e. washing the teat

9. __________ is the most important aspect of a cow's udder for hand milking.

   a. Adequate sized teats
   b. Ease of milking
   c. Softness
   d. Spacing of teats
   e. Uniformness

10. The milk-let- down hormone causes the contraction of the myoepithelum which forces the milk out of the __________.

    a. alveoli
    b. cistern
    c. lobule
    d. teat
    e. udder

11. The milk-let-down hormone is produced by the __________.

    a. heart
    b. kidneys
    c. milk gland
    d. pituitary gland
    e. stomach

12. The milk-let-down hormone is released into the blood when __________.

    a. the cow's face is rubbed
    b. the cow's udder is washed
    c. the cow hears loud, unusual noises
    d. the cow is fed
    e. the cow is frightened

13. Milking should be completed within __________ after the milk-let-down hormone has been released.

    a. 1 minute
    b. 5 minutes
    c. 10 minutes
    d. 15 minutes
    e. 30 minutes

14. All of the following, except __________ will cause the action of the milk-let-down hormone to be stopped immediately.

    a. attaching a milking machine without waiting at least a minute after stimulation
    b. fright
    c. pain
    d. tying the rear legs together after beginning the milking process
    e. udder stimulation

TUMAINI SECONDARY SCHOOL

SMALL ENGINES I

This is a programmed instruction unit in small engines.

In this unit you are to learn:

1. the common types of small engines.
2. the principles of compression.
3. how to calculate piston displacement.
4. how to calculate compression ratio.
5. the importance of and function of valves.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Small Engines I

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

Name ______________________ Form ____________

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engines	1. Small internal combustion engines are an important source of power on the farm. Single-cylinder engines developing from one to ten or more horsepower are widely used to drive irrigation pumps, small tractors, chain saws, water pumps, air compressors, electric generators, and many other kinds of equipment. Small e_____ are an important source of power on farms.
small engines	2. Several small engines may be found on most larger farms today. It is therefore important that people working on these farms understand something about these engines so they can operate them efficiently and adjust and maintain them properly. A knowledge of s_____ e__________ is necessary for operating them properly.
cylinder	3. Single-cylinder engines are generally petrol burning, have spark ignition, and are air cooled. Small engines are single-c________ engines.
four-cycle two-cycle	4. They may be either four-cycle or two-cycle types. Each type has certain advantages and disadvantages. Before considering these it is necessary to understand the basic differences between the two types. Small engines may be either f___-cycle or t___-cycle.
intake compression power exhaust	5. Four-cycle or four-stroke cycle engines make two revolutions of the crankshaft for each power stroke of the piston. There are four distinct strokes for each complete cycle: intake, compression, power, and exhaust. The four strokes of a four-cycle engine are: i_______, c___________, p__________, and e_________.
fuel air	6. On the intake stroke (Fig. 1) the intake valve opens while the exhaust valve remains closed. The piston moves downward and a mixture of fuel and air is drawn into the cylinder. On the intake stroke a mixture of f____ and a____ is drawn into the cylinder.

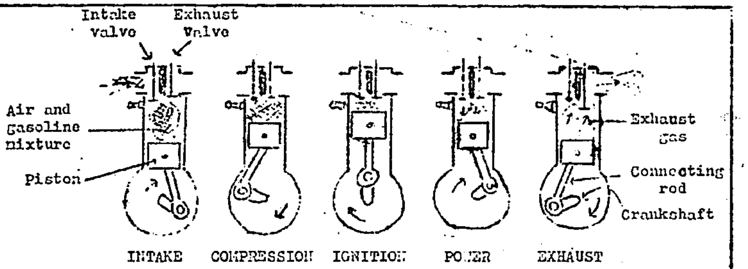


Fig. 1. The piston in a four-stroke cycle engine makes four strokes. (1) Intake, a stroke down to draw gasoline-air mixture into the cylinder. (2) Compression, a stroke up to squeeze, or compress, the fuel mixture. Ignition, or setting fire to the fuel with an electric spark, takes place at the top of the compression stroke. (3) Power, a stroke down to deliver power from the burned and expanding gases to the crankshaft. (4) Exhaust, a stroke up to push out burned gases.

fuel-air	7. On the compression stroke (Fig. 1), both valves are closed. As the piston moves upward the fuel-air mixture is compressed into the small space between the top of the piston and the cylinder head. On the compression stroke the _______ mixture is compressed.
fuel-air piston	8. The power stroke occurs next in the cylinder (Fig. 1). Both valves remain closed and and a spark ignites the fuel-air mixture. The force of the explosion pushes the piston down. On the power stroke the exploding __________ mixture forces the p_______ down.
gases exhaust	9. The final stroke in the cycle is the exhaust stroke (Fig. 1). The exhaust valve opens and the upward movement of the piston forces the burned gases out of the cylinder. On the exhaust stroke the burned _______ are forced out through the e_______ valve.
intake exhaust	10. At the end of the exhaust stroke the exhaust valve closes, the intake valve opens, and the next cycle is ready to begin as before. The fuel-air mixture passes into the cylinder through the _______ valve while the burned gases leave the cylinder through the ________ valve.

intake compression power exhaust	11. The four strokes of a four-cycle engine are: ______, ______, ______, and ______.
compression power	12. Two-cycle or two-stroke cycle engines have a power stroke for each revolution of the crankshaft. Thus there are only two strokes in the complete cycle; a compression stroke and a power stroke. The two strokes of a two-cycle engine are c______ and p______.
intake exhaust	13. In between or during these strokes opportunity must be provided for intake and exhaust. There are no i______ or e______ strokes in a two-cycle engine.
compression	14. The fuel-air mixture enters the crank case during the compression stroke because of the partial vacuum created in the crankcase as the piston moves toward the engine head (Fig. 2). During the c______ stroke, the fuel-air mixture enters the crankcase.

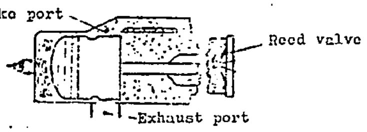


Fig. 2. On the compression stroke, the two-cycle engine draws its next charge of fuel-air mixture into the crankcase.

compression power	15. The crankcase of a two-cycle engine is made tight and ordinarily does not contain a supply of lubricating oil like that of a four-cycle engine. The two strokes of a two-cycle engine are ______ and ______.

reed	16. The intake valve of many two-cycle engines is a reed type which opens one way only. It opens into the crankcase as the fuel-air mixture is drawn in. A ______ type valve is a common type of intake valve of two-cycle engines.
- -	17. Other two-cycle engines may have a rotary valve which is timed to open when the piston starts moving on the compression stroke.
power	18. As the piston moves back toward the crankcase on the power stroke, the air-fuel mixture in the crankcase is compressed. When the intake port is exposed on one side of the cylinder this mixture is forced into the combustion chamber (Fig. 3). The ______ stroke, in a two-cycle engine, forces the fuel-air mixture into the combustion chamber.

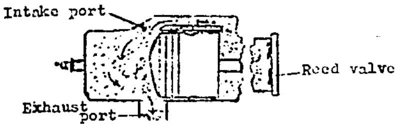


Fig. 3. On the power stroke of a two-cycle engine, burned gases escape through the exhaust port and a new charge enters the cylinder from the crankcase through the intake port.

power	19. At the same time the exhaust port is exposed on the opposite side of the cylinder and the burned gases escape through the exhaust system. The charge of fresh fuel-air mixture rushing into the cylinder helps drive the burned gases out. The burned gases are exhausted at the end of the ______ stroke in a two-cycle engine.
two	20. As the piston starts back on the compression stroke, intake and exhasut ports are sealed again and the new charge of fuel-air mixture is compressed. At the end of this stroke the spark ignites the charge, starting the cycle over again. There isa power stroke every revolution of the crankshaft in a ______-cycle engine.

four	21. Since intake and exhaust are separate strokes in a four-cycle engine, there is somewhat greater efficiency of these operations and less chance of burned and unburned gases getting mixed then in two-cycle engines. ________-cycle engines have more efficient intake and exhaust operations.
two	22. The four cycle engine may be subject to slightly less trouble in starting and will operate more smoothly at slow speeds. ______-cycle engines may be harder to start.
two-cycle	23. The two-cycle engine produces more power per unit of weight since there is a power stroke every revolution of the crankshaft. This is important with equipment like chain saws and outboard motors where light weight is very desirable. _______ engines are usually used on portable equipment.
two	24. Two-cycle engines are simpler in construction and hence may be cheaper in first cost. _______-cycle engines are usually cheaper to construct.
two	25. Since the crankcase of a two-cycle engine is part of the fuel intake system, lubricating oil is generally mixed with the fuel. This is somewhat more troublesome and probably results in a less efficient job of engine lubrication. Lubricating oil is usually mixed with the fuel for ________-cycle engines.
compression carburetion ignition	26. The Basic Principles of Engine Operation. Three primary essentials for the operation of any internal combustion engine are compression, carburetion, and ignition. The three primary essentials for internal combustion engine operation are ________, and ________, and ________.

cooling lubrication	27. In addition to these, secondary functions of cooling and lubrication must be performed to enable the engine to operate satisfactorily. The secondary essentials for engine operation are ____________ and __________.
compression carburation ignition	28. Each engine has a system of mechanisms for these primary and secondary functions. A basic understanding of these is important to the operator of small engines. The three primary essentials for engine operation are ____________, ______________, and ___________.
leakage	29. Compression. When the fuel-air mixture is being compressed in the cylinder, it is important that all moving parts fit properly to avoid leakage. The piston must fit as tightly as possible in the cylinder without binding or seizing. L_______ of the fuel-air mixture from the cylinder reduces the compression.
- -	30. The piston and cylinder become heated to high temperatures when the engine is running and they do not expand uniformly. They may be made of different metals and are subject to unequal exposure to the cooling effect of outside air.
piston	31. Consequently there must be a certain amount of clearance between the piston ~~and~~ cylinder wall (Fig. 4). This clearance is generally greater at the top of the piston than at the skirt. Some clearance between these parts is also necessary to permit their separation by a film of lubricating oil. Some clearance between p________ and cylinder wall is necessary.
Piston rings	32. The true sealing of piston and cylinder walls is done by piston rings. Piston rings are fitted in grooves near the top of the piston (Fig. 5). P______ r______ provide the seal between the piston and cylinder walls.

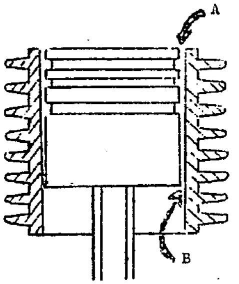


Fig. 4. Slightly more clearance is provided between the piston and cylinder at the top of the piston (A) than at the skirt (B).

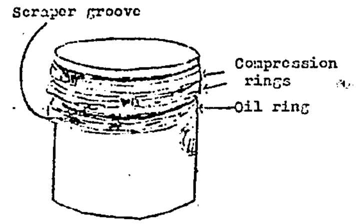
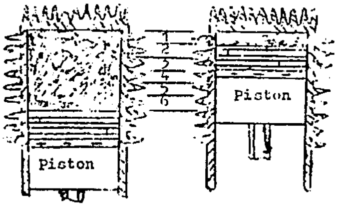


Fig. 5. Flexible rings are provided to seal the piston in the cylinder.

fuel-air	33. The ends of the piston rings are separated by a gap so they can exert pressure on the cylinder walls to make a tight seal but can still expand without breaking when they become hot. Piston rings prevent the ________ mixture from escaping into the crankcase.
Piston rings	34. The rings also scrape the oil back away from the combustion chamber to keep it from being burned along with the fuel. _______ _________ also prevent crankcase oil from entering the cylinder.
compression oil	35. Upper rings are solid and called "compression rings". The bottom ring is often perforated to permit oil to be spread onto the cylinder wall and is called an "oil ring". Two kinds of piston rings are ______ rings and ________ rings.
	36. <u>Piston displacement</u> refers to the space displaced by the piston in its travel. Piston displacement can be computed in cubic centimetres by the following formula: Piston displacement = radius^2 X π X stroke

- -	37. For example, the piston displacement of an engine with a 5 centimetre bore and a 5 centimetre stroke would be: 2.5^2 X 3.1416 X 5 = 98.175 cubic centimetres
307.96 cubic centimetres	38. What is the pistondisplacement of an engine with a 7 centimetre bore and an 8 centimetre stroke? 3.5^2 X 3.1416 X 8 = __________
- -	39. In larger engines the piston displacement is often expressed in litres. (1000 cubic centimetres = 1 litre).
power	40. Piston displacement is a measure of the quantity of fuel-air mixture that can be taken into the cylinder on an intake stroke and therefore is an indication of the power the engine can develop. Increasing the size of the bore, length of stroke, or both, increases the potential power of the engine. The larger the piston displacement the more p________ and engine can develop.
volume	41. <u>Compression ratio</u> is a comparison between the volume of the cylinder when the piston is at the bottom of its stroke and the volume of the cylinder when it is at the top of its stroke (Fig. 6). Compression ratio is a comparison between the v________ of the cylinder at the top and bottom piston strokes.

Fig. 6. This engine has a compression ratio of 6 to 1.



	42. If the piston is flat on top and the underside of the cylinder head is also flat, compression ratio can be determined by measurement. However, one or both is generally irregular in shape so compression ratio is not easy to determine.
5:1	43. The compression ratio of most small engines varies from about 5:1 to 6:1. What is the compression ratio of an engine whose cylinder volume is 250 cubic centimetres when the piston is at the bottom of its stroke and 50 centimetres when the piston is at the top of its stroke? ______
compression ratio	44. For a given piston displacement, the higher the compression ratio the more power you can expect from the engine. However, there are practical limits to compression ratio for small, single-cylinder, air cooled engines. The higher the c____ r______ the more power one can expect, when piston displacement is equal.
fuel-air burned gases	45. Valves and ports. Valve condition is probably the most important factor in maintaining good compression in a four-cycle engine. Valves must be timed to open as wide as possible at the right instant and to close quickly and completely. Valves permit the entry of the ______ mixture into the cylinder and the exit of ________ from the cylinder.
valves	46. At high speeds each valve must open and close in 1/50 of a second or less. When open the valves must permit free passage of gases in or out of the cylinder. When closed they must hold pressures which may exceed 35 kscm (kilograms per square centimetre) during the power stroke. V______ close the openings into the cylinder during the compression and power strokes.
cooled	47. The heads of the valves are in the combustion chamber and are often heated to 650°C. or more. Proper cooling to prevent warping and burning is very important. Valves must be properly c_______.

cooling	48. Cooling is accomplished mainly by contact between the valve face and valve seat during the time that the valve is closed (Fig. 7). C______ of valves is done mainly by conduction of heat from the valve to the valve seat.

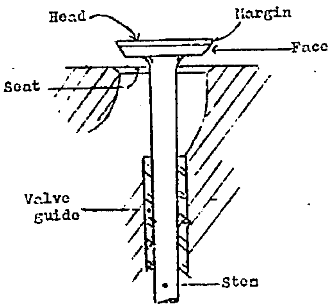


Fig. 7. A good fit of all parts is important to proper valve function.

compression	49. Intake and exhaust ports of the two-cycle engine are sealed by the action of the piston rings on the cylinder walls. Proper fit of these parts is necessary to prevent loss of compression through the ports. A loss of ________ will occur if the piston rings do not fit properly.
compression	50. Loss of compression in a two-cycle engine may also occur if the reed type or rotary type intake valve does not hold properly or if worn main bearing oil seals or poor crankcase gaskets permit leakage. Any leakage of gases from the cylinder reduces _________.
compression carburetion ignition	51. The three primary essentials for the operation of any internal combustion engine are _________, __________, and _________.

The information in this unit was taken from the University of Illinois VAS unit 3041.

Name ____________________ Form _____
Date ______________

TEST

Small Engines I

UNDERLINE THE CORRECT ANSWER

1. The two strokes of a two-cycle engine are _______ and _______. (Choose 1 answer.)
   - a. compression and power
   - b. cooling and intake
   - c. displacement and intake
   - d. exhaust and lubrication
   - e. power and exhaust

2. The four strokes of a four-cycle engine are: __________, __________, __________, and __________. (Choose only 1 answer.)
   - a. carburetion, exhaust, displacement, lubrication
   - b. carburetion, lubrication, exhaust, power
   - c. displacement, lubrication, carburetion, compression
   - d. intake, carburetion, power, cooling
   - e. intake, compression, power, exhaust

3. In a four-cycle engine, the fuel-air mixture is drawn into the cylinder during the _______ stroke.
   - a. carburetion
   - b. compression
   - c. exhaust
   - d. intake
   - e. lubrication

4. Chain saws and other portable equipment usually use _________ engines.
   - a. diesel
   - b. four-cycle
   - c. one-cycle
   - d. steam
   - e. two-cycle

5. The three primary essentials for the operation of an internal combustion engine are ______________.
   - a. carburetion, intake, power
   - b. compression, carburetion, ignition
   - c. cooling, compression, carburetion
   - d. intake, exhaust, lubrication
   - e. lubrication, cooling, exhaust.

6. ___________ form a seal betwee the cylinder walls and the piston.
   - a. Crankcases
   - b. Piston rings
   - c. Reed valves
   - d. Rotary valves
   - e. Spark plugs

7. Piston displacement is a measure of the _______ of an engine.
   - a. efficiency
   - b. lubrication
   - c. power
   - d. value
   - e. weight

8. Valves are mainly cooled by ___________.
   - a. conduction
   - b. convection
   - c. oil
   - d. radiation
   - e. water

9. If a certain engine has a cylinder volume of 25 cubic centimetres when the piston is at the top of its stroke and a volume of 150 cubic centimetres at the bottom of its stroke, what is the compression ratio of that engine?

a. 1:1
b. 1:4
c. 5:1
d. 6:1
e. 10:1

10. If valves do not fit properly there will be a loss of ________.

a. carburetion
b. compression
c. exhaust
d. ignition
e. oil

11. One of the advantages of a two-cycle engine over a four-cycle engine is that it ________.

a. is heavier
b. is easier to start
c. is simpler in construction
d. uses less petrol
e. has no crankcase

12. The fuel-air mixture is exploded in the cylinder by ________.

a. heat
b. the piston
c. pressure
d. a spark
e. the valves

13. Two-cycle engines do not have ________.

a. compression
b. exhaust valves
c. reed valves
d. pistons
e. power

TUMAINI SECONDARY SCHOOL

SMALL ENGINES II

This is a programmed instruction unit in small engines which follows the small engines I unit.

In this unit you are to learn:

1. the major parts of the carburetion system.
2. the differences and similarities between the gravity and suction fuel systems.
3. the operation of the carburetor
4. the importance of the air cleaner and breather.
5. the major parts of the ignition system.
6. the operation of the magneto.
7. the secondary functions of cooling and lubrication in engine operation.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Small Engines II

If you have not read the cover page, do so now, then proceed to frame 1.

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compression carburetion ignition	1. The three primary essentials for internal combustion engine operation are ________, ________, and ________.
air gas cylinder	2. Carburetion. The functions of the carburetion system are to atomize the fuel, mix it with the proper proportion of air, vaporize it, and deliver the mixture to the cylinder. The carburetion system mixes the fuel with ________, changes it from a liquid into a ________, and delivers it to the ________.
fuel tank carburetor intake manifold	3. The parts of the carburetion system include the air inlet system, fuel tank and line, carburetor, and intake manifold or valve-port passages. The fuel supply is stored in the f____ t____, it is mixed with air and vaporized in the c________, and it enters the cylinder through the i____ m________.
fuel air	4. Fuel is atomized by breaking it up into a spray of fine droplets of liquid. These droplets are then converted into a gaseous state and mixed with air in a combustible proportion. This ranges from 8 to 18 parts by weight of air for each one part of petrol. The best operating mixture is about 12 or 13 parts to one. The best operating fuel mixture is 1 part ________ to 12 or 13 parts ________.
suction	5. Types of fuel systems. Some engines have a gravity-feed fuel system in which the fuel tank is above the carburetor. Others have a suction system in which the fuel supply is below the carburetor and fuel is raised by a vacuum. When the fuel tank is located below the carburetor the engine has a s________ fuel system.
float valve	6. Gravity system. When the tank is above the carburetor, fuel flows by gravity into the carburetor bowl (Fig. 1). As fuel enters it raises a metal float which is linked to the needle in the float valve. At a predetermined level the float valve closes, shutting off the supply of fuel. A f____ v________ controls the admission of fuel into the carburetor in a gravity fuel system.

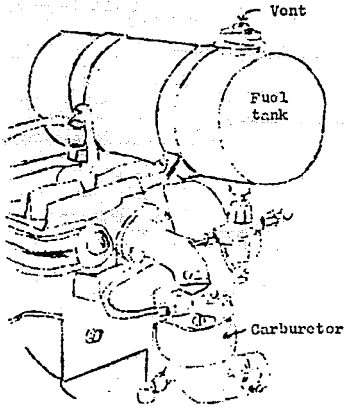

Fig. 1. In the gravity feed system the fuel tank is located above the carburetor.

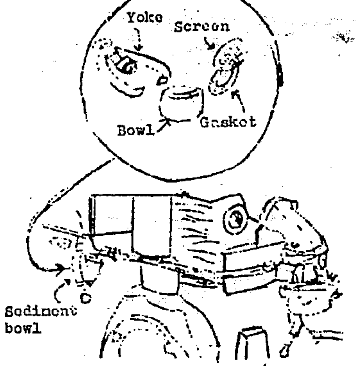

Fig. 2. A sediment bowl is generally provided in the fuel line of a gravity feed system.

float valve	7. As fuel is used by the engine, the float lowers and opens the valve again. Thus a constant level of fuel is maintained in the carburetor bowl. This level is high enough to provide an ample supply at full throttle but low enough to prevent leaking or flooding. The purpose of the ________ is to maintain a constant level of fuel in the carburetor bowl.
air vent	8. A small vent hole is provided in the fuel tank cap to permit air to enter the tank as the fuel flows out. Likewise there is an air vent in the carburetor bowl to allow the air to escape as fuel flows in. An a____ v________ permits air to enter or escape as the fuel level changes in both the fuel tank and carburetor bowl.
sediment bowl	9. A sediment bowl is often provided in the fuel line of a gravity feed system (Fig. 2). Fuel flows from the tank into the sediment bowl and up through a screen into the line leading to the carburetor. Both water and solid particles are heavier than petrol and will settle out in the bottom of the bowl. The purpose of the s____ b________ is to remove water and solid particles from the fuel.

sediment bowl	10. The bowl is made of glass or other transparent material so that the accumulation of water and sediment can be seen. Thus the operator can tell when to remove and clean the sediment bowl. The ________ ________ is transparent so that water and sediment accumulated in it can be seen.
suction feed	11. Suction system. In the suction-feed fuel system (Fig. 3), the fuel tank is mounted below the carburetor so the tank itself takes the place of the carburetor bowl. However, the level of fuel is not constant like in a carburetor bowl with its float control. A s________ f________ fuel system does not have a carburetor bowl.

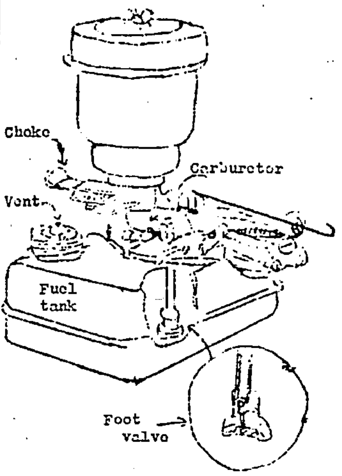

Fig. 3. In the suction feed system the fuel tank is located below the carburetor.

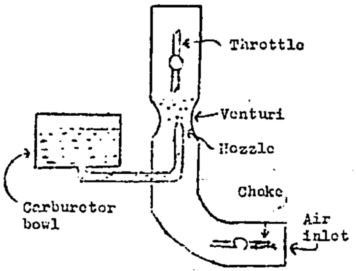

Fig. 4. Air moving through the venturi causes fuel to be drawn from the nozzle and atomized.

foot valve	12. Fuel is drawn from the tank through the fuel tube by the engine suction. A foot valve in the bottom of this tube keeps the fuel from running back and thus insures that the tube is full of fuel at all times. A f________ v________ prevents fuel from running out of the fuel tube back into the fuel tank.

fuel	13. Operation of the carburetor. Air enters the carburetor through the air inlet on the intake or suction stroke of the engine. As it reaches the restricted section of the air passage called the "venturi", its velocity is greatly increased. This causes the fuel to be drawn out of the fuel nozzle and atomized, similar to the action of a flit gun (Fig. 4). Air moving through the venturi causes ________ to be drawn from the nozzle and atomized.
butterfly	14. Speed control is provided by placing a flat disc called a "butterfly" in the carburetor above the venturi. The butterfly is mounted on a shaft so that it can be rotated to open or close the passage. A b_______ located in the carburetor above the venturi provides speed control.
governor	15. Position of the butterfly is controlled manually by a throttle lever, or automatically by a governor. A governor has some kind of mechanism which senses the speed of the engine. At a given setting it opens the throttle when the engine speed falls below this rate and closes the throttle when it runs faster. A g_______ automatically controls the position of the butterfly to keep the speed of the engine constant.
air vane centrifugal	16. Two common types of governors are the air vane and centrifugal types. The air vane governor consists of a light sheet metal blade or flap which is placed in the air stream from the fins on the flywheel (Fig. 5). Two common governor types are the ________ and ________ types.
air vane	17. As the engine speed increases, the velocity and quantity of air also increases. This deflects the flap and closes the butterfly valve on the air vane type of governor. As speed decreases, a spring moves the flap in the opposite direction and opens the butterfly. The hand throttle generally increases or decreases the tension on this spring. The velocity and quantity of air generated by the flywheel fins controls the position of the butterfly in an _______ type of governor.
centrifugal	18. The centrifugal or mechanical governor has weights which move outward at high speeds and are pulled in by a spring at low speeds. Through a linkage, the movement of the governor weights opens and closes the throttle (Fig. 6). The c________ type of governor controls the position of the butterfly by the position of weights which changes with the speed of the engine.

