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RESERVE

THE EFFECTS OF TRADE, PRICE AND MACROECONOMIC  
POLICIES ON RETURNS TO WHEAT RESEARCH IN KENYA

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Abstract

Kenya, which has been traditionally near self-sufficiency in most food-stuffs, faces the imminent danger that rapid population growth may overtake increases in food production capacity. In a situation where the international community and donor agencies have been aiding Kenya both in terms of research development and food-aid, there is the logical pressure to justify research budgets in the face of slow agricultural productivity increases. Wheat is one commodity whose productivity increase has not marched demand. This study analyses the returns to wheat research and the policy factors that may affect those returns. The study applies time series econometric analysis with recent modifications of the Error correction models.

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## I THE PROBLEM

Kenya relies heavily on the agricultural sector for the production of food and generation of income, employment and foreign exchange earnings. Yet the agricultural sector is faced with problems that have to be resolved in order for it to continue playing a major role in the country's economic development. First, only 20 per cent of Kenya's land area is suitable for agricultural production. This poses a major problem, particularly in a situation of rapid rural population growth. Land pressure is already being felt in the high potential parts of central and Western Kenya. This has exacerbated the problem of rural-rural and rural-urban migration.

The more potent problem of this migration is environmental degradation caused by the intensive cultivation of poor soils and the clearing of sparse bushes for fuel wood and grazing land. Even though the environmental impact has not yet been fully documented, already there is a national awareness of the fragility of the ecosystem. At the household level the shortage of such resources like fuel wood for cooking is already posing a major problem in both the high and low potential parts of the country.

The agricultural sector has also been undergoing structural changes that have implications on food and income policy. Farmers have been switching to high value export and industrial crops at the expense of food crops. There has been debate as to what the implications of this are for the process of agricultural development (Odada 1987; Kenedy, 1987, 1989). The food and cash crop trade-off has implications on income distribution as well as on food security. For instance, maintaining low food prices to protect urban consumers shifts income from the rural areas to the urban areas. On the other hand, both individual and regional income distribution will be reflected by the distribution of the cash crops vis-a-vis the food crops.

The major policy objectives of the Kenya government have been broad self-sufficiency in food production, increased earnings to farmers and increased foreign exchange earnings from agricultural exports. One of the guiding principles has been that agriculture should grow fast enough not only to feed the rapidly increasing population but also to provide surplus resources for investment in industry and infrastructure for social

development. This has to be achieved through increased agricultural productivity. Indeed, given the shortage of arable land, research and development (R & D) have to play a major role in improved productivity.

There is evidence that Kenya's economy has reached a turning point in terms of the broad economic structure. This is particularly true within the agricultural sector where institutional and structural changes are required to combat the bottlenecks that have become evident in the 1980s (Kenya 1986, 1989 World Bank 1989). The key issue is how to increase agricultural production without compromising the objectives of food self-sufficiency, environmental protection and income equality. Because of the land constraint, the solution lies in intensive but not extensive agriculture. To achieve this requires the adequate development of agricultural incentives, services and institutions needed to encourage innovation and investment (World Bank, 1984). Innovation will occur through increased agricultural research and development (R & D). While private investment is a function of relative returns to agriculture and other incentives, research is a function of a wide range of factors, most of them linked to public policy.

One of the key questions is whether macroeconomic policies have any role to play in such a transformation. The development of incentives and institutions will depend on national agricultural and macro-economic policies. It is therefore imperative that the consequences of past agricultural and macro-economic policies on the agricultural sector be well understood in order to design new strategies for increasing agricultural productivity in the years to come.

These questions can be raised with respect to a specific commodity within the agricultural sector. This study focuses on wheat research and production in Kenya. Wheat production in Kenya faces a number of challenges. From the demand side wheat consumption is likely to expand at a rate of 7 per cent per annum in the next decade due to rapid population expansion and increased urbanization. On the supply side even though yields have improved from 1.32 tones per hectare in 1964 to 1.76 tones in 1985 and production increased at a rate of 10 per cent per annum, today domestic production satisfies only 60 per cent of consumption and the gap between production and consumption is likely to expand. It is therefore logical that self-sufficiency in wheat include wheat imports. The pertinent question is what role domestic research and production policy should play in such



an environment. Is it desirable or even possible for Kenya to produce enough wheat to meet domestic consumption requirements? If imports are inevitable, what is the role of wheat research and how can we tell if the current research agenda is appropriate? These are the central questions in this study.

