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March 1985
CP-85-15

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A study carried out by the

International Institute for Applied Systems Analysis

Laxenburg, Austria

for the

Food and Agriculture Organization of the United Nations

Rome, Italy

## FOREWORD

Understanding the nature and dimension of the food problem and the policies available to alleviate it has been the focal point of the Food and Agriculture Programme (FAP) at the International Institute for Applied Systems Analysis (IIASA) since the program began in 1977.

National food systems are highly interdependent, and yet the major policy options exist at the national level. Therefore, to explore these options, we have developed policy models for national economies which are linked together by trade and capital transfers. For greater realism the models in this scheme are kept descriptive, rather than normative. The linked system contains some twenty national models which together account for nearly 80 percent of important agricultural attributes, such as area, production, population, exports, imports, etc., and somewhat simplified 15 regional models which cover the remaining countries of the world.

Policies have to be guided not only by the economic reality but also by the agro-ecological resource constraints facing the country. Thus, we have collaborated earlier with the FAO and UNFPA in a study to asses the agro-ecological agricultural production potential of the developing countries of the world.

One of the major food problems in the world, if not the most important one, is the problem of inadequate food availability to many in the world. Here the problem in Africa is of particular concern as it seems to be getting worse. The problem manifests itself in the growing food imports by Africa.

This study explores the problem of growing dependence of Africa on imported wheat using the analytical models, both economic and agro-ecological, developed at FAP.

We are grateful to the Food and Agriculture Organization of the United Nations for partially supporting this study.

Kirit S. Parikh
Project Leader
Food and Agriculture Programme

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**ACKNOWLEDGEMENT**

The cooperation of the Statistics Division and the Land and Water Development Division of FAO in making available data and information is highly appreciated.

We are particularly grateful to Janos Hrabovszky for his invaluable advice, insights and constructive comments throughout all stages of this work. Klaus Frohberg and Odd Gulbrandsen reviewed an earlier draft of this report and their comments are highly appreciated.

Barbara Huddleston of IFPRI made available the very useful time series data on cereal aid to African countries.

We are grateful to Helmut Frey and Ulli Sichra for their ever-willing assistance in producing the figures and tables presented in the report. Andreas Fischer (aged 13 years) so ably digitized the map of Africa presented in the study. Last, but not least, we are particularly grateful to Lilo Roggenland for patiently typing and retyping the report.

## SUMMARY

Food production in many African countries has in recent years not expanded fast enough to keep up with population growth. In still more of them the increase in production has fallen behind that in total demand, stemming from rising incomes as well as population. There is considerable concern at their diminishing selfsufficiency and food security, and the consequent increase in their import requirements.

The slow growth of food production in Africa could be a result of a number of interrelated factors:

- Inadequacy of resources
- Neglect of agricultural sector by governments leading to
    - Insufficient expansion of cultivated area
    - Slow growth of yields
    - Inadequate spread of improved farming technology
- Weather variability and recurring droughts
- Disease and parasite problems
- Social and political constraints.

Across the continent of Africa, there is a wide variation in the climatic and ecological conditions as well as level of population and development. The climatic patterns and soil conditions strongly influence what can be grown and consequently what is eaten. For example, in the winter rainfall areas in Northern Africa, wheat and barley have traditionally been the main crops in terms of

production and consumption. Moving south of the Sahara, sorghum and millet predominate the low summer rainfall areas whereas maize and cassava are the major production and consumption crops in good summer rainfall areas. In the very high rainfall humid areas root crops are important.

With development and changes in population distribution (e.g. urbanization) these are increasing changes in the dietary patterns throughout Africa. This in turn is affecting the production and import mix.

Among all food items, wheat stands out as the one commodity whose influence in consumption seems to be rapidly growing. What are the underlying causes of the increasing role of wheat in Africa? Some of the more obvious possible reasons include:

- Increasing demand due to rising incomes (wheat and also rice substituting some of the coarse grains).
- Shortfalls in cereal (other than wheat) and food production being met by the more easily available food commodity, namely wheat, on the world market.
- Growing levels of urbanization leading to demand for convenience foods, e.g. wheat bread.

In recent years much of the increase in wheat consumption, in most of the countries of Africa, has come through increased imports since production possibilities exist only in a few countries. What are the facts, the reasons and implications of this growing dependence on imported wheat in Africa?

The purpose of this study is to

(A) describe in detail the trends in wheat, rice and coarse grains consumption, production and trade in African countries

(B) analyze some of the underlying causes and consequences of the above trends

(C) assess the ecological and economic potential and comparative advantage of wheat production in Africa

(D) evaluate the impact of future world market prices of wheat and wheat aid on development in selected African countries and regions.

In this study, results for (A), (B) and (C) as mentioned above are presented for all individual African countries as well as four regional subgroups derived on the basis of

- High wheat consumption and good production potential (5 North African countries)
- Moderate wheat consumption and good production potential (8 Subsahara countries referred to as Subsahara 1)
- Moderate wheat consumption and insignificant production potential (14 Subsahara countries referred to as Subsahara 2)
- Low wheat consumption and insignificant production potential (22 Subsahara countries referred to as Subsahara 3).

In the case of (D) above, results for three selected countries, namely Egypt, Kenya and Nigeria are presented on the basis of national agricultural models within the framework of IIASA's World Food and Agriculture model. Additionally, results for the rest of the African countries are also presented in terms of five broad regional groups.

The main results of the study are summarized below.

## Past trends in consumption, production and trade

### Consumption

- During the period 1966-68 to 1978-80, consumption of wheat in almost all countries in Africa has gone up absolutely as well as in terms of percentage of total calorie intake obtained from wheat. However, the total calories obtained from wheat are not very much for most of the African countries. For example, wheat consumption amounting to more than 20% of calorie intake occurred in only seven countries and of these, five are North African countries, who are traditional wheat eaters.
- The North African countries are the major wheat consumers – getting 35 to 55% of their calorie intake from wheat. In these countries the share of wheat calories has more or less remained unchanged during the period 1966-68 and 1978-80.
- In Subsahara Africa, wheat accounted for between 10 to 25% of total calorie intake in 12 countries. The total population of these countries in 1978-80 was 63 million. The remaining countries, with a population of 276 million in 1978-80, on the average had wheat consumption amounting to about 4% of total calories consumed.
- In Subsahara Africa, with the exception of Ethiopia, wheat consumption tended to be higher in the countries with relatively higher incomes as well as levels of urbanization.
- Of the 49 countries considered in the study, per capita calorie intake increased in 30 countries (1978-80 population of 250 million) and declined in 19 countries (1978-80 population of 177 million) over the period 1966-68 to 1978-80. In the former group of countries, increase in calorie from wheat provided the main (more than a third) source of improvement in the

food intake. Wheat calories also rose significantly in the latter group of countries; the deteriorating food situation in these countries would have further worsened in the absence of calories from wheat.

**Selfsufficiency**

- Over the period 1966-68 to 1978-80, SSR for wheat on the average declined in North Africa as well as Subsahara 1 to 3. SSR for all four country groups also declined for rice as well as for coarse grains. The highest rates of decline in SSR are for wheat, followed by rice and then coarse grains.

**Production**

- The area under coarse grains in Subsahara Africa in 1978-80 was 77.28 million hectares whereas for wheat it was only 1.07 million hectares and for rice 4.21 million hectares.
- Area under coarse grains increased faster than under wheat. The area under rice increased at a higher rate than the area under coarse grains. In fact, 14.7 million hectares were added under coarse grains, 0.99 million hectares for rice, and only 0.17 million hectares for wheat over the period 1966-68 to 1978-80 in Africa.
- Yields on the other hand increased faster in all country groups other than Subsahara 2 for wheat, followed by rice and yields for coarse grains actually declined. In Subsahara 2, yields of coarse grains increased and wheat declined.
- Thus wheat production has not displaced coarse grain production nor does wheat seem to have diverted significant amounts of inputs in Subsahara Africa.

- In North Africa, where areas under wheat and coarse grains are comparable coarse grain area has grown faster but wheat yields have grown a bit faster than coarse grains.
- Of the 13 wheat growing countries, only in Egypt producer price was lower for wheat than for coarse grains. In all other countries it was higher and in most countries significantly higher, the differences being much larger than on the world market. However, during the last two decades coarse grain producer prices have been rising faster than wheat producer prices in many African countries.
- Wheat yields are generally higher than coarse grains and with higher prices this difference is likely to be further increased. In Subsahara Africa the relatively high wheat yields are due to the fact that wheat is produced under large-scale commercial conditions.
- Thus production of wheat does not seem to have been hampered by relatively poor prices. If price incentives were inadequate for wheat, they must have been even more so for coarse grains.
- Thus low growth in production of wheat has to be explained by either poor ecological possibilities or just poor incentives for food production in general.

**Trade and Aid**

- Total imports of all grains have increased in Africa. At the country group levels , all groups increased imports of grains at annual rates varying from 7 to 10 percent over the period 1966-68 to 1978-80. Total imports of coarse grains, rice and wheat have all increased at similar and rapid rates:
- In 1978-80, African countries together imported 18.83 million mT of grains of which 16.19 million mT were commercial imports and only 2.64 million

mT were aid imports (grant and concessional rates imports).