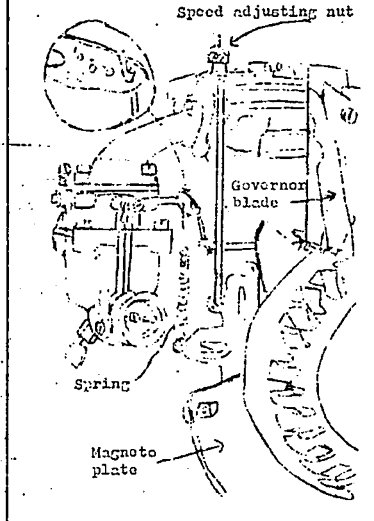

Fig. 5. The air vane governor has a light sheet metal blade that is deflected by the stream of air from the flywheel fins.

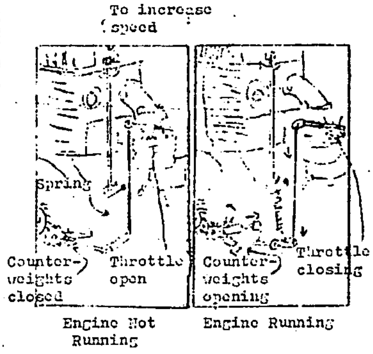

Fig. 6. The mechanical governor has moving weights that open and close the throttle.

	19. Mixture control. If an engine is to run at a constant speed, the fuel mixture could be controlled by a single jet with an adjustable needle valve to provide the proper size opening. However, most small engines are operated at varying speeds so some system must be provided to change the proportion of fuel to air for idling, part throttle, and full throttle operation to compensate for changes in engine suction.
idle jet	20. Most carburetors have a second jet which opens into the air passage just above the butterfly when it is in closed position. This is called the "idle jet". The proportion of fuel to air is metered by turning the idle jet needle valve in or out until the best mixture for idling speed is obtained (Fig. 7). The proportion of fuel to air at idling speed is adjusted by turning the i___ j___ needle valve.
richer	21. In order to provide the proper air-fuel mixture for speeds varying from idle to full throttle, some system is provided to compensate for the fact that the flow of fuel from a carburetor jet increases faster than the flow of air, as the engine speed increases. This causes the mixture to become richer as speed increases. If the proportion of fuel increases in the fuel-air mixture, the mixture is said to become r______.

air bleed	22. A principle widely used in carburetors for small engines is the "air bleed". A vent is provided which allows air to mix with the fuel in the main jet before it enters the air stream at the venturi (Fig. 8). An a___ b_______ system is often used to compensate for the fuel-air mixture increase in richness during acceleration.

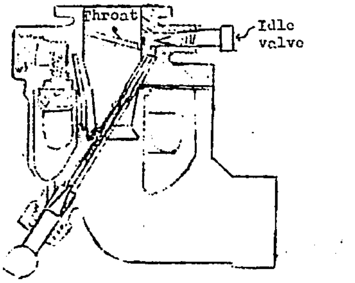

Fig. 7. The proper fuel-air mixture for idle speed operation is obtained by adjusting the idle valve.

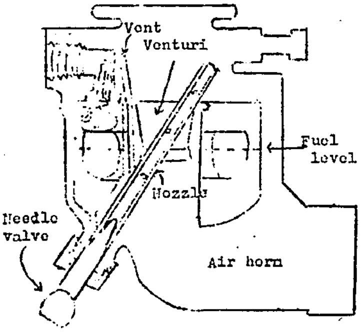

Fig. 8. In the air-bleed system, air enters the vent and mixes with the fuel in the main fuel nozzle.

needle	23. As suction increases, more air enters through the vent, preventing the mixture from becoming too rich at high speeds. At low speeds when vacuum drops, relatively more fuel enters from the main jet because less air mixes with the fuel. The n_______ valve controls the amount of fuel in the fuel-air mixture.
richer	24. Choke. Starting an engine when it is cold requires a richer fuel mixture than when it is warm. This is because cold petrol does not vaporize readily and therefore a substantially greater proportion of liquid fuel must be introduced into the air stream to obtain a combustible mixture. This is obtained by "choking". Starting a cold engine requires a r_______ fuel mixture than when it is warm.
butterfly	25. A second butterfly valve is generally placed in the air horn of the carburetor so that you can close, or partially close the opening and increase the suction at the venturi. This causes a rush of fuel from the nozzle into a relatively small amount of air. The resulting mixture has a larger proportion of fuel to air and will permit easy starting even at low vaporization. A choke usually consists of a manually operated b_______ valve.

choke	26. The choke (Fig. 9) is closed for starting and opened again as soon as the engine fires. If the engine coughs or starts to die, it may require more choking for a short time while cold. Do not load the engine until it will run without choking. The ______ is used only to start the engine and get it heated up.

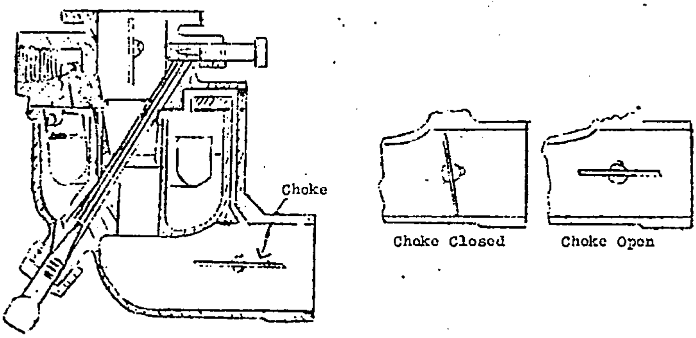

Fig. 9. The choke is closed to restrict air intake when starting a cold engine, and opened again as soon as it starts.

oil	27. Prolonged choking may be harmful to the engine as it causes too much "raw" or liquid petrol to be drawn into the cylinder. This will wash away the lubricating oil film from the cylinder wall and piston, causing undue wear of these parts. Excessive choking can harm an engine by causing the lubricating ______ to be washed away.
air cleaner	28. <u>Air Cleaner and Breather.</u> Small engines often operate in dusty, dirty conditions. It is important to prevent dirt and grit from being carried into the engine through the carburetor. An a____ c________ removes dirt from the air entering the carburetor.
air cleaner	29. It is estimated that a small engine operating at 3600rpm (revolutions per minute) uses about 11 cubic metres of air per hour. An air cleaner is provided to remove harmful dirt from this air. Harmful dirt is prevented from entering the engine through the carburetor by an __________.

oil-bath	30. There are several good types of air cleaners. The oil-bath type (Fig. 10) has a quantity of lubricating oil in its base and all of the air passes through this oil before it enters the air horn of the carburetor. One type of air cleaner is the o ____ b ________ type.

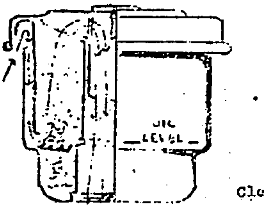

Fig. 10. The oil-bath air cleaner contains a quantity of oil through which all of the intake air must pass.

oil	31. Dust and dirt are washed out of the air and accumulate in the bottom of the oil cup as sediment. This air cleaner must be maintained properly if it is to do its job. The sediment should be removed regularly and the cleaner refilled with clean oil up to the level indicated on the cup. In the oil-bath type air cleaner dirt and dust is removed from the air by ________.
oil-saturated	32. The oil-staurated type of air cleaner has an element of fine wire mesh which is saturated with lubricating oil. As the air passes through this element, the dirt clings to the film of oil on the mesh and is removed from the oil. This air cleaner is serviced by washing the element in kerosene or solvent, followed by dipping in clean oil, draining, and replacing. In the o ____ -s ________ type air cleaner, dirt and dust sticks to a film of oil on a wire mesh.
dry	33. Dry-type air cleaners contain a filter element which may be made of felt, moss, or paper. Some dry-type air cleaner elements can be cleaned in solvent and dried before reassembly. Others have disposable elements which are replaced when they become clogged. Instructions printed on the air cleaner or in the instruction manual should be followed carefully in servicing these cleaners. In a d______ type air cleaner, dirt and dust is filtered out by drawing the air through a fine meshed dry filter.
crankcase	34. Every four-stroke cycle engine has some sort of a crankcase breather system. Air is forced out of the breather when the piston moves toward the crankcase on the intake and power strokes. When the piston moves away from the crankcase on the compression and exhaust strokes, air is drawn through the breather. The crankcase breather permits air to flow in and out of the __________.

serviced	35. When air moves into the crankcase, there is danger of dirt also entering unless a filter is supplied for the breather opening. This filter is generally a dry type or an oil saturated element type and should be serviced regularly. The crankcase breather filter should be s ________ regularly.
magnetos	36. Ignition Small engines generally have magnetos as the source of energy to produce the electric spark that ignites the fuel-air mixture. These magnetos are high-tension, inductor types which produce a spark-plug voltage of 10,000 volts or more. Small engines normally produce electricity for ignition from ________.
magnet	37. Many small engine magnetos are of the flywheel type. Permanent magnets are embedded in the flywheel with an armature either inside or outside of the flywheel. Others have external magnetos with a magnetic rotor inside an armature. Magnetos generate electricity by rotating a m ________ inside an armature.
electricity	38. Principles of the Magneto A magneto uses mechanical energy to transform magnetic force to electrical energy. It depends on the fact that when a coil of insulated wire is moved through a magnetic field, or if a magnetic field moves through a stationary coil, a flow of electric current is produced in that coil (Fig. 11). A magneto produces ________.

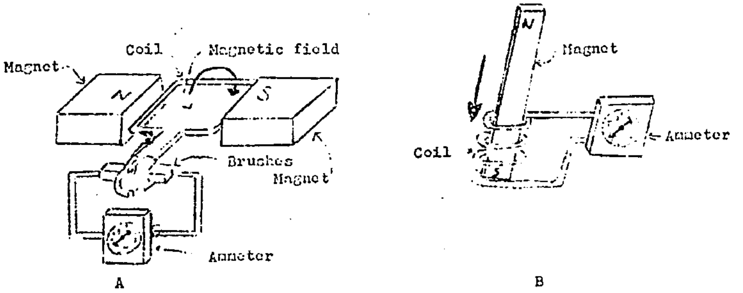

Fig. 11. An electric current is generated when a coil of wire moves through a magnetic field (A), or when a magnetic field moves through a coil of wire (B).

magnets	39. Moving-coil or wound-rotor magnetos were widely used at one time. Modern magnetos, however, generally use moving magnets and the armature, which consists of a soft iron core wound with a coil of insulated wire, stands still. In modern magnetos the _______ move.
flywheel	40. Many small engines have magnets imbedded in the flywheel and the armature has pole pieces that are separated from the magnets by only a small air gap. As the magnets move past the pole pieces, the magnetic field is concentrated in the soft iron armature and lines of force are cut through the armature coil. In small engines, the magnets are often contained in the ___________.
- -	41. The coil has a primary and a secondary winding. The primary winding has relatively few turns of large wire while the secondary winding has many turns of very fine wire.
primary	42. The ends of the primary coil are connected to the breaker points. Actually one end of the primary coil is "grounded" to the frame of the engine and one of the breaker points is similarly grounded. The other end of the primary coil is connected by an insulated wire to the ungrounded breaker point (Fig. 12). The ends of the p_______ coil are connected to the breaker points.
breaker points	43. As the moving magnets in the flywheel approach the armature pole pieces, the magnetic field cuts through the turns of the primary coil, but no current flows until the breaker points close. The b_____ p_________ act as a switch in the primary circuit of the armature.
breaker points	44. When the breaker points close the current starts to flow and a stronger magnetic field builds up around the armature core. When the breaker points open, this field suddenly collapses, the lines of force again cut through the primary coil and a surge of current at about 100 volts occurs through the coil. Opening the ___________ causes a sudden surge of electric current through the coil.

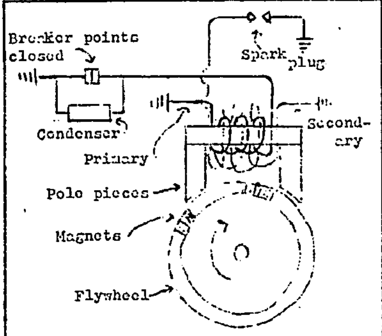

Fig. 12. Current flows through the primary circuit when the breaker points are closed and the magnets are moving past the armature pole pieces.

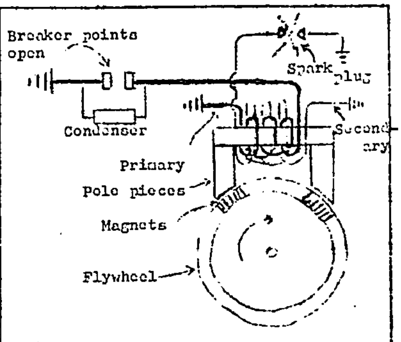

Fig. 13. When the breaker points open a high-voltage current is induced in the secondary circuit and a spark occurs at the spark plug.

spark plug	45. Since the secondary coil is wound over the primary coil, the collapsing magnetic field also cuts through the many turns of fine wire that make up the secondary coil. Thus a current flow of several thousand volts is induced in this coil. The high-voltage current is carried to the spark plug and has sufficient pressure to cause a spark to jump the gap (Fig. 13). The current produced in the secondary coil of the armature is sufficient to cause the s______ p______ to fire.
condenser	46. The effectiveness of this ignition system depends on the quick collapse of the magnetic field at the right time in the magneto and engine cycle. This is promoted by connecting a small condenser across the breaker points (Fig. 14). The c________ helps the magnetic field collapse quickly.

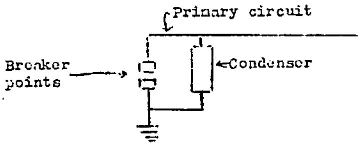

Fig. 14. A condenser is connected across the breaker points to cause the magnetic field to collapse quickly and to prevent excessive arcing at the points.

burning pitting	47. The quick collapse of the magnetic field is the main function of the condenser. It also prevents a lingering arc at the breaker points when they open which would produce excessive burning and pitting. The condenser also prevents b________ and p________ of the breaker points.

Timing	48. Timing the spark. In designing the ignition system, the manufacturer provides for timing the spark to come at the proper moment in the engine cycle. This is done by having the breaker points open at the right time. T________ means that the ignition spark occurs at exactly the right time in the engine cycle.
magnets	49. The magnets must also be at the proper position with reference to the magneto armature or stator. Some engines have their timing fixed and are nonadjustable. Timing means that the m________ of the magneto must be in the proper position at the right time.
- -	50. Other engines have provision for slight adjustment of the timing of the ignition spark, usually by moving the magneto stator plate. Manuals for these engines generally specify the correct timing either in degrees or in millimetres of piston travel before top dead centre.
cam	51. Breaker points are opened and closed by some kind of "cam" action. All two-cycle and some four-cycle engines have the cam on the crankshaft so the breaker points close and open once each revolution. A c_____ action is used to open or close the breaker points on most small engines.
- -	52. A common system is to have a breaker-point plunger, generally made of fibre, with one end riding on the crankshaft. The other end of the plunger bears against the breaker-point arm (Fig. 15). A flat spot is machined on one side of the crankshaft. When the plunger rides on this flat spot, it allows the breaker points to close, but opens the points when it rides on the full circumference of the shaft.
crankshaft	53. Thus in this system the points are normally open and a spark occurs once each revolution of the crankshaft. Every other one of these sparks is useful in the four-cycle engine; the one that occurs at the end of the compression stroke. An extra or "maverick" spark occurs at the end of the exhaust stroke, which does no good and may shorten the life of the breaker points and spark plug. In the common type of ignition system, a spark occurs once each revolution of the c__________.

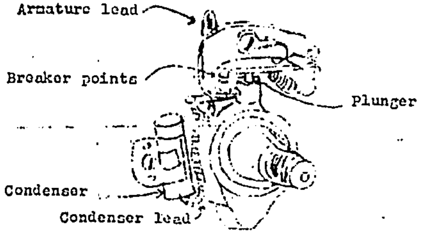

Fig. 15. In some engines, the breaker points are opened and closed by a plunger which rides on the crankshaft.

camshaft	54. Some small four-cycle engines have an ignition system similar to that used on all modern multi-cylinder engines. The breaker-point assembly is mounted so that the points are opened by a cam on the main camshaft gear in the crankcase. In an improved ignition system the breaker points are operated from the main c__________.
compression	55. The camshaft gear rotates at half the speed of the crankshaft so that a spark occurs only once in the complete cycle, at the end of the compression stroke. The breaker points are normally closed and open at the point when a spark is needed. The spark normally occurs at the end of the __________ stroke in a four-cycle engine.
closed	56. Points that are normally closed permit better matching of magneto output to ignition requirements. A good spark is produced at slow speeds for starting but the voltage at operating speeds is not excessive. Better ignition systems have points which are normally c__________.
spark	57. This ignition system also makes it possible to use a device to automatically retard the spark at low speeds and to advance it at high speeds. This is usually done by centrifugal action of a weight on the camshaft gear. Automatic adjustment of the timing of the __________ is found on some engines.

cooling lubrication	58. <u>Secondary functions.</u> As was mentioned previously, in addition to the primary functions and systems of compression, carburetion, and ignition; secondary functions of cooling and lubrication must also be performed. The secondary functions required for engine operation are __________ and __________.
air	59. <u>Cooling.</u> Most small engines used on farms are air cooled rather than liquid cooled. Efficient cooling is promoted in two ways. The cylinder and cylinder head are generally made with cooling fins or ridges. Most small engines are a_____ cooled.
air	60. This makes it possible to have these parts thinner, with ridges acting as reinforcing members to furnish the necessary strength. It also greatly increases the surface area exposed to the air and promotes heat transfer to the air surrounding the engine. ________ cooled engines generally have cooling fins or ridges to promote rapid heat transfer.
flywheel	61. The second feature is the provision of fins on the flywheel which makes it operate as a fan. This blows air onto the hot parts of the engine and promotes cooling. Fins on the ________ also help cool the engine.
cooling	62. It is important to keep small engines clean as an accumulation of dirt and other foreign matter on the outside of the cylinder and engine may cause these parts to overheat. Overheating or unequal cooling may cause warping and burning of engine parts, particularly the valves. Engines must be kept clean to insure proper __________ cooling takes place.
dip-splash oil slinger	63. <u>Lubrication.</u> The four-cycle engine is lubricated from a supply of oil in the crankcase. Some engines have a dip-splash system with a dipper on the connecting rod bearing cap, or an oil slinger that is gear driven. Two systems of lubricating a four-cycle engine are __________ and __________.

pump	64. These devices pick up oil from the sump and splash it onto the moving parts. Other engines have oil pumps to force oil to various bearings and surfaces (Fig. 16). A third type of engine lubrication is by an oil ________.

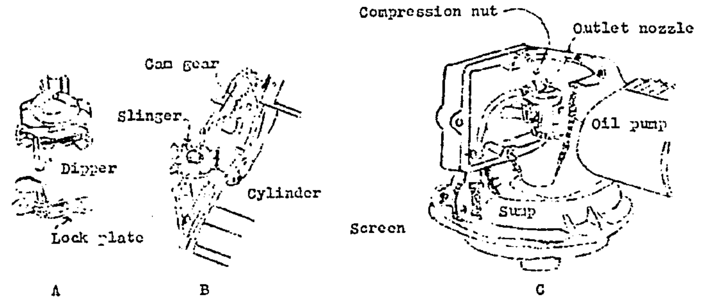

Fig. 16. Several types of lubrication systems are found on four-cycle engines.

A. Dipper on connecting rod cap to splash oil.
B. Oil slinger driven by cam gear.
C. Oil pump to force oil under pressure.

level	65. It is important to maintain the proper oil level in the crankcase of these engines and to follow the manufacturer's recommendations on draining and refilling with oil of proper type and viscosity. The oil ________ must be properly maintained in the engine crankcase.
oil	66. As mentioned previously, two-cycle engines are generally lubricated by mixing oil with the fuel according to manufacturer's recommendations. When the fuel burns away, most of the vaporized oil remains to work its way past the piston and condense on working surfaces of cylinder walls, bearings, etc. supplying a lubricating film. Two-cycle engines are lubricated by mixing ______ with the fuel.

The information in this unit was taken from the University of Illinois VAS unit3014.

Name ______________ Form ______
Date ______________

TEST

Small Engines II

UNDERLINE THE CORRECT ANSWER

1. The usual source of energy to produce the electric spark for igniting the fuel-air mixture in small engines is a __________.

   a. battery
   b. carburetor
   c. condenser
   d. magneto
   e. spark plug

2. The secondary functions necessary for the successful operation of an engine are __________.

   a. carburetion and compression
   b. compression and ignition
   c. cooling and lubrication
   d. ignition and cooling
   e. lubrication and carburetion

3. In a gravity type of fuel system the level of fuel in the carburetor is controlled by a __________.

   a. butterfly
   b. float valve
   c. foot valve
   d. governor
   e. needlevalve

4. The speed of an engine is controlled by the position of the __________.

   a. carburetor
   b. choke
   c. filter
   d. throttle butterfly
   e. venturi

5. When the __________ open a current flow is sent to the spark plug sufficient to cause a spark to jump the gap in the spark plug.

   a. breaker points
   b. cams
   c. coils
   d. magnets
   e. valves

6. Most small engines are cooled by __________.

   a. air
   b. flywheels
   c. magnets
   d. oil
   e. water

7. Many gravity feed fuel systems contain a ________ in which water and solid particles can settle out from the fuel.

   a. carburetor
   b. crankcase
   c. cylinder
   d. fuel tank
   e. sediment bowl

8. The best fuel-air operating mixture for an engine is about one part fuel to ________ parts air.

   a. two
   b. five
   c. twelve
   d. fifteen
   e. twenty

9. The ________ of an ignition system causes the magnetic field to collapse very quickly.

   a. breaker points
   b. condenser
   c. magnets
   d. primary coil
   e. spark plug

10. Two-cycle engines are lubricated by putting oil in the ________.

   a. coil
   b. condenser
   c. crankcase
   d. fuel
   e. flywheel

11. Fuel is vaporized and mixed with air in the ________.

   a. carburetor
   b. coil
   c. crankcase
   d. cylinder
   e. fuel tank

12. An engine is choked, the richness of the fuel-air mixture increased, when it is ________.

   a. dirty
   b. new
   c. overheated
   d. started cold
   e. under heavy load

13. The ________ is a restricted air passage in the carburetor which causes the velocity of the air to be increased.

   a. air horn
   b. butterfly
   c. choke
   d. throat
   e. venturi

14. The ________ removes dust and dirt from the air entering the carburetor.

   a. air cleaner
   b. butterfly
   c. magneto
   d. oil sump
   e. sediment bowl

TUMAINI SECONDARY SCHOOL

INTRODUCTION TO ANIMAL BREEDING

This is a programmed instruction unit in animal breeding.

In this unit you are to learn:

1. what cells are.
2. what cell division and maturation are.
3. what reproduction is.
4. what fertilization is.
5. the use of the square method to determine the probable distribution ratio of genes when making various crosses.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not eaase your incorrect answer.

Introduction to Animal Breeding

If you have not read the cover page, do so now, then proceed to frame 1.

— Cut —

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Name ______________________ Form ____________

1. ____________

2. ____________
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3. ____________

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31. ____________

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57. ____________
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58. - -

59. a. ____________
    b. ____________
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Introduction to
Animal Breeding
continued

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Name ____________________ Form __________

60. a. __________

b. __________

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f. __________

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h. __________

____

61. - -

62. __________

63. a. __________

b. __________

c. __________

d. __________

e. __________

f. __________

g. __________

h. __________

____ black

____ blue

____ white

64. - -

65. __________

66. __________

67. __________

68. __________

69. __________

70. __________

breeding	1. When we study animal breeding, we are interested in improvements such as more milk per cow, more eggs per hen, or more gain per 100 kilograms of feed. Animals can be improved through ______________.
inheritance environment	2. Since production is an inherited characteristic and is also influenced by environmental factors, such study is quite complicated. Because of this it is necessary that we study the basic principles of plant and animal improvement before we can make rapid or systematic progress in the more complicated phases of breeding. Production depends on both i_________ and e_________.
cells	3. If any part of an animal's body is examined closely under a microscope, it will be found to be made up of very small structural units called c_______.
cell	4. Cells are very small, some are so small that 725,000 placed side by side would measure only one centimetre. A living plant or animal contains millions of living cells. The ______ is also the basis of improvement since most animals start their life from a single fertilized cell.
protoplasm	5. A cell is largely made up of material called p_________ (see Fig. 1).

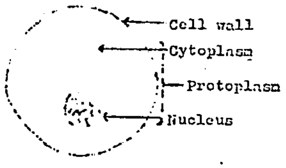


Fig. 1. A cell showing the different parts.

