Technological options and Policy Incentives for Higher Self-Sufficiency in Wheat for Eastern and Southern Africa

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Setting:

Domestic supply of wheat has shown slower growth records than consumption in a large number of wheat-importing African countries over the last two decades. The unproportional growth in wheat consumption have led to declining self-sufficiency ratios and increased importation of wheat into Africa. This has important implications for food security and allocation of foreign exchange resources in such economies already experiencing severe external deficits and declining per capita production of principal staples.

Several governments have chosen to expand local production in an attempt to bridge the wheat gap. While this option leads to reduced reliance on external food and lower demand for foreign exchange, it contributes to increased competition for domestic resources. It is therefore important to determine the scarcity value of these resources for proper assessment of net social gains from wheat production. Evaluation of the comparative advantage of

local wheat versus alternative uses of domestic resources provides stronger basis for guiding resource allocation decisions in these countries. This is also necessary to assess the potential contribution of wheat research to improved economic efficiency and assist national and international research institutions decide on the optimal level of resources to commit to wheat.

Apart from the economic efficiency considerations, increased dependance on home produced wheat is often challenged as a better strategy for food security in most African environments. Given the large foreign component in wheat production, the unreliable input procurement and delivery systems plus the unfavourable and highly unstable physical and economic conditions in these countries, it is questionable whether domestic production provides a more stable source of wheat supply than the world market.

This paper reviews the causal factors behind internal wheat demand-supply imbalances and presents methods of comparative advantage analysis. The procedures discussed in this paper follow closely the analytical framework proposed by CIMMYT for studying the comparative advantage of local wheat industries (Byerlee and Morris, 1989; Morris, 1989). The same analytical tools were used by CIMMYT economists to evaluate the competitiveness of domestic wheat in using production and research resources in a number of countries

(Ecuador: Byerlee, 1985; Mexico: Byerlee and Longmire, 1986; Kenya: Longmire and Lugogo, 1989; Zimbabwe: Morris, 1988). The present research extends this framework to study the efficiency of local wheat production in Eastern and Southern Africa. A comprehensive analysis of the technological determinants and policy constraints to higher wheat self-sufficiency in the region is in progress. Preliminary results of the on-going research project, however, are reported here.

The next section reviews regional wheat trends and analyzes some of the main forces leading to the current wheat gap. Section two discusses some options for increased self-sufficiency in wheat. Domestic resource cost methods are presented in section three. A summary section concludes the study.

The growing wheat gap

Annual wheat consumption in sub-saharan Africa has jumped from 1.8 to over 6 million tons between 1961 and 1987. Local production, on the other hand, improved by about 0.6 million tons a year only, over the same period. Self-sufficiency in wheat has accordingly dropped from above 50% to 25% by 1987 (Table 1). It is important to notice that about 87% of the increased consumption has been imported. Figure 1 depicts the growing wheat gap in sub-saharan

Table 1. Wheat production, consumption, self-sufficiency and Food aid for sub-Saharan Africa

Region	Domestic Production (000 Ton)		Total Consumption (000 ton)		Self-sufficiency %		per capita (kg)		% of imports as food aid (%)	
	1961-1965	1983-1987	61-65	83-87	61-65	83-87	61-65	83-87	61-65	83-87
Eastern	780	1144	917	2656	85	43	17	25	39	81
Southern	118	296	454	1058	26	28	9	13	16	39
Central Western Sahel	51	99	489	2499	10	4	4	11	20	22
Sub-Saharan Africa	949	1539	1860	6213	51	25	8	15	19	40

Source: CIMMYT Economics, Country data base

Africa. Interesting regional variations in wheat consumption and production patterns are also revealed by Table 1. Per capita consumption in Eastern and Southern Africa was higher in the early sixties than the sahel, central and western Africa countries but grew slower thereafter. The table also shows that unlike other regions, local supply of wheat increased faster than consumption in Southern Africa, although the region still imports 72% of its total needs.