- Five countries of North Africa accounted for 11.48 million mT of imports, 9.64 million mT of commercial imports and 1.84 million mT of aid imports. For the Subsahara African countries the total quantity of grain aid was 0.8 million mT of which wheat aid was 0.6 million mT. Thus the extent of grain aid for the Subsahara African countries has been miniscule in 1978-80 -- and was even smaller in the past.

- There is also an increasing use of imported coarse grains as feed especially in North Africa where feed use doubled from 1.8 to 3.7 million mT over the period 1966-68 to 1978-80.

- In a number of countries, financing of commercial cereal imports is beginning to take a significant share of merchandise export earnings. This trend, particularly for the low income countries (less than US$250 GNP per capita in 1979), namely Ethiopia, Mozambique, Mali, Upper Volta, Burundi, Somalia, Benin and Sierra Leone, is of particular concern. It is important that wherever possible domestic food production needs to be stepped up to ensure that export earnings can be channelled into the financing of much needed capital and essential goods.

- Of the five North African countries, no wheat aid has been or is given to Libya. In Tunisia, Algeria and Morocco, wheat aid has declined but commercial imports have gone up whereas in Egypt wheat aid has gone up over this period by a million tonnes whereas commercial imports have gone up by 2 million tonnes. Thus only for North Africa, one could perhaps say that past wheat aid may have created a market for wheat. However, these countries were wheat consuming countries to begin with and the share of calories derived from wheat in 1966-68 was comparable or even higher than in 1978-80.

- Increasing imports of wheat by African countries are more likely to be the outcome of poor growth of agricultural production rather than wheat being pushed on the Africans by wheat exporters through attractive aid offers and availability on the world market.

**Wheat production potential in African countries**

The ecological and economic rationality of growing wheat vis-a-vis other food crops is estimated on the basis of the soil and climate resources and the methodology of the FAO agro-ecological zone project. The computerized land resources (climate and soil) data comprises of a mosaic of unique land units (10000 Ha) with particular combinations of soil and climatic conditions by location in each African country.

The total area agroclimatically suitable for growing wheat under rainfed conditions in each country is identified. All this land is not likely to be devoted to wheat cultivation unless wheat prices are sufficiently attractive relative to other crops and unless necessary infrastructure facilities are created. Monocropping with wheat would also not be a technically feasible proposal. However, it gives an idea of the maximum rainfed wheat production potential in Africa.

Economically viable production depends on relative prices and on alternative crop production potentials on the same land. Using 1975 world relative prices, rainfed production potentials for wheat when net revenue is maximized are lower. For North Africa, under net revenue maximization, less than 70 percent of the potential wheat land would be devoted to wheat and production would be around 80 percent of the total wheat potential. This shows that North African soil and climate are in general suitable for wheat. This is also confirmed by the findings that when wheat prices are doubled (this was explored only under intermediate level of inputs) the net revenue maximizing wheat area and production equal the total potential.

The agro-climatic suitability for wheat is much poorer for Subsahara Africa. Under intermediate technology, of the 17.7 million Ha of potential wheat land only 1 million Ha (less than 6 percent) gets allocated to wheat production under income strategy and the production is only 3 million mT, i.e. 11 percent of the total wheat potential production of 28.7 million mT. With doubling of wheat prices, 41% of potential wheat land is allocated to wheat and wheat production is also 41% of the potential.

The areas under rainfed wheat in 1978-80 in major wheat producing countries (with the exception of Tunisia and Libya) were smaller than land areas where wheat can be competitively grown under a food as well as an income strategy. This indicates that scope exists to increase wheat production in Africa, through policies that increase farmers' incentives to do so.

The extent to which selfsufficiency in wheat for Africa can be realized depends on the magnitude of demand, based on the economic and demographic growth scenario and on the price and incentive policies pursued to promote acreage expansion and, in particular, yield increases through intensive cultivation.

Though theoretically with intermediate technology Africa could produce 47 mT of rainfed wheat and be selfsufficient for this commodity, this would be at substantial opportunity cost. The rainfed wheat potential under income strategy is only 17.6 mT with intermediate technology and 24.4 mT with high technology. Thus trying to push production above these limits would cause a loss of income for African farmers.

Even when relative price structures are modified and a food strategy is pursued to further food security through calorie maximization, rainfed wheat output is also around 17 million mT and 24 million mT under intermediate and high technologies. So here again selfsufficiency in wheat (year 2000) would be expensive for Africa. If wheat production is pushed beyond the food strategy limits, imports of other foods would have to be increased.

Looking at the country level results wheat selfsufficiency is not economically viable for most African countries, the exceptions being Algeria, Morocco and Ethiopia under intermediate technology. With high technology Tunisia and Libya can in addition become selfsufficient but Ethiopia does not remain selfsufficient as other crops become more attractive.

Since the theoretical, technically defined rainfed wheat production potential is high, selfsufficiency could be attained with appropriate incentives and this is shown when relative wheat prices are doubled. The rainfed production potential under intermediate technology becomes 29.9 million mT, slightly more than the needed (in year 2000) 29 million mT. Though relative price of wheat may be doubled by 2000, if the world prices do not change similarly, this could involve a substantial cost to African countries for attaining selfsufficiency. In any case world price relatives are not likely to change so radically and the more likely course is a lower relative wheat price.

The results for some selected countries with major wheat production potential are presented in the form of supply and cost curves. These curves relate yields to total area and to total production, costs of wheat production to different levels of output as also opportunity costs in terms of revenue as well as food (calories) foregone for producing wheat. These curves are of considerable theoretical interest and one can briefly point out some thought-provoking observations.

- Yield does not fall monotonically with area when net revenues are maximized. This is understandable, as a high yield-higher input cost land may be selected later than a low yield-lower input land which gives higher net revenue.

- Similarly cost per tonne does not change monotonically when production is increased.

These observations question some of the assumptions traditionally made in econometric estimations of yield and cost functions.

Future production of wheat in Africa will depend not only on the ecological and economic rationality of producing wheat but also on the demand and availability and prices of wheat on the world market.

**Impact of Changes in World Market Prices of Wheat and Wheat Aid on Selected African Countries and Regions**

This analysis is carried out on the basis of IIASA's World Food and Agriculture model comprising of a set of linked national and regional models.

The relative world prices remain more or less on historical trends on the reference scenario of our linked system of models. With these prices cereal import in Africa continues to rise till 2000, the end of our simulation period and reaches a level of about 30 million tonnes. So do the imports of wheat which would constitute two thirds of the cereal imports in Africa in 2000. African wheat imports react significantly to world price. The price elasticity of wheat imports is around -0.55 when price increases and -0.75 when price decreases.

These significant responses of wheat imports to world market prices get transferred to domestic wheat prices and in turn leads to significant production response. Response of domestic wheat production to prices is significant and a price elasticity of wheat production in Africa of 0.8 is indicated.

The demand for wheat, however is not as price elastic as supply and imports. The price elasticity of demand for Africa is -0.07 when price increases and -0.18 when price decreases. Of course these elasticities vary from country to country and is much higher for some countries.

These significant responses to prices underline the importance of price policies for Africa. The scope of the present study is limited and we have not tried to find specific price policies for specific countries.

Increases in domestic prices, however, have to be considered in the light of the impact on consumers as well. The impact of world wheat price on average per capita calorie consumption is low as wheat is of relatively minor importance in consumption in most African countries. Only in one group of African countries where it is an important item of consumption, average per capita calorie intake goes down by 2.25 percent when world wheat prices double. Though this is still a small reduction unless transport, trade and administrative infrastructure are adequate to protect the vulnerable classes in rural and urban areas. The development of such infrastructure is particularly important for countries who depend on wheat aid significantly or where aid and imports contribute a major supply for some groups of the economy.

Wheat self-sufficiency and wheat aid affect domestic agricultural production and consumption. We have explored these impacts as well as impacts of sudden withdrawal of aid with our national models for Kenya, Egypt and Nigeria.

Domestic selfsufficiency in wheat is feasible for Kenya to attain. It increases domestic agricultural production, improves income parity for the farmers, but of course marginally reduces average calorie intake. The adverse impact of selfsufficiency constraint on calorie intake is much larger when the policy is introduced. This indicates that such policy changes, if desired, should be gradually introduced.

The aid scenarios for Egypt which gets sizeable wheat aid, showed the following:

- Wheat aid depresses domestic agricultural production and agricultural incomes. However, with the low food prices due to wheat aid, consumers are better off and the total calorie consumption improves. Thus, if appropriate compensation can be given to farmers for lost income, wheat aid is desirable for Egypt.
- Economically, Egypt should be able to adjust to sudden withdrawal of wheat aid if it can adjust its trade patterns and is able to find alternative suppliers.
- However, the development path is altered because of wheat aid withdrawal and these effects last for some years even after wheat aid is withdrawn.

As was to be expected, Nigeria would profit from lower wheat prices on the world market and, of course, from food aid in addition to keeping the level of commercial imports high. Similarly, a forced reduction of wheat imports to 1980 levels of about 1 million tons would create (in 2000) a calorie gap equivalent to the basic requirements of 3.7 million people in Nigeria and would therefore probably create political instability (which is also indicated by the extremely high equilibrium price of wheat). The induced pressure on domestic food production would, however, slightly improve the incomes in the rural areas.