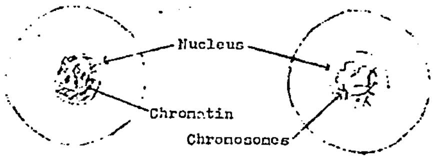


Fig. 2. Chromatin material is located within the nucleus of the cell. In certain stages the chromatin changes into rather definite bodies, called chromosomes.

nucleus	6. The nucleus, which is also composed of protoplasm, is the most vital part of the cell, because without the nucleus, the cell does not have the power to digest food, grow, or divide. The ______ is the most important part of a cell.
cytoplasm	7. The protoplasm outside the nucleus is called c__________. The <u>cell wall</u> in animal cells is usually not very well defined and may be absent entirely.
chromatin	8. Another important part of the nucleus is the chromatin (Fig. 2). In certain stages of cell life the chromatin material is formed into definite bodies called chromosomes. Chromosomes form from _______________.
chromosomes	9. The chromosomes carry the genes - the units which are transmitted from parent to offspring. All the cells of an animal contain the same number of chromosomes. The number is also constant for all individuals of the same species. Genes are carried by the __________.
– –	10. The numbers of chromosomes possessed by some animals are as follows: Pigs . . . . 38 Mouse . . . . . . 40 Rat . . . . 42 Man 48
cell division	11. Growth is largely the result of an increase in the number of cells rather than in size of cells. Thus most growth takes place through a process of cell division. Most growth occurs from c_______ d__________.

	12. By this process one cell divides and forms two. Each of these in turn divides, making four, and each of the four divides, thus forming eight, and so on until the adult size has been reached.

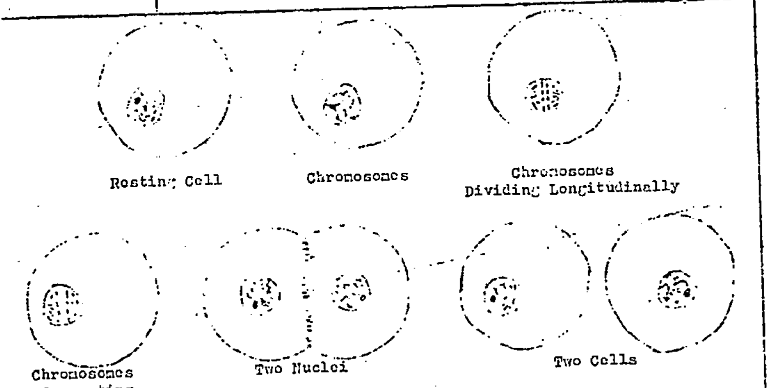


Fig. 3. Steps in ordinary cell division (mitosis).

mitosis	13. Figure 3 diagrammatically indicates the stages in ordinary cell division known as mitosis. The actual process is of course more complicated than might be assumed from the diagram. Ordinary cell division is called ____________.
Mitosis	14. In mitosis, the chromosomes divide in such a way that no one of the characteristics is lost in any of the cells formed. Each of the new cells is exactly like the parent cell. This type of cell division is the means by which plants and animals increase in size but is not the usual means by which a new individual is produced. ____________ is not the usual way in which new individuals are produced.
male female	15. There are two general types of reproduction, sexual and asexual. Sexual reproduction is the type of reproduction in which a new individual is produced by the union of m________ and f________ germ cells. All of our domestic animals reproduce in this way.

asexually	16. Asexual reproduction occurs without the aid of germ cells. One form of asexual-reproduction is simple cell division as in the case of bacteria or other single-celled or simple forms of life. Bacteria reproduce ______.
budding	17. Another method is by budding, in which new individuals are formed from buds. Yeasts reproduce this way. Yeasts reproduce by ______.
cell	18. Every sexually produced animal started as a single fertilized cell. The large bull or the small baby chick each started from a single fertilized cell. The cells from which a new individual is produced are called reproductive cells, germ-cells, or gametes. Secually produced animals began life as a single ______.
- -	19. The germ-cells formed by the male are called male germ cells, sperms, or spermatozoa (singular - spermatozoon).
- -	20. Those formed by the female are called female germ cells, eggs, or ova (singular - ovum).
24 21	21. Before the male and female germ-cells unite they go through a process known as maturation (Fig. 4). It should be noted that in the maturation process the number of chromosomes in both the male and female germ-cells is reduced to half the original number. Human germ-cells each contain ______ chromosomes and rat germ cells each contain ______ chromosomes.

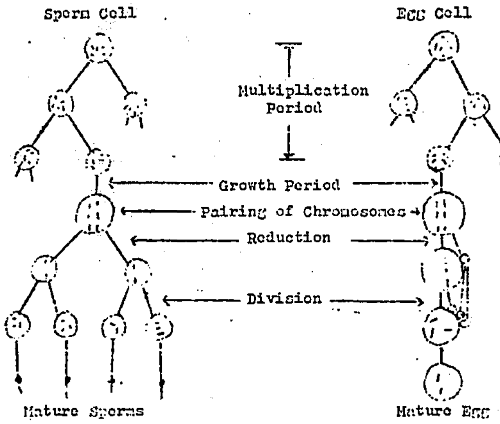


Fig. 4. Steps in maturation of male and female reproductive cells.

48	22. This is quite different from what happens when cells divide by mitosis since in division by that process each new cell contains the same number of chromosomes as the parent cell. Each human cell, after division by mitosis, contains ______ chromosomes.
4 1	23. One essential difference between the maturation of the male and female germ-cells is that in the female only one of the four resulting cells is functional, whereas in the male all four are functional and capable of producing a new individual after uniting with an egg. One sperm cell forms ______ functional sperms, while one egg cell forms ______ functional egg.
eggs	24. In the male, large numbers of spermatozoa are formed - often millions. This makes the formation of young more likely because the female produces only a small number of ________. The number produced by a female at a given time is probably indicated to some extent by the number of young produced at birth.

spermatozoa eggs	25. Mares and cows usually produce one at birth, while sows may average eight or nine and occasionally produce as many as eighteen in a litter. Fewer eggs are present in the mare and cow at the time of mating than are present in the sow. The male produces s________ and the female produces e________.
- -	26. Some eggs are present which never develop into young; on the other hand, in some cases, occurring rather infrequently, one fertilized egg will form two separate parts, and from each part an individual is produced.
2	27. Two such individuals are of the same sex and alike in other characters since they came from the same original fertilized egg. This is the origin of "identical" twins. Twins, however, are normally developed from two eggs and thus are no more identical than brothers and sisters. Twins can be produced in ________ ways.
male germ-cells (sperms)	28. The male germ-cells are very small and must be magnified many times before they are visible to the eye. Eggs are usually larger (Fig. 5) because they must contain food material to last the developing young for some time. Eggs are much larger than ________.

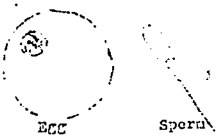


Fig. 5. Eggs are usually much larger than the sperm. The tail of the sperm serves as an organ of locomotion.

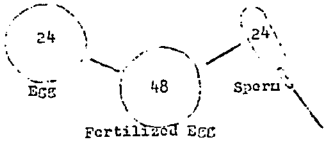


Fig. 6. Fertilization restores the original number of chromosomes, which was reduced during maturation.

germ-cell	29. In chickens the eggs are very large owing to the fact that they contain a great amount of food which is to furnish nutriment for the developing chicks for twenty-one days before the eggs hatch and the young are able to obtain food for themselves. A chicken egg is an example of a female g_____-c______.

- -	30. The eggs of turkeys and geese are larger than those of hens, and the young do not hatch until a longer period of time has passed. The eggs formed by our domestic mammals are much smaller than the ones just mentioned.
true	31. They need to possess only a small amount of food, because the mother begins to nourish the young shortly after the male and female germ-cells unite. The eggs of most mammals would need to be magnified in order to be seen. Mammals' eggs are smaller than birds' eggs. True or False?
fertilization	32. Fertilization is the union of a spermatozoan and an egg. It restores the original number of chromosomes which was reduced in maturation (Fig. 6). The union of egg and sperm is called ________.
40	33. The fertilized egg (sometimes called a zygote) contains all of the hereditary material which the developing plant or animal will ever have. After fertilization, the mouse zygote has _____ chromosomes.
character	34. A character may be defined as a distinguishing detail of structure or form of an individual - such as horns or polled condition in cattle, and rose or single comb in poultry. Colour of an individual is a __________.
character	35. It should be noted that a character itself is not present in the cell but that there is present that "something" which produces the ________ in the individual. That "something" in the reproductive cell that gives rise to a character is known as a factor or gene.

genes	36. The development of all characteristics is conditioned by the presence of genes but some are modified by differences in environment that exist at that time. Not all characters which an animal inherits are visible. The characteristics of an individual are determined by his ____________.
horns	37. Some genes when present will mask or hide the presence of others. For example, if both horned and polled genes are present in cattle, only the polled condition would show. Polled means that an animal has no ________.
Dominant	38. Genes that hide or mask the presence of another (polled over horned in cattle) are said to be dominant and are usually designated by capital letters (P in the case of polled). D________ genes mask the presence of other genes.
dominant recessive	39. The opposite condition (horned) is said to be recessive and is commonly designated by a small letter of the dominant gene (p = horned). Genes can be either d________ or r__________.
pure homozygous	40. An individual that carries two genes for a character is said to be pure or homozygous for that character (example, PP - polled; or pp - horned). An individual with two dominant or two recessive genes for a particular character is _________ for that character.
genes	41. An individual that carries two different genes which affect a character differently is said to be impure or heterozygous for that character (example, Pp). An individual that is heterozygous for a character has two different _______ affecting that character.

one half	42. It was previously mentioned that as a result of the maturation process the number of chromosomes in both the male and female germ-cells is reduced to half the original number. Further, in this reduction process the gene pairs invariably separate, going to different gametes. Each gamete has ________ the number of chromosomes of normal cells.
2 gene	43. Thus after maturation the gene for a simple character is always present only singly in the reproductive cell even though two genes for that character are always present in the fertilized egg or in the body cells of an individual (except for sex-linked characters, which will be mentioned later). Each simple character in an individual's body has ______ genes, however the reproductive cell contains only one ________ for that character.
maturation	44. For example, in the maturation process the two genes representing the polled condition in cattle (PP or Pp) would never go to the same germ-cell. The gene pairs are split into separate germ-cells during the process of __________.
alleles	45. Figure 7 shows reproductive cells of cattle, homozygous for the polled condition (PP), all containing only the polled gene (P). Genes such as P and p are known as alleles. ____________ are the dominant and recessive genes for a particular character.

Fig. 7. In the maturation process, the two genes for a character are divided, each going to different germ cells.

- -	46. In studying probable results of crosses the "square" method is commonly used (Fig. 8). The male germ-cells are indicated on one margin (usually across the top) and the female germ-cells are indicated on the other margin (usually along the left side).

Male Germ-Cells

Female Germ-Cells

	P	P
P	PP (Polled)	PP (Polled)
P	PP (Polled)	PP (Polled)

Fig. 8. Cattle, homozygous for polled condition, would, if mated, produce only polled offspring.

	P	P
p	Pp (Polled-impure)	Pp (Polled-impure)
p	Pp (Polled-impure)	Pp (Polled-impure)

Fig. 9. A homozygous polled bull mated to a homozygous horned cow will produce offspring heterozygous for the polled condition.

heterozygous

47. A cross between a bull, homozygous for polled condition (PP) and a cow homozygous for horned condition (pp), will produce only polled offspring in the F_1 (first filial generation), although all of the F_1s will be heterozygous (Pp) (Fig. 9).

A cross between a male homozygous for the dominant gene and a female homozygous for the recessive gene will result in all offspring being ________ for the characteristic.

"
2
1
1

48. In appearance (if there are large enough numbers) the offspring resulting from a cross between individuals heterozygous for the polled condition (Pp) will be in the approximate ratio of 3 polled to 1 horned (Fig. 10).

When two animals heterozygous for a particular trait are mated, the chances for an offspring which is also heterozygous are _______ to 4. The chances for an offspring homozygous in the dominant character are ___ to 4. Likewise, the chance for an offspring homozygous in the recessive character are _____ to 4.

	P	p
P	PP (Polled-pure)	Pp (Polled-impure)
p	Pp (Polled-impure)	pp (Horned-pure)

Fig. 10. The mating of a large number of heterozygous polled individuals will produce approximately 3 polled to one horned offspring.

- -	49. Further, horned individuals produced from polled parents will not carry a gene for the polled condition even though both parents were polled. In other words, it is entirely possible to get from a mating of polled animals, offspring that are horned and that do not carry genes for the polled condition even though both parents were polled.
50	50. One should remember that ratios are influenced by chance. For example, if a shilling is tossed 100 times it is probable that Nyerere (or Mwenge) will come up about one-half the times. If you toss a shilling 100 times, Nyerere should appear about ______ times.
chance	51. In any 100 tosses, however, the ratio of Nyerere to Mwenge might not be exactly 50:50. Likewise, chance to a large extent determines which one of hundreds of sperms will unite with a given egg. _________ determines which sperm carrying which genes unites with any given egg.
- -	52. Consequently ratios expected as a result of crosses should be expected to vary somewhat from the theoretical ratio. Further, large numbers are essential in order to get a reasonable basis for estimating actual ratios.
recessive	53. You may be interested in working out a breeding program that would enable you to determine which animals in a herd were pure for polled condition. Of course, since the horned condition is _________, this character shows only if a gene for polled condition is absent.
polled	54. One knows that the horned animals are pure for that condition (pp). One, however, can not tell by appearance whether polled animals are pure or impure for that character. Figure 11 indicates a breeding program that will enable you to determine this. If the bull is pure for the polled condition all of his offspring from horned cows will be _________.

	P	P
p	Pp (Polled-impure)	Pp (Polled-impure)
p	Pp (Polled-impure)	Pp (Polled-impure)

	P	p
p	Pp (Polled-impure)	pp (Horned-pure)
p	Pp (Polled-impure)	pp (Horned-pure)

Fig. 11. To determine whether a bull is pure for the polled condition, cross him with horned cows. If he is pure, all the offspring will be polled (left diagram). If he is impure for polled condition, approximately one-half of the calves will be horned (right diagram).

one-half	55. The procedure given can be used to determine which individuals are pure (or impure) for almost any character resulting from a single dominant gene. If a bull is impure (heterozygous) for the polled condition about ________ of his offspring from horned cows will be horned.
- -	56. Hatcherymen have culled out many White Wyandotte baby chicks because they had single combs, instead of rose combs, which a Wyandotte is supposed to have. From some Wyandotte flocks the percentage of chicks with single combs runs quite high, Yet it is a relatively simple matter to set up a breeding program that will practically eliminate single comb chicks from such crosses.
dominant recessive	57. The examples given are typical of these crosses where the difference between two characters (single comb and rose comb) involves one pair of alleles. The knowledge of d____________ and r________ characters can help a farmer improve his herd through a breeding program.
- -	58. There is a large number of such characters and if you are interested in working out additional crosses you might be interested in the following: Black colour in cattle is dominant to red. White face in cattle is dominant to coloured face. Rose comb in chickens is dominant to single comb. Colour in animals is dominant to albinism. Yellow coloured cotyledons in peas is dominant to green coloured cotyledons.

a. B
b. B
c. b
d. b
e. Bb
f. Bb
g. Bb
h. Bb
black

59. For practice, supply the missing information in the following table to show the possible results if a black bull (BB) is mated with a red cow (bb).

	a. ___	b. ___
c. ___	e. ___	f. ___
d. ___	g. ___	h. ___

All the offspring would be ______ in colour.

a. B
b. b
c. B
d. b
e. BB
f. Bb
g. Bb
h. bb
3 to 1

60. What would be the results if a black bull (Bb) and a black cow (Bb) were mated (both impure or heterozygous for black colour)?

	a. ___	b. ___
c. ___	e. ___	f. ___
d. ___	g. ___	h. ___

The ratio of the colour of the offspring would be ______ black to ______ red.

– –

61. Sometimes a character is the result of incomplete dominance. Roan colour in Shorthorn cattle is the result of incomplete dominance of red and white. (In such cases capital letters are used to designate each gene -- R = red, W = white.) Figures 12, 13, 14, and 15 indicate the ratios that might be expected in crosses where genes for both red and white are involved.

blue

62. There are other examples of incomplete dominance. One of these is colour in Andalusian chickens. Here the blue colour is a result of a cross between individuals that are black (BB) with those referred to as splashed white (WW).

What would be the colour of the offspring when a black Andalusian cock is mated with a splashed white hen? ______

	R	R
W	RW (Roan)	RW (Roan)
W	RW (Roan)	RW (Roan)

Fig. 12. An animal pure for red (RR) crossed with one pure for white (WW) will produce all roan offspring.

	R	W
R	RR (Red)	RW (Roan)
W	RW (Roan)	WW (White)

Fig. 13. The crossing of roan individuals will produce offspring in the approximate proportion of two roan, one red, and one white.

	W	W
R	RW (Roan)	RW (Roan)
W	WW (White)	WW (White)

Fig. 14. The crossing of roan and white individuals will produce offspring in the approximate proportion of two roan to two white.

	R	R
R	RR (Red)	RR (Red)
W	RW (Roan)	RW (Roan)

Fig. 15. If roan and red individuals are mated, about half of the offspring will be red and the other half roan.

63. Exercise in incomplete dominance. Supply the missing information in the following table to show the possible results if a blue Andalusian cock (BW) is mated with a black hen (BB).

	a. ____	b. ____
c. ____	e. ____	f. ____
d. ____	g. ____	h. ____

The colour ratio of the offspring from such a mating would be: ______ black; ______ blue; ______ white

a. B
b. W
c. B
d. B
e. BB
f. BW
g. BB
h. BW

2 black
2 blue
0 white

- -

64. Thus far we have been considering only a single character in a given cross. Actually all crosses involve a number of characters. Figures 16, 17, and 18 may help to give a little better understanding of what actually occurs in crosses.

	PW	PW	PW	PW
pw	PpWw (Polled white f	PpWw (Polled white f.	PpWw (Polled white f	PpWw (Polled white f.
pw	PpWw (Polled white f	PpWw (Polled white f.	PpWw (Polled white f	PpWw (Polled white f.
pw	PpWw (Polled white f	PpWw (Polled white f.	PpWw (Polled white f	PpWw (Polled white f.
pw	PpWw (Polled white f	PpWw (Polled white f.	PpWw (Polled white f	PpWw (Polled white f.

Fig. 16. A cross involving two characters-- polled, whiteface (PPWW) x horned, coloured face (ppww).

	PW	Pw	pW	pw
PW	PPWW (Polled white-faced)	PPWw (Polled white-faced)	PpWW (Polled white-faced)	PpWw (Polled white-faced)
Pw	PPWw (Polled white-faced)	PPww (Polled colored faced)	PpWw (Polled white-faced)	Ppww (Polled colored faced)
pW	PpWW (Polled white-faced)	PpWw (Polled white-faced)	ppWW (Horned white faced)	ppWw (Horned white-faced)
pw	PpWw (Polled white-faced)	Ppww (Polled colored faced)	ppWw (horned white faced)	ppww (Horned colored faced)

Fig. 17. Crosses between individuals impure for both horned and whitefaced conditions (PpWw) should result in a ratio of 9 polled, whitefaced; 3 polled coloured faced; 3 horned, white faced; 1 horned, colored faced.

offspring

65. It has already been mentioned that large numbers of offspring are necessary in order to be reasonably sure of the accuracy of ratios resulting from certain crosses. Because of this many of the experiments have been carried on with such animals as rabbits, chickens, guinea pigs, mice, rats, and plants because they produce large numbers of ____________.

ratio

66. Ordinarily a cow will produce only one offspring a year, while guinea pigs, rabbits, and plants, will produce many times that number (sometimes hundreds) in the same period of time.

Large numbers of offspring are needed to determine the r________ of character distribution resulting from various crosses.

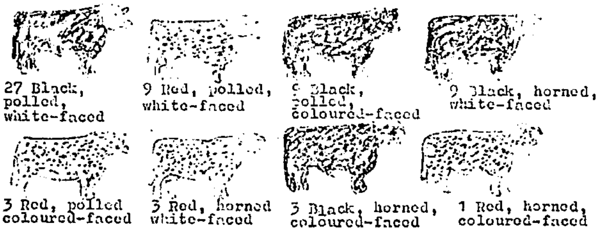
gene

67. You have observed that certain ratios may be expected as a result of given crosses. In a cross between individuals heterozygous for a dominant character, the expected ratio based on the appearance of the offspring would be 3:1.

Heterozygous means that an individual carries two different g_______ which affect a character differently.

ratio	68. With two pairs of heterozygous characters, the expected ratios would be 9:3:3:1. With three pairs of heterozygous characters, the ratio would be 27:9:9:9:3:3:3:1. Note that for each additional character the ratio is changed to the extent of multiplying the preceding ratio by 3:1. When individuals with homozygous characters are mated, the offspring do not differ from the parents and there is no r_______ of character distribution.
characters	69. Perhaps your understanding of how characters are transmitted will now enable you to appreciate more fully the truth of the statement made previously that the inheritance of such an improvement as more eggs per hen was quite complicated. Improvement of animals through breeding becomes more complicated as the number of c_______ influencing an aspect of an individual increases.
breeding	70. For example, at least five inherited characters are involved in egg production, namely; early sexual maturity, intensity, broodiness, seasonal pause, and persistency. Further, at least two genes are involved in broodiness and at least the gene for early sexual maturity is sex linked. The improvement of animals through _______ is a complicated process.

	BPW	BPw	BpW	Bpw	bPW	bPw	bpW	bpw
BPW	BBPPWW	BBPPWw	BBPpWW	BBPpWw	BbPPWW	BbPPWw	BbPpWW	BbPpWw
BPw	BBPPWw	BBPPww	BBPpWw	BBPpww	BbPPWw	BbPPww	BbPpWw	BbPpww
BpW	BBPpWW	BBPpWw	BBppWW	BBppWw	BbPpWW	BbPpWw	BbppWW	BbppWw
Bpw	BBPpWw	BBPpww	BBppWw	BBppww	BbPpWw	BbPpww	BbppWw	Bbppww
bPW	BbPPWW	BbPPWw	BbPpWW	BbPpWw	bbPPWW	bbPPWw	bbPpWW	bbPpWw
bPw	BbPPWw	BbPPww	BbPpWw	BbPpww	bbPPWw	bbPPww	bbPpWw	bbPpww
bpW	BbPpWW	BbPpWw	BbppWW	BbppWw	bbPpWW	bbPpWw	bbppWW	bbppWw
bpw	BbPpWw	BbPpww	BbppWw	Bbppww	bbPpWw	bbPpww	bbppWw	bbppww



27 Black, polled, white-faced

9 Red, polled, white-faced

9 Black, polled, coloured-faced

9 Black, horned, white-faced

3 Red, polled coloured-faced

3 Red, horned white-faced

3 Black, horned, coloured-faced

1 Red, horned, coloured-faced

Fig. 18. Descriptions and expected ratios from crosses between individuals that are heterozygous for black colour, polled condition, and white face (BbPpWw X BbPpWw).

The information in this unit was taken from the University of Illinois VAS unit 1009.

Name ______________________ Form______
Date __________________

TEST

Introduction to Animal Breeding

UNDERLINE THE CORRECT ANSWER

1. The ________ is the basic of improving animals through breeding.

   a. allele
   b. cell
   c. cytoplasm
   d. character
   e. egg

2. Ordinary cell division, the process by which most growth occurs, is called ____________.

   a. budding
   b. fertilization
   c. maturation
   d. mitosis
   e. reproduction

3. During maturation, the number of chromosomes in the germ cells __________.

   a. doubles
   b. remains the same
   c. is increased by one-half
   d. is decreased by one-half

4. The material carried by the chromosomes which gives rise to a character are called _________.

   a. chromatin
   b. eggs
   c. gametes
   d. genes
   e. germ-cells

5. Male germ-cells are called ____________________.

   a. eggs or genes
   b. genes or sperms
   c. ova or eggs
   d. sperms or eggs
   e. spermatozoa or sperms

6. A ________ gene hides or masks the presence of another gene.

   a. dominant
   b. heterozygous
   c. homozygous
   d. mutant
   e. recessive

7. An individual is said to be ________ for a character if he carries two different genes for that character.

   a. dominant
   b. heterozygous
   c. homozygous
   d. mutant
   e. recessive

8. An individual, who is the result of sexual reproduction, has received _________ of his genes from his mother.

   a. all
   b. one-eighth
   c. one-fourth
   d. one-half
   e. none

9. The union of sperm and egg is called __________.

 a. fertilization
 b. maturation
 c. mitosis
 d. mutation
 e. reproduction

10. When a bull, homozygous for polled condition (PP), is mated with a cow, homozygous for horned condition (pp), all of their offspring will be ______.

 a. black
 b. homozygous
 c. horned
 d. polled
 e. white-faced

(The polled condition is dominant to the horned condition in cattle.)

11. Answer the next questions from information found in this table:

Male Germ-Cells

Female Germ-Cells

	P	p
P	11-1. ___	11-2. ___
p	11-3. ___	11-4. ___

Table showing the expected results of mating cattle heterozygous for the polled condition.

11-1.		11-2.		11-3.	
a.	PP (Polled)	a.	PP (Polled)	a.	PP (Polled)
b.	Pp (Polled)	b.	Pp (Polled)	b.	Pp (Polled)
c.	pp (horned)	c.	pp (Horned)	c.	pp (Horned)

11-4. a. PP (Polled)
 b. Pp (Polled)
 c. pp (Horned)

11-5. In a very large number of such matings, what would be the resulting ratio of polled to horned offspring?

 a. all offspring horned
 b. all offspring polled
 c. 1 polled to 3 horned
 d. 2 polled to 2 horned
 e. 3 polled to 1 horned

12. In a cross between individuals heterozygous for a dominant character, the expected ratio based on the appearance of the offspring would be _________.

 a. 2:2
 b. 1:3
 c. 3:1
 d. 0:4
 e. 4:0

13. The colour of Shorthorn cattle is an example of incomplete dominance. Shorthorn cattle may be red, white or roan in colour. Answer the next questions from information found in this table:

	R	R
R	13-1. _____	13-2. _____
R	13-3. _____	13-4. _____

Table showing the expected results of mating Shorthorn cattle, the male being red (RR) and the female being roan (RW).