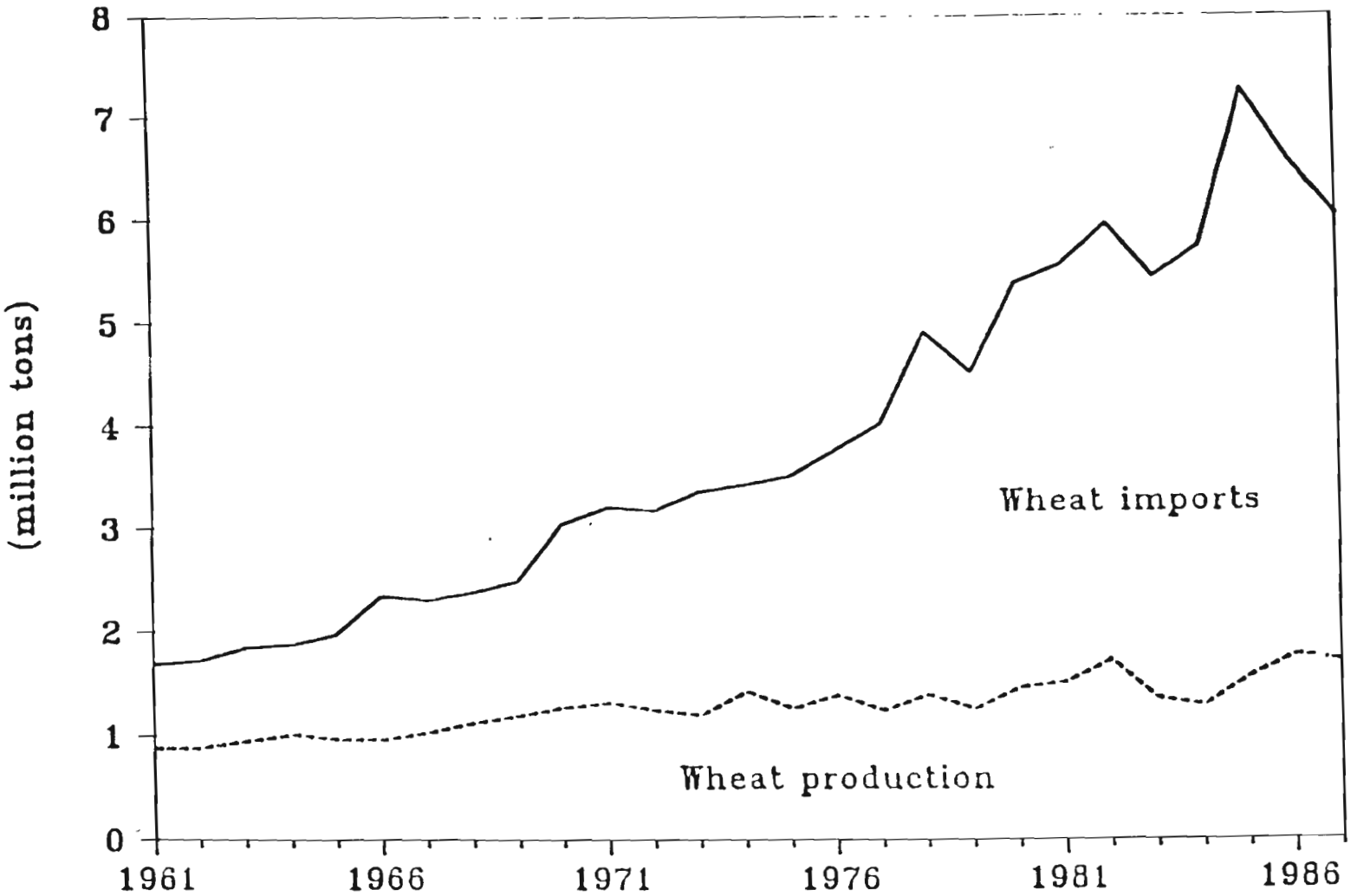

Figure 1: Wheat production and imports in sub-Saharan Africa (1961-1987)

(Borrowed from Byerlee and Morris 1989)

Inspite of the rapid growth in its consumption wheat is still not the main food staple for the vast majority of the African people. It is however, an important commodity for other economic and political reasons. In addition to being a big user of the scarce foreign exchange resources of these countries, wheat is the basic food for the politically powerful urban populations. Important factors that have contributed to the divergent demand-supply trends are briefly reviewed below.