Studies done elsewhere have shown returns to wheat research ranging between 11-12 per cent to 125-150 per cent (Daniels et al 1989). The rate of return depended on the existence of other infrastructure like irrigation networks and good marketing policies. The key question is whether Kenya has the infrastructure to benefit from increased wheat research or not, and if so, what rate of return would be the minimum required to justify continued wheat research. Secondly, studies on wheat research in the developed countries show a deliberate choice either towards chemical, biological or mechanical technology depending on the resource constraints. We would like to determine what option Kenya's wheat research has taken, and on what criteria.

## II) OBJECTIVE

Our main objective in this study is to analyze Kenya's wheat sector and determine the interaction among research and development (R & D), yield, area planted and the overall trade and macroeconomic policies of exchange rate and interest rate determination. Indeed, there is a wide spectrum of issues that one can look at in terms of the link between macroeconomic policy and wheat production. However, in this study we specifically shall concentrate on: 1) Measuring the returns to past investment in wheat production in Kenya; 2) Modeling the effects of trade, price and macroeconomic policies on the wheat sector; 3) Quantifying the impact of these policies on the returns to wheat production research and 4) Designing a forward-looking policy framework which increases Kenyan wheat production at minimum cost to the economy.

At the domestic level wheat faces two challenges. One is the competition from maize and barley which grow in the same agro-ecological zones as wheat and they may be more profitable in monetary terms than wheat to farmers. With the continuous subdivision of land due to population pressure farmers are likely to switch from <sup>wheat</sup> to maize production. The second challenge is from triticale (a cross-breed between <sup>wheat</sup> and rye) and sorghum. Agro-industrial research on these two commodities has shown that

they can be used in making bread just as wheat and they have the advantage of being resistant to drought. Given these challenges, the key question is how much of the scarce national resources should be devoted to wheat production and research. Our final objective is then to analyze different policy scenarios and evaluate their impact on returns to research, output and the overall welfare of the Kenyan people.

### III) IMPORTANCE OF THE STUDY

While Kenya has been near self-sufficient in most food-stuffs, there is the imminent danger that the rapid population growth rate may by-pass food production capacity thus leading to an increasing food import bill. In a situation where the international community and donor agencies have been aiding Kenya both in terms of research development and food-aid, there may be the pressure to justify their research budgets in the face of slow agricultural productivity growth and projections of increasing food shortages over the next decade. The wheat sector in Kenya is one of the clearest cases of this scenario. There is the need to clearly define Kenya's wheat research objectives and to measure the impacts of past research endeavors. More important is that relatively very few studies on returns to research have been done in Kenya and Africa as a whole compared to other parts of the world (Daniels 1989, Karanja 1990). This study will be an addition to the scarce studies on <sup>the</sup> rate of return to agricultural research in Kenya.

Secondly, one of the major tasks of agricultural planning in Kenya has been to synchronize production targets as provided by the Ministry of Agriculture and the financial requirements by the Treasury. For instance subsidies to the various parastatals involved in agriculture end up being borne by the Treasury. So long as treasury activities influence macro-economic variables like the money supply, interest rate, exchange rate and inflation, decisions taken in the agricultural sector will have impacts on the overall economy and vice versa. Even though this issue has been raised in the planning circles, no commodity studies have been done to determine the interactions between commodity policies and macroeconomic policies.