13-1.		13-2.	
a.	RR (red)	a.	RR (red)
b.	RW (Roan	b.	RW (roan)
c.	WW (white)	c.	WW (white)

13-3.		13-4.	
a.	RR (red)	a.	RR (red)
b.	RW (roan)	b.	RW (roan)
c.	WW (white)	c.	WW (white)

TUMAINI SECONDARY SCHOOL

ANIMAL BREEDING, PART II

This is a programmed instruction unit in animal breeding which continues the study begin in the unit Introduction to Animal Breeding.

In this unit you are to learn:

1. how sex is determined.
2. what sex-linked characters are.
3. the importance of linkage, crossing over, and mutation.
4. how improvement can be made by selection.
5. the causes of individual variation.
6. the methods of selection.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Animal Breeding,
Part II.

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

Name ______________________ Form ________

1. ______________
2. ______________
3. ______________
4. - -
5. ______________
6. ______________
7. ______________
8. ______________
9. - -
10. - -
11. ______________
12. ______________
13-1. ____________
-2. ____________
-3. ____________
-4. ____________
14. ______________
15. ______________
16. ______________
17. ______________
18. ______________
19. ______________
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21. ______________
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22. ______________

23. ______________
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45. - -
46. ______________
47. ______________
48. - -
49. ______________
50. ______________
51. ______________
52. ______________
53. - -
54. ______________
55. ______________
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____
____
56. - -
57. ______________
58. ______________
59. - -

fertilization	1. Sex is determined at the time of f__________.
XX	2. In mammals (including humans) the female has, in addition to the regular chromosomes, two sex chromosomes. The letters XX are sometimes used to refer to these. The two female sex chromosomes are referred to by the letters ________.
sex	3. Only one sex (X) chromosome is present in the male, the other designated as Y. Consequently after maturation all of the eggs will contain an X or sex chromosome. Males have only one ______ chromosome.
- -	4. One-half of the sperms will contain an X chromosome and the other half a Y (fig. 1).

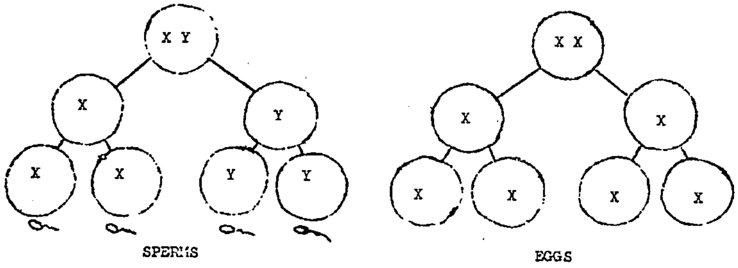

Fig. 1. In mammals the male is commonly designated XY. After maturation half of the sperm and all of the eggs will carry an X chromosome.

male	5. If in fertilization, a sperm carrying an X chromosome unites with an egg, the resulting offspring will be female (XX). If a sperm carrying a Y chromosome unites with an egg the resulting offspring will be a male (XY). (See fig. 2.) In mammals, the germ-cell produced by the ________ determines the sex of the offspring.

	X	Y
X	XX Female	XY Male
X	XX Female	XY Male

Fig. 2. Sex of an individual is determined by the sex chromosomes.

female	6. In poultry, the male carries two sex chromosomes while the female carries only one. These are commonly referred to by the letter Z to distinguish this type from those refferred to by the letter X. In poultry, the sex of the offspring is determined by the germ-cells produced by the __________.
male (ZZ)	7. The letter W is used to indicate the sex chromosome in the female. Thus, the male would be designated as ZZ and the female as ZW. After maturation all of the sperms would carry a Z chromosome but only one-half the eggs would carry Z (fig. 3). An offspring resulting from the combination of a Z female germ-cell and a Z male germ cell would be a ________.
sex-linked	8. Certain genes located on the X or Z chromosome are referred to as sex-linked. Sex linkage has been extensively used to determine the sex of day-old chicks, especially before the art of sexing chickens became common. Genes located on the sex chromosomes are known as __________ genes.

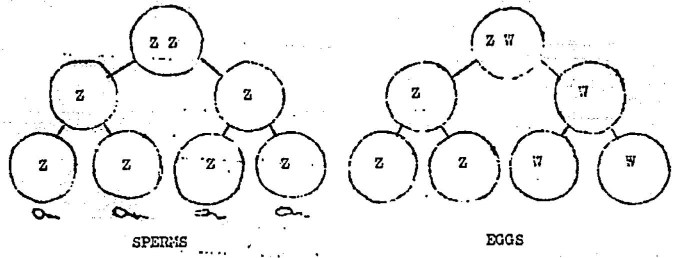

Fig. 3. In poultry, after maturation all of the sperms and half of the eggs will carry a Z chromosome.

9. The barring of Barred Plymouth Rock chickens is a sex linked character. If barred hens are mated with nonbarred males, such as the nonbarred Langshan, all of the barred chicks are males while all of the nonbarred chicks are females (fig. 4).

	Z^b	Z^b
Z^B	Z^BZ^b Male- barred	Z^BZ^b Male- barred
W	Z^bW Female- black	Z^bW Female- black

Fig. 4. Since only half the eggs carry a Z chromosome, only half of the offspring will carry the gene for barring.

10. The thoughfull student will probably wonder what evidence there is to prove the theory of sex-linkage. Of course the actual results of a cross such as referred to in figure 4 produce some evidence. Further evidence is to be found in the results from a reciprocal cross (black females X barred males). (See figure 5.)

	Z^B	Z^B
Z^b	Z^BZ^b Male-barred	Z^BZ^b Male-barred
W	Z^BW Female-barred	Z^BW Female-barred

Fig. 5. Matings between black hens and barred males produce all barred chicks.

sex-linked	11. Colour blindness in humans is a character that is sex-linked. In studying the results of crosses involving sex-linkage in humans remember that the male carries only one X chromosome and that this differs from the illustration used with poultry in that in poultry the male carried two sex chromosomes. Colour blindness is an example of a _________ character in humans.
normal colour vision	12. Figure 6 illustrates the probable results of certain crosses involving colour blindness in humans. From figure 6 it can be seen that all the offspring of a colourblind father and a normal colour vision female will have _______________.

	X^B	Y
X^B	X^BX^B Female-normal colour vision	X^BY Male-normal colour vision
X^b	X^BX^b Female-normal colour vision	X^bY Male-colour blind

	X^b	Y
X^B	X^BX^b Female-normal colour vision	X^BY Male-normal colour vision
X^B	X^BX^b Female-normal colour vision	X^BY Male-normal colour vision

Fig. 6. Results of crosses involving colour blindness in people. Left diagram shows results of a cross between a male with normal vision and a female that is heterozygous for the condition. Right diagram shows results of a cross between a colour blind male and a normal colour vision female.

13-1. X^BX^b female-normal vis.
13-2. X^BY Male-normal vis.
13-3. X^bX^b female-colourblind
13-4. X^bY Male-colourblind

13. Supply the missing information in the following table which shows the expected results of crossing a colourblind male with a female that is heterozygous for the condition.

	X^b	Y
X^B	13-1 _____	13-2 _____
X^b	13-3 _____	13-4 _____

linkage

14. Sex linkage has already been mentioned. There is another type of linkage which the plant or animal breeder should know. In some cases certain characters tend to be transmitted together or linked.

L__________ occurs when certain characters tend to be transmitted together.

chromosome

15. This is because the genes which are responsible for the characters are located on the same chromosome (fig. 7). Of course, one should remember that a large number of genes are carried on a single chromosome.

The genes for linked characters are found together on the same ______________.

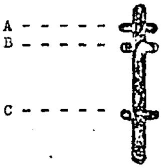

Fig. 7. Genes A and B are more likely to remain together when chromosomes divide than are genes A and C, because A and B are more closely associated.

crossing over

16. In some cases there apparently is an interchange of entire segments of certain chromosomes (fig. 8) as a result of crossing over. In some cases double crossing over may occur.

_______ ________ occurs when pairs of chromosomes exchange parts.

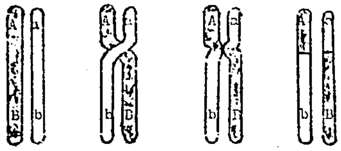

Fig. 8. Chromosomes cross over other chromosomes sometimes and split. When they do, they make new combinations of genes.

mutation	17. Occasionally something occurs that actually changes a gene. As a result an individual is produced with a new character. Such a change is called a mutation and the individual is called a mutant. A change in a gene which produces a new character is called a ________.
mutation	18. Since a change has actually occurred in the germinal material, mutants will pass the new character on to succeeding generations. Most mutations are not beneficial and some are even harmful. Changes which occur by ________ are passed on to the offspring.
mutations	19. If progress in plant and animal breeding was dependent on beneficial mutation, it would be a slow process. Progress in plant and animal breeding does not depend only on ________.
	20. The polled Hereford is an example of a mutation. The polled Hereford resulted from a cross between horned individuals. We know this must have been a mutation since the polled condition is dominant and would have shown had it been in a herd of horned cattle.
crossing over mutation	21. If a horned animal were to come from a cross between polled animals, we could not be certain whether or not it was a mutation since the horned condition is recessive and might be carried and show up at almost any time. It is of course quite possible that there have been horned individuals produced that were the result of mutation. Two processes which can cause changes in the genetic character of individuals are ________ and ________.
selection	22. Selection in plants and animals is deciding which ones will be allowed to reproduce and which ones will not. Such decisions are necessary for improvement. Improvement of plants and animals is based on ________.

selection	23. No matter what system of breeding you follow or how high the quality of the stock, progress will be determined to a great extent by the selection practiced. Deciding which individuals to be allowed to reproduce is called ____________.
variations	24. At first you may be discouraged by the seemingly endless variations that are possible and likely to occur in crosses. The intelligent individual, however, welcomes these variations, because without them there could be no progress. The v__________ from crosses of individuals provides the material on which selection can be made.
improvement	25. It is obvious that if there were no differences, then there would be no basis for selection and therefore no progress in breeding for improvement of plants and animals. Variations between individuals is the basis of i________.
natural artificial	26. Selection may be divided roughly into two kinds - natural and artificial. The two kinds of selection are __________ and _________.
natural	27. Natural selection refers to that kind of selection which takes place out in the wild. The elimination of white animals in the wild, because such a colour makes them easy prey for their enemies, is a good example of natural selection. _________ selection takes place without aid from humans.
artificial	28. The kind of selection animal and plant breeders are interested in may be termed artificial selection. This is the selection that man practices in order to develop desirable types and varieties. _________ selection is used by man for improvement of his plants and animals.

hereditary	29. Since selection is so important, it is very necessary for us to know that the differences upon which we base selection are permanent - that they are due to heredity rather than to fluctuating, temporary, environmental differences. Selection is based on h______ differences.
environment, recombination of characters, mutation	30. This leads us to consider the causes of variation and the relation of selection to each. The causes of variations may be classed under three heads: environment, recombination of characters, and mutation. The three causes of variation are ________, _________, and ________.
Environment	31. The first cause of variation is environment. All living things differ greatly on account of environmental conditions. Plants differ because of differences in soil, moisture, light, and many other circumstances. Animals differ because of the different methods used in feeding, the different feeds used, the locality in which the animals are brought up, and so on. E________ can cause variation between living things.
environment	32. These are all differences due to environment and are not caused by differences in germ-cells. A pure variety of a plant may produce individuals of different sizes due to the environment. Differences due to _______ are not caused by differences in germ-cells.
environment	33. It should be clear that selection based upon differences due to the environment will be ineffective. Selection can be effective only when the differences are due to the formation of different kinds of germ-cells, as has been shown. Selection should not be made on differences due to the _______________.
germ-cells	34. If there are environmental conditions which affect the germ-cells directly, there may be effects showing in the offspring. It is obvious that nothing can be transmitted to the offspring unless it is carried in the germ-cells. Characters are transmitted to offspring in the G________-c________ of the parents.

offspring	35. There-fore the question is, are there things in the environment which may affect the germ-cells directly, and consequently be transmitted to the offspring? A few things are known to affect the germ cells in this way. Some environmental conditions may affect the germ-cells and these effects will be trasmitted to the ________.
hereditary	36. Among these are X-rays and certain chemicals by which mutations are induced. Such changes are hereditary, that is, they are transmitted from one generation to the next. H ________ changes are transmitted from one generation to the next.
- -	37. Much has been said about the relative importance of heredity and environment, or of nature and nurture, but the gist of the whole question can be put simply by saying that usual environmental conditions do not produce in the individual anything which it has not received by inheritance and that a favourable environment is necessary to develop the characters which have been received by inheritance.
inheritance	38. Some characters are much more easily influenced by the environment than are others. In animals such a character as colour is little influenced by environment, whereas such a character as size is very dependent upon the environment for its expression. Environment influences the development of characters received by ________.
inheritances	39. It is not true that every individual receives the same characters that every other individual receives, and it is not true that all individuals have the capacity to develop in the same way if the environment is the same for all. Two people growing up in exactly the same environment will have different characters because they have different ________.
germ-cells	40. The second cause of variation is recombination of characters. This is one of the major causes of differences among plants and animals. These differences are due to the fact that different kinds of germ-cells are produced. A recombination of characters is passed on from one generation to another through the g____-c________.

recombination of characters	41. Selection based upon differences arising from this cause is effective, for the reason that these differences are inherited permanently and are not temporary on account of the environment. Differences caused by r________ __ c__________ are an effective basis for selection.
recombination of characters	42. The formation of our different breeds of animals and of many varieties of plants is proof of the effectiveness of selection based upon such differences. Selection can be effective if based on variations caused by __________ ___ __________.
mutation	43. The third cause of variation is mutation. As previously mentioned, however, selection based on a mutation is permanent, but most mutations are not beneficial. They do not make a basis for rapid progress in improvement by selection. Variation caused by m__________ is inherited.
judging pedigree actual production progeny test	44. There are several methods used in selection. Among which the following are the most important: judging, pedigree, actual production and the progeny test. Four methods used in selection are: __________, __________, __________, and __________.
	45. In judging, you can only estimate roughly the value of the different points about the animal as they appear on the outside. This, however, means a great deal because we know that the animal must possess the characters which give it this appearance, though at the same time it may possess some characters which do not show and which might be very undesirable.
type	46. Judging has been one of the most effective factors in the improvement of animals. It is usually easy to distinguish types. In cattle, for example, the conformation of a beef type is very different from that of a dairy type. Judging is the visual observation of an animal to determine if it fits a certain t_______.

judging	47. Exact studies are needed to determine the relation between the points considered in judging and the value of the animal as a producer of milk and as a breeder. Not a great deal is now known concerning the relation between many points used in judging and quality, and it is better to follow experience until these relations shall have been established. J.__________ has been an effective method of selection but requires a great deal of experience.
	48. The fact that an animal wins first place in judging is not absolute proof that its offspring will also win first place. There are many other things necessary to take into consideration in addition to the appearance of the individual.
pedigree	49. The pedigree, or ancestry, of an animal is important. It is not the only thing, as has been pointed out, but it serves as some indication of what the individual may produce. The p__________ is another method of selection.
pedigree	50. It is readily seen that an animal with many good ancestors behind it has a much greater chance of producing better offspring than one which has a long line of bad ancestors. Selection by ____________ is based on an individual's ancestors.
production	51. A third way in which an animal should be selected, if it is at all possible, is by what it actually produces, such as milk, eggs, and meat. This can be determined more readily with dairy cattle and poultry, where production can be easily measured than it can with meat-producing animals. Selection on p____________ involves measuring what the animal produces.
progeny testing	52. A fourth very important method of selection is by the kind of offspring which the animal produces. This is called p______ t__________.

– –	53. If, for example, a bull produces daughters with larger milk production than that of dams, it is very clear that the bull is of good quality and is improving the herd. If, however, the daughters produce only as much milk as the dams, it shows clearly that the bull is not aiding in the betterment of the herd.
progeny testing	54. If the daughters' production is less than the dams', he is lowering the quality. By looking at the kind of animals which an individual produces, a great deal can be learned about its quality. ________ ________ is selection based on the kind of offspring produced.
judging pedigree actual production progeny test	55. Four methods of selection are: ________, ________, ________, and ________.
– –	56. Although the work of improving animals through breeding is complicated, it nevertheless is not too difficult if you are willing to study the problem and work at it. With only a limited understanding of the principles involved in inheritance you can make some progress and as your knowledge increases, greater progress becomes possible.
breeding	57. The improvement that has been made in hybrid maize is an indication of what can be done through intelligent and systematic efforts. Much of the marked and systematic improvement in plants and animals in the future must come through breeding. Plants and animals can be improved through ________.
environmental hereditary	58. Much improvement has come through environmental changes such as in feeding and management but such improvement is not inherited. In many cases we are undoubtedly approaching the time when possibility for improvement through environmental changes will decrease and the improvement must come through hereditary changes. Improvement of plants and animals can be accomplished through both ________ and ________ changes.

- -	59. Improving animals through breeding is a fascinating one, and opportunity for progress is great. The would-be plant or animal breeder who is willing to study the subject and to apply his best efforts will find those efforts resulting in improvement.

The information in this unit was taken from the University of Illinois VAS unit 1009.

Name ______________ Form _______
Date ______________

TEST

Animal Breeding, Part II

UNDERLINE THE CORRECT ANSWER

1. The sex of an individual is determined at the time of ____________.
   a. crossing-over
   b. fertilization
   c. maturation
   d. mitosis
   e. mutation

2. Certain genes located on the sex chromosomes are known as ________ genes.
   a. character
   b. factor
   c. germ-cell
   d. mutant
   e. sex-linked

3. ____________ is an interchange of entire segments of certain chromosomes.
   a. Crossing-over
   b. Linkage
   c. Mitosis
   d. Mutation
   e. Sex-linkage

4. __________ in plants and animals is deciding which ones will be allowed to reproduce.
   a. Breeding
   b. Selection
   c. Judging
   d. Linkage
   e. Mutation

5. The sex of an individual is determined by the sex _________.
   a. alleles
   b. chromosomes
   c. factors
   d. genes
   e. germ-cells

6. A _________ is something which occurs which actually changes a gene.
   a. crossing over
   b. factor
   c. linkage
   d. mutation
   e. recombination of characters

7. Farmers can improve plants and animals by _______________.
   a. breeding and mutation
   b. changing the environment and breeding
   c. crossing over and breeding
   d. fertilization and maturation
   e. mutation and changing the environment

8. Changes in individuals caused by _________ can be transmitted from one generation to another.
   a. accidents
   b. disease
   c. feed
   d. weather
   e. X-rays

		Male Germ-Cells	
		X	Y
Female Germ-Cells	X	XX	XY
	X	XX	XY

Table 1. The results expected in the determination of sex of mammals.

9. The sex of an offspring with chromosomes XX will be ______. (See table 1.)
   a. male
   b. female
   c. neither

10. The expected ratio of male to female offspring is _______ in table 1.
    a. 4:0
    b. 3:1
    c. 2:2
    d. 1:3
    e. 0:4

11. Improvement of animals or plants by selection must be based on variations which are due to ___________.
    a. the environment
    b. heredity
    c. incomplete dominance
    d. sex-linked characters
    e. complete dominance

12. __________ is the selection of an animal for breeding on the basis of its ancestry.
    a. conformity
    b. judging
    c. pedigree evaluation
    d. progeny testing
    e. production testing

13. ___________ is the tendency for certain characters to be transmitted together.
    a. crossing over
    b. linkage
    c. mitosis
    d. mutation
    e. recombination of characters

14. Individuals vary from one another because they differ in ___________.
    a. environment and mitosis
    b. fertilization and heredity
    c. heredity and environment
    d. mutation and mitosis
    e. mitosis and heredity

15. Variation caused by _________ is not a good basis for making rapid progress in improving animals by selection.
    a. linkage
    b. mitosis
    c. mutation
    d. recessive characters
    e. recombination of characters

16. Selection of an individual based on its external appearance is called _____.
    a. breeding
    b. characterization
    c. judging
    d. pedigree evaluation
    e. progeny testing

TUMAINI SECONDARY SCHOOL

MAKING AND USING CONCRETE ON THE FARM
PART I

This is the first of three programmed instruction units in making and using concrete on the farm.

In this unit you are to learn:

1. the advantages of concrete construction.
2. the ingrediants of concrete.
3. the selection and testing of concrete ingrediants.
4. the proportioning of the ingrediants of concrete.
5. The steps in preparing a workable concrete mixture.

Instructions

You are pr vided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Making and using concrete on the Farm, Part I

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

Name ______________________ Form _____

1. ____________
2. - -
3. ____________
4. ____________ ____________
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58. ____________
59. - -
60. ____________ ____________ ____________ ____________ ____________

concrete	1. Concrete is a very important construction material on the farm. It is widely used for footings, foundation walls, walls above ground, and floors for all kinds of buildings. C________ is an important farm construction material.
- -	2. It is also used for many farm improvements such as feeding floors, paved lots, watering tanks and troughs, silos, cisterns, well platforms, sidewalks, driveways, retaining walls, and septic tanks. Concrete has many advantages as a building material on the farm. The following are some of the outstanding advantages.
burn	3. <u>Firesafe</u>. Concrete is noncombustible and eliminates much of the fire hazard which is always a problem on farms. Concrete does not ________.
insects rodents	4. <u>Insect and rodent proof</u>. Insects, particularly termites, cause much damage to farm buildings. Rats and other rodents destroy millions of bags of grain and do countless other damage to poultry and livestock each year. Concrete can not be damaged by these pests. ________ and ________ can not damage concrete.
storms	5. <u>Storm resistant</u>. Concrete is a very dense material which will withstand windstorms and other attacks of the elements. In fact, reinforced concrete is the standard material used for building storm and bomb shelters. Concrete buildings are resistant to damage by ______.
rot decay	6. <u>Permanent</u>. Concrete is not subject to rot and decay. Good-quality concrete will last a lifetime with no maintenance required. Concrete will not _______ and ________.

liquids	7. Watertight. If properly mixed and placed, concrete can be made watertight. Because of this characteristic, it can be used for tanks, floors, walls, and other places where liquids must be kept in or out. Concrete can be used to keep __________ in or out.
cleaned	8. Sanitary. Concrete is a great aid to livestock sanitation on the farm. It can be thoroughly cleaned and disinfected and permits large numbers of livestock and poultry to be raised in confinement without undue losses from disease or parasites. Concrete can be easily _______ and disinfected.
concrete	9. Homemade. Concrete can be handled by the farmer and his farm help. It can be mixed, placed in home-built forms, and cured by the farmer. Farmers themselves can easily handle ______ construction.
economical	10. Economical. Concrete is an economical building material by several standards. Its first cost is reasonable. In some cases, the sand and gravel may be available from local sources or even on the farm. Due to its long life, concrete is always economical in per-year cost. Maintenance cost is low to non-existent. Concrete is an e_________ building material.
concrete	11. In order to obtain concrete that has the foregoing advantages it must be made of proper ingrediants, correctly proportioned and mixed, properly placed, finished, and cured. _________ must be properly made to be good.
Portland cement water fine aggregate coarse aggregate	12. This lesson unit describes a few simple rules to follow in making good concrete. The ingrediants of concrete are Portland cement, water, fine aggregate, and coarse aggregate. The ingrediants of concrete are __________, __________, __________, and __________.

limestone shale	13. Portland cement is usually purchased in paper bags. Each bag contains 50 kilograms of cement. "Portland" is not a brand name but desgnates a type of cement which is made by burning pulverized limestone and shale together to form a clinker. Portland cement is made from ________ and ________.
Portland cement	14. This clinker is then ground to a fineness such that 90 percent or more will pass through a 200-mesh screen (this size screen will hold water). The clinker formed by burning limestone and shale together is ground up to form P____________.
dry	15. Portland cement must be stored in a dry place. If it contains lumps that cannot be pulverized between the thumb and finger, it should not be used. Portland cement must be stored in a ______ place.
water	16. In general, water suitable for making concrete should be fit to drink. This means that it should be free from oil, acid, alkalai, and harmful amounts of dirt. ________ for making concrete must be clean enough to drink.
fine	17. Aggregates may be classified according to the size of particles as either fine or coarse. Fine aggregate consists of sand or other suitable fine material. Sand is a _______ aggregate.
6	18. A good sand for concrete will contain particles varying uniformly in size from very fine up to those which will just pass through a 6 millimetre mesh screen (each mesh is a 6 mm square). In a well-graded sand the finer particles help to fill the spaces between the larger particles. Sand should be free from dirt or organic matter. A fine aggregate has particles up to ______ millimetres in diameter.

coarse	19. Coarse aggregate consists of gravel, crushed stone, or other similar material larger than 6 millimetres in particle size. Coarse aggregates that are sound, hard, and durable are best for making concrete. Those that are soft or flaky, or wear away rapidly are generally unsatisfactory. _______ aggregate is made up of particles larger than 6 mm. in diameter.
Dirt (organic matter)	20. Dirt or organic matter in the coarse aggregate is objectionable because it prevents the cement paste from binding the particles of sound, durable aggregates together. This reduces the strength of the concrete and makes it more porous. _______ in the coarse aggregate makes weak concrete.
dirty	21. Concrete made with dirty aggregates hardens slowly and may never harden enough to serve its intended purpose. Good concrete can not be made with _______ materials.
1/5 1/3	22. Coarse aggregate ranges in size from 6 mm. up. Particle size in a well-graded, coarse aggregate should range uniformly from 6 mm. up to the largest size that can be used on the particular job being done. In general, the largest particles of coarse aggregate should not be more than 1/5 to 1/3 the thickness of the concrete being placed. Coarse aggregate should not be larger than _____ to _____ the thickness of the concrete being placed.
coarse aggregate	23. By another standard, the largest piece of aggregate should never be larger than 3/4 of the width of the narrowest opening through which the concrete mixture is required to pass when placing. __________ should not be too large or the quality of the concrete will be reduced.
bank-run	24. In some areas, concrete is made from the natural mixture of fine and coarse aggregates as taken from a gravel bank or pit. This mixture is often called bank-run gravel. Bank-run gravel does not usually make the most economical high-quality concrete. B___-r___ gravel is usually not suitable for making good concrete.

fine coarse	25. Most gravel banks contain an excessive amount of fine material. If this material is available on the farm or at low cost from local sources, it usually pays to screen it with a 6 mm. mesh screen. Fine and coarse aggregate can then be recombined in the desired proportion. Good concrete contains the right proportions of ______ and ______ aggregates.
silt	26. If bank-run gravel is used, the fine aggregate should be tested for quality. The silt test is used to detect the presence of too much extremely fine material (fig. 1). The ______ test is used to determine if too much fine material is present in fine aggregate.