1. Subsidized bread prices

The high subsidy on bread prices is considered one major reason behind increased wheat consumption in most African countries (Byerlee 83, Mwangi 82). Consumer wheat prices are subsidized both directly through budgetary allocations and by applying overvalued exchange rates to wheat imports. One example is given in Table 2, where the direct cost of a consumer price subsidy on locally produced wheat in Sudan is calculated. The table shows that the government absorded more than 50% of the actual cost of local wheat flour in 1987. Part of the consumer subsidy was borne by producers through low grain prices paid at an exchange rate at least 50% lower than its shadow price. When wheat was moved to the parallel market the government share jumped to 82% and 73% in 1988 and 1989 respectively as producer prices

Table 2. Calculation of the consumer price subsidy on locally produced wheat in Sudan (1987-89).

	1987 (LS/Ton)[1]	1988 (LS/Ton)	1989 (LS/Ton)
a- Grain price to producers	770	2400	3000
b- Cost of flour at 80% extraction rate (a ÷ 0.8)	963	3000	3750
c- Milling costs	180	260	400
d- Actual cost of flour (b+c)	1142	3260	4150
e- Selling price of flour	540	580	1100
f- Subsidy on flour (d-e)	602	2680	3050
Selling price as % of acual cost	47%	18%	27%
Cost to the government as % of total cost	53%	82%	73%

Source: Own calculation - secondary information compiled from Ministry of Internal trade, Ministry of Finance, Sudan Gezira Board, Wheat self-sufficiency committee reports, Food security study (1988) and survey of Milling firms.

improved. It has also been found that more than 30% of the countries of sub-saharan Africa maintained a consumer price for wheat lower than its import parity cost valued at the official exchange rate (Byerlee and Morris 88). This number jumps to 50% of the countries when exchange rate is adjusted towards its market value.

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1 LS refers to Sudanese pounds

Wheat price to consumers have therefore stayed lower in real as well as absolute terms relative to other food staples providing strong incentive to increased wheat consumption and substitution away from traditional foods. Wheat share in total cereals consumption have accordingly risen from 5% to over 10% in sub-saharan Africa over the last two decades (Byerlee and Morris 89). Figure 2 portrays the declining shares of coarse grains and rising wheat component in per capita consumption of cereals.

2. Food Aid:

The fact that most food aid to sub-Saharan Africa was given in wheat contributed significantly to increased wheat consumption. Wheat aid was the basic source of funding bread subsidies and even generating surplus revenues for many African governments. It was also the main reason why these countries could sustain such high levels of wheat imports. The proportion of total annual wheat imports received as food aid increased from about 20% to 40% between 1961 and 1987 in sub-Saharan Africa (Table 1). Wheat aid paid for more than 80% of total wheat imports in Eastern Africa in 1987.

While food aid is necessary as a temporary relief to occasional food shortages, it generates more stable long-