Thirdly, Kenya is an open economy relying heavily on imports and exports for economic development. Trade shocks and the way they are managed will therefore continue having a significant impact on Kenya's economy. The difficulties associated with negotiating international commodity agreements have made it imperative for developing countries to learn how to

survive in unstable international commodity markets, rather than to hope for a stable one. This requires internal macroeconomic policies that would facilitate fast responses by the agricultural sector to the changing world commodity environment. This is particularly critical in many developing countries which need imported capital goods for economic development in the face of increasing food import bills (Scobie 1981). Thus there is a need to understand the interaction between international trade shocks and domestic commodity production.

Finally, from the theoretical point of view, a review of the literature on agricultural policy indicates increasing emphasis on understanding the role of macroeconomic policies in agricultural development. This has been necessitated by the continuing debate in macroeconomics on the importance of certain policies within the economy and the linkages among micro, sectoral, macro and international variables. Underneath any policy model is the question: Do policies really matter? While advances have been made in this area in the developed countries, few studies have been done in the developing world.

#### IV) RESEARCH METHODS

##### a) Towards a Theoretical Framework

This study will be done within the framework of economic theory and agricultural policy, based on two fundamental theoretical assumptions: 1) that farmers as economic agents aim to optimize net return on agricultural output over time and in doing this they respond to real factor and output prices in the economy, and 2) that through decisions on trade, money supply and taxation the government influences the relative prices in the economy. As to the first assumption there is evidence to show that Kenyan farmers are responsive to price changes, especially the large commercial wheat farmers (Heyer et al 1976, Maitha 1974, Kere et al 1986). The second assumption has been a matter of great intellectual debate in macroeconomic theory. While there is no agreement as to the direction and magnitude of government influence on macroeconomic variables, there is the consensus that government policy does indeed influence macroeconomic variables.

The basic model in this study is the demand and supply of wheat as functions of wheat prices, prices of close substitutes and compliments, income and a wide range of other shift factors. From this demand and supply

relationship we can estimate the improvement of national welfare due to increased wheat yield emanating from wheat research using the rate of return and social surplus methods (Daniels et al 1989). We can relax as many assumptions as possible concerning the estimation depending on data availability and the computation methods. For instance while many studies have assumed the government policies as exogenous we will internalize them. Since the 1980s many studies have been done in the developing countries aimed at measuring government policy impacts by internalizing the policy variables in the demand and supply framework (Scobie 1981, Krishna and Chhibber:1983, Oyejide 1986, Eeven, Collier and Gunning 1987). Others have taken a sectoral approach to analyze different scenarios of government policy using Computable General Equilibrium (here after CGE) models.

Questions have been raised about the robustness of both econometric demand and supply models as well as CGE models. For instance the CGE models are based on the assumption of flexible prices, thus marketing clearing conditions. It could be possible that prices do not clear in the short run. Models have been developed that combine both short run price rigidity and long run price flexibility. For instance using Error Correction Models (here after ECM) one can test for long-run equilibrium relationship among variables while allowing for short-run deviation from the equilibrium (Engle and Granger, 1987, Robertson and Orden 1988). We will try to apply the ECM approach in this study.

The study of the impact of macro-economic policies on agriculture has been done at two interrelated levels. The first has been to determine which among the various macro-economic policies affect the agricultural sector. The second has been looking<sup>at</sup> the mechanisms by which these policies affect the agricultural sector. It has, however, been difficult to separate the policy from the process. One aim of this study is to devise a method of analyzing the interrelationships among macroeconomic policies and sector specific variables.

The two categories of macroeconomic policies are the fiscal and monetary policies. In general, monetary policies have attracted more interest among macro-economists than fiscal policies (Schuh 1981, Frankel 1984). In Kenya, monetary policies were rarely used as policy instruments until the 1970s (Killick, 1981). Monetary policies affect the structure of interest rates, the foreign exchange rate and the general and relative price levels. As stated earlier, it will be assumed that agents within

the agricultural sector (farmers, middlemen, processors and government) take their decisions based on the actual and expected values of these variables in the economy. The first level of analysis is whether monetary policy affects the above three variables and in what direction. Our aim will not be to test the theory of these relationships but make plausible assumptions about the long run equilibrium relationships and determine the short-run deviation from these long run relationships using the ECM and other time series models discussed below.