Finally, the scenarios show that the economically viable rainfed wheat production limits as identified in the AEZ study are not exceeded by our model scenarios which is as it should be as in the model scenarios the realization of production potentials are constrained by availability of resources. The scenarios do indicate that in most African countries wheat selfsufficiency is not a feasible or a desirable goal. This should indicate that the development of agriculture should be pushed in a direction that is appropriate for the economic reality and agro-ecological potential of the country.

# 1. INTRODUCTION

## 1.1. The Background and Issues

Over the past three decades the importance of wheat has grown in food consumption in Africa. Much of this increase has come through increased imports of wheat. Wheat utilization per capita has grown from 36kg in 1966-68 to nearly 47kg in 1978-80. Of these 48% were imported in 1966-68 and 66% in 1978-80.

A number of questions arise from Africa's growing dependence on imported wheat:

(i) *Why has this happened*? Why have African countries imported growing quantities of wheat? Is it because cheap wheat was available from abroad and it was in Africa's comparative advantage to do so? Was wheat cheap in the international market or was it made available by aid givers? This is important because prices on the international market may be considered less volatile than whims of aid givers.

Or is it because Africa was unable to grow adequate food and had to import food? Wheat may have been imported as being the cheapest or most easily available grain. A lack of transport and infrastructure, as well as location of major urban areas along the coast have made imported wheat seem "cheaper" and "easily available". In turn, availability of cheap imported wheat may have contributed to neglect of development of transport and infrastructure.

It could also be the outcome of the fact that eating wheat is considered the proper thing to do and that growing urban population and wealth have forced the government to import wheat even when it was more expensive and even when locally produced traditional substitutes, such as maize, were available. This also implies that either Africa has a comparative disadvantage in growing wheat and that there was not adequate potential for growing wheat cheaply domestically or it was not possible to exploit this potential fast enough to keep pace with the growing "demand" for wheat.

(ii) ***What has it done?*** How have these cheap wheat imports affected the development of African agriculture? How has it affected the nutritional status? A number of different effects are possible.

Imports of food increase the availability of food in a country, at least in the short run. What have been the nutritional impacts of wheat imports? How has it affected the levels of calorie intake?

On the other hand wheat imports could also have led to adverse impacts. Has the import of wheat led to lower food prices and to lower farm incomes, reduced incentive to increase domestic output and to lower agricultural growth? Has it led governments to neglect development of agriculture which would be reflected in low level of resources devoted to the development of agriculture, such as direct investment in agriculture as well as in rural infrastructures and agricultural research?

Has it affected cropping patterns and structure of agriculture? Has it led to greater emphasis on export crops? Has it lowered food selfsufficiency for Africa? Has it retarded the growth of traditional food crops of Africa, either through increased emphasis on export crops or through diversion of land to an unsuitable crop, namely, wheat, for which now a taste and market is created?

(iii) ***What could it lead to?*** What could be the future impact on Africa of this dependence on imported wheat? What are some of its future implications?

If cheap wheat were to continue to be available on the international market in future, the reliance on imported wheat does not pose any economic burden. However, even when cheap wheat were to be available in the future substantial reliance on imported wheat may be considered politically unacceptable if it leads to dependence on one or two major wheat suppliers. If many countries would be exporting wheat in the future, dependence on cheap imported wheat may not be politically harmful.

One cannot be sure that cheap wheat will continue to be available in future. What would happen when in the future wheat prices are suddenly raised? During the time needed to restructure African agriculture, Africa would be highly vulnerable to pressures from those who dominate wheat supplies.

Such considerations may lead one to consider selfsufficiency in food grains a desirable goal for African countries. However, there are costs of such selfsufficiency. The gains of international specialization through exploitation of comparative advantage can be substantial. Yet such gains are realizable only in the ideal world of competitive international markets. In the real world some countries dominate markets. If African countries were to specialize in luxury goods, such as coffee and cocoa for exports, hoping to import wheat, they may become doubly vulnerable. The rich countries dominate the market for luxury goods as buyers and dominate the market for staples such as wheat as sellers. Once this dominance is accounted for, food selfsufficiency, or at least some degree of it, may be desirable for African countries. What is the desirable goal of food selfsufficiency for Africa?

## 1.2. The Scope of the Study

This study explores and analyzes some of the issues and hypotheses implied above. Our collaborative work with the FAO Agro-ecological Zone Project (FAO/IIASA/UNFPA, 1983) and the Food and Agricultural World Model (Basic Linked System) developed at IIASA and the associated data banks, offer unique opportunities to analyze these issues. We begin in Section 2 with an analysis of historical data (1966 to 1980) to see which of these hypotheses are supported prima facie by empirical evidence. The ecological and economic rationality of growing wheat vis-a-vis other food crops are investigated in Section 3 on the basis of the land resources data base and methodology of the FAO Agro-ecological Zone Project. In Section 4 the results of a number of scenarios with the FAP Basic Linked System are analyzed to obtain an understanding of prospects for future world prices of wheat, as well as the availability of it. The implication of low and high levels of world market wheat prices and aid are examined. These runs show from the national models of the selected African countries (Kenya, Nigeria and Egypt) the growth of wheat imports under alternative policy scenarios of these countries. Scenarios are generated in which wheat exporters suddenly choke their exports to see the consequences of such shocks on the African importers. In addition to the results of the above three African countries, results for the rest of Africa in terms of five major subgroups are also discussed.

# 2. ANALYSIS OF PAST TRENDS

## 2.1. Historical Data and Country Coverage

### 2.1.1. The Data Base

The analysis carried out in this study include a historical review of wheat, rice and coarse grains production, trade, consumption, prices and aid patterns in developing countries in Africa. The 1966-81 FAO Time Series Data from the Supply Utilization Accounts was the main data source. These accounts report data by some 600 commodities for each country. For the cereal commodities the data were aggregated as follows: wheat (8 wheat and wheat products to 1 commodity : wheat equivalent), rice (9 rice and rice products to 1 commodity : milled rice) and coarse grains (28 coarse grains and coarse grains products to 1 commodity : coarse grains).

Aid data utilized in the study are from IFPRI and FAO. For the period 1966-75, IFPRI Time Series Data providing information on cereal (by commodity) aid data by four major donors (U.S.A., Canada, Australia and the European Community) and individual recipient countries. For the period 1976-80, FAO time series data on shipments of cereal food aid by recipient and by donor have been used. It should be noted that in the present study the commercial imports have been estimated as the difference of total imports and aid. No attempt is made in the study to differentiate aid by type, e.g. grant aid and concessional imports. This type of differentiation and valuation of cereal aid has been reported by Huddleston (1984).

### 2.1.2. Country Coverage

Forty-nine countries in Africa have been considered in the study; Equatorial Guinea and Western Sahara have been excluded since complete time series data were not available. Table 2.1 shows some selected economic and agricultural indicators and data on wheat consumption in these countries. The countries have been grouped into four subgroups, namely North Africa and Subsahara 1 to 3. These country groups were derived on the basis of wheat consumption levels and also the potential for wheat production. For example, the highest per capita wheat consumption and production occurs in the countries of North Africa. In Subsahara Africa, the countries of Subsahara 1 and 2 have relatively higher per capita consumption of wheat. The countries included in Subsahara 1 also produce and/or have the potential to domestically produce wheat. In contrast, wheat is not an ecologically viable* crop in most of the countries of Subsahara 2. Finally the countries of Subsahara 3 have relatively low per capita consumption levels of wheat and hardly any production of wheat.

The above country groups are shown in map-form in Fig. 2.1. It is interesting to note that countries with relatively higher per capita consumption of wheat tend to be coastal countries. In 1978-80, thirteen African countries had a per capita wheat consumption of 4kg or less. However, out of these thirteen countries, seven land locked countries, namely Mali, Upper Volta, Niger, Chad, Central African Empire, Zaire and Uganda, accounted for more than 80% of the total 1978-80 population of 82.4 million in the thirteen countries.

Some common features, Table 2.1, of the countries included in each subgroup are summarized below.

**North Africa**

Tunisia, Algeria, Morocco, Libya and Egypt are included in this group. In 1978-80, these countries on the average produced 66kg and consumed and 127kg per capita of wheat. Wheat is traditionally the main food crop accounting for a third to half of the average per capita calorie intake in these countries.

*This situation could change if appropriate tropical wheat varieties were to be available.

Table 2.1.