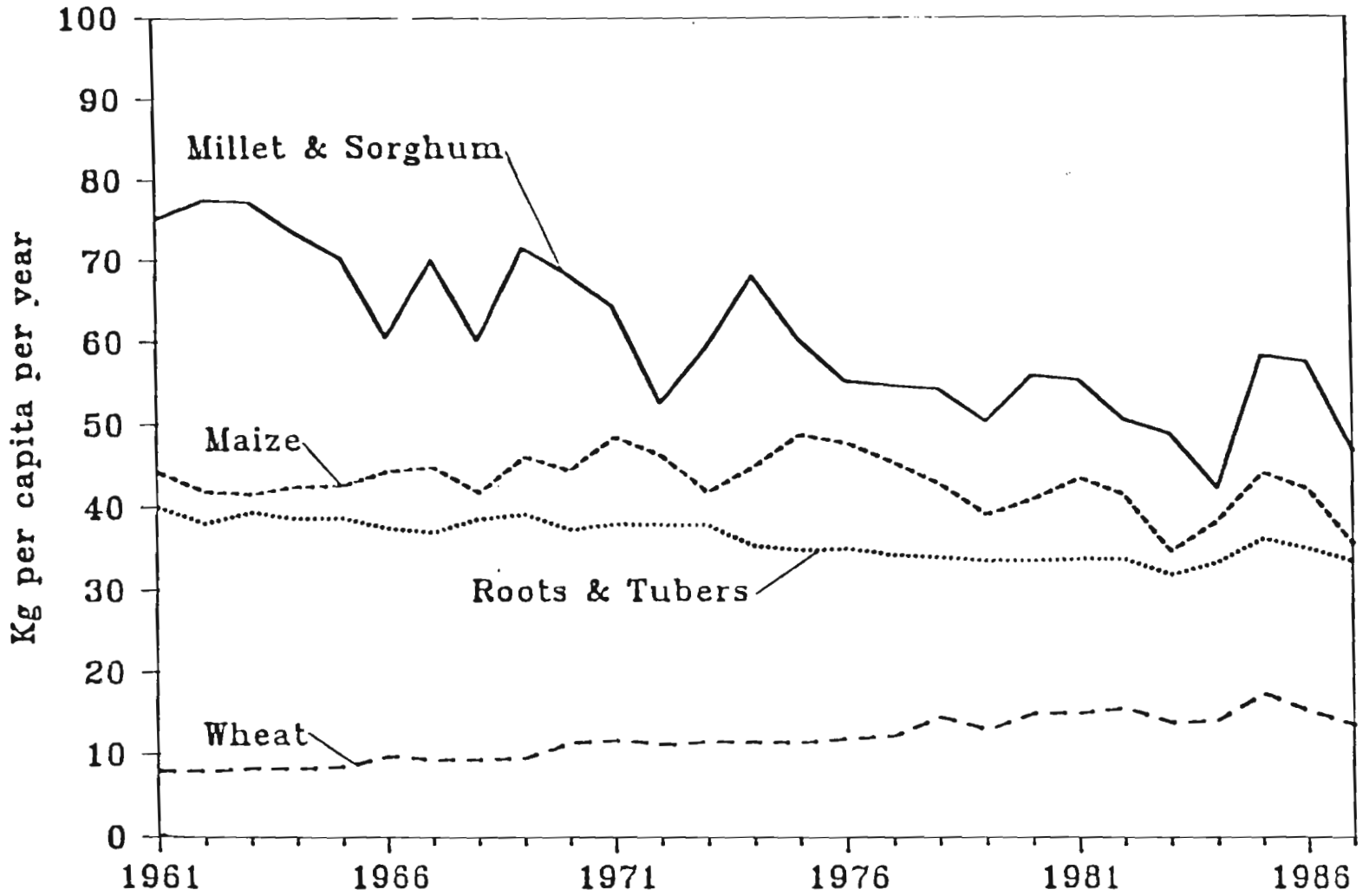


Figure 2: Per capita consumption of principal staple foods in sub-Saharan Africa (1961-1987)

(Borrowed from Byerlee and Morris 1989)

term effects on consumption habits if persists over time. As wheat aid continues to support low consumer prices and high wheat imports a permanent taste for wheat develops and wheat changes from being a minor food to a basic staple by time particularly for the urban population in these countries. Moreover, wheat aid has helped establish large local wheat processing industries adding one more interest group (Millers) to lobby for policies promoting wheat consumption.

3. Urbanization:

Urban populations consume twice as much wheat as rural people do in sub-Saharan Africa (Byerlee and Morris 1988). The high rate of rural-urban out migration and rapidly crowding cities in Africa have been another wheat promoting factor. Wheat is more attractive to urban consumers as a convenience food. It takes less time and backing energy to process wheat bread relative to other grains, given the current state of baking technology for alternative staples (Mwangi 82, Senauer et al 86). There is also some evidence that as more women join the labor force in the cities consumption of bread increases (Damous 86, Senauer et al 86). This is simply because as women leave home for work the number of people demanding meals away from home rises.

4. Producer incentives and pricing policies:

There are mixed empirical results with regards to whether wheat production has been taxed or subsidized in Africa. As most countries maintained over-valued exchange rates, it has been argued that this biases structure of incentives against production of local substitutes. At the same time, wheat producers usually enjoy an indirect subsidy on imported inputs (chemical inputs and machinery) through the very same currency over-valuation. There is enough evidence however, that agricultural and macro economic policies have discriminated against agricultural tradables in general (food & cash crops) and agriculture provided the tax base and cheap source of food and industrial inputs for the urban based manufacturing industries and population in most developing countries (Krueger, Schiff and Valdes 1988, Valdes 86, Hassan 90, Scobie 83). It is nevertheless, difficult to generalize as the effects of these policies are quite complex and the extent to which individual commodities are discouraged varies by country and changes over time.