Since the 1980s many studies have been done, particularly in the Developed Countries, to show the link between macroeconomic policy and agricultural performance. Among the interesting studies in the USA are those by Chambers (1984) and Frankel (1984) who have shown that monetary and exchange rate policies have significant influences on the agricultural sector. Applying similar methods of analysis to Brazil and New Zealand, Bessler (1984) and Robertson and Orden (1988) respectively came up with the same conclusions that monetary policies do affect the relative price ratios between agriculture and other sectors of the economy.

The ECM analysis has two major problems: a) degrees of freedom and b) the identification procedure. It is obvious that if many variables are included then, given long lag lengths, the degrees of freedom may be compromised. Secondly, the identification method may assume certain structures that may not conform with reality.

## b) Returns to Research

Research methods are to some extent limited by data availability and the nature of the issue under investigation. Given our four objectives we will try to use the most appropriate analytical methods given the data limitations. However we will emphasize three analytical methods; cost-benefit analysis, time series econometric analysis and qualitative analysis.

The cost-benefit analysis will be used to determine the rate of return of wheat research in Kenya. This method will be applied in an ex post fashion, focussing on past research investments, and measuring the research benefits. The benefits are measured by the shift in the supply curve of the given product which will lead to an improvement in social welfare. Many studies have been done using this method both in the developed and developing countries (Karanja 1990).

Some potential problems include the lack of data, particularly in developing countries and the problem of separating the effects of other supply shifters like extension, infrastructure and policy. With respect to the first problem there may not be a serious data constraint since wheat has been grown and researched for over 80 years. Data may be available for at least the last forty years, which is excellent by developing country standards.

With respect to the second problem, it is true that other intervening factors have contributed towards increased wheat productivity in Kenya. More so the international research community and donor agencies have played a central role in the promotion of the research itself. Historically wheat farmers have been at the forefront of wheat production innovation and adoption (Huxley, 1957). We will therefore incorporate as much econometric information as possible to try to isolate the effects of research, but will also rely on qualitative information when appropriate. We will get a sample of wheat farmers to determine their experience in wheat production and research.

There is also the problem of trying to ascertain whether the benefits of research go to farmers or urban consumers for equity purposes. While many studies have favored directing research benefit to farmers (Daniels et al 1989), it is the case in Kenya that farmers who grow wheat may be wealthier than the urban consumers, so that for equity purposes, it may

be desirable to direct the benefits of wheat research to consumers. This issue will be developed in detail in the study.

c) Impact of Macroeconomic and Price Policies.

The time series econometric model will be used in analyzing the link between wheat production and research and government macroeconomic and price policies. In this study we do have a major problem with data in that we have annual data of the variables under investigation for only 45 years. We will try to determine ways of utilizing limited observations in VAR and ECM models, for instance dealing with fewer variables at a time. The other problem is that many structural changes have taken place not only in the wheat sector alone but also in the rest of the Kenyan economy. We will also have to look for ways of dealing with this problem.

The basic model

Suppose we had a conventional simultaneous demand and supply model of the form:

$$By_t = ax_t + e_t \quad (1)$$

where  $y_t$  is a vector ( $n \times 1$ ) of endogenous variables,  $x_t$  is a vector ( $k \times 1$ ) of endogenous variables,  $B$  and  $a$  are structural parameters and  $e_t$  is a vector ( $n \times 1$ ) of the errors with zero mean and constant variance, then the VAR model equivalent will be:

$$By_t = B_1 y_{t-1} + a + e_t \quad (2)$$

where  $y_t$  is a vector ( $n \times 1$ ) variables.  $B$  and  $a$  are vectors on the contemporaneous relationship between  $y_t$  and  $e_t$ , and  $B_1$  a parameter matrix of the dynamic link among the variables  $y_t$ . We can obtain the inverse of  $B$  such that equation 2 becomes

$$y_t = y_{t-1} + a + e_t \quad (3)$$

where  $a = B^{-1}a$ ,  $e_t = B^{-1}e_t$  and  $cov(e_t) = B^{-1}cov(e_t)B^{-1}$

Equation 3 is central to the identification, estimation and analysis of VAR models. A wide range of analyses and tests can be done on the model in equation 3. In this paper we will determine the behavior of the

variables like research expenditure, wheat prices, interest rates, money supply and the exchange rate over time by testing each for unit-root and co-integration. We will also use the Granger Causality and Response Analysis to determine the responses of the various variables to different shocks. In our case we will be interested in the impact of macroeconomic and price shocks on wheat output (yield Area).