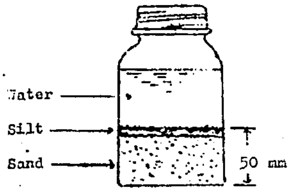

Fig. 1. Making a silt test.

A. Materials needed:
   1. Sample of aggregate to be tested.
   2. Glass container (one litre or larger).
   3. Water
   4. Rule

B. Steps to follow:
   1. Fill the container to a depth of 50 mm with a representative sample of the dry material to be tested.
   2. Add water until the container is about 3/4 full.
   3. Fasten cover on and shake vigorously for 1 minute, making the last few shakes in a sidewise direction to level off the sand.
   4. Allow the container to stand for an hour, or until the liquid above the sand is clear.
   5. Measure the thickness of the silt deposit on top of the aggregate. If this layer is more than 3 mm thick, the aggregate is not suitable for concrete work unless excess silt is removed by washing.

washing	27. The excess silt in fine aggregate can be removed by ____________.
organic matter	28. The organic-matter test is used to detect the presence of harmful amounts of organic matter (fig. 2). O_____ m_______ can be harmful to concrete..

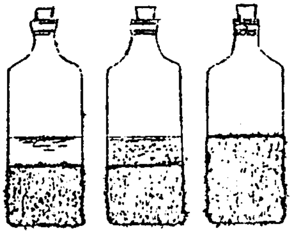

Fig. 2. Making an organic-matter test.

A. Materials needed:
1. Sample of aggregate to be tested.
2. A 500 ml prescription bottle with cork or cap.
3. A 3 percent solution of sodium hydroxide (made by dissolving 25 grams of sodium hydroxide, household lye, or caustic soda, in a litre of water, preferably distilled).

B. Steps to follow:
1. Fill the prescription bottle to the 125 ml mark with aggregate.
2. Fill to the 200 ml mark with the 3 percent solution of sodium hydroxide.
3. Shake thoroughly for 1 or 2 minutes and allow to stand for 24 hours.
4. Read test.

The colour of the liquid will indicate whether or not the aggregate contains too much organic matter.

A. A colourless liquid indicates a clean agregate, free from organic matter.

B. A light yellow coloured solution, indicates some organic matter but not enough to be seriously objectionable.

C. Darker colours mean that it contains injurious amounts of organic matter and should not be used unless it is washed and tested again.

(Caution. Handling sodium hydroxide with moist hands may result in serious burns. Care should be taken not to spill the solution as it is highly injurious to clothing and most other materials.)

washing	29. Excess organic-matter may be removed from fine aggregate by ____________.
silt	30. A ________ test is made to determine if too much extremely fine material is present in fine aggregate.
organic-matter	31. An __________ test is made to determine if there are harmful amounts of organic-matter in the fine aggregate.
water	32. Controlling water-cement ratio. Strength, durability, and watertightness of concrete are controlled by the amount of water used per bag of cement. The amount of ________ used per bag of cement is important in determining the quality of the concrete.
water	33. In general the less water used the better the quality of the concrete, so long as the mixture is plastic and workable. Some concrete jobs must be stronger and more watertight than others; for such concrete use less water. Generally, the less ______ the better the concrete.
water	34. The recommended amounts of water per bag of cement are as follows: a. 32 litres of water for each bag of cement for such jobs as watertight floors, watertight foundations, and water tanks. b. 37 litres of water for each bag of cement for ordinary foundation walls and footings. The 32 litre mix is also suitable for foundation walls and footings but the 37 litre mix is somewhat more economical. By reducing the the concrete becomes more waterproof.

35. Most concrete mixers used on small jobs do not hold a full one-bag batch. It is therefore necessary to use 1/2, 1/3, 1/4 or some other fraction of a bag per batch. The amount of water used per batch should be figured accordingly.

36. Most fine aggregate contains some water and allowance should be made for this water in determining the amount to be added to the mix. Otherwise the mix will contain more than the correct amount of water to get the quality of concrete desired.

The _______ in the fine aggregate must be allowed for when making concrete.

water

37. Table 1 shows how much water to add per batch of cement to obtain a 32- or 37-litre mix according to the moisture content of the sand.

Mix	When sand is:		
	Damp	Wet	Very Wet
32 l. per bag of cement	30 l.	28 l.	24 l.
37 l. per bag of cement	34 l.	30 l.	27 l.

How much water should be mixed with 1 bag of cement when wet sand is being used to construct a water tank?

28 litres

38. Table 2 shows the proportion of water to cement by measured volume. This information may be more useful when less than a full-bag batch is being mixed.

For	When sand is:		
	Damp	Wet	Very Wet
32 l. mix	3/4 vol. water to 1 vol. cement	2/3 vol. water to 1 vol. cement	7/12 vol. water to 1 vol. cement
37 l. mix	5/6 vol. water to 1 vol. cement	3/4 vol. water to 1 vol. cement	2/3 vol. water to 1 vol. cement

How many volumes of water should be used to 1 volume of cement when using damp sand to construct an ordinary footing?

5/6 volume

39. Recognizing moisture content of sand. It is important to learn to recognize sand that is dry, damp, wet, or very wet, in order to judge the amount of water to add to the mix as suggested in Table 1. The following demonstration will help you learn this.

Demonstration 1. Preparing samples of sand with known moisture content.

A. Materials needed:
   1. Sand
   2. Three litre jars
   3. Measuring cup
   4. Water
   5. Three mixing pans

B. Steps to follow:
   1. Spread about 4 litres of sand on a clean floor, paper, or canvas and allow to dry thoroughly at room temperature. Stir occasionally and continue drying until sand will flow freely.
   2. Fill the three jars level full with dry sand. Then pour the contents of each jar into a separate pan.
   3. Add 70 millilitres of water to pan A, 140 millilitres to pan B, and 210 millilitres to pan C, mixing each thoroughly.
   4. Handle and examine the sand in the three pans until you can easily recognize the difference in moisture content. The three samples should handle as follows:

      Pan A - Damp sand - feels slightly damp to the touch but leaves very little moisture on the hands.

      Pan B - Wet sand - feels wet and forms a ball when squeezed. It leaves some moisture on the hands.

      Pan C - Very wet sand - dripping wet and sparkles. It leaves more moisture on the hands than wet sand.

   5. Save the material for the next demonstration.

Wet damp dry very wet	40. ________ sand feels wet and forms a ball when squeezed. ________ sand feels slightly damp but leaves no moisture on the hands. ________ sand feels neither damp nor wet. ________ sand is dripping wet.
water	41. It is important to be able to determine the moisture content of sand so that the correct amount of ________ can be used in making concrete.

bulking	42. When moisture is added to dry sand, films of water are formed on the surfaces of the particles, fluffing them apart. This causes an increase in the volume, even greater than the volume of water added. The increase in the volume of sand caused by water is called b_________.
volume	43. So a given volume of damp sand is the equivalent of a much smaller volume of dry sand. This bulking increases rapidly with increases in moisture content up to about 5 percent by weight of moisture. At this point bulking may be as much as 20 to 30 percent (fig. 3). A small increase in moisture content can cause sand to increase as much as 20 to 30 percent in v_________.

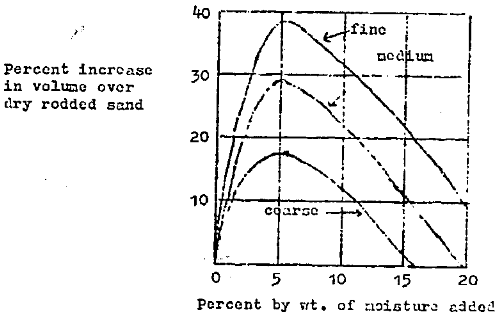

Fig. 3. Sand bulks considerably with a small amount of moisture.

water	44. Further additions of water tend to flood or pack the sand, decreasing the amount of bulking. When sand is completely covered with water, its volume is about the same as when measured dry and loose. Bulking of sand is reduced when the _________ content increases beyond 5 percent.
fine	45. The finer the sand, the more it will bulk for a given moisture content. The size of the measure and the method of filling also affect bulking and should be taken into consideration for each job. Coarse aggregates do not bulk noticeably by the addition of water. Bulking occurs with f_________ aggregates.

bulking	46. Allowance must be made for bulking. Failure to allow for this bulking not only increases the cost of the concrete but affects the mixture, making undersanded mixes which are harsh and difficult to place. B________ must be allowed for when making concrete.
sand	47. This means that 1 cubic metre of dry sand occupies 1.26 cubic metres in the damp condition. Therefore, 1 cubic metre of damp sand contains 1/1.29 or about .78 cubic metre of dry sand. Bulking means that a certain volume of damp sand actually contains a lower amount of dry ________.
bulking	48. If the mix is to be measured 1:2:4 by volume and no correction is made for bulking, instead of 2 parts sand, the mix will contain only about 1.5 parts sand in dry condition. This reduction in the ratio of sand causes a reduction in the quantity of concrete produced with each sack of Portland cement and in most cases will not make a good workable mixture. A knowledge of b______ is necessary in order to make good quality concrete.
	Demonstration 2. Noting the effect of moisture on bulking sand. A. Materials needed: 1. Sand used in the preceding demonstration. 2. Water b. Steps to follow: 1. Refill each of the three jars with the sand that has had water added to it. Note that the sand has bulked and all of it cannot be returned to the jar. Also note the amount of bulking with different amounts of moisture added. 2. Take any of the jars of sand and fill it with water. Now take the surplus sand from that lot and put it in the jar. The jar holds as much saturated sand as it did dry sand. The volume of the sand, if measured when damp, wet, or very wet, is therefore greater than the volume the sand will occupy when it is in the concrete mix.
bulking	49. B________ of sand is a factor in measuring the volume needed for making concrete, it is not a factor once the sand is in the concrete mix.

thin	50. A workable concrete mixture is one that is smooth and plastic and that will place and finish well. It should not be so thin that it runs nor so stiff that it crumbles. It should be rather sticky when worked with a shovel or trowel. For most jobs a workable mix is one that is "mushy" but not "soupy". A concrete mixture that runs is too ______.
water	51. The first step, as already indicated, is to determine the correct amount of water to use per bag of cement to produce a concrete that will withstand the weathering elements and the service to which the concrete will be subjected in use. The first step in making concrete is to determine the amount of ______ to use per bag of cement.
water	52. This proportion of water to cement should not be changed as it controls the strength, durability, watertightness, and other desirable qualities of the concrete. The quality of the concrete depends greatly on the proportion of ______ to cement in the mixture.
coarse fine	53. The second step is to proportion the fine and coarse aggregates in such a way that the finer particles will fill the voids between the larger ones. This is most easily done when the aggregates are separated into two sizes - fine and coarse. The two sizes of aggregates for making concrete are ______ and ______.
coarse	54. Use as much coarse aggregate as possible without making the mixture harsh and hard to work. This is done to save cement paste as it requires less paste to cover the surfaces of large particles having the same volume (fig. 4). As much ______ aggregate as possible should be used.

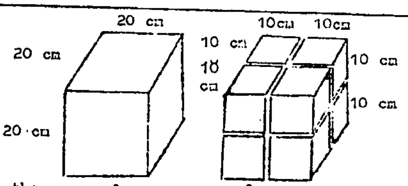

Fig. 4. These two figures have the same volume, but the 8 small blocks on the right have twice the surface area of the large block on the left.

dry	55. Usual proportion of fine and coarse aggregates on the dry basis for workable mixtures (used with 1 part cement) are: for 32-litre mixture 2¼ parts sand to 3 parts coarse aggregate for 37-litre mixture 2¼ parts sand to 4 parts coarse aggregate The proportion of fine and coarse aggregates are determined on a _____ basis.
water cement	56. If the proportions suggested do not make a workable mixture in the first or trial batch, change the proportion of fine and coarse aggregate slightly but do not change the amount of cement and water. Never change the amount of _____ and _____ when adjusting a cement mixture.
- -	57. When using bank-run aggregates or another in which the fine and coarse aggregates are already mixed, the steps in preparing a workable mixture are the same as those for using separated aggregates except that you add the aggregate mixture to the mix until a plastic, mushy mixture is obtained.
trial	58. The amount of bank-run or other combined aggregate added in the trial batch will be the basis for determining the amount to add in succeeding batches. The amount of combined aggregate to add to a concrete mixture is determined by a _______ batch.
- -	59. In using a mixture that contains both fine and coarse aggregate (such as bank-run gravel), remember that the fine aggregate is largely carried in the void spaces between the particles of coarse aggregate. For example, ½ cubic metre of fine aggregates plus 1 cubic metre of course aggregate would probably result in a volume of only a little more than 1 cubic metre when combined together.
Portland cement water fine aggregate coarse aggregate	60. Most gravel banks contain an excess of sand in proportion to coarse material. This does not make the most economical mixture for concrete work, largely because more cement paste is required to cover the surface area of fine particles. These particles must be covered by ________ to produce a high quality concrete. The ingredients of concrete are: __________, ________, ____________, and ___________.

The information in this unit was taken from the University of Illinois VAS unit 3007.

Name ____________________ Form _____
Date

TEST

Making and Using Concrete on the Farm, Part I

UNDERLINE THE CORRECT ANSWER

1. Two of the ingrediants of concrete are _____ and _____. (Choose 2 answers.)
   - a. organic matter
   - b. Portland cement
   - c. silt
   - d. straw
   - e. water
2. A fine aggregate is one whose particles are no larger than _____ in diameter.
   - a. 1 millimetre
   - b. 6 millimetres
   - c. 20 millimetres
   - d. 30 millimetres
   - e. 50 millimetres
3. _______ is commonly used as a fine aggregate in concrete.
   - a. Cement
   - b. Clinker
   - c. Gravel
   - d. Sand
   - e. Silt
4. Portland cement that contains very hard lumps ____________________.
   - a. can be used as usual
   - b. should not be used
   - c. should be used only for foundations
   - d. should be placed in water overnight
   - e. should be used only for water tanks
5. Dirt in concrete ________________.
   - a. decreases its hardening time
   - b. helps fill the spaces between the aggregates
   - c. increases its strength
   - d. lowers its quality
   - e. makes it more waterproof
6. The largest particles of coarse aggregate should not be more than ______ the thickness of the concrete being placed.
   - a. 1/10
   - b. 1/3
   - c. 1/2
   - d. 2/3
   - e. 9/10
7. A ______ test is run to determine if the aggregate contains too much extremely fine material.
   - a. dirt
   - b. pH
   - c. sand
   - d. silt
   - e. water
8. Water for making concrete should ____________.
   - a. have an acid reaction
   - b. be boiled
   - c. be clean enough to drink
   - d. come only from wells
   - e. contain some oil
9. A bag of Portland cement contains _______ kilograms of cement.
   - a. 25
   - b. 40
   - c. 50
   - d. 56
   - e. 60

10. Portland cement is made from ________________.

a. clay and sand
b. granite and shale
c. limestone and clay
d. Portland chalk and limestone
e. shale and limestone

11. ________ is commonly used as a coarse aggregate in concrete.

a. clay
b. crushed stone
c. organic matter
d. sand
e. silt

12. Strength, durability, and watertightness of concrete are determined by the amount of ________ used per bag of cement.

a. cement paste
b. coarse aggregate
c. fine aggregate
d. stones
e. water

13. The first step in preparing a workable concrete mixture is to determine the correct ____________.

a. cement-aggregate proportion
b. fine aggregate-coarse aggregate proportion
c. water-aggregate proportion
d. water-cement proportion
e. mixing time

14. The recommended amount of water to use to make watertight concrete is ______ litres per bag of cement.

a. 20
b. 25
c. 32
d. 37
e. 45

15. The recommended amount of water to use for making ordinary concrete is ________ litres per bag of cement.

a. 20
b. 25
c. 32
d. 37
e. 45

16. When using wet sand, the amount of water added to the concrete mixture must ________.

a. be bulked
b. be increased
c. be reduced
d. remain the same

17. Dirt may be removed from the fine aggregate by ____________.

a. filtering
b. screening
c. testing
d. washing
e. winnowing

18. Concrete is a good farm building material because it is ________________.

a. combustible and light weight.
b. expensive and insect proof
c. insect proof and light weight
d. permanent and insect proof
e. porous to water and permanent

TUMAINI SECONDARY SCHOOL

MAKING AND USING CONCRETE ON THE FARM
PART II

This is the second of three programmed instruction units in making and using concrete on the farm.

In this unit you are to learn:

1. procedures for mixing concrete by hand and by machine.
2. making and shaping of forms.
3. proper placing of concrete.
4. concrete finishing.
5. concrete curing.
6. reinforcement of concrete.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Making and using concrete on the farm, Part II

If you have not read the cover page, do so now, then proceed to frame 1.

-cut-

-cut-

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Making and using concrete on the farm, Part II continued

- Cut -

- Cut -

Name ____________________ Form ________

66. ____________

67. ____________

68. ____________

69. ____________

70. - -

71. ____________

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72. ____________

73. ____________

____

74. - -

75. ____________

76. ____________

77. ____________

78. ____________

concrete	1. It is important to mix concrete thoroughly. Continue mixing until the cement paste (cement and water) completely covers every particle of aggregate and fills the voids between them. ________ must be thoroughly mixed to be of high quality.
cement paste	2. Hasty or incomplete mixing will result in concrete that is not of uniform high quality. The concrete must be mixed so that the c____ p______ covers every particle of aggregate.
sand cement	3. Concrete can be mixed by hand in small quantities. To hand mix, place the measured amount of sand on a watertight mixing platform. Spread the cement evenly over the sand and turn the two materials with a shovel until a uniform colour shows that the sand and cement are thoroughly mixed together. The first step in making concrete by hand is to mix the ________ and _______ together.
coarse aggregate	4. Then spread this mixture out evenly and add the measured amount of coarse aggregate. Mix thoroughly again. After mixing the sand and cement, the __________ is added and thoroughly mixed in.
water	5. Then form a hollow in the material and slowly add the measured quantity of water. Continue mixing until every particle has been completely covered with cement paste. __________ is the final ingrediant added when mixing concrete by hand.
mixed	6. A machine mixer of the drum type is commonly used for mixing concrete. It is usually powered by an engine, tractor, or electric motor. It should turn at a speed slow enough to allow the materials time to fall away from the top of the drum as it revolves. A concrete mixer must turn slow enough to enable the ingrediants to be properly __________.

cement fine aggregate coarse aggregate	7. The typical small concrete mixer is the ½-bag batch size. This means that it will hold the amount of concrete that can be mixed using half a bag of cement. The next nine frames contain the steps suggested in making a ½-bag batch of 1:2¼:3 concrete mixture, 32 litres of water per bag of cement. 1:2¼:3 means 1 part ________, 2¼ parts ________, and 3 parts ________.
water	8. Step 1. Mark a water bucket to be used as a water measure. If the sand is wet, 27 litres of water will be used per bag of cement to obtain the 32 litre mix, as previously indicated. For the ½-bag batch mark the bucket at the 16 litre level. A bucket should be marked at the correct level to make it easy to measure the ________ while mixing concrete.
cement	9. Step 2. Divide a bag of cement equally in two 25 litre buckets. Mark one bucket at the ½ bag level. A c________ measure is also needed.
sand coarse aggregate	10. Step 3. Using the marked cement bucket, count the number of shovels of sand required to fill the bucket to 1-1/8 times the capacity to the cement line. Count the number of shovels of coarse aggregate required to fill the bucket to 1½ times the capacity to the cement line. The amounts of s________ and c______ a______ by shovelsful, is determined by counting the number of shovelsful needed to obtain the right cement-sand-coarse aggregate ratio.
water	11. Step 4. Start the mixer and pour in 16 litres of water. ________ is the first ingredient added when mixing concrete by machine.
coarse aggregate cement	12. Step 5. Put in 2 or 3 shovelsful of coarse aggregate followed by the measured amount (½ bag) of cement. The coarse aggregate helps to prevent the cement from sticking to the sides of the mixer. After the water is put into the mixer, some ______ is added and then the ________ is put in.

sand coarse aggregate	13. Step 6. Place the counted number of shovelsful of sand in the mixer. Then add the remaining shovelsful of coarse aggregate. Following the water, part of the coarse aggregate, and cement; the __________ and the remaining __________ are put into the mixer.
1 to 2	14. Step 7. Allow the mixer to run for 1 to 2 minutes after all ingrediants have been added to secure thorough mixing. The mixer should run for ______ minutes after all ingrediants have been added.
consistency	15. Step 8. Observe the consistency of the mix carefully as it is dumped from the mixer to see that it is mushy and workable. The _______ of the mix must be observed as the concrete comes from the mixer.
aggregate cement water	16. Step 9. After this first or trial batch has been made, amounts of aggregate can be changed for succeeding batches if necessary to change the consistency of the mix. The amounts of cement and water, however, should remain the same. To change the consistency of the mix, adjust the amount of ____________. Never adjust the amount of _______ or __________.
forms	17. Forms are the molds or receptacles into which the concrete mixture is placed so that it will have the desired shape when hardened. Concrete, being plastic at the time of mixing, can be molded into almost any desired shape. The degree of success obtained depends largely on the forms used. Concrete is placed in ______ to harden.
substantial (strong)	18. Forms must be substantial enough to retain their correct shape when filled. Freshly mixed concrete exerts great pressure. Concrete forms must be s________.

19. It is not sufficient that forms be strong; they must also be rigid (fig. 1). It may be almost as serious if forms bulge badly from the pressure as if they actually break.

Concrete forms must be strong and r________.

rigid

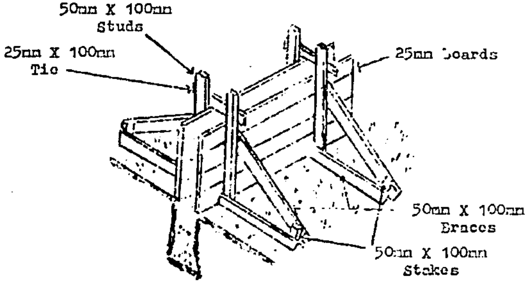

Fig. 1. Forms should be tight, rigidly fastened, and well braced.

20. Forms should be tight to prevent the escape of the water-cement paste which will change the character of the remaining mixture.

The ____________ should not be allowed to escape from the forms.

water-cement paste

21. Forms should be easily filled and easily removed after the concrete has hardered. Double-headed nails or screws which can be easily withdrawn will greatly assist in removing forms without damaging the new concrete.

Forms should be easy to f_____ and r_______.

fill
remove

22. Forms may be made of wood, metal, or special manufactured products. Where lumber is used for forms, it should be sound and free from knotholes or decay.