Table 2.1. African Countries: Selected Indicators

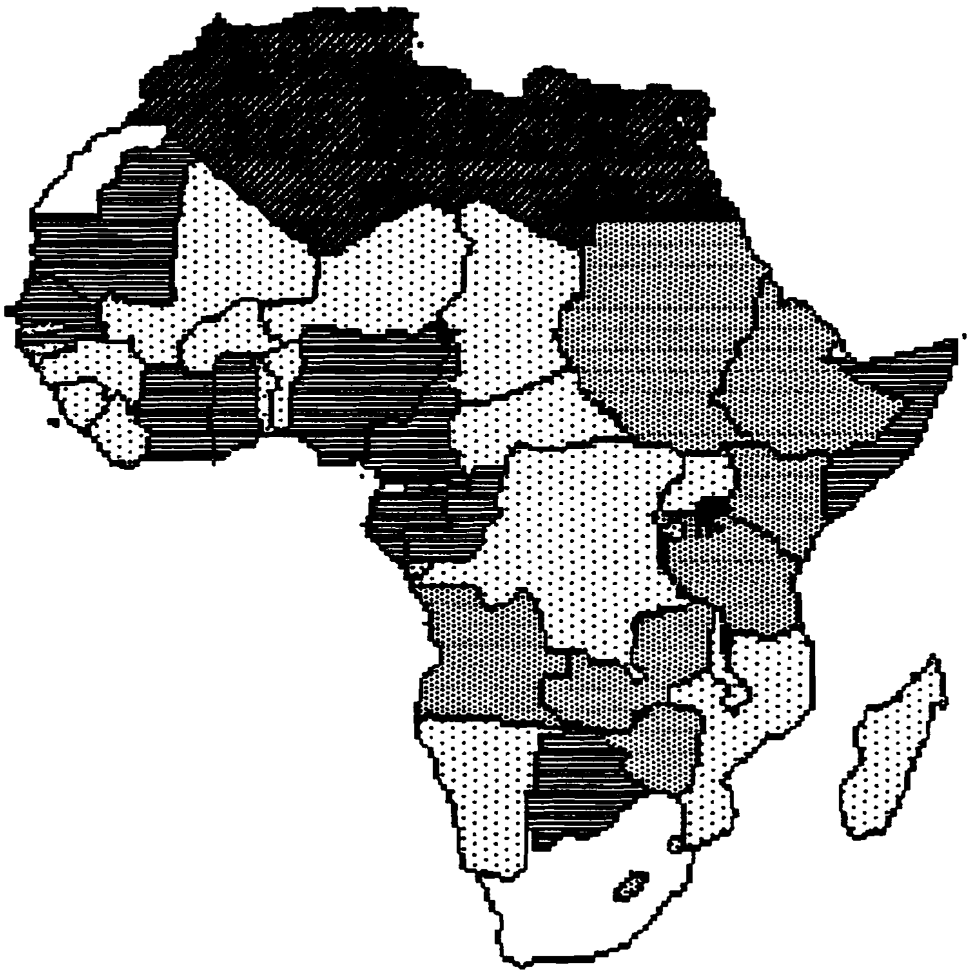
| | Average 1976-80 Popul. Million | GNP/ Capita 1979$ | Agriculture as % GDP 1979 | 1979 Net Barter Terms of Trade 1975=100 | 1969-71 to 1977-79 Average Annual Growth Rate: Volume of Agricultural Production | 1969-71 to 1977-79 Average Annual Growth Rate: Per Capita Agricultural Production | Urbanisation % of Total Population 1980 | Average per Capita Calorie Intake 1966-68 | Average per Capita Calorie Intake 1978-80 | Share of Wheat in Calorie Intake % 1966-1968 | Share of Wheat in Calorie Intake % 1978-80 | 1978-80 Per Capita Wheat Consumption | 1976-80 Per Capita Wheat Production |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **North Africa:** | | | | | | | | | | | | | |
| Tunisia* | 6.2 | 1120 | 16 | 86 | 4.4 | 2.3 | 52 | 2246 | 2751 | 54 | 62 | 167 | 122 |
| Algeria* | 18.0 | 1590 | 7 | 116 | -0.4 | -3.6 | 44 | 1829 | 2406 | 56 | 52 | 156 | 67 |
| Morocco* | 19.6 | 740 | 19 | 84 | 0.6 | -2.2 | 41 | 2314 | 2651 | 44 | 46 | 129 | 93 |
| Libya* | 3.1 | 8170 | 2 | 124 | 7.8 | 3.6 | 52 | 2316 | 3418 | 38 | 35 | 131 | 37 |
| Egypt* | 40.9 | 480 | 23 | 82 | 0.8 | -1.1 | 45 | 2541 | 2949 | 32 | 36 | 116 | 46 |
| **Subsahara 1:** | | | | | | | | | | | | | |
| Lesotho* | 1.3 | 340 | 36 | n.a. | 1.4 | -0.9 | 5 | 2079 | 2442 | 22 | 25 | 67 | 31 |
| Sudan | 17.9 | 370 | 38 | 75 | 1.6 | -0.8 | 25 | 1921 | 2371 | 8 | 10 | 28 | 15 |
| Zambia | 5.6 | 500 | 15 | 100 | 2.8 | -0.2 | 38 | 2115 | 1992 | 5 | 10 | 21 | 1 |
| Ethiopia* | 31.8 | 130 | 46 | 142 | 0.4 | -1.7 | 15 | 2012 | 1729 | 10 | 10 | 19 | 14 |
| Zimbabwe | 7.2 | 470 | 12 | n.a. | 2.9 | -0.4 | 23 | 2120 | 1911 | 7 | 9 | 16 | 26 |
| Kenya* | 15.8 | 380 | 34 | 110 | 4.0 | 0.6 | 14 | 2262 | 2056 | 4 | 8 | 14 | 12 |
| Angola | 6.9 | 440 | 48 | 113 | -3.3 | -5.6 | 21 | 1938 | 2110 | 5 | 5 | 11 | 1 |
| Tanzania | 17.4 | 260 | 54 | 102 | 1.4 | -2.0 | 12 | 2062 | 2025 | 2 | 3 | 7 | 4 |
| **Subsahara 2:** | | | | | | | | | | | | | |
| Mauritius* | 1.0 | 1030 | 28 | 49 | 1.9 | 0.6 | n.a. | 2376 | 2703 | 18 | 20 | 69 | 0 |
| Gabon | 0.5 | 3280 | 8 | 106 | 0.1 | -1.1 | n.a. | 2166 | 2644 | 7 | 16 | 47 | 0 |
| Sao Tome | 0.1 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 2167 | 2324 | 12 | 14 | 36 | 0 |
| Congo | 1.6 | 630 | 13 | 91 | -0.1 | -2.6 | 45 | 2094 | 2200 | 6 | 14 | 35 | 0 |
| Reunion* | 0.5 | 2020 | n.a. | 37 | -2.8 | -4.4 | n.a. | 2466 | 2695 | 8 | 11 | 33 | 0 |
| Cape Verde* | 0.3 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1630 | 2764 | 6 | 10 | 31 | 0 |
| Mauritania | 1.6 | 320 | 27 | 78 | -1.3 | -4.0 | 23 | 2064 | 2051 | 4 | 14 | 31 | 0 |
| Botswana | 0.8 | 720 | 21 | n.a. | 1.1 | -1.1 | n.a. | 1962 | 2161 | 1 | 10 | 23 | 1 |
| Senegal | 5.5 | 430 | 29 | 76 | 1.1 | -1.8 | 25 | 2262 | 2073 | 10 | 8 | 19 | 0 |
| Ivory Coast | 7.5 | 1040 | 26 | 129 | 3.8 | -1.7 | 38 | 2064 | 2623 | 4 | 6 | 16 | 0 |
| Somalia* | 3.5 | 230 | 60 | 97 | 0.6 | -1.7 | 30 | 2203 | 2131 | 4 | 8 | 16 | 0 |
| Nigeria* | 74.6 | 670 | 22 | 119 | 1.7 | -0.8 | 20 | 2190 | 2335 | 1 | 5 | 12 | 0 |
| Ghana | 11.3 | 400 | 66 | 144 | -0.1 | -3.1 | 36 | 2167 | 2016 | 3 | 5 | 11 | 0 |
| Cameroon | 8.2 | 560 | 32 | 144 | 3.1 | 0.9 | 35 | 2067 | 2461 | 2 | 4 | 10 | 0 |
| **Subsahara 3:** | | | | | | | | | | | | | |
| Mozambique | 10.2 | 250 | 44 | 76 | -1.0 | -3.6 | 9 | 2033 | 1891 | 3 | 5 | 11 | 0 |
| Gambia* | 0.6 | 250 | 46 | 95 | 0.1 | -2.9 | n.a. | 2230 | 2250 | 2 | 4 | 10 | 0 |
| Benin | 3.4 | 250 | 43 | 97 | 2.3 | -0.6 | 14 | 2166 | 2310 | 1 | 3 | 8 | 0 |
| Togo* | 2.6 | 350 | 25 | 82 | -0.4 | -2.6 | 20 | 2213 | 2106 | 2 | 4 | 8 | 0 |
| Liberia | 1.8 | 500 | 35 | 86 | 2.7 | -0.8 | 33 | 2270 | 2474 | 2 | 3 | 8 | 0 |
| Sierra Leone* | 3.4 | 250 | 36 | 108 | 1.7 | -0.8 | 25 | 2231 | 2108 | 3 | 3 | 7 | 0 |
| Madagascar | 8.5 | 290 | 34 | 100 | 1.7 | -0.8 | 18 | 2340 | 2436 | 1 | 2 | 6 | 0 |
| Comoros* | 0.3 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 2216 | 2306 | 2 | 2 | 5 | 0 |
| Guinea | 4.9 | 280 | 41 | n.a. | 0.2 | -2.7 | 18 | 2026 | 1934 | 2 | 3 | 6 | 0 |
| Zaire | 27.6 | 260 | 33 | 91 | 1.2 | -1.5 | 34 | 2192 | 2133 | 1 | 2 | 4 | 0 |
| Guin Bissau | 0.8 | 170 | 54 | 111 | 1.4 | -0.2 | n.a. | 1984 | 2357 | 2 | 2 | 4 | 0 |
| Upper Volta* | 6.7 | 180 | 38 | 94 | 2.1 | 0.6 | 9 | 2010 | 2018 | 1 | 2 | 4 | 0 |
| Central Afr.Emp. | 2.2 | 290 | 37 | 108 | 2.0 | 0.0 | 41 | 2043 | 2161 | 2 | 2 | 4 | 0 |
| Niger* | 5.2 | 270 | 44 | 90 | 1.3 | -1.5 | 13 | 2165 | 2217 | 1 | 2 | 4 | 0 |
| Chad | 4.4 | 110 | 70 | 100 | 1.1 | -0.9 | 16 | 2340 | 1808 | 1 | 2 | 4 | 1 |
| Burundi* | 4.4 | 180 | 56 | n.a. | 2.8 | 0.6 | 2 | 2237 | 2162 | 1 | 1 | 3 | 1 |
| Mali* | 6.5 | 140 | 42 | 95 | 1.4 | -1.2 | 20 | 2067 | 1996 | 1 | 2 | 5 | 0 |
| Swaziland | 0.5 | 650 | n.a. | n.a. | 4.6 | 2.1 | n.a. | 2080 | 2499 | <1 | 1 | 2 | 2 |
| Rwanda* | 4.7 | 200 | 42 | 148 | 3.9 | 1.1 | 4 | 1904 | 2202 | <1 | 1 | 2 | 1 |
| Malawi | 6.0 | 200 | 43 | 84 | 4.0 | 1.2 | 10 | 2098 | 2219 | 1 | 1 | 1 | 0 |
| Uganda | 12.8 | 290 | 55 | 136 | -0.6 | -3.8 | 12 | 2176 | 1662 | 1 | 1 | 1 | 1 |
| Namibia* | 1.0 | n.a. | n.a. | n.a. | 0.6 | -2.3 | n.a. | 2268 | 2224 | <1 | <1 | 1 | 1 |