The VAR and ECM regression analysis will be used to determine parameter estimates of wheat production and demand as functions of lagged output, relative prices, exchange rate and interest rates as endogenous variables. Factors such as weather conditions will be considered exogenous. Simultaneous equation systems with lagged variables will be applied in order to capture the links among the variables as well as a supply and demand relations of the wheat market. Assuming long-run equilibrium of demand and supply, we will analyze the sources of demand and supply shock to the long-run equilibrium; most important will be the supply-based shocks which are related to technological innovations.

Data requirements will include time series data from 1945 to 1989 on wheat output, prices, coffee and tea price, maize output and prices, expenditure on wheat research, exchange rate, interest rate and related policies instituted by the government over this period. This period is chosen on the basis of the availability of secondary data for wheat production and research. A cross sectional survey will be undertaken to determine the state of the wheat sector as reflected in performance parameters such as yield, foreign exchange component, profitability and resource (Financial and Foreign Exchange) requirements. We will also utilize existing information of supply and demand elasticities.

#### V) TIME-FRAME

The research will be in three phases. Phase I includes finalizing the proposal, designing the questionnaire and doing the literature review in Michigan State University. This will be from November to December 1990. Phase II will be the fieldwork in Kenya which will include: 1) Compiling secondary data from the Ministries of Finance, Planning and Economic Development, Agriculture and Supplies, <sup>& marketing</sup> on wheat production, exports, consumption and livestock related macroeconomic policies; 2) Compiling secondary data on wheat research at the National Plant Breeding Station, Njoro; 3) Doing a literature review on wheat research and macro-economic policies in Kenya; 4) Collecting primary data on wheat farming from a sample of farmers in the Rift Valley and finally 5)



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Analyzing the data to determine the key findings of the research and writing a draft dissertation. This should take 9 to 12 months in Kenya. Phase III will be finalizing the dissertation and writing working papers. This will take about 6 months in Michigan State University.

#### VI) OUTPUT

The outline of the Dissertation is as follows:

##### Chapter 1: Background

a) Wheat Production in Kenya: A description of the production and consumption trends of wheat since it was first introduced in Kenya in 1904. This will include defining the problem as well as the significance of the study to agricultural policy formulation in Kenya.

b) Wheat Research in Kenya: A description of wheat research analyzing how the National Plant Breeding Station (for wheat) has developed and its interaction with local wheat farmers, other regional and international wheat research organizations and donor agencies.

c) Trade, Agriculture and Macroeconomic policies: A analysis of the formulation and implementation of these policies and how they are interrelated.

##### 2) Chapter 2: Methodology.

This will include a review of the literature on a) measurement of returns to research b) Analysis the determination of trade agricultural and macroeconomic policies within the commodity demand and supply analysis. It will also include setting up of the hypothesis and methods of testing them using time series econometrics.

Chapter 3: Data collection

Analysis of the data collection and validation methods

Chapter 4: Rate of Return to wheat research

An ex post analysis of return to Past investment in Kenyan wheat research. This will involve econometric and cost-benefit analysis by analyzing wheat supply and demand shifters.

Chapter 5: Impact of Trade, Agricultural and Macroeconomic Policies

A time series analysis of the contemporaneous relationships between returns to wheat and the different policies. This will include unit root tests, co-integration error correction and impulse analysis.

Chapter 6: Wheat Policy

On the basis of the results in 5 project different scenarios of the impact of policies on wheat research on treasury and the overall allocation of resources in the economy.

Chapter 7: Summary and Conclusion.

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