________ can be made from wood, metal, or other material.

forms

forms	23. Tight joints can be obtained by using matched lumber, such as shiplap or tongue-and-grooved stock. For foundation walls, this lumber is often used again for roof sheathing or some similar purpose. Lumber used for ______ can be reused later in other parts of the construction.
	24. The sizes of lumber commonly used for forms are: 25mm stock for floor, foundation, and wall forms, columns, and beam sides; 50mm for beam bottoms and heavy concrete construction; 50mm X 100mm stock for studs, column yokes, and framing for panels; 50mm X 150mm or 50mm X 200mm stock for stringers, wales, and joists; 75mm X 100mm or 100mm X 100mm stock for posts, struts, shores, and sometimes for stringers; 25mm X 100mm stock for cleats; and 25mm X 150mm stock for crossties and similar bracing.
plywood panels	25. For extra smooth walls, plywood panels are often used, particularly when they can be used repeatedly. Exterior plywood which is made with waterproof glue should be chosen for this purpose. P______ p______ can be used for forms when smooth walls are desired.
concrete	26. Steel, cast iron, and other metals make excellent forms for concrete and are used extensively by contractors. Metal units can be assembled in a variety of shapes for special purposes. Metal forms are very durable and the cost of the form per unit constructed decreases with the number of times used. Metal is a good material for making c______ forms.
spacers	27. After the forms are made be sure they are well braced in position, level and plumb. Wood spacers are often used for walls to hold opposite form faces the right distance apart. Form walls are held the correct distance apart by s______.
Wires	28. Use wire ties, passed through or around form studs and across the space between forms, to tighten the forms against the spacers and hold them true so the finished wall will be straight and uniform in thickness. W______ are used to tighten the forms against the spacers.

concrete	29. Tighten the wire ties by twisting inside the forms. Remove the spacers as filling progresses and the pressure of the concrete will hold the wires tight. The spacers are removed as the _______ is placed in the forms.
spacers	30. For exposed work, many builders use special spreader ties instead of wires and wood spacer blocks. After the forms are removed, these tie rods are broken off about 25mm back in the concrete and the holes patched with a Portland-cement mortar. Special metal rods are sometimes used as s_________.
white	31. To prevent the patched areas from appearing darker than the wall, use white Portland cement to replace ¼ to ½ of the regular cement used in patching. Patches in concrete can be made less noticable by using _______ Portland cement.
1 to 2 7	32. Wall forms can generally be stripped (removed) after 1 or 2 days, in warm weather. Forms for floors, roofs, and other similar construction should be left in place for at least 7 days. Forms must never be removed until it is certain that the concrete has hardened enough to be self-sustaining. Wall forms can be removed after _______ days, but floor forms must be left for at least _______ days.
oil	33. To prevent concrete from sticking to the forms and to make form removal easy, it is customary to oil form faces that come in contact with concrete. _________ is put on forms to make them easy to remove.
kerosene	34. A light, clear lubricating oil is suitable for this purpose. For easy brushing, cut the oil with about an equal amount of kerosene. Clean and oil the forms each time they are used. Mixing an equal amount of _____ with the oil makes it easy to apply.

oiled	35. Dry, untreated forms will absorb water from the concrete. Often leaving the surface too dry for best results. Forms may also warp badly if not oiled. O____ forms usually result in higher quality concrete.
water	36. If concrete slabs are built over a dirt or sand bottom, thoroughly soak the surface with water before the concrete is placed. Otherwise this dry material may absorb so much water from the concrete mix that the quality of the finished product will be impaired. Soil and sand which come in contact with concrete should be soaked with ________ before placing the concrete.
wheelbarrows	37. On small jobs concrete is usually transported from the mixer to the forms in wheelbarrows. On larger jobs buggies and chutes are commonly used. __________ are usually used to transport concrete on small jobs.
transported	38. Whatever method is used for transport, care should be taken to prevent separation of coarse from fine particles. Such separation is likely to occur when concrete is transported over rough ground or runways, particularly if the mixture is too sloppy. Separation of coarse and fine particles must be prevented when the concrete mix is __________.
forms	39. Deposit the concrete in level layers in the forms, tamping and spading just enough to make it settle thoroughly and produce a dense mass. Spading the concrete next to the forms insures a smooth, dense surface when forms are removed. Concrete should not be overworked after being placed in the __________.
forms	40. It is just as important to prevent separation of materials in the forms as it is in transporting concrete from the mixer to the forms. Deposit the concrete uniformly around the forms where it is to be used rather than placing it at a few points and dragging or causing it to flow where needed. The concrete mix should be placed in the ________ at the place it is to be used.

worked	41. Use extra care in working the material into corners and angles of forms and in reinforced work, around the reinforcement. Avoid excessive working of freshly placed concrete as this promotes separation and will bring water to the tops of the forms. Freshly placed concrete should not be excessively ______.
thin	42. If water begins to accumulate on top of the concrete in the normal process of filling, it may be necessary to use a stiffer mixture. Change consistency by varying the amount of aggregates, not the water. The concrete mixture is too t______ if water accumulates on top while filling forms.
forms	43. When the forms are full, strike off the surface level with the top edges of the forms with a sawing motion of a straight strike board. The top surface of the concrete is struck off level with the top edges of the ______________.
roughen	44. At the end of the days's run or where the work has to stop long enough for the concrete to begin hardening, roughen the top surface just before it hardens to provide a good bond for the next layer of concrete. To create a good bond between layers of concrete, __________ the top surface of the first layer just before it hardens.
cement-water	45. Just before starting again, clean the roughened surface and then brush with a cement-water paste of a thick, creamy consistency. Before placing the new layer, the roughened surface of the previous layer is brushed with a ___________ paste.
- -	46. Apply this just ahead of the concreting operation so that it does not have a chance to dry before it is covered with concrete. This precaution to get a good bond between different layers of concrete is very important wherever the concrete construction is to be watertight.

sparingly	47. There are several methods of finsihing a concrete surface and the method used will depend on the use to which the concrete is to be put. In any event, the surface should be worked sparingly during and immediately after placing. Concrete should be worked s________ during and immediately after placing.
strike board	48. This usually means a reasonable amount of spading along the sides of the forms and once or twice over with the strike board to level the surface with the top of the forms. Do not use the steel trowel at all at this stage. The surface of freshly placed concrete is leveled with a s____ b________.
wood float	49. After the surface has become fairly stiff and beyond the point where separation of water and other ingrediants will take place, it should be worked with a wood float. A float can be made from a piece of 25mm by 150mm board with a handle like a trowel (fig. 2). A w___ f______ is used to work the surface of the concrete after it is fairly stiff.

Fig. 2. A wood float can be purchased or built from a 25mm X 150mm board.

wood float	50. Use the float to further level the surface and remove any unevenness left by the strike board. A long handle on the float makes it useful for the first finishing operation on a floor or other large surface before the concrete is hard enough to get out on, even with kneeling boards. The __________ is used to level the surface and remove unevenness left by the strike board.
water	51. If water appears on the surface of the concrete, it is best to allow it to evaporate before finishing. If there is considerable water, remove it with a broom, float, or other convienient means. Concrete should not be worked if there is _______ standing on the surface.

cement	52. It is never a good practice to sprinkle dry cement or a mixture of dry cement and fine aggregate on fresh concrete to take up surface water. These materials only form a layer on the surface that is likely to dust, hair check, or peel off after the concrete hardens. Surface water on concrete should never be taken up by putting dry ______ on it.
broom wood float	53. For livestock floors, paved yards, driveways, sidewalks and other work where a non-skid surface is required, the final finish may be put on with the wood float or a broom. Broom strokes should be in the direction of the slope. A non-skid finish may be put on concrete with a ________ or ____________.
non-skid	54. For sidewalks and porch steps a hair broom finish is most satisfactory. This brooming operation is performed after the surface has been steel troweled once. Varying degrees of roughness can be provided by varying the time between the steel troweling and brooming or by varying the coarseness of the fibre in the broom. A broom is used to make the concrete surface n____-s_____.
steel	55. For a smooth finish such as is required for feed mangers, poultry house floors and dairy barn gutters; follow the wood float with a steel trowel after the surface has become quite stiff. A ________ trowel is used to obtain a smooth finish.
temperature	56. In extremely hot weather, steel troweling may be started withing the hour after the concrete is placed. In cool weather, several hours may be required before troweling begins. The time to begin steel troweling depends on the t______.
stiff	57. To secure a smooth, dense surface on concrete, at least twice over with the steel trowel is required. However, use the steel trowel sparingly until the concrete has become quite stiff. The concrete should be quite s______ before the steel trowel is used.

Portland cement water	58. Proper curing of concrete is necessary for obtaining strength, durability, and watertightness. Concrete hardens because of a chemical reaction between Portland cement and water. Concrete hardens due to a chemical reaction between ________ and ________.
temperature moisture	59. Hardening continues as long as temperatures are favorable and moisture is present to hydrate the cement. Moist curing greatly increases the strength of concrete. Proper hardening of concrete requires the proper t________ and m________ conditions.
damp-cured	60. Tests show that concrete which is damp-cured for 7 days is about 50 percent stronger than similar concrete which is permitted to dry out. Concrete damp-cured for 1 month is about 100 percent stronger than similar concrete kept in dry air. Concrete is stronger if it is d____-c________.
damp-cured	61. Thorough damp-curing aids in producing watertight concrete. As the cement paste in concrete hardens, additional solid matter is formed which closes off the space between the cement particles through which water might otherwise seep. Concrete that is to be watertight should be ________.
dense	62. The more complete the hydration, the denser and more watertight the cement paste becomes. Damp-during helps to make the concrete d______.
wearing	63. It is very important to damp-cure floors, pavements, and other surfaces subject to wear because damp-curing produces a harder wearing surface. Continuous damp-curing particularly in the early stages of hardening, helps to make a hard dense surface and to prevent checking and dusting. Damp-curing helps to produce a hard w________ surface.

moist (damp) (wet)	64. Some common methods used in curing concrete are to cover the concrete with straw, sand, wet burlap, canvas, or heavy paper as soon as it can be done without marring the surface. The covering must be kept continuously wet by sprinkling. Concrete is covered to keep it __________.
water	65. The same result can be obtained without covering if the surface can be flooded with water. In some cases it is possible to build small earth dikes to hold the water on the surface. Concrete can be cured by keeping it covered with w______.
7	66. Walls and other vertical surfaces can be protected by leaving the forms in place temporarily, or by hanging burlap or canvas over them. Keep these coverings constantly moist by sprinkling. Curing should continue for at least 7 days, and for longer periods when practical. Concrete should be cured for at least _____ days.
reinforcement	67. Reinforcement is the term used to describe the steel bars or mesh placed in concrete, usually to increase its tensile strength. Steel bars placed in concrete are called __________.
Reinforcement	68. Concrete is a material which is very strong in compression, that is, in resisting loads that are placed directly upon it. However, steel bars or other metal reinforcement in some structures will greatly increase its resistance to stresses or forces that tend to bend or pull it apart. R__________ increases the resistance of concrete to bending and pulling stresses.
Reinforcing	69. In a simple beam, such as a concrete lintel over a window or door opening, where the forces applied are primarily in a downward direction, the upper half of the beam is in compression and the lower half is in tension. Therefore the reinforcing steel should be placed in the lower half of the beam. ____________ in simple beams should be placed in the lower half of the beam.

	70. Long beams, such as those supporting large floors and extending continuously over a number of columns or other supports, may be subject to negative bending, or tension on the upper side of the supports.
upper lower	71. In this case, reinforcement is placed in the upper portion to carry these tensile stresses. Reinforcement is also placed in the lower portion of the beam to take care of tensile stresses occurring in the beam between supports. Long beams need to be reinforced in both the u______ and l______ portions.
reinforcement	72. Reinforcement may also be used in walls and floors to prevent cracking of the concrete from expansion due to temperature changes. In extreme cases, the reinforcement may not prevent shrinkage cracks from appearing but will keep the surface faces from shifting or separating. Cracking of floors and walls may be prevented by using ____________.
overlap wired	73. Reinforcing bars should overlap each other and be wired securely together at each joint (fig. 3). Reinforcing bars should o________ and be w________ together.

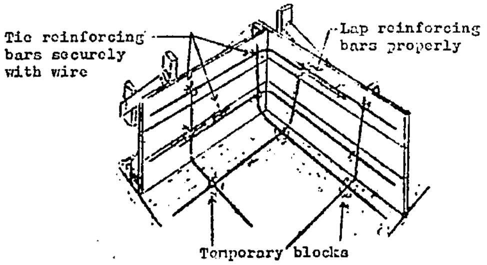

Fig. 3. Reinforcing bars should be bent around corners, lapped, and wired securely together.

- -	74. Determining the size, type, and spacing of reinforcing steel for a particular concrete structure is a problem for the design engineer. Specifications on plans and blueprints should be followed closely in farm concrete construction.
clean	75. The following general rules for the use of reinforcing concrete are important: a. Use only clean reinforcing rods or mesh, free from rust, paint, or scale. (Old fence, scrap iron, etc., are not satisfactory.) Reinforcing metal must be c ________.
20	76. b. Place steel no closer than 20mm from exposed surfaces. c. Limit size of aggregates to ¾ the size of the smallest openings between reinforcing members. Steel reinforcing should be placed no closer than ________mm from concrete surfaces.
48	77. d. Lap reinforcing rods 48 times their diameter (10mm rods should be lapped 480mm and wired together). Reinforcing rods are lapped ______ times their diameter when they are joined together.
tension	78. c. Study the structure and place the reinforcement where there is likely to be tension. Reinforcement should be placed where ________ is likely to occur.

The information in this unit was taken from the University of Illinois VAS unit 3007.

Name ________________ Form ______
Date ____________

TEST

Making and Using Concrete on the Farm, Part II

UNDERLINE THE CORRECT ANSWER

1. When mixing concrete by hand, the first step is to mix the ______ together.
   - a. sand and coarse aggregate
   - b. sand and cement
   - c. sand and water
   - d. coarse aggregate and sand
   - e. water and cement
2. When mixing concrete by machine the first ingrediant placed in the machine is __________.
   - a. cement
   - b. coarse aggregate
   - c. concrete
   - d. sand
   - e. water
3. If the consistency of machine mixed concrete is not correct, then the amount of ________ in the mixture should be changed.
   - a. aggregate
   - b. cement
   - c. concrete
   - d. reinforcement
   - e. water
4. Concrete must be mixed until every particle is covered with ________.
   - a. cement
   - b. cement paste
   - c. coarse aggregate
   - d. sand
   - e. water
5. Forms are used to hold concrete while it _________.
   - a. hardens
   - b. is made watertight
   - c. is made firesafe
   - d. is mixed
   - e. is reinforced
6. Concrete forms should be tight to prevent the escape of the ________.
   - a. aggregate
   - b. cement
   - c. cement paste
   - d. sand
   - e. water
7. Concrete forms for floors and roofs should be left in place for at least _______ days after placing the concrete.
   - a. 2
   - b. 4
   - c. 7
   - d. 10
   - e. 12
8. Before placing concrete on a dirt bottom, the dirt should be ________.
   - a. covered with cloth
   - b. covered with paper
   - c. covered with sand
   - d. dried completely
   - e. soaked with water
9. Care must be taken when transporting concrete to prevent _________.
   - a. excessive mixing
   - b. separation of coarse from fine particles
   - c. the cement paste from disappearing
   - d. the concrete mixture from becoming too sloppy
   - e. the reinforcement from settling out

10. When joining new concrete to old, the old surface should be brushed with ________ before placing the new concrete.
    a. cement
    b. cement-water paste
    c. paint
    d. petrol
    e. water

11. To finish the surface of concrete it should first be worked with ________.
    a. a broom
    b. a shovel
    c. a steel trowel
    d. the hands
    e. a wood float

12. When finishing concrete, water which appears on the surface should be ______.
    a. allowed to evaporate
    b. ignored
    c. removed by sprinkling with dry cement
    d. removed by sprinkling with dry sand
    e. removed by sprinkling with a mixture of cement and sand

13. Non-skid surfaces for livestock floors and sidewalks can be made by using a ________ to finish the surface.
    a. broom
    b. rake
    c. shovel
    d. steel trowel
    e. tree branch

14. A smooth concrete surface is obtained by using a ______ to finish the surface.
    a. broom
    b. form
    c. shovel
    d. steel trowel
    e. wood float

15. Proper curing of concrete occurs when it is kept __________.
    a. cool
    b. covered
    c. damp
    d. dark
    e. hot

16. Curing should continue for at least ___________.
    a. 2 days
    b. 7 days
    c. 2 weeks
    d. 3 weeks
    e. 1 month

17. Reinforcement should come no closer than ______ to any exposed surface.
    a. 5 millimetres
    b. 10 millimetres
    c. 20 millimetres
    d. 30 millimetres
    e. 50 millimetres

18. Reinforcing rods 10 millimetres in diameter should be lapped ____ at joints.
    a. 10 millimetres
    b. 24 millimetres
    c. 48 millimetres
    d. 76 millimetres
    e. 100 millimetres

19. The form faces can be ______ to prevent concrete from sticking to them.
    a. disinfected
    b. oiled
    c. painted
    d. reinforced
    e. soaked in water

TUMAINI SECONDARY SCHOOL

MAKING AND USING CONCRETE ON THE FARM
PART III

This is the third of three programmed instruction units in making and using concrete on the farm

In this unit you are to learn:

1. to determine the amount of concrete needed.
2. to determine the amount of materials needed for concrete jobs.
3. to determine the cost of concrete.

Instructions

You are provided with a program and a combination answer sheet and mask to cover the answers.

1. Place the mask (answer sheet) over the answer in a way that exposes one question (frame) at a time.
2. Write your answer on the answer sheet.
3. Move the answer sheet down to expose the next frame and answer to the previous frame.
4. Should your answer be wrong, write the correct answer above or along side - do not erase your incorrect answer.

Making and using concrete on the farm, part III.

If you have not read the cover page, do so now, then proceed to frame 1.

cut

-cut-

Name ____________________ Form ________

1. - -
2. ____________
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30. ____________
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31. ____ ____ ____
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35. - -
36. - -
37. - -
38. ____________
    ____
    ____
    ____

- -	1. It is important to know how to estimate the amounts and costs of materials needed for a given concrete job.
amounts costs	2. Knowing the amounts of materials needed makes it possible to have the right amounts of materials on hand for the job. When we know what the cost of a particular job will be we can compare it to the cost of alternate methods of construction. The ability to estimate the a______ and c______ of materials needed for a job is important.
volume	3. The first step in estimating the amount of materials needed is to calculate the volume of concrete needed for the job. The v________ of concrete needed is the first step.
1,000	4. It is customary to specify the volume of concrete in cubic metres. One cubic metre equals 1,000 cubic decimetres or 1,000,000 cubic centimetres. There are ________ cubic decimetres in one cubic metre.
length width height	5. The volume is estimated by multiplying the length X width X height of the job. The result is expressed in cubic metres. Volume is calculated by multiplying the ________ X ________ X ________.
- -	6. Example 1: How much concrete is needed for the footings and walls of the building in figure 1? The building is 10 metres X 6 metres and the footing is 20 centimetres thick (high) and 40 centimetres wide. The walls are 20 centimetres thick (wide) and 60 centimetres high.

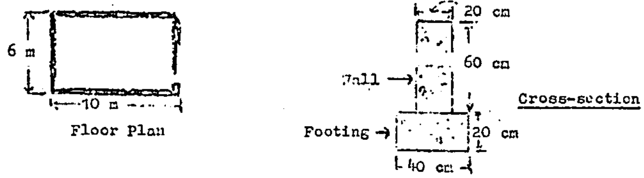

Fig. 1. Floor plan and cross-section of foundation for a building.

- -	7. First calculate the volume of the footing. Width X Height X Length 40 cm X 20 cm X 32 m .4 m X .2 m X 32 m = 2.56 cubic metres Remember, the length is the total length of the footing; here the four walls are 6 metres + 10 metres + 6 metres + 10 metres for a total length of 32 metres. Also when multiplying, the measurements must be expressed in similar units so the 40 centimetres width is changed to .4 metres and the 20 cm. height is changed to .2 metres.
width heigth length	8. Secondly calculate the volume of the walls. Width X Height X Length 20 cm X 60 cm X 32 m .2 m X .6 m X 32 m = 3.84 cubic metre Volume is calculated by multiplying ________, ________, and ________.
6.40	9. Third; to calculate the total volume needed for both the footings and walls, as the problem requests, add the volumes of each one together. volume of footing = 2.56 cubic metres volume of wall = 3.84 cubic metres Total = 6.40 cubic metres The volume of concrete needed for the walls and footings in this problem is ________ cubic metres.
- -	10. Example 2: How much concrete is needed for the floor of the building in figure 1 if it is 10 centimetres thick? Width X Height X Length 6 m X 10 cm X 10 m 6 m X .1 m X 10 m = 6 cubic metres
12.4 cubic metres	11.. The total volume of concrete needed for the footings, walls, and floor of this building is calculated by adding together the individual volumes for each of them. Footing + Wall + Floor = Total 2.56 cu m . + 3.84 cu m + 6 cu m = ________ cu m

	12. Now, for practice, estimate the volume of concrete needed for the building shown in figure 2.

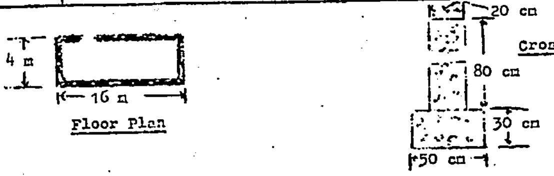

Fig. 2. Floor plan and cross-section of foundation for a building.

.5 metre .3 metre 40 metres 6 cubic metres	13. The volume of the footing is: Width X Height X Length _____ X _____ X _____ = _______
.2 metre .8 metre 40 metres 6.4 cubic metres	14. The volume of the walls is: Width X Height X Length _____ X _____ X _____ = _______
4 metres .14 metre 16 metres 8.96 cubic metres	15. The volume of the floor, if it is 14 centimetres thick, is: Width X Height X Length _____ X _____ X _____ = _______
6 cubic metres 6.4 cubic metres 8.96 cubic metres 21.36 cubic metres	16. The total estimated volume of concrete needed for this building is: Footing + Wall + Floor _____ + _____ + _____ = _______

17. The next step is to calculate the amounts of ingrediants needed to mix the required number of cubic metres of concrete.

18. Table 1 indicates the number of bags of Portland cement, cubic metres of fine aggregate, and cubic metres of coarse aggregate required to produce 1 cubic metre of concrete for the different suggested trial mixes.

Table 1. Quantities of Materials and suggested Trial Mixes.

Recommended proportions of water to cement and suggested trial mixes.*

	Litres of water to add to each bag batch if sand is			Suggested mixture for trial batch			Materials per cubic metre of concrete		
Kinds of Work	Very Wet	Wet	Damp	Cement bags	Fine cu dm	Coarse cu dm	Cement bags	Fine cu dm	Coarse cu dm
32 litre mix for driveways, walks, water-tight floors and walls	24	28	30	1	75	100	6¼	460	630
37 litre mix for foundation walls, footings mass concrete, etc.	27	30	34	1	90	135	5	460	690

*Quantities are estimated on wet aggregates using suggested trial mixes and medium consistencies--quantities will vary according to the grading of aggregate and the workability desired.

19. Multiply the amount of each material needed for 1 cubic metre of concrete by the number of cubic metres required (which we have already calculated). Remember, there are 1,000 cubic decimetres per cubic metre.

- -	20. Example 3. How much cement, fine aggregate, and coarse aggregate will be required for the footing and foundation walls of the building shown in figure 1 and used in example 1?
- -	21. If we assume these do not need to be watertight, we shall use a 37 litre mix of 1:90:135 (cement, fine aggregate:coarse aggregate).
1,000	22. From Table 1 we find that 1 cubic metre of concrete requires: 5 bags cement 460 cubic decimetres fine aggregate 690 cubic decimetres coarse aggregate One cubic metre contains _______ cubic decimetres.
- -	23. In example 1 it was determined that 6.4 cubic metres of concrete were required for the walls and footings; therefore we need a total of: 6.4 X 5 = 32 bags of cement 6.4 X 460 = 2944 cubic decimetres or 2.944 cubic metres fine aggregate 6.4 X 690 = 4416 cubic decimetres or 4.416 cubic metres coarse aggregate
- -	24. Example 4. How much cement, fine aggregate, and coarse aggregate will be required for the floor of the building shown in figure 1 and used in example 2?
- -	25. If we assume the floor should be watertight, we shall use a 32 litre mix of 1:75:100.

<table>
<tr><td>32</td><td>26. From Table 1 we find that 1 cubic metre of concrete requires:
6¼ bags cement
460 cubic decimetres fine aggregate
630 cubic decimetres coarse aggregate

A ______ litre mixture (water per bag of cement) is used for watertight concrete.</td></tr>
<tr><td>– –</td><td>27. In example 2 it was determined that 6 cubic metres of concrete were required for the floor, therefore we need a total of:
6 x 6¼ = 37½ bags cement
6 x 460 = 2760 cubic decimetres or 2.76 cubic metres fine aggregate
6 x 630 = 3780 cubic decimetres or 3.78 cubic metres coarse aggregate</td></tr>
<tr><td>– –</td><td>28. The total amount of materials needed for this job is:
<table>
<tr><th></th><th>Cement</th><th>Fine aggregate</th><th>Coarse aggregate</th></tr>
<tr><td>Walls & footing</td><td>32 bags</td><td>2.944 cu m</td><td>4.416 cu m</td></tr>
<tr><td>Floor</td><td>37½ bags</td><td>2.760 cu m</td><td>3.780 cu m</td></tr>
<tr><td>Total</td><td>69½ bags</td><td>5.704 cu m</td><td>8.196 cu m</td></tr>
</table></td></tr>
<tr><td>– –</td><td>29. For practise, calculate the materials needed for the building in figure 2.</td></tr>
<tr><td>5
460
690</td><td>30. Using a 37 litre mix for the wall and footing means that for 1 cubic metre of concrete we need: (from table 1)
________ bags cement
________ cubic decimetres fine aggregate
________ cubic decimetres coarse aggregate</td></tr>
<tr><td>12.4 X 5 = 62
12.4 X 460 cu dm = 5.704
12.4 X 690 cu dm = 8.556</td><td>31. For the building in figure 2 it was estimated that 12.4 cubic metres of concrete were needed for the footing and wall, therefore we need a total of:
________ X ______ = _____ bags cement
________ X ______ = _____ cubic metres fine aggregate
________ X ______ = _____ cubic metres coarse aggregate</td></tr>
</table>

6¼
460
630

32. Using a 32 litre mix for the floor means that for one cubic metre of concrete we need: (from Table 1)

_____ bags cement
_____ cubic decimetres fine aggregate
_____ cubic decimetres coarse aggregate

8.96 X 6¼ = 56
8.96 X 460 cu dm = 4.121 cu m
8.96 X 630 cu dm = 5.644 cu m

33. For the floor of the building in figure 2 it was estimated that 8.96 cubic metres of concrete were needed, therefore the total materials needed is:

_____ X _____ = _____ bags cement
_____ X _____ = _____ cubic metres fine aggregate
_____ X _____ = _____ cubic metres coarse aggregate

---

118 bags
9.825 cu m
14.200 cu m

34. The total amount of materials needed for the footing, wall, and floor of the building in figure 2 is:

	Cement	Fine aggregate	Coarse aggregate
Wall & footing	62 bags	5.704 cu m	8.556 cu m
Floor	56 bags	4.121 cu m	5.644 cu m
	_____	_____	_____

– –

35. It is desirable to calculate the cost of concrete in order to compare its cost with other alternative construction materials and for budget purposes.