5. Physical and technological factors:

While no general conclusion can be reached about the negative effects of pricing policies on production, other physical, economic and technology constraints have limited wheat productivity and area expansions in sub-saharan

Africa. The physical environment, inefficient production technologies and farmers management, poor input delivery and output distribution systems and infrastructure and the low levels of investment in research and extension were identified as major barriers to promoting local wheat production (Byerlee & Morris 89). While total area that is climatically suitable for wheat cultivation in sub-Saharan Africa is limited (20 million ha by FAO estimates) only 1% of it is currently sown to wheat. Table 3 below summarizes the major technical and economic constraints to local wheat production in sub-Saharan Africa. These factors on the other hand, present real opportunities and challenges for potential contributions of investment in wheat research and development. A procedure for assessing the net social gain and economic efficiency of these options is discussed below.

Policy options and productivity potentials for self-sufficiency in wheat

Higher self-sufficiency and reduced dependance on wheat imports can be accomplished through restricting consumption and/or promotion of local wheat production.

Table 3. Major wheat production environments and production constraints in sub-Saharan Africa.

Agro-climatic environment	Area of wheat	Countries	Major Production Constraints	
			Technical	Economic
1. Highland cool wet (over 1800m)	900,000 ha	Burundi Ethiopia Kenya Rwanda Tanzania Uganda Zaire	Disease (stripe rust and *septoria tritici*), weeds, soil acidity, poor drainage	Competing crop and livestock enterprises
2. Mid-altitude irrigated cool dry (winter season)	54,000 ha	Madagascar Malawi Zambia Zimbabwe	Disease (stem rust, leaf rust)	High cost of irrigation and competing uses of scarce water
3. Mid-altitude warm humid (rainy season)	3,000 ha	Madagascar Malawi Zambia	Disease (esp. *Helminthosporium*), soil acidity	Competition from staple crops and low wheat yields
4. Low altitude irrigated hot dry (winter season)	130,000 ha	Ethiopia Malawi Nigeria Sudan	Heat stress	High cost of irrigation and competing uses of scarce water

Source: Byerlee and Morris (1989)

1. Demand Management:

Estimates of price elasticities of demand indicate that wheat consumption is very responsive to movement in relative prices in most African countries (Byerlee and Morris 89, Damous 86). Removal of consumer subsidies and exchange rate adjustments will therefore be effective measures for curbing wheat consumption. Currency devaluation and elimination of bread subsidies however, are politically sensitive policies and difficult to implement for most governments.

Another factor that would contribute to reduced wheat consumption is to shift food aid to other staples that are suitable and consistent with the consumption habits of the majority in these countries. Controlling for the effects of urbanization and women participation in work, on the other hand, represent targets for long-term planning and rural development strategies. There are however, other options for managing urban demand in the short to medium runs such as increased use of composite flours for bread making and introduction of efficient baking technologies for local substitutes to compete with wheat for the convenience and tastes of the urban consumer. It is also important to reduce unnecessary investments in local wheat processing and prevent the irrational build up of excess milling capacities, particularly in the wrong locations (e.g. coastal cities). Tariffs and trade policies that favour

importing wheat as grain should be reversed to encourage flour imports instead.

Some of these measures are already in effect in many African countries where economic recovery programs have recently been initiated. Several economic adjustments were made in order to reform price distortions. Consumer subsidies were being gradually reduced and exchange rates adjusted in many countries inspite of the strong resistance by various interest groups particularly in the urban centres. The use of composite flours has also increased and more research resources are being diverted to the development of suitable mixtures and improved processing and bread making technologies, e.g. Sudan, Kenya, Ethiopia. The share of cereals other than wheat (rice, maize and sorghum) in food aid to Africa have also improved recently bringing the share of wheat in total food aid to Africa down to about 50% compared to 75% share in food aid to all developing countries (Byerlee and Morris 88). While a lot more remain to be desired in demand management, these policies have caused wheat consumption to decline in sub-Saharan Africa since 1985 (Byerlee and Morris 89). The favourable effects of these policies have at least demonstrated the potential for demand measures in controlling wheat consumption.

2. Promotion of local production

Before research and production resources are committed to expanding local wheat industries, the optimality of these decisions need to be assessed carefully. The economic efficiency of these investments and their contribution to food security should be adequately evaluated against viable alternative options.

a) Local wheat for food security:

The main objective of food security is to ensure an adequate and stable supply of food to the country. The question is therefore if local wheat provides a more reliable supply of food than the world market.