n.a. Data not available

* Countries where reserves of agricultural land resources are at present or will be scarce by the year 2000 (Shah et al., 1984).

Figure 2.1

## COUNTRY GROUPS : HISTORICAL ANALYSIS



| | | |
|---|---|---|
| NORTH AFRICA | : | HIGH WHEAT CONSUMPTION<br>GOOD PRODUCTION POTENTIAL |
| SUB - SAHARA 1 | : | MODERATE WHEAT CONSUMPTION<br>GOOD PRODUCTION POTENTIAL |
| SUB - SAHARA 2 | : | MODERATE WHEAT CONSUMPTION<br>INSIGNIFICANT PRODUCTION POTENTIAL |
| SUB - SAHARA 3 | : | LOW WHEAT CONSUMPTION<br>INSIGNIFICANT PRODUCTION POTENTIAL |

The main indicators, as shown in Table 2.1 for these countries are:

- Reserves of agricultural land resources are generally very limited in all five countries. At present, Algeria and Libya have about 10 to 30% of potentially cultivable land in reserve whereas for the other three countries this share is less than 10%.
- Egypt is a lower middle income (US$300 to US$500) country, Tunisia, Algeria and Morocco are middle income (US$500 to US$3500) countries and Libya is a very high income (above US$8000) country.
- Agriculture provided less than a quarter of GDP in 1979 in all countries.
- Since 1975 the terms of trade have deteriorated in Morocco, Egypt and Tunisia but have improved for Algeria and Libya.
- Agricultural production per caput during the last two decades have declined except in the case of Libya and Tunisia.
- Level of urbanization is high in all countries of the region.
- Substantial improvements in per capita food intake has been achieved in all countries during the last two decades.

**Subsahara 1**

Of the eight countries included in this group, seven are in Eastern and Southern Africa. The main reason to include these countries in this group was their present and/or potential wheat production. In all countries, except for Tanzania, per capita wheat consumption in 1978-80 was above 10kg. Per capita production also exceeded 10kg in all countries except for Zambia, Angola and Tanzania. For the region as a whole per capita wheat consumption and production were 17kg and 12kg respectively. As shown in Table 2.1, the common features of these countries are:

- All countries except for Lesotho, Ethiopia and Kenya have large reserves of agricultural land. In the case of Ethiopia and Kenya the land resource situation will be especially inadequate for domestic self-sufficiency in food production by the year 2000.
- Except for Ethiopia and Tanzania which are low income (less than US$300) countries, all countries fall in the lower middle income category.
- Agriculture is an important part of the national economy except for Zambia and Zimbabwe. The latter two are mineral rich countries.
- Generally the terms of trade have improved since 1975 in all countries, except Sudan where they have deteriorated.
- Per capita agricultural production has declined in all countries except Kenya. The very large declines in Ethiopia and Angola may have been mainly due to the political situations in these countries.
- Level of urbanization is less than a quarter in all countries except for Zambia.
- In the last two decades food intake levels have improved in Lesotho, Sudan and Angola. In all other countries there has been a deterioration.

**Subsahara 2**

Ten of the fourteen countries included in this group are in West Africa. Mauritius, Reunion, Cape Verde and Somalia are the additional four countries. In 1978-80 per capita wheat consumption in all these countries was above 10kg; the average for the group being 14kg per capita. There is hardly any wheat production in these countries; Nigeria produced 21000mT and Botswana, Somalia and Cameroon each produced only about 1000mT in 1978-80.

The main development indicators of these countries, Table 2.1, are summarized below:

- Among this group of countries, Mauritius, Reunion and Cape Verde have less than 10% of potential cultivable land in reserve at present and for Nigeria this share is less than 30%.
- Except for Somalia (low income), Mauritania, Senegal and Ghana (lower middle income), the countries of this group are middle income countries.
- Agriculture provides more than 60% of the national GDP in Somalia and Ghana. In all other countries agriculture's share of GDP is less than 30%.
- Since 1975 terms of trade have deteriorated for all countries except the oil and mineral exporters: Gabon, Nigeria and Cameroon and major agricultural exporters Ivory Coast and Ghana.
- During the last two decades, per capita agricultural production has declined in all countries except for Cameroon and Mauritius.
- Urbanization level is more than 25% in all countries except for Mauritania and Nigeria.
- In many countries of the region there has been a substantial improvement in per capita food intake in the last two decades. The exception are Mauritania, Senegal, Somalia and Ghana, where there has been a deterioration.

**Subsahara 3**

The remaining twenty-two African countries have been included in this group. In 1978-80, per capita wheat consumption was below 10kg in all countries except for Mozambique and Gambia. The latter two countries were not included in Subsahara 2 because of the fact that their per capita wheat consumption was 11 and 10kg in 1978-80 due to a per capita wheat aid of 8 and 3kg respectively. Of the twenty countries included in this group, wheat was produced (mostly under irrigation) in about half; however even in these countries per capita production was below 2kg in 1978-80.

The main development indicators, Table 2.1, for the countries included in Subsahara 3 are summarized below:

- Out of the twenty-two countries included, four have less than 10% of their potentially cultivable land in reserve. These are Comoros, Niger, Rwanda and Namibia. Additionally Burundi, Gambia, Togo, Sierra Leone, Upper Volta and Mali would have very inadequate agricultural land resources for domestic food selfsufficiency by the year 2000.
- Except for Swaziland, Liberia and Togo all countries included in this group are low income countries with per capita GNP below $300 (1979).
- In most of these countries agriculture provided well above a third of total GDP in 1979. The exception was Togo, with a share of 25%.
- Since 1975 terms of trade have deteriorated in most countries. The exceptions were Sierra Leone, Madagascar, Guinea Bissau, Central African Empire, Uganda and Rwanda where there was some improvement.
- Over the period 1966-68 to 1978-80 per capita agricultural production declined in all countries except for Upper Volta, Burundi, Swaziland, Rwanda and Malawi.
- In 1980, the level of urbanization was low (below 20%) in most countries except for Liberia, Sierra Leone, Zaire, Central African Empire, where urbanization level was between 25 and 41%.
- Food intake levels have substantially deteriorated in more than half the countries included in this group. Only in the case of Swaziland, Guinea Bissau, Rwanda, Liberia and Benin, have calorie intake levels improved by 10% or more in 1978-80 compared to the levels of 1966-68.

The above grouping of countries, though generally not in relation to geographical proximity, provides fairly homogenous units to analyze past trends of consumption, production and trade of wheat and other cereals. Complete historical data and growth rates for 1966-68 to 1978-80 are given in the statistical tables in Annex A.

## 2.2. Cereal Consumption Trends

### 2.2.1. Wheat

Fig. 2.2 and Table 2.2 show the distribution of wheat utilization, selfsufficiency ratios and per capita consumption among various regions in Africa in 1966-68 and 1978-80. The share of wheat in per capita cereal consumption in individual countries by six broad classes is shown in map-form in Fig. 2.3.

In 1978-80, North African countries on the average consumed 127kg of wheat per capita out of a total cereal consumption of 187kg per capita as food. In this region Tunisia had the highest wheat consumption at 157kg per capita and Egypt has the lowest at 116kg per capita. During the period 1966-68 to 1978-80, per capita consumption increased by more than 1% annually in Morocco, Tunisia and Algeria and by more than 2% annually in Egypt and Libya.