– –

36. Using the building in figure one, determine what the cost of the concrete would be if:

cement = Shs. 15.00 per bag
fine aggregate = Shs. 20.00 per cubic metre
coarse aggregate = Shs. 24.00 per cubic metre

– –

37. The total cost is determined by multiplying the cost per unit (bag, cubic metre) by the number of units required (from frame 28 for figure 1).

cement: Shs. 15.00 X 69½ bags = Shs. 1,042.50
fine aggregate: Shs. 20.00 X 5.704 cu m = Shs. 164.10
coarse aggregate: Shs. 24.00 X 8.196 cu m = Shs. 196.70

Shs. Total 1,303.30

Shs. 1,770.00 Shs. 196.50 Shs. 340.80 Shs. 2,307.30	38. Using these same material costs calculate the cost of the concrete for the building in figure 2. cement: Shs. 15.00 X 118 bags = Shs. ______ fine aggregate: Shs. 20.00 X 9.825 cu m = Shs. ______ coarse aggregate: Shs. 24. X 14.2 cu m = Shs. ______ Total Shs. ______

The information in this unit was taken from the University of Illinois VAS unit 3007.

Name ________________ Form ________
Date ________________

TEST

Making and Using Concrete on the Farm, Part III

UNDERLINE THE CORRECT ANSWER

1. The correct order of the steps for estimating the materials and costs of concrete construction is:
   a. determine the cost, estimate the volume of concrete needed, determine the amount of materials needed
   b. determine the amount of materials needed, estimate the volume of concrete needed, determine the cost
   c. determine the amount of materials needed, determine the cost, estimate the volume of concrete needed
   d. estimate the volume of concrete needed, determine the cost, determine the amount of materials needed
   e. estimate the volume of concrete needed, determine the amount of materials needed, determine the cost

2. What volume of concrete is needed for the floor of a building which is 6 metres wide and 12 metres long, if the floor is 10 centimetres thick?
   a. 2.4 cubic metres
   b. 3.6 cubic metres
   c. 7.2 cubic metres
   d. 36 cubic metres
   e. 72 cubic metres

3. What volume of concrete is needed for the footing of this building which is 6 metres wide and 12 metres long if the footing is to be 30 centimetres wide and 15 centimetres high?
   a. .0162 cubic metres
   b. .162 cubic metres
   c. 1.62 cubic metres
   d. 16.2 cubic metres
   e. 162 cubic metres

4. What volume of concrete is needed for the wall of a building which is 10 metres wide and 14 metres long, if the wall is 20 centimetres wide and 60 centimetres high?
   a. 1.68 cubic metres
   b. 5.76 cubic metres
   c. 8.4 cubic metres
   d. 16.8 cubic metres
   e. 57.6 cubic metres

5. A certain building is 5 metres wide and 8 metres long, its footing is to be 26 centimetres wide and 12 centimetres thick and its wall is to be 14 centimetres wide and 68 centimetres high. How much concrete is needed for the footing and wall together?
   a. 0.82 cubic metres
   b. 2.48 cubic metres
   c. 3.29 cubic metres
   d. 5.77 cubic metres
   e. 8.25 cubic metres

6. If: cement costs Shs. 15.00 per bag
   fine aggregate costs Shs. 20.00 per cubic metre
   coarse aggregate costs Shs. 24.00 per cubic metre

   What is the total cost of the materials for a job which requires:
   34 bags of cement
   2.89 cubic metres fine aggregate
   4.09 cubic metres coarse aggregate

   a. Shs. 635.60
   b. Shs. 665.95
   c. Shs. 706.30
   d. Shs. 835.95
   e. Shs. 971.95

7. Calculate the amount of cement, fine aggregate, and coarse aggregate needed to construct the floor of a building which requires a volume of 8.5 cubic metres of concrete. Use a 32 litre mix, which for one cubic metre of concrete requires:

6¼ bags cement
460 cubic decimetres fine aggregate
630 cubic decimetres coarse aggregate

(i) This job will require ________ bags of cement.

a. 8.5
b. 13.4
c. 25.6
d. 53.2
e. 68.0

(ii) This job will require ________ cubic metres of fine aggregate.

a. .391
b. 3.91
c. 39.1
d. 391
e. 3910

(iii). This job will require _____ cubic metres of coarse aggregate.

a. 2.720
b. 5.355
c. 27.20
d. 53.55
e.. 63.00

8. Calculate the amount of cement, fine aggregate, and coarse aggregate needed to construct the walls and footing of a building which require a total volume of 4.2 cubic metres of concrete. Use a 37 litre mix which, for one cubic metre of concrete requires:

5 bags cement
460 cubic decimetres fine aggregate
690 cubic decimetres coarse aggregate

(i) This job will require ______ bags of cement.

a. 5
b. 21
c. 46
d. 69
e. 185

(ii) This job will require _______ cubic metres of fine aggregate.

a. 1.554
b. 1.932
c. 2.300
d. 3.652
e. 6.322

(iii) This job will require ______ cubic metres of coarse aggregate.

a. 2.554
b. 2.898
c. 3.450
d. 5.321
e. 8.976

APPENDIX C

Posttest and Retention Test Dates

TABLE 23

The Dates of Posttests and Retention Tests and The Time Interval Between Them for the Agricultural Units Taught at Tumaini Secondary School During First Term 1973

Unit number	Date of Posttest	Date of Retention Test	Weeks Between Posttest and Retention Test
1	1/23	3/6	6
2	1/26	3/6	5 1/2
3	1/31	3/6	5
4	2/6	3/6	4
5	2/9	3/23	6
6	2/14	3/23	5 1/2
7	2/19	3/23	4 1/2
8	2/22	3/23	4
9	2/26	3/30	4 1/2
10	3/1	3/30	4
11	3/5	4/13	5 1/2
12	3/9	4/13	5
13	3/13	4/13	4 1/2
14	3/16	4/13	4
15	3/21	4/27	5 1/2
16	3/27	4/27	4 1/2
17	3/30	4/27	4
18	4/12	5/16	5
19	4/18	5/16	4
20	4/27	5/31	5
21	5/3	5/31	4
22	5/7	6/6	4 1/2

APPENDIX D

Comparison of Means for All Statistical Tests

TABLE 24

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction at Tumaini Secondary School, First Term 1973

Unit	Form I & II Combined			Form I			Form II		
	Experimental* Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.91	6.03	-	5.21	4.59	+	6.83	7.62	-
2	5.88	5.47	+	4.74	4.84	-	7.00	6.22	+
3	3.87	4.33	-	2.82	3.69	-	5.19	5.32	-
4	6.16	4.81	+	5.62	3.31	+	6.87	6.75	+
5	8.00	6.88	+	7.30	6.05	+	8.84	8.07	+
6	9.57	9.73	-	9.10	9.29	-	10.11	10.28	-
7	7.69	7.76	-	6.88	6.62	+	8.83	9.21	-
8	12.13	12.85	-	11.10	11.52	-	13.41	14.55	-
9	7.88	6.95	+	6.85	6.33	+	9.12	7.73	+
10	9.01	7.39	+	8.26	6.72	+	9.91	8.18	+
11	12.27	11.51	+	10.93	9.83	+	13.94	13.77	+
12	6.95	6.45	+	6.32	5.44	+	7.84	7.90	-
13	9.36	9.24	+	8.89	7.90	+	10.00	10.94	-
14	10.74	9.41	+	9.20	8.88	+	12.66	10.14	+
15	5.54	5.63	-	5.14	5.09	+	6.03	6.33	-
16	5.74	4.90	+	5.00	4.36	+	6.67	5.62	+
17	4.33	4.69	-	3.70	3.60	+	5.11	6.13	-
18	8.13	10.04	-	7.25	9.93	-	9.44	10.21	-
19	5.83	6.00	-	5.29	5.46	-	6.75	6.73	+
20	7.53	8.07	-	6.36	6.72	-	9.13	9.81	-
21	8.71	6.66	+	7.86	5.88	+	9.84	7.65	+
22	4.10	3.23	+	3.35	3.03	+	5.04	3.45	+
Total +			12			15			11

*The experimental method was programmed instruction and the control method was lecture-discussion.

TABLE 25

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction at Tumaini Sceondary School, First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.66	5.93	-	5.19	4.81	+	6.31	7.14	-
2	5.84	5.94	-	4.73	5.03	-	6.88	7.11	-
3	4.50	4.51	-	3.58	4.14	-	5.72	5.14	+
4	5.56	5.00	+	5.41	3.94	+	5.78	6.33	-
5	5.65	5.37	+	4.54	4.68	-	6.97	6.33	+
6	8.49	8.96	-	8.13	8.22	-	8.91	9.81	-
7	8.44	7.79	+	7.55	6.32	+	9.70	9.69	+
8	11.17	11.80	-	10.67	10.47	+	11.83	13.38	-
9	6.49	5.69	+	5.37	5.23	+	7.87	6.28	+
10	8.74	8.13	+	8.35	7.76	+	9.19	8.56	+
11	10.24	8.94	+	9.03	8.20	+	11.83	10.08	+
12	5.62	5.56	+	5.07	4.73	+	6.58	6.81	-
13	8.96	8.36	+	8.26	7.18	+	10.04	9.90	+
14	8.60	8.42	+	7.45	7.09	+	10.18	10.28	-
15	4.88	4.72	+	4.32	4.20	+	5.59	5.39	+
16	4.97	4.90	+	4.34	4.67	-	5.77	5.24	+
17	3.32	3.76	-	2.68	2.87	-	4.20	4.97	+
18	8.20	9.55	-	6.97	9.60	-	10.22	9.48	-
19	4.69	4.88	-	4.27	4.64	-	5.52	5.23	+
20	6.61	7.81	-	5.50	6.74	-	8.31	9.24	-
21	7.10	6.31	+	6.46	5.68	+	7.97	7.31	+
22	4.21	3.41	+	3.71	2.97	+	4.85	3.94	+
Total +			13			13			13

TABLE 26

The Experimental and Control Posttest Means and Sign for Each Unit of Agriculture Instruction for the Boys at Tumaini Secondary School, First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	6.30	6.94	-	5.44	5.15	+	7.52	8.94	-
2	6.08	5.75	+	5.29	5.19	+	6.75	6.39	+
3	4.08	4.54	-	2.55	3.80	-	5.81	5.75	+
4	6.68	5.80	+	6.03	4.15	+	7.57	7.64	-
5	8.17	7.11	+	7.65	6.44	+	8.70	8.11	+
6	9.80	10.10	-	9.31	9.28	+	10.25	11.25	-
7	8.10	8.25	-	6.96	7.13	-	9.57	9.47	+
8	12.63	13.16	-	11.63	11.48	+	13.63	15.47	-
9	7.88	7.26	+	6.76	6.50	+	9.00	8.16	+
10	9.02	7.77	+	8.19	7.28	+	10.10	8.21	+
11	13.17	12.18	+	11.42	10.21	+	15.00	14.95	+
12	7.27	6.93	+	6.36	5.88	+	8.57	8.31	+
13	9.73	9.40	+	9.10	8.08	+	10.59	11.00	-
14	11.21	10.71	+	9.57	9.47	+	13.63	12.16	+
15	5.80	6.13	-	5.79	5.16	+	5.82	7.35	-
16	5.93	5.51	+	5.03	5.04	-	7.15	6.00	+
17	5.04	5.19	-	4.13	3.85	+	5.91	7.15	-
18	8.71	10.81	-	7.59	10.45	-	9.95	11.36	-
19	6.00	6.00	-	5.22	5.55	-	7.21	6.63	+
20	8.52	9.04	-	7.16	7.26	-	10.15	11.47	-
21	9.06	6.91	+	8.37	5.92	+	10.10	8.00	+
22	4.28	3.39	+	3.18	3.14	+	5.70	3.63	+
Total +			12			16			13

TABLE 27

The Experimental and Control Posttest Means and Sign for Each Unit of Agriculture Instruction for the Girls at Tumaini Secondary School, First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.13	4.72	+	4.66	3.76	+	5.63	5.75	-
2	5.50	4.80	+	4.07	4.08	-	7.41	5.77	+
3	3.59	3.90	-	3.12	3.46	-	4.27	4.55	-
4	5.16	3.53	+	4.76	2.35	+	5.63	5.36	+
5	7.75	6.43	+	6.88	5.23	+	9.09	8.00	+
6	9.20	9.00	+	8.83	9.30	-	9.81	8.66	+
7	6.77	7.06	-	6.71	6.00	+	6.87	8.75	-
8	11.32	12.24	-	10.44	11.61	-	12.90	12.91	-
9	7.87	6.21	+	6.94	6.00	+	9.33	6.55	+
10	9.00	6.78	+	8.38	6.05	+	9.61	8.10	+
11	11.15	10.20	+	10.40	9.07	+	12.30	11.63	+
12	6.25	5.78	+	6.21	4.90	+	6.30	7.25	-
13	8.60	9.00	-	8.42	7.66	+	8.81	10.84	-
14	9.46	7.70	+	8.33	8.21	+	11.23	6.81	+
15	4.95	4.90	+	3.69	5.00	-	6.45	4.76	+
16	5.40	3.90	+	4.92	3.50	+	5.92	4.70	+
17	3.25	3.81	-	3.20	3.07	+	3.36	4.61	-
18	7.16	8.39	-	6.83	8.69	-	8.00	8.00	-
19	5.62	6.00	-	5.36	5.28	+	6.10	6.90	-
20	6.03	6.38	-	5.27	5.71	-	7.27	7.12	+
21	8.07	6.24	+	6.78	5.83	+	9.46	6.90	+
22	3.77	2.96	+	3.66	2.87	+	3.90	3.09	+
Total +			14			15			13

TABLE 28

The Experimental and Control Retention Test Means and Sign for Each Unit of Agriculture Instruction for the Boys at Tumaini Secondary School, First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.79	6.71	-	4.95	4.83	+	7.13	8.70	-
2	6.36	6.34	+	5.25	5.17	+	7.25	7.83	-
3	4.68	4.94	-	3.23	4.47	-	6.33	5.76	+
4	6.15	6.06	+	5.79	4.82	+	6.68	7.57	-
5	6.05	5.54	+	5.00	4.70	+	7.10	6.66	+
6	8.60	9.26	-	8.09	8.36	-	9.08	10.40	-
7	8.77	8.23	+	7.88	6.68	+	9.90	9.95	-
8	11.54	11.84	-	10.61	10.23	+	12.47	13.95	-
9	7.02	6.02	+	5.94	5.57	+	8.10	6.52	+
10	8.52	8.56	-	8.20	8.52	-	8.94	8.59	+
11	10.51	9.02	+	9.20	8.03	+	12.05	10.68	+
12	5.90	6.00	-	5.17	5.26	-	7.33	6.94	+
13	9.36	8.78	+	8.44	7.22	+	10.94	10.57	+
14	9.06	10.00	-	7.81	8.31	-	10.94	12.13	-
15	4.93	4.95	-	4.32	4.04	+	5.77	6.10	-
16	5.27	5.44	-	4.80	5.00	-	5.94	6.00	-
17	3.83	4.18	-	3.08	3.03	+	4.73	5.94	-
18	8.32	10.31	-	6.72	10.06	-	10.27	10.75	-
19	4.88	4.97	-	4.45	4.72	-	5.66	5.35	+
20	8.10	8.78	-	6.50	7.40	-	10.31	10.82	-
21	7.65	7.00	+	6.70	6.08	+	9.17	8.31	+
22	4.48	3.81	+	3.95	3.19	+	5.17	4.40	+
Total +			9			13			10

TABLE 29

The Experimental and Control Retention Test Means and Sign for Each Unit of Agriculture Instruction for the Girls at Tumaini Secondary School, First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.43	4.84	+	5.66	4.76	+	5.18	4.91	+
2	5.11	5.14	-	4.14	4.75	-	6.25	5.66	+
3	4.26	3.81	+	3.93	3.53	+	4.80	4.22	+
4	4.58	3.75	+	4.69	3.05	+	4.45	4.81	-
5	5.07	5.04	+	4.00	4.61	-	6.72	5.66	+
6	8.28	8.37	-	8.16	7.91	+	8.50	8.83	-
7	7.70	7.19	+	6.92	5.89	+	9.14	9.25	-
8	10.59	11.70	-	10.72	11.00	-	10.33	12.41	-
9	5.83	5.00	+	4.78	4.57	+	7.50	5.66	+
10	9.07	7.50	+	8.61	6.94	+	9.53	8.50	+
11	9.75	8.78	+	8.83	8.53	+	11.40	9.10	+
12	5.04	4.88	+	4.84	4.05	+	5.33	6.55	-
13	8.13	7.69	+	7.84	7.12	+	8.50	8.60	-
14	7.61	6.34	+	6.54	5.62	+	8.80	7.50	+
15	4.78	4.35	+	4.33	4.43	-	5.27	4.25	+
16	4.44	4.07	+	3.46	4.22	-	5.50	3.80	+
17	2.58	3.04	-	2.16	2.53	-	3.45	3.58	-
18	7.95	8.00	-	7.31	8.53	-	10.00	7.22	+
19	4.46	4.69	-	4.05	4.50	-	5.33	5.00	+
20	4.57	6.23	-	4.27	5.57	-	5.10	7.00	-
21	6.18	5.35	+	6.00	5.16	+	6.38	5.70	+
22	3.72	2.77	+	3.25	2.62	+	4.30	3.00	+
Total +			15			13			14

TABLE 30

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Sceondary School Students Ranking in the Upper Half of Their Agriculture Class at the end of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	6.45	6.88	-	5.47	5.00	+	8.16	8.57	-
2	6.47	6.35	+	5.29	5.28	+	7.42	8.07	-
3	4.52	5.06	-	2.93	4.00	-	5.94	7.00	-
4	7.66	6.17	+	6.04	3.94	+	9.69	8.27	+
5	9.29	8.40	+	8.11	6.86	+	10.30	11.00	-
6	10.25	10.44	-	9.66	9.34	+	11.00	11.70	-
7	8.76	8.87	-	7.38	7.50	-	11.00	10.04	+
8	13.45	13.93	-	11.55	11.78	-	16.07	16.28	-
9	9.10	8.21	+	8.00	6.86	+	9.42	10.42	-
10	9.58	8.43	+	8.77	7.23	+	10.42	10.00	+
11	14.55	12.86	+	12.72	10.65	+	16.20	16.76	-
12	7.54	7.57	-	6.48	6.00	+	9.75	9.15	+
13	10.15	10.34	-	9.16	8.05	+	12.07	12.40	-
14	12.00	11.53	+	9.66	10.12	-	14.80	13.41	+
15	6.32	6.80	-	5.83	5.65	+	7.23	7.90	-
16	6.15	5.41	+	5.12	4.75	+	7.33	6.35	+
17	5.61	5.41	+	4.10	3.88	+	7.78	7.23	+
18	9.00	11.62	-	8.05	10.72	-	9.94	13.50	-
19	6.20	6.26	-	5.31	5.52	-	7.72	7.15	+
20	9.12	9.74	-	7.05	7.58	-	12.30	12.47	-
21	9.51	7.78	+	8.68	6.30	+	10.55	10.07	+
22	4.33	3.90	+	3.25	3.27	-	5.47	4.76	+
Total +			11			14			10

TABLE 31

The Experimental and Control Posttest Means and Difference Sign for each Unit of Agriculture Instruction for the Tumaini Sceondary School Students Ranking in the Lower Half of Their Agriculture Class at the end of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.42	4.79	+	4.88	4.07	+	5.94	5.80	+
2	5.00	4.57	+	4.00	4.12	-	6.18	4.94	+
3	3.11	3.71	-	2.82	3.50	-	3.66	4.00	-
4	4.94	3.25	+	5.17	2.83	+	4.70	4.00	+
5	6.33	5.18	+	6.42	4.88	+	6.18	5.53	+
6	9.07	8.68	+	8.61	9.23	-	9.52	7.91	+
7	6.65	6.48	+	6.31	5.82	+	7.06	7.75	-
8	11.07	11.30	-	10.61	11.16	-	11.57	11.50	+
9	6.60	5.71	+	6.04	5.68	+	7.66	5.73	+
10	8.17	6.64	+	7.58	6.31	+	9.00	7.00	+
11	9.74	10.18	-	9.31	8.84	+	10.46	11.61	-
12	6.36	5.14	+	6.10	4.91	+	6.63	5.63	+
13	8.58	7.43	+	8.52	7.69	+	8.65	8.69	-
14	8.75	7.87	+	8.50	7.91	+	9.08	7.82	+
15	4.79	4.20	+	4.22	4.54	-	5.28	3.58	+
16	5.10	4.47	+	4.82	3.95	+	5.50	5.10	+
17	3.34	3.50	-	3.36	3.17	+	3.33	4.00	-
18	6.92	8.37	-	6.40	8.83	-	8.25	7.88	+
19	5.51	5.62	-	5.27	5.38	-	5.92	6.00	-
20	6.22	5.50	+	5.72	5.43	+	6.83	5.58	+
21	7.50	5.81	+	6.72	5.52	+	8.66	6.14	+
22	3.68	2.69	+	3.50	2.78	+	4.00	2.60	+
Total +			16			15			16

TABLE 32

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Upper Half of Their Agriculture Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.67	6.83	-	5.05	5.11	-	6.81	8.36	-
2	6.89	6.71	+	5.58	5.25	+	7.95	9.16	-
3	5.26	5.37	-	3.62	4.52	-	6.72	7.00	-
4	7.22	6.44	+	6.35	4.47	+	8.81	8.41	+
5	6.45	6.20	+	4.52	4.80	-	8.10	8.46	-
6	9.12	9.76	-	8.44	8.54	-	10.00	11.11	-
7	9.61	8.84	+	7.95	7.11	+	12.30	10.40	+
8	12.25	21.45	-	10.83	10.50	+	14.23	14.60	-
9	7.56	6.43	+	6.25	5.78	+	8.57	7.50	+
10	8.86	9.00	-	8.36	8.17	+	9.38	10.07	-
11	11.29	9.42	+	9.72	8.39	+	12.78	11.41	+
12	6.44	6.41	+	5.40	5.50	-	8.81	7.36	+
13	9.67	9.45	+	8.32	7.61	+	12.50	11.21	+
14	9.46	10.77	-	7.58	8.50	-	11.84	14.09	-
15	5.11	5.58	-	4.30	4.55	-	6.66	6.68	-
16	5.47	6.06	-	4.78	5.40	-	6.31	7.07	-
17	4.12	4.20	-	3.00	2.95	+	5.84	5.78	+
18	9.36	11.11	-	7.84	10.44	-	11.05	13.00	-
19	5.35	5.12	+	5.21	4.68	+	5.66	5.70	-
20	8.25	8.90	-	6.47	7.30	-	11.08	10.84	+
21	7.70	7.03	+	6.66	6.21	+	8.95	8.33	+
22	4.64	4.06	+	3.95	3.22	+	5.36	5.23	+
Total +			11			12			10

TABLE 33

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Lower Half of Their Agriculture Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.64	4.56	+	5.37	4.38	+	5.93	4.80	+
2	4.04	5.10	-	3.33	4.73	-	4.81	5.46	-
3	3.47	3.65	-	3.62	3.70	-	3.14	3.58	-
4	4.00	3.19	+	4.29	3.43	+	3.68	2.80	+
5	4.63	4.43	+	4.47	4.50	-	4.90	4.35	+
6	8.00	7.92	+	7.85	8.13	-	8.15	7.66	+
7	7.16	6.64	+	7.05	5.63	+	7.28	8.50	-
8	10.08	10.82	-	10.15	10.43	-	10.00	11.33	-
9	5.25	4.91	+	4.70	4.47	+	6.40	5.33	+
10	8.52	7.46	+	8.33	7.40	+	8.80	7.52	+
11	8.89	8.38	+	8.31	7.94	+	10.00	8.92	+
12	4.63	4.32	+	4.58	3.85	+	4.69	5.50	-
13	8.12	7.00	+	8.17	6.89	+	8.06	7.40	+
14	7.00	6.56	+	7.21	6.00	+	6.66	7.28	-
15	4.29	3.65	+	4.35	8.85	+	4.82	3.33	+
16	3.00	3.89	-	3.66	4.00	-	4.81	3.75	+
17	2.63	3.00	-	2.38	2.73	-	2.94	3.40	-
18	6.52	7.93	-	6.10	8.35	-	7.83	7.50	+
19	4.14	4.50	-	3.45	4.58	-	5.41	4.33	+
20	5.14	6.03	-	4.61	5.93	-	5.92	6.22	-
21	6.11	5.69	+	6.17	5.22	+	6.00	6.42	-
22	3.45	2.89	+	3.35	2.68	+	3.62	3.10	+
Total +			14			12			13

TABLE 34

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Upper Half of Their Form at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.95	7.00	-	5.15	5.38	-	7.42	8.05	-
2	6.52	5.63	+	5.06	4.76	+	7.57	7.13	+
3	4.55	4.48	+	3.14	3.48	-	5.55	6.28	-
4	6.80	6.25	+	6.07	4.28	+	8.14	7.77	+
5	9.19	7.57	+	8.46	6.40	+	9.71	10.00	-
6	10.33	10.24	+	9.64	9.57	+	10.93	11.14	-
7	11.20	8.89	+	12.12	7.56	+	10.14	9.86	+
8	14.06	13.70	+	12.31	12.14	+	16.07	15.68	+
9	9.27	7.76	+	7.73	6.71	+	10.31	9.73	+
10	9.22	8.55	+	8.38	7.80	+	10.22	9.35	+
11	13.05	12.65	+	10.75	10.53	+	14.80	16.60	-
12	7.54	7.60	-	6.89	6.33	+	8.80	8.75	+
13	9.65	10.69	-	9.06	8.88	+	10.80	12.09	-
14	11.32	12.26	-	9.48	11.40	-	13.85	13.13	+
15	5.76	6.33	-	4.96	5.70	-	7.26	6.81	+
16	6.10	4.52	+	5.14	3.11	+	7.31	6.12	+
17	5.48	5.05	+	4.11	3.75	+	7.13	6.77	+
18	8.58	11.26	-	7.43	10.64	-	9.61	12.50	-
19	6.06	6.26	-	4.94	5.58	-	7.61	7.25	+
20	9.27	9.04	+	7.38	7.06	+	11.53	11.76	-
21	9.14	7.67	+	8.10	6.27	+	10.57	9.25	+
22	4.44	4.12	+	3.54	3.64	-	5.57	4.62	+
Total +			15			15			14