Wheat yields in sub-saharan Africa were found to be highly sensitive to water shortages, high temperatures, timely planting and delivery of essential inputs mainly due to the relatively unfavourable and erratic climates, poor infrastructures and a short growing season. Coefficients of variation (CV) in wheat yield calculated for a number of African countries ranged between 52% in Nigeria and 18% in Kenya for the period 1967-87 (Byerlee and Morris 89). Compared to a CV around trend of 28% for the world price of wheat indicate that for many countries e.g. Sudan 38%,

Zimbabwe 30%, local wheat production is less stable than the world market supply.

It is important to notice however that the international wheat market is not perfectly competitive due to the influences of export promotion strategies of major wheat exporting countries. The stability of international prices and supply of wheat in the long-run is therefore dependant on changing production conditions and policies of these countries. Moreover, the potential contribution of wheat research into improved production technologies and farming methods to lower yield variability need to be studied. The focus on wheat as a priority option of food security versus promotion of other major food staples that are more important to the majority of the population in sub-Saharan Africa (sorghum, Maize, tubers) is also questioned. There are other strategies of food security to consider and compare to the alternative of expanding local wheat production e.g. establishing buffer stocks.

b) Local wheat and Economic efficiency:

A more important question in promoting domestic wheat production is whether wheat is the most efficient user of domestic resources. Local wheat has to pass

essentially two tests to establish a comparative advantage in using any country's resources. First, the amount of foreign exchange needed to produce one unit of local wheat has to be less than the cost of importing the same unit into the country. Meeting this requirement is of course not sufficient as it assumes away the presence of alternative productive uses and hence assigns zero opportunity costs to domestic resources invested in local wheat. The second test is therefore for wheat to generate the largest net social gains from using the country's land, labor and capital resources over available alternative options. Net foreign exchange saved or gained per unit resource used in wheat production must be greater than that earned in all other viable investments.

The Domestic Resource Cost (DRC) ratio provides a useful measure of the competitiveness of alternative uses of domestic resources. The DRC methodology is outlined next.

Determining the Comparative Advantage of local wheat

The concept of comparative advantage dates back to Ricardo's (1817) work on international competitiveness and welfare gains from specialization and trade. This framework then

led to the development and use of DRC ratio to measure relative efficiency of resource use for purposes of project selection, policy analysis and country-wide evaluation of alternative investment strategies (Bruno 1967, Pearson and Monke 1987). The basic formula for computing the DRC coefficient and its variants is defined below. More detailed description of the DRC procedure and useful applications on wheat are given in Morris (1989).

$$C_i = \frac{\sum_r N_r X_{ri}}{\sum_i P_i Q_i - \sum_j P_j Q_{ji}} \qquad (1)$$

where:

C_i measures the cost or value of domestic resources used in saving or generating a unit of value added in activity i.

N_r opportunity cost price for the non-traded primary factor r.

X_{ri} quantity of factor r used in activity i

P_i, Q_i import parity price and quantity of the traded product i

P_j, Q_{ji} import parity price and quantity of traded input j used in i

The numerator of equation (1) represents the economic value of domestic resources invested whereas the denominator derives value added in activity i. C_i gives the DRC coefficient when the numerator is expressed in domestic

prices and denominator in foreign currency. DRC ratios thus measure relative efficiency in terms of cost of domestic resources in local currency required to save or generate one unit of foreign exchange. This coefficient is interpreted as the rate of transformation between domestic and foreign currencies in activity i, and is usually compared to the effective exchange rate e. If DRC_i is greater than e this implies that it costs more in terms of domestic money (resources) to generate one unit of foreign exchange through activity i than converting currency in the official (parallel) money markets (using the official or parallel exchange rate e). Accordingly activity i is non-competitive and vis-versa.

A more useful and straight forward criteria for comparing the economic efficiency of alternative investments is the Resource Cost Ratio (RCR) which obtains when both the numerator and denominator of C_i are expressed in same currency units (usually domestic). The RCR coefficient is then used as follows to determine the comparative advantage of activity i :

$0 < RCR_i < 1$ implying that value added per unit of product i is larger than the value of domestic resources used to produce that unit and thus i has comparative advantage.

$RCR_i > 1$ value of domestic resources used to generate one unit of i is greater than value added per unit of i and thus no comparative advantage.