In Subsahara Africa, for the countries included in Subsahara group 1, average per capita wheat consumption increased from 15kg in 1966-68 to 17kg in 1978-80. Lesotho had the highest consumption level at 67kg per capita in 1978-80, followed by Sudan and Zambia at 26 and 21kg per capita. The remaining countries in Subsahara 1 consumed between 10-20kg per capita except for Tanzania with a consumption level of 7kg per capita in 1978-80. Over the period 1966-68 to 1978-80, per capita consumption has increased by more than 3% annually in Zambia and Sudan, by more than 2% in Lesotho, Kenya and Tanzania and by 0.6% in Zimbabwe. In contrast per capita consumption has declined by 1% and 0.3% in Ethiopia and Angola respectively. It should be noted that the

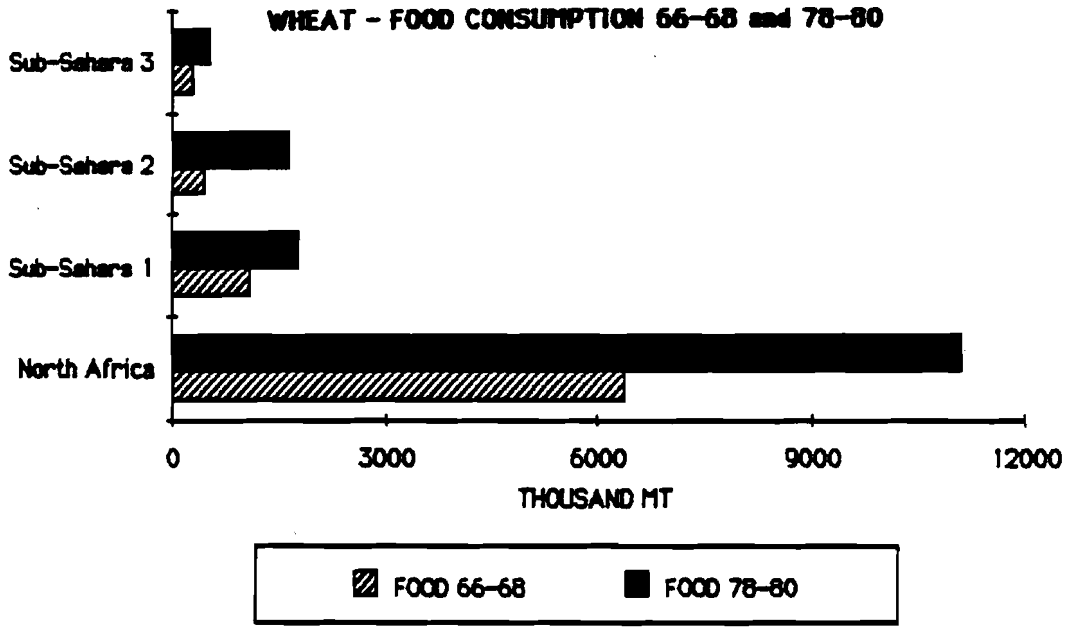



Fig.2.2. Wheat - Food Consumption (1966-68 and 1978-80).

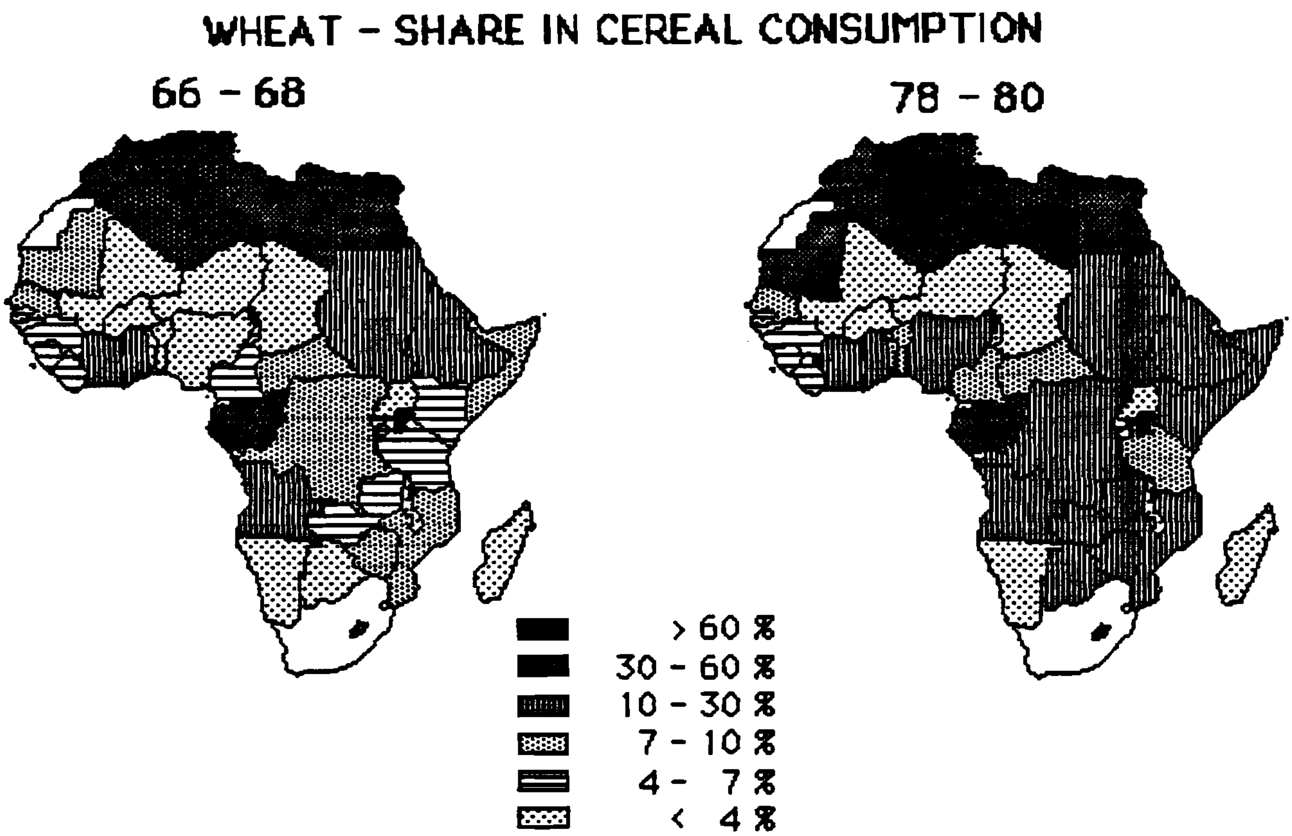



Fig.2.3. Wheat - Share in cereal consumption.

Table 2.2. African Cereal Utilization, Selfsufficiency Ratios (SSR) and Consumption: Levels and Annual Growth Rates 1966-68 to 1978-80

| | 1966-68 | | | 1978-80 | | | Annual Growth Rate 1966-68 to 1978-80 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Utili-zation Mill.mT | SSR % | Per capita Food Con-sumption kg | Total Utili-zation Mill.mT | SSR % | Per capita Food Con-sumption kg | Total Utili-zation % | SSR % | Per capita Food Con-sumption % |
| **Wheat:** | | | | | | | | | |
| Subsahara 1 | 1.36 | 72 | 15 | 2.13 | 57 | 17 | 3.81 | -1.93 | 1.25 |
| Subsahara 2 | 0.48 | 4 | 6 | 1.82 | 1 | 14 | 11.70 | -10.91 | 7.63 |
| Subsahara 3 | 0.33 | 11 | 3 | 0.61 | 7 | 5 | 5.44 | -3.70 | 2.34 |
| Subsahara Total | 2.17 | 47 | 8 | 4.56 | 28 | 12 | 6.41 | -4.22 | 3.52 |
| North Africa | 8.88 | 56 | 101 | 15.60 | 37 | 127 | 4.80 | -3.39 | 1.89 |
| Total Africa | 11.05 | 54 | 27 | 20.16 | 35 | 35 | 5.14 | -3.55 | 2.24 |
| **Rice:** | | | | | | | | | |
| Subsahara 1 | 0.15 | 79 | 2 | 0.28 | 73 | 2 | 5.54 | -0.66 | 2.83 |
| Subsahara 2 | 1.00 | 59 | 10 | 2.07 | 45 | 15 | 6.21 | -2.23 | 3.45 |
| Subsahara 3 | 2.28 | 95 | 20 | 3.32 | 83 | 22 | 3.18 | -1.12 | 0.89 |
| Subsahara Total | 3.43 | 84 | 11 | 5.66 | 69 | 14 | 4.28 | -1.63 | 1.81 |
| North Africa | 1.11 | 134 | 13 | 1.58 | 103 | 14 | 2.96 | -2.17 | 0.49 |
| Total Africa | 4.54 | 96 | 11 | 7.24 | 76 | 14 | 3.97 | -1.93 | 1.51 |
| **Coarse Grains:** | | | | | | | | | |
| Subsahara 1 | 10.68 | 105 | 115 | 13.36 | 100 | 105 | 1.88 | -0.41 | -0.79 |
| Subsahara 2 | 9.06 | 97 | 89 | 12.07 | 93 | 77 | 2.41 | -0.35 | -1.16 |
| Subsahara 3 | 8.84 | 100 | 78 | 10.75 | 94 | 70 | 1.64 | -0.51 | -0.82 |
| Subsahara Total | 28.58 | 101 | 93 | 36.17 | 96 | 83 | 1.98 | -0.42 | -0.91 |
| North Africa | 6.40 | 96 | 52 | 8.87 | 82 | 47 | 2.76 | -1.30 | -0.96 |
| Total Africa | 34.98 | 100 | 84 | 45.04 | 93 | 76 | 2.13 | -0.60 | -0.91 |
| **All Grains:** | | | | | | | | | |
| Subsahara 1 | 12.18 | 101 | 132 | 15.76 | 94 | 124 | 2.17 | -0.60 | -0.48 |
| Subsahara 2 | 10.55 | 89 | 105 | 15.96 | 77 | 106 | 3.51 | -1.20 | 0.14 |
| Subsahara 3 | 11.44 | 96 | 101 | 14.68 | 88 | 97 | 2.10 | -0.72 | -0.33 |
| Subsahara Total | 34.17 | 96 | 112 | 46.40 | 86 | 109 | 2.58 | -0.91 | -0.22 |
| North Africa | 16.39 | 77 | 166 | 26.05 | 56 | 187 | 3.94 | -2.62 | 0.97 |
| Total Africa | 50.56 | 90 | 123 | 72.44 | 75 | 125 | 3.04 | -1.51 | 0.12 |

abovementioned countries were included in Subsahara group 1 because of their ecological potential for domestic wheat production (see Section 3) as well as their present levels of wheat production.