TABLE 35

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Lower Half of Their Form at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.89	4.88	+	5.33	4.00	+	6.31	6.66	-
2	5.03	5.17	-	4.40	4.81	-	5.90	5.41	+
3	3.07	4.20	-	2.68	4.30	-	4.14	4.09	+
4	5.32	3.45	+	4.75	2.76	+	5.75	4.90	+
5	6.54	5.81	+	6.33	5.08	+	7.00	6.40	+
6	9.06	8.65	+	8.80	8.66	+	9.42	8.63	+
7	6.72	6.52	+	5.78	5.92	-	7.60	7.90	-
8	10.68	11.12	-	10.17	10.15	+	11.63	12.27	-
9	6.42	3.00	+	6.29	5.57	+	6.72	6.05	+
10	8.58	6.60	+	8.00	6.04	+	9.27	7.31	+
11	11.41	9.86	+	10.91	8.42	+	12.41	11.12	+
12	6.09	5.24	+	5.20	4.76	+	6.93	6.36	+
13	8.96	7.60	+	8.53	7.12	+	9.33	8.63	+
14	9.40	7.10	+	8.45	7.20	+	10.36	6.92	+
15	5.24	4.86	+	5.50	4.64	+	5.05	5.36	-
16	5.00	5.15	-	4.69	5.15	-	5.36	5.16	+
17	3.50	3.86	-	3.41	3.23	+	3.60	4.70	-
18	7.62	8.33	-	7.04	8.60	-	9.11	8.06	+
19	5.61	5.40	+	5.56	5.16	+	5.72	5.70	+
20	6.10	5.76	+	5.58	5.81	-	6.87	5.70	+
21	7.84	5.86	+	7.35	5.60	+	8.45	6.22	+
22	3.27	2.43	+	2.90	2.50	+	3.75	2.35	+
Total +			16			16			17

TABLE 36

The Experimental and Ctonrol Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Upper Half of Their Form at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.75	7.15	-	5.44	6.00	-	6.41	7.90	-
2	6.52	6.50	+	5.46	5.32	+	7.28	8.76	-
3	4.97	5.16	-	3.78	4.50	-	5.80	6.50	-
4	6.43	6.45	-	5.84	4.85	+	7.66	7.76	-
5	6.72	5.76	+	5.13	4.76	+	7.85	7.76	+
6	9.60	9.37	+	9.07	8.33	+	10.06	10.71	-
7	9.37	9.25	+	7.96	7.40	+	12.00	10.57	+
8	12.44	12.62	-	10.73	11.18	-	14.28	14.47	-
9	7.43	5.97	+	5.73	5.28	+	8.59	7.35	+
10	8.97	9.53	-	8.38	8.93	-	9.68	10.23	-
11	11.23	9.78	+	9.46	8.77	+	12.63	11.71	+
12	6.11	6.60	-	4.96	5.64	-	8.42	7.50	+
13	9.23	9.50	-	8.17	7.62	+	11.42	11.00	+
14	9.27	9.44	-	7.71	6.38	+	11.57	12.28	-
15	5.24	5.32	-	4.59	4.05	+	6.50	6.19	+
16	5.10	5.84	-	4.44	5.22	-	5.95	6.60	-
17	4.06	4.08	-	3.05	3.03	+	5.35	5.47	-
18	9.81	11.17	-	8.56	10.64	-	11.06	12.54	-
19	5.03	5.14	-	4.44	4.92	-	6.10	5.47	+
20	8.18	8.36	-	6.83	7.17	-	9.80	10.00	-
21	7.54	7.21	+	6.75	6.38	+	8.61	8.20	+
22	4.76	4.12	+	4.00	3.47	+	5.73	4.81	+
Total +			8			13			10

TABLE 37

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Lower Half of Their Form at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.52	4.42	+	4.63	3.88	+	6.21	5.44	+
2	4.80	5.04	-	3.78	4.30	-	6.09	5.57	+
3	3.91	3.45	+	3.50	3.41	+	5.40	3.50	+
4	3.73	3.51	+	4.50	3.31	+	4.26	3.90	+
5	4.38	4.76	-	4.04	4.45	-	5.10	5.00	+
6	7.72	8.00	-	7.60	7.90	-	7.88	8.09	-
7	6.96	6.36	+	6.66	5.64	+	7.23	8.00	-
8	10.05	10.00	+	10.30	8.72	+	9.68	11.27	-
9	5.41	5.30	+	5.13	5.08	+	6.11	5.44	+
10	8.15	7.17	+	8.72	6.95	+	8.00	7.42	+
11	9.18	7.56	+	8.68	7.00	+	10.30	8.16	+
12	4.75	4.37	+	5.28	3.95	+	4.00	5.44	-
13	8.50	7.10	+	8.46	6.95	+	8.53	7.44	+
14	6.94	7.68	-	6.70	7.66	-	7.22	7.72	-
15	4.28	4.12	+	3.60	4.30	-	4.73	3.70	+
16	4.65	4.07	+	4.09	4.25	-	5.33	3.78	+
17	2.71	2.94	-	2.39	2.45	-	3.18	3.62	-
18	6.41	7.28	-	5.81	7.50	-	8.28	7.07	+
19	4.41	4.16	+	4.13	3.90	+	5.00	4.57	+
20	5.03	6.27	-	4.40	5.50	-	6.27	7.25	-
21	6.04	5.44	+	5.75	5.13	+	6.44	6.09	+
22	2.88	2.78	+	3.00	2.50	+	2.75	3.11	-
Total +			15			13			14

TABLE 38

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agruculture Instruction for the Tumaini Secondary School Students Ranking in the Upper Half of Their English Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	6.19	6.88	-	5.37	4.93	+	7.83	8.35	-
2	6.55	6.30	+	4.93	5.37	-	7.85	8.16	-
3	4.50	5.00	-	3.06	4.17	-	5.65	6.72	-
4	6.88	5.97	+	6.25	4.05	+	8.40	7.88	+
5	9.10	7.71	+	7.94	6.84	+	10.10	9.90	+
6	10.03	10.26	-	9.47	9.46	+	10.83	11.30	-
7	8.36	8.87	-	7.58	7.22	+	9.91	10.28	-
8	13.61	13.91	-	12.16	12.15	-	15.61	16.09	-
9	9.07	7.81	+	7.29	7.03	+	10.52	9.50	+
10	9.52	8.24	+	8.88	7.66	+	10.28	9.18	+
11	13.20	12.44	+	11.00	10.61	+	15.30	16.41	-
12	7.34	7.67	-	6.57	6.40	+	9.00	8.95	+
13	10.02	10.46	-	9.23	8.72	+	11.90	11.95	-
14	11.53	12.03	-	9.69	11.06	-	13.80	13.45	+
15	5.81	6.17	-	5.16	5.63	-	7.16	6.66	+
16	6.08	5.54	+	5.11	5.00	+	7.28	6.38	+
17	5.00	5.27	-	3.75	3.80	-	6.92	7.09	-
18	8.97	11.13	-	8.00	10.36	-	10.00	12.90	-
19	6.15	6.34	-	5.05	5.69	-	8.00	7.27	+
20	8.75	9.20	-	7.05	7.53	-	11.58	11.47	+
21	9.34	7.60	+	8.00	6.05	+	11.10	10.00	+
22	4.42	4.40	+	3.33	3.31	+	5.63	6.00	-
Total +			9			14			11

TABLE 39

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Lower Half of Their English Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.26	4.88	+	4.92	4.25	+	6.16	6.00	+
2	5.00	4.51	+	4.50	3.69	+	5.58	5.05	+
3	3.04	3.65	-	2.70	3.13	-	3.85	4.21	-
4	5.50	3.58	+	4.64	2.72	+	6.10	5.00	+
5	6.56	5.93	+	6.57	4.50	+	6.54	7.05	-
6	9.28	8.80	+	8.81	9.00	-	9.73	8.58	+
7	6.96	6.48	+	5.81	6.04	-	8.05	7.33	+
8	10.95	11.03	-	10.09	10.40	-	11.89	11.83	+
9	6.96	6.05	+	6.50	5.18	+	6.66	6.71	-
10	8.11	6.81	+	7.14	5.90	+	9.25	7.68	+
11	11.14	10.48	+	10.71	8.56	+	11.84	12.10	-
12	6.54	5.02	+	5.94	4.58	+	7.10	6.00	+
13	8.75	7.85	+	8.38	7.17	+	9.04	9.16	-
14	10.04	10.09	-	9.71	7.26	+	10.45	8.11	+
15	5.28	5.00	+	5.11	4.60	+	5.40	5.75	-
16	5.14	4.40	+	4.80	3.75	+	5.58	5.14	+
17	3.86	3.41	+	3.68	2.88	+	4.04	4.27	-
18	7.16	8.94	-	6.52	9.33	-	8.50	8.55	-
19	5.51	5.44	+	5.52	5.06	+	5.50	5.91	-
20	6.58	6.11	+	5.72	5.21	+	7.57	7.16	+
21	7.68	5.95	+	7.64	5.73	+	7.75	6.19	+
22	3.47	2.23	+	3.38	2.72	+	3.62	1.80	+
Total +			18			17			13

TABLE 40

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Upper Half of Their English Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	6.06	6.97	-	5.56	5.53	+	7.20	8.05	-
2	6.44	6.21	+	5.25	5.21	+	7.40	8.50	-
3	5.13	5.03	+	3.87	4.27	-	6.15	6.88	-
4	6.40	6.26	+	6.04	4.52	+	7.33	8.00	-
5	6.75	5.67	+	5.05	4.91	+	8.20	7.50	+
6	9.27	9.80	-	8.64	8.88	-	10.16	10.95	-
7	8.63	9.13	-	7.64	7.23	+	10.90	10.75	+
8	12.24	12.42	-	10.88	10.76	+	14.16	14.50	-
9	7.63	6.47	+	6.00	6.03	-	8.95	7.41	+
10	9.30	8.93	+	8.84	8.44	+	9.85	9.72	+
11	11.33	9.85	+	9.44	9.08	+	13.22	11.80	+
12	6.62	6.54	-	5.64	5.42	+	9.10	7.72	+
13	9.28	9.41	-	8.16	7.52	+	12.10	11.10	+
14	9.45	10.25	-	7.80	8.21	-	11.63	13.10	-
15	5.08	5.21	-	4.41	4.05	+	6.54	6.36	+
16	5.04	5.62	-	4.32	5.05	-	6.00	6.58	-
17	3.84	4.27	-	3.15	2.92	+	5.00	6.05	-
18	9.30	10.50	-	8.00	9.80	-	10.86	12.44	-
19	5.23	5.14	+	4.60	4.80	-	6.50	5.64	+
20	8.09	8.63	-	6.65	7.40	-	10.72	10.26	+
21	7.51	6.93	+	6.48	6.05	+	8.80	8.54	+
22	4.92	4.12	+	4.33	3.10	+	5.57	5.61	-
Total +			11			14			11

TABLE 41

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Ranking in the Lower Half of Their English Class at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.20	4.45	+	4.53	4.06	+	5.75	5.11	+
2	4.92	5.62	-	3.92	4.66	-	6.00	6.29	-
3	3.52	3.92	-	3.37	3.92	-	4.00	3.92	+
4	4.71	3.42	+	4.35	3.37	+	5.00	3.50	+
5	4.26	5.03	-	4.00	4.23	-	4.72	5.64	-
6	7.97	7.37	+	7.72	6.83	+	8.22	7.91	+
7	8.20	6.40	+	7.38	5.60	+	8.87	7.91	+
8	10.20	10.68	-	10.14	9.92	+	10.27	11.50	-
9	5.10	4.82	+	4.85	3.71	+	5.60	5.60	-
10	7.54	7.55	-	7.33	7.10	+	7.80	7.95	-
11	8.93	7.90	+	8.57	6.73	+	9.54	9.00	+
12	4.48	4.30	+	4.23	4.00	+	4.78	5.00	-
13	8.61	7.20	+	8.41	7.00	+	8.82	7.60	+
14	6.90	7.28	-	6.76	6.45	+	7.11	8.40	-
15	4.64	4.15	+	4.15	4.33	-	5.00	3.83	+
16	4.83	4.30	+	4.38	4.31	+	5.36	4.29	+
17	2.89	2.83	+	2.23	2.78	-	3.66	2.90	+
18	6.89	8.57	-	6.05	9.29	-	9.00	7.81	+
19	4.18	4.39	-	3.95	4.35	-	4.63	4.44	+
20	5.28	6.29	-	4.35	5.57	-	6.53	7.30	-
21	6.38	5.94	+	6.43	5.33	+	6.30	6.40	-
22	2.85	2.81	+	2.69	2.77	-	3.12	2.85	+
Total +			13			13			13

TABLE 42

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Who Indicated a Preference for the Programmed Instruction Method at the End of the First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	6.14	5.76	+	5.86	5.33	+	6.46	6.25	+
2	5.86	5.48	+	5.16	5.73	-	6.33	5.25	+
3	3.52	4.20	-	2.55	3.85	-	4.62	4.70	-
4	6.13	4.61	+	5.75	4.20	+	6.61	5.12	+
5	8.10	6.85	+	7.36	6.18	+	9.00	7.75	+
6	9.77	9.28	+	9.45	9.43	+	10.00	9.00	+
7	7.51	7.61	-	7.06	6.25	+	8.07	9.44	-
8	12.23	12.00	+	12.09	11.37	+	12.33	13.11	-
9	7.63	6.33	+	7.10	5.76	+	8.22	6.93	+
10	8.75	8.00	+	8.26	7.45	+	9.55	7.75	+
11	10.85	11.60	-	10.54	10.46	+	11.22	12.92	-
12	6.67	5.71	+	5.76	5.66	+	7.78	5.77	+
13	10.16	9.25	+	9.70	8.72	+	10.71	9.88	+
14	8.95	8.42	+	8.40	7.88	+	9.88	8.90	+
15	5.93	4.66	+	5.81	4.25	+	6.06	5.22	+
16	5.16	4.88	+	4.93	4.50	+	5.62	5.20	+
17	3.36	4.00	-	4.25	3.70	+	4.81	4.71	+
18	8.56	9.53	-	8.36	10.31	-	9.00	8.50	+
19	5.94	5.54	+	5.00	5.18	-	7.57	6.25	+
20	7.96	6.50	+	7.33	6.56	+	8.53	6.37	+
21	7.30	6.40	+	7.00	6.00	+	7.88	6.73	+
22	3.63	2.60	+	3.46	2.54	+	4.00	2.64	+
Total +			17			18			18

TABLE 43

The Experimental and Control Posttest Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Who Indicated a Preference for the Lecture-Discussion Method at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.77	6.16	-	4.78	4.27	+	7.11	8.14	-
2	5.91	5.42	+	4.62	4.13	+	7.26	7.18	+
3	4.06	4.48	-	3.00	3.70	-	5.42	5.73	-
4	6.23	4.97	+	5.59	3.04	+	7.05	7.40	-
5	7.91	6.87	+	7.16	5.86	+	8.77	8.31	+
6	9.46	9.97	-	8.96	9.20	-	10.21	10.78	-
7	7.82	7.79	+	6.75	6.68	+	9.43	9.12	+
8	12.04	13.30	-	10.64	11.60	-	14.35	15.00	-
9	7.98	7.42	+	6.75	6.72	+	9.45	8.47	+
10	9.14	7.24	+	8.25	6.42	+	10.04	8.58	+
11	12.77	11.44	+	10.96	9.48	+	14.95	14.38	+
12	7.13	6.72	+	6.66	5.31	+	7.88	8.77	-
13	8.82	9.22	-	8.37	7.53	+	9.47	11.33	-
14	11.62	9.75	+	9.68	9.10	+	13.73	10.78	+
15	5.26	6.00	-	4.73	5.40	-	6.00	6.75	-
16	6.02	4.88	+	5.04	4.25	+	7.00	5.94	+
17	4.22	5.02	-	3.50	3.52	-	5.36	6.52	-
18	7.98	10.36	-	6.75	9.70	-	9.54	11.41	-
19	5.78	6.23	-	5.41	5.64	-	6.41	6.90	-
20	7.31	8.87	-	5.96	6.83	-	9.55	11.00	-
21	9.44	6.80	+	8.42	5.83	+	10.60	8.36	+
22	4.30	3.57	+	3.28	3.23	+	5.33	4.05	+
Total +			12			14			10

TABLE 44

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Who Indicated A Preference for the Programmed Instruction Method at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.88	5.35	+	5.40	5.55	-	6.54	5.12	+
2	5.80	6.25	-	5.50	5.73	-	6.00	6.84	-
3	4.81	4.82	-	3.77	4.71	-	6.14	5.00	+
4	5.42	4.23	+	5.25	4.11	+	5.66	3.12	+
5	6.90	5.12	+	5.63	4.85	+	7.55	5.45	+
6	9.07	7.91	+	9.00	8.00	+	9.13	7.77	+
7	8.15	8.10	+	7.60	7.36	+	8.90	9.00	-
8	10.95	11.21	-	11.30	10.71	+	10.69	12.00	-
9	6.64	5.46	+	5.40	5.17	+	8.42	5.80	+
10	8.54	7.69	+	8.06	7.81	+	9.57	7.60	+
11	10.23	8.16	+	10.20	7.86	+	10.28	8.66	+
12	5.34	4.83	+	5.13	4.36	+	5.75	5.57	+
13	8.84	7.52	+	8.00	7.60	+	10.10	7.42	+
14	8.25	9.20	-	8.30	8.62	-	8.14	9.85	-
15	4.69	4.25	+	4.35	4.08	+	5.08	4.50	+
16	4.59	4.78	-	4.60	4.75	-	4.57	4.81	-
17	3.58	3.09	+	3.00	3.13	+	4.16	3.00	+
18	7.26	8.96	-	7.09	10.06	-	7.75	7.36	+
19	4.78	4.69	+	4.16	4.62	-	5.85	4.85	+
20	6.57	6.90	-	6.16	6.75	-	7.11	7.33	-
21	5.95	5.76	+	5.58	5.66	-	6.85	5.88	+
22	4.63	3.68	+	4.76	3.18	+	4.33	4.07	+
Total +			15			12			16

TABLE 45

The Experimental and Control Retention Test Means and Difference Sign for Each Unit of Agriculture Instruction for the Tumaini Secondary School Students Who Indicated A Preference for the Lecture-Discussion Method at the End of First Term 1973

	Form I & II Combined			Form I			Form II		
Unit	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign	Experimental Method	Control Method	Sign
1	5.50	6.19	-	5.04	4.47	+	6.13	7.90	-
2	5.82	5.67	+	4.43	4.50	-	7.21	7.35	-
3	3.56	4.31	-	2.48	3.77	-	5.55	5.23	+
4	5.66	5.34	+	5.52	3.91	+	5.86	7.15	-
5	5.27	5.53	-	4.00	4.56	-	6.72	6.93	-
6	8.17	9.47	-	7.78	8.34	-	8.73	10.60	-
7	8.64	7.69	+	7.52	5.89	+	10.25	9.95	+
8	11.13	12.08	-	10.17	10.33	-	12.70	13.91	-
9	6.47	5.87	+	5.37	5.26	+	7.70	6.70	+
10	8.82	8.39	+	8.54	7.73	+	9.08	9.41	-
11	10.24	9.38	+	8.55	8.40	+	12.31	10.82	+
12	5.76	5.79	-	5.03	4.79	+	7.00	7.25	-
13	9.02	8.71	+	8.40	7.11	+	10.00	10.68	-
14	8.76	8.25	+	7.00	6.73	+	10.85	10.44	+
15	5.00	4.90	+	4.30	4.25	+	5.94	5.69	+
16	5.15	4.95	+	4.17	4.63	-	6.13	5.50	+
17	3.19	4.06	-	2.55	2.70	-	4.22	5.47	-
18	8.50	9.95	-	6.92	9.30	-	10.73	11.14	-
19	4.65	4.97	-	4.31	4.65	-	5.35	5.36	-
20	6.62	8.23	-	5.21	6.73	-	8.94	9.73	-
21	7.68	6.56	+	7.08	5.68	+	8.30	8.05	+
22	4.02	3.26	+	3.04	2.84	+	5.00	3.84	+
Total +			12			12			9

APPENDIX E

End of Term Agriculture Class Questionnaire

Jina ________________ Kidato ____
Tarehe ______________

Maswali ya Kilimo

Wakati wa term hii baadhi ya masomo ya kilimo yametolewa na Mr. Anderson kwenye jengo la dining hall kuonyesha mifano ya kawaida. Na baadhi yameonyeshwa na Mrs. Anderson kwenye Room 6 akitumia "programmed instruction". Tafadhali jibu maswali yafuatayo juu ya masomo yaliotajwa juu.

1. Njia gani unaipendelea zaidi? (chagua moja)
   a. "Programmed instruction" kwenye Room 6 ____
   b. Mafundisho ya kawaida kwenye dining hall ____

2. Kwenye njia gani uliojifunza zaidi? (chagua moja)
   a. kwenye masomo yaliofundishwa kwenye dining hall ________
   b. kwenye masomo yaliofundishwa kwenye Room 6 ________

3. Je, unapendelea kujifunza zaidi masomo ya kilimo kwa term ijayo? (chagua moja)
   a. Ndiyo _____
   b. Hapana _____

4. Kama utahitaji kuchagua kwa wakati ujao ni darasa gani utapendelea kwa masomo ya kilimo? (chagua moja)
   a. Room 6 kwenye "programmed instruction" ______
   b. Dining hall kwenye masomo ya kawaida ______

5. Kwenye mithani ipi uliopata marks nyingi? (chagua moja)
   a. Kwenye mitihani iliofundishwa kwenye dining hall kuhusu masomo ya kawaida __________
   b. Kwenye mitihani iliofundishwa kwenye Room 6 kuhusu "programmed instruction" __________

6. Panga masomo yafuatayo katika mpangilio 1 mpaka 10. Ukianzia somo ulipendalo zaidi namba 1, na mpaka mwisho namba 10.

   ____ Elimu ya Siasa
   ____ Elimu ya Viumbe
   ____ Fizikia
   ____ Geografia
   ____ Hesabu
   ____ Historia
   ____ Kemia
   ____ Kiingereza
   ____ Kilimo
   ____ Kiswahili

7. Njia gani ni nzuri kujifunza kilimo? (chagua moja)
   a. kwenye Room 6 ukitumia "programmed learning" _____
   b. kwenye dining hall ukitumia masomo ya kawaida _____

8. Kuna mambo mengi yanayofanywa na wanafunzi wa sekondari. Panga mambo hapa kwa mfuatano 1 mpaka 10. Ukianzia na unalolipenda zaidi kwa namba 1 na ukimalizia na la namba 10. Yafuatane kwa kadiri unanyoyapenda.

   ____ Kazi ya shamba
   ____ Kufanya usafi
   ____ Kujifunza darasani
   ____ Kula
   ____ Kulala
   ____ Prep
   ____ Social kama Siku ya Jumamosi jioni
   ____ Sports, games, & athletics
   ____ Tanu Youth League
   ____ Utamaduni

Agriculture Questionnaire
(English Translation)

During this term, some of your agriculture classes were taught by Mr. Anderson in the dining hall in the usual manner. Others were taught by Mrs. Anderson in Room 6 using "programmed instruction." Please answer the following questions about this instruction.

1. Which type of instruction do you like the most? (choose one)
   a. "programmed instruction" in Room 6 ________
   b. the usual instruction in the dining hall ______

2. From which type of instruction did you learn the most? (choose one)
   a. from the lessons taught in the dining hall _______
   b. from the lessons taught in Room 6 ________

3. Do you want to continue to study agriculture next term? (choose one)
   a. yes _____
   b. no _____

4. If you are given a choice next term, in which room would you like to study agriculture? (choose one)
   a. Room 6 with programmed instruction__________
   b. Dining hall with regular classes __________

5. On which test did you receive the most marks? (choose one)
   a. tests on the units which were taught in the dining hall with regular instruction________
   b. tests on the units which were taught in Room 6 with programmed instruction__________

6. Arrange the following subjects in the order you like them from 1 to 10. Begin with the subject you like the most as number 1 and continue through number 10.

   _____ Political education
   _____ Biology
   _____ Physics
   _____ Geography
   _____ Mathematics
   _____ History
   _____ Chemistry
   _____ English
   _____ Agriculture
   _____ Swahili

7. Which is the best way to learn agriculture? (choose one)
   a. in Room 6 by using programmed instruction________
   b. in the dining hall by using regular instruction________

8. There are many activities for secondary school students. Arrange the following activities in the order you like them from 1 to 10. Begin with the one you like the most as number 1 and finish with number 10.

______ garden work
______ cleaning up
______ classroom study
______ eating
______ sleeping
______ evening preparation
______ social activities
______ sports, games, athletics
______ Tanu Youth League
______ traditional dancing and games

TITLE OF THESIS An Experimental Evaluation of Programmed Agriculture Instruction in a Private Tanzanian Secondary School

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