$RCR_i < 0$ value of the foreign and domestic tradeables used to generate one unit of i is larger than the unit price of i (negative value added) and hence no comparative advantage.

Social profitability measured as the Net Economic Benefit (NEB) from activity i is obtained by subtracting the numerator (cost of primary factors) from the denominator of RCR. The NEB criterion is therefore equivalent to RCR with terms rearranged.

Although the arithmetic is simple, data requirements for the DRC analysis are extensive and complex. Choosing the right price for non-traded primary factors such as land, labor and capital and for valuing foreign exchange is commonly a major difficulty in deriving DRC coefficients. While outputs and traded components of used inputs are priced at their import parity cost, the share of non-traded resources (land, labor and capital) in purchased inputs need to be estimated, priced at their respective opportunity costs and included with the cost of domestic resources in the numerator. Decomposition of purchased inputs and services into their traded and non-traded components is usually a difficult

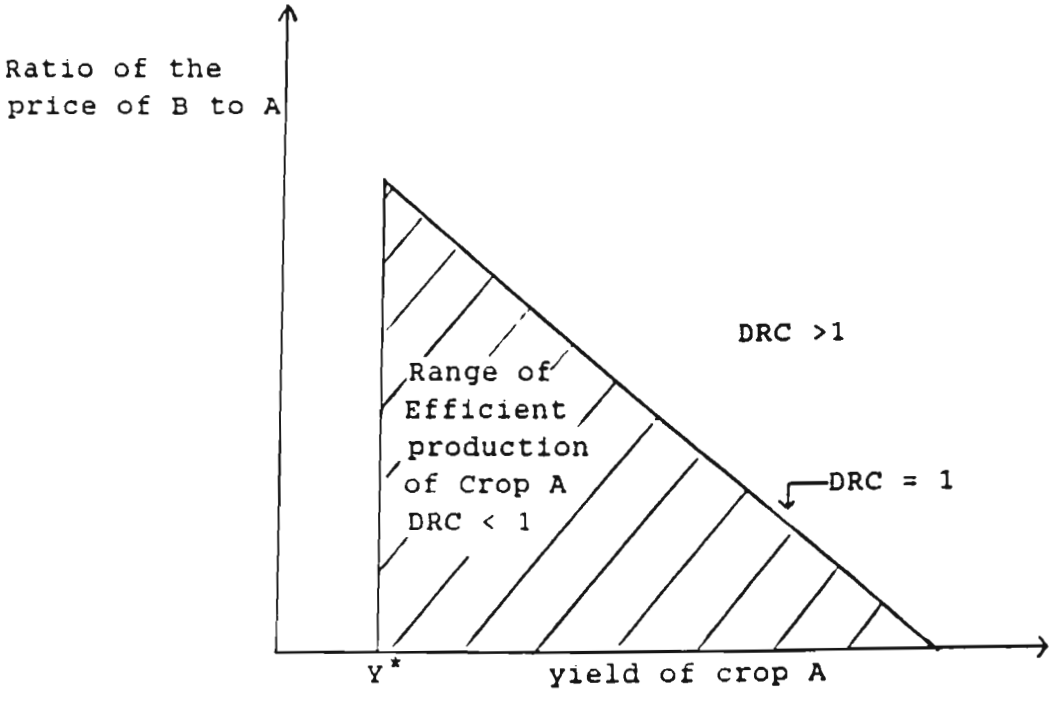
task. DRC analysis also corrects for distortions created by taxes, subsidies, tariffs, etc. in market prices to arrive at the true economic value of inputs and outputs involved.

Uses and limitations of DRC analysis

The DRC framework can be used to examine comparative advantage across crop enterprises, production regions and technologies. It provides a useful criteria for identifying the most efficient commodities, locations and technological options to direct research and production resources into. This information can be utilized by policy makers and research managers to set priorities for agricultural research and investment.

The most important limitation of the DRC analysis include the use of Linear and static technological specifications and constant prices. Non-linear segments of the production frontier, technical progress and uncertainty and endogeneity of prices (the general equilibrium effects) however, can be handled through sensitivity analysis within the DRC framework. By subjecting comparative advantage measures to discrete jumps in productivity and movements in relative prices a range over which DRC results remain valid can be defined. Figure 3 below provides an example where the efficiency range for various combinations of yields and relative prices is defined.