The fourteen countries included in Subsahara 2 consumed an average of 14kg per capita of wheat in 1978-80. Mauritius and Gabon had a consumption level of more than 47kg per capita whereas Mauritania, Cape Verde, Reunion, Congo and Sao Tome had per capita consumption levels in the range 31 to 36kg. In the remaining seven countries, per capita consumption ranged between 10 and 23kg. In countries of Subsahara 2, there has been a significant increase in per capita wheat consumption during the period 1966-68 to 1978-80 with the exception of Senegal where per capita consumption has declined by 2.6% annually. For example, the annual growth rates of per capita wheat consumption during the period 1966-68 to 1978-80 were:

- 11.3 to 18.3%: Mauritania, Nigeria and Botswana
- 6.1 to 9.6%: Cameroon, Somalia, Congo, Cape Verde and Gabon
- 3.2 to 3.8%: Reunion, Ivory Coast and Ghana
- 1.9 and 2.1%: Mauritius and Sao Tome.

Among countries included in Subsahara 3, Zaire, Guinea, Comoros, Madagascar, Sierra Leone, Liberia, Togo, Benin, Gambia, and Mozambique had a wheat consumption level of 5 to 11kg per capita in 1978-80. All other countries in this group had a consumption level of 1 to 5kg per capita. Over the period 1966-68 to 1978-80, most of the countries in this group have increased per capita consumption by more than 3% annually with the exception of Burundi, Comoros, Guinea Bissau, Guinea and Chad where consumption has increased in the range 0.1 to 1.8% annually and Namibia, Central African Empire, Sierra Leone, Malawi and Uganda where per capita consumption has declined by 0.3% to 9.2% annually. The substantial decline in the case of Uganda (9.2% annually) is a result of recent political events.

The results in Table 2.2 show that the selfsufficiency ratio for wheat has declined for all groups. Similarly for all groups, the selfsufficiency ratio for rice and maize also declined, albeit at a lower rate for rice and a much lower rate for coarse grains. Given the marketing system and government policies in many African countries, it is to be expected that wheat and rice demand will rise as incomes grow. In general, the ecological potential for rice production is higher than wheat production especially in Subsahara countries (Fischer and

Shah, 1984). Hence in the long run, higher imports of wheat than rice are likely in the case of many Subsahara African countries.

It is interesting to note the growing importance of wheat in total cereal consumption in terms of the six consumption classes shown in Fig.2.3 as follows:

- Countries where consumption of wheat has grown by two classes: Mauritania, Kenya, Zambia
- Countries where consumption of wheat has grown by one class: Libya, Nigeria, Cameroon, Somalia, Tanzania, Zaire, Zimbabwe, Mozambique, Botswana, Lesotho, Congo.

In fact, of the 49 African countries (see Table 2.1), the share of wheat in total calorie intake increased in 35 countries over the period 1966-68 to 1978-80.

**2.2.2. Rice**

Table 2.2 shows the distribution of rice utilization, consumption and selfsufficiency ratios among various regions in Africa in 1966-68 and 1978-80.

For Africa as a whole, in 1978-80 the average per capita consumption of rice amounted to 12kg in comparison to a wheat consumption of 27kg per capita. Rice consumption was concentrated in a few countries as shown in Table 2.3.

Among the countries where rice is a major consumption cereal (more than 50kg per capita) per capita consumption increases occurred in Guinea Bissau (2.7% annually), Ivory Coast (1.8%), Liberia (1.6%), Guinea (0.9%), Gambia (0.8%) and Madagascar (0.5%), whereas in Comoros, Reunion, Sierra Leone, Mauritius and Senegal per capita consumption declined by 0.1 to 0.9% annually. In countries with moderate per capita consumption of rice (20 to 30kg in 1978-80),

Table 2.3. 1978-80 Per Capita Rice Consumption in AFRICAN Countries

| Per Capita Consumption kg | Country |
|---|---|
| >90 | Sierra Leone, Liberia, Madagascar |
| 50-90 | Ivory Coast, Comoros, Guinea, Gambia, Senegal, Mauritius, Reunion, Guinea Bissau |
| 30-50 | No countries |
| 20-30 | Sao Tome, Mali, Egypt, Mauritania |
| 10-20 | Mozambique, Libya, Gabon, Cape Verde, Somalia |
| <10 | All remaining countries |

annual growth rate of per capita consumption was 10.3% in Mauritania and 0.8% to 1.7% in Egypt, Sao Tome and Mali over the period 1966-68 to 1970-78. Finally in countries where consumption level was 10-20kg per capita, in 1978-80, annual growth rate over the period 1966-68 to 1978-80 had been very rapid – in the range 3.7 to 10.5%.

**2.2.3. Coarse Grains**

Table 2.2 shows the distribution of coarse grain utilization, consumption and selfsufficiency among various regions in Africa in 1966-68 and 1978-80. North Africa and Subsahara Africa respectively consumed an average of 52 and 93kg per capita in 1966-68 and 47 and 83kg per capita in 1978-80, i.e. a decline of 1% and 0.9% annually over this period. Generally the decline in average consumption in the countries of North Africa and Subsahara 2 has been compensated by an increasing consumption of wheat and rice. However, in a large number of other Subsahara countries the decline in per capita consumption is part of overall deterioration in food consumption during the last two decades.

Table 2.4 shows the grouping of countries according to per capita consumption levels of coarse grains in 1978-80. The annual change in consumption over the period 1966-68 to 1978-80 is also indicated. These results show that per

Table 2.4. Grouping of countries according to level of per capita consumption of coarse grains in 1978-80 and annual change in per capita consumption over the period 1966-68 to 1978-80.

| | Countries where per capita consumption of coarse grains increased (1966-68 to 1978-80) Annual % change | | | Countries where per capita consumption of coarse grains decreased (1966-68 to 1978-80) Annual % change | | |
|---|---|---|---|---|---|---|
| | More than 3.0% | 1.6 to 2.1% | 0.2 to 1.0% | More than 2.4% | 1.2 to 2.3% | 0 to 1.0% |
| **1978-80 Per Capita Consumption** | | | | | | |
| 123-180kg | | Sudan | Malawi<br>Swaziland | | Zambia<br>Zimbabwe | Niger<br>Upper Volta<br>Lesotho<br>Mali |
| 105-116kg | Cape -Verde | | | Senegal<br>Chad | Kenya<br>Ethiopia<br>Botswana | Namibia |
| 54-89kg | | | Cameroon<br>Morocco | Somalia | Uganda<br>Gambia<br>Egypt | Nigeria<br>Togo<br>Benin<br>Tanzania<br>Burundi<br>Angola |
| 25-52kg | | | Zaire<br>Gabon | Mozambique<br>Mauritania<br>Centr.Afr.Emp.<br>Sao Tome | Ghana<br>Ivory -Coast | Rwanda<br>Guinea Bissau<br>Reunion |
| 4-18kg | Congo | Sierra -Leone<br>Liberia | Comoros | Guinea<br>Libya<br>Madagascar<br>Tunisia | Algeria<br>Mauritius | |

capita consumption declined in all North African countries by 1.1 to 4.4% annually except for Morocco where consumption increased by 0.3% per annum. It should also be noted that in addition to the human consumption of coarse grains in North African countries, increasing quantities of coarse grains are being used as feed in these countries (see Section 2.4.3).

In Subsahara Africa there was a decline in per capita consumption over this period in all countries except for 11 countries. Of these 11 countries, per capita consumption increased by more than 3.0% in Cape Verde, Congo and Gabon, by 1.6 to 2.0% annually in Sudan, Sierra Leone and Liberia.

Coarse grains provide a major share of calorie intake in Subsahara African countries and the declining trends in per capita consumption levels during the last two decades have also resulted in declining intake of calories in nineteen countries (see Table 2.1). Many of these countries have the ecological potential to increase production of coarse grains, especially by increasing the low levels of present day yields.

**2.3. Production Trends**

Cereal production in Africa increased at 1.55% annually over the period 1966-68 to 1978-80; this being well below a population growth rate of 2.81% during this period. Of the 49 countries in Africa, cereal production kept abreast of population growth only in Tunisia, Sudan, Mauritius, Gabon, Sao Tome, Congo, Cameroon, Liberia, Niger and Swaziland. In most of these countries, acreage expansion as well as productivity increases played an important role in the expansion of cereal production. In all other countries there was a decline in per capita cereal production and the situation was particularly critical in two groups, namely Zambia, Angola, Somalia, Ghana, Mozambique, Gambia, Guinea Bissau and Cape Verde, Mauritania, Botswana, where total cereal production declined annually by more than 3% and 5% respectively for the two groups over the period 1966-68 to 1978-80. In the present section the production trends of wheat, rice and coarse grains are discussed separately.

### 2.3.1. Wheat

Wheat production increased in Africa from 6.0 mill.mT in 1966-68 to 7.1 mill.mT in 1978-80. Fig.2.4 and Table 2.5 show the distribution of wheat production, area and yields among different regions in Africa. The countries of North Africa and Subsahara 1 account for more than 99% of wheat area and production in Africa. The production and area shares and yield levels for North African countries are also shown in Fig.2.4.

The countries of North Africa in 1978-80 produced an average of 66kg per capita with Tunisia producing the highest amount, 122kg per capita, and Libya the lowest amount, 37kg per capita. Over the period 1966-68 to 1978-80, these countries in total increased production by 1.3% annually; the largest increases occurred in Libya (6.1% annually), Egypt (2.2%) and Tunisia (2.0%). However, these increases in production were less than the growth in population in all countries except for Libya.

Among the major wheat producers in Subsahara 1, annual production changes over the period 1966-68 to 1978-80 were as follows: Ethiopia (-2.3%), Sudan (10.9%), Kenya (1.0%), Zimbabwe (22.5%), Tanzania (5.1%) and Lesotho (-2.3%). In terms of per capita production, Lesotho and Zimbabwe in 1978-80 produced 35kg and 25kg respectively, followed by Sudan, Ethiopia, Kenya and Tanzania with 15, 14, 12 and 4kg per capita respectively.

All other countries in Subsahara Africa either do not produce wheat or produced less than 1kg per capita in 1978-80. Countries in the latter group included Swaziland, Zambia, Angola, Botswana, Chad, Burundi, Rwanda, Uganda and Namibia.

The overall regional results in Table 2.5 show that in North Africa, area and yield increased by 0.3% and 1.0% annually during the period 1966-68 to 1978-80, Figure :

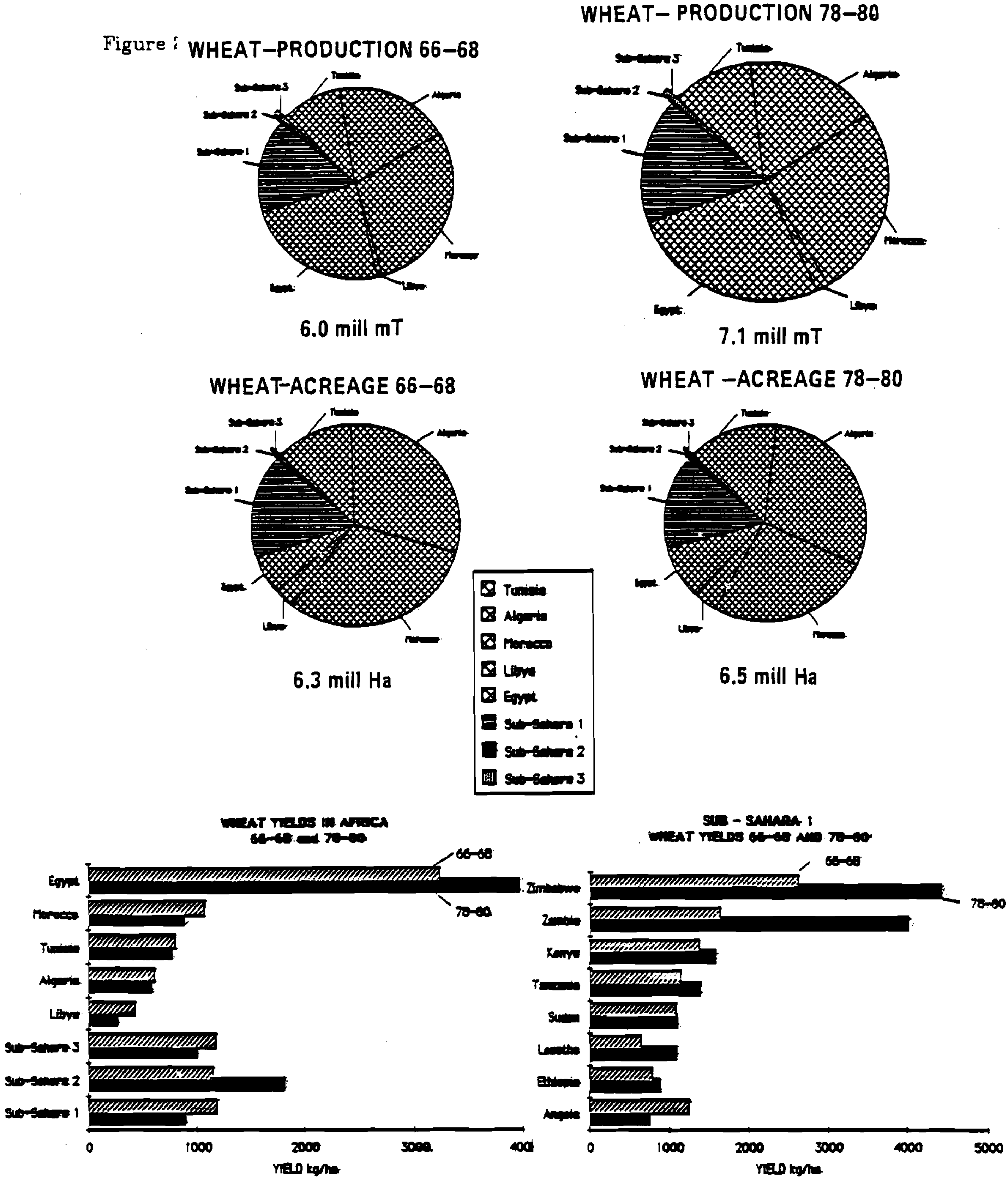



Fig.2.4. Area, yield and production of wheat in Africa (1966-68 and 1978-80)

Table 2.5. Area, Yield and Production of Cereals in Africa: 1978-80 Levels and Annual Growth Rates 1966-68 to 1978-80

| | 1978-80 | | | Annual Growth Rate (%) 1966-68 to 1978-80 | | |
|---|---|---|---|---|---|---|
| | Area Mill.Ha | Yield mT/Ha | Production Mill.mT | Area % | Yield % | Production % |
| **Wheat**: | | | | | | |
| Subsahara 1 | 1.01 | 1.20 | 1.21 | -0.46 | 2.36 | 1.88 |
| Subsahara 2 | 0.02 | 1.16 | 0.02 | 5.00 | -3.67 | 1.13 |
| Subsahara 3 | 0.03 | 1.18 | 0.04 | 0.24 | 1.28 | 1.52 |
| Subsahara Total | 1.07 | 1.20 | 1.28 | -0.36 | 2.23 | 1.86 |
| North Africa | 5.43 | 1.06 | 5.77 | 0.34 | 0.96 | 1.25 |
| Total Africa | 6.50 | 1.08 | 7.05 | 0.22 | 1.18 | 1.36 |
| **Rice**: | | | | | | |
| Subsahara 1 | 0.23 | 0.87 | 0.20 | 3.64 | 1.19 | 4.91 |
| Subsahara 2 | 1.03 | 0.91 | 0.94 | 3.85 | 0.07 | 3.85 |
| Subsahara 3 | 2.95 | 0.93 | 2.75 | 1.71 | 0.30 | 2.01 |
| Subsahara Total | 4.21 | 0.92 | 3.90 | 2.28 | 0.27 | 2.55 |
| North Africa | 0.44 | 3.74 | 1.63 | -0.21 | 1.00 | 0.74 |
| Total Africa | 4.65 | 1.19 | 5.52 | 2.01 | -0.01 | 1.97 |
| **Coarse Grains**: | | | | | | |
| Subsahara 1 | 22.67 | 0.59 | 13.33 | 2.14 | -0.64 | 1.47 |
| Subsahara 2 | 29.67 | 0.38 | 11.24 | 1.56 | 0.49 | 2.05 |
| Subsahara 3 | 24.94 | 0.40 | 10.05 | 1.48 | -0.38 | 1.10 |
| Subsahara Total | 77.27 | 0.45 | 34.62 | 1.70 | -0.15 | 1.54 |
| North Africa | 5.91 | 1.24 | 7.30 | 0.82 | 0.73 | 1.49 |
| Total Africa | 83.18 | 0.50 | 41.93 | 1.63 | -0.09 | 1.53 |

whereas in Subsahara 1 acreage declined by 0.5% and yield increased by 2.4% annually. In North Africa, acreage expansion occurred in Egypt (3.5% annually), Tunisia and Libya (1.7%) and Algeria (0.2%), and acreage in Morocco declined by 1.2% per annum. Yields increased by 4.2% and 1.6% annually in Libya and Morocco and