Figure 3.



y^* represent the thresh-hold yield beyond which value added in crop A is negative for all price combinations.

Important Determinants of the Competitiveness of local wheat in Eastern & Southern Africa

Results obtained from previous studies (Byerlee & Morris 89) and data compiled for a number of countries in Eastern and Southern Africa indicate that the comparative advantage of local wheat industries in the region is sensitive to several economic and technological factors. Among the most important determinants are the following:

1. Presence of competitive crop enterprises

The economic efficiency of wheat production varies by country and region depending on the availability of alternative productive uses of agricultural resources. In some regions wheat is the only crop that uses the idle winter land. As the opportunity cost of using domestic resource is very low due to lack of competitive alternatives wheat enjoys a comparative advantage even at very low yields (Madagascar and Zimbabwe). In other places wheat competes with high-value crops such as cotton in Sudan and dairying in Kenya. The opportunity cost of using domestic agricultural resources is high in this case and wheat yields has to compete with the productivity of competing

enterprises. Limited land area in Northern Sudan for example, is the scarce resource for which wheat competes, whereas irrigation water is the limiting resource in the central irrigation schemes.

2. Size of holding and choice of technology

With land reform and redistribution the size of holding in many areas in Eastern and southern Africa have become smaller and in the hands of farmers with limited resource base. This have led to a shift from capital intensive to labor intensive technologies and farming practices. While yields have dropped as a result, the use of labor-intensive technologies have proved wheat remains competitive on small farms e.g. Kenya (Longmire and Lugogo 1989). There are also potentials for substantial gains in yield with appropriate harvesting and land preparation technologies developed for small scale wheat farming (Kenya, Tanzania)

While the large capital-intensive wheat production systems have shown efficiency in some countries (Kenya) they were found inefficient in many others (Zambia, Tanzania, Nigeria, Sudan) unless very high yields are realized (Byerlee and Morris 89, Frank and Loyns 1989). Under current production practices in the Sudan Gezira, where 70% of the country's wheat is harvested, yield levels of 1.4 tons/ha are realized. This is non-competitive given the high foreign

exchange component in wheat and competition from other important export crops (cotton) for the scarce water resources. Recent Research and results from a large number of farmers managed trials and demonstration plots in Gezira have shown a high response in wheat yields to phosphorous, timely planting and application of fertilizer and improved land preparation. Gains of up to 50% in yield on average were obtained on the Agric. Research Corporation (ARC) trials and Global 2000 plots. Wheat production in Gezira has shown comparative advantage over cotton with the potential yield improvement of the new ARC package under particular agricultural pricing and exchange rate regimes (Hassan 90).

3. Distances between production and consumption points

Comparative advantage of local wheat industries is very sensitive to transportation costs between production and consumption centres. One advantage of Gezira wheat in Sudan is the proximity to the biggest consumption centres e.g. Khartoum and Central region, which are distant from the Port city and thus high costs are involved in transporting imported wheat in-land. Large distances and poor transport systems in many countries have been important determinants of the economic efficiency of local wheat for several geographical locations. Local wheat has shown a comparative advantage over imports for in-land markets but was non-

competitive for coastal markets in Tanzania and Nigeria (Frank and Loyns 89, Byerlee & Morris 89). It is interesting to note that while coastal cities in the two countries e.g. Dar es Salaam and Lagos, represent the major wheat consuming centres, the largest potentials for local wheat production exist in the Northern in-land parts. This indicates how the distance from main consumption points may limit the domestic market and hence producer prices of local wheat.

Summary and Conclusions

The gap between domestic production and consumption of wheat in sub-Saharan Africa has been steadily growing wider over the last two decades. The result was increased importation of wheat and a sharp decline in self-sufficiency from over 50% to 25% between 1961-1987. This trend has significant implications for food security and foreign exchange allocations in these countries. The present paper reviews the main forces behind increased consumption of wheat in sub-Saharan Africa. Economic policy and technological options for achieving higher self-sufficiency in wheat are also discussed. The analysis indicate that removal of bread subsidies, exchange rate adjustments and provision of food aid in staples other than wheat provide effective measures for managing wheat demand. Comparative advantage measures,

on the other hand, are proposed as an analytical framework for evaluating the efficiency of promoting local wheat as an alternative to bridge the wheat gap. DRC analysis is also needed to help direct research and production resources in their most efficient uses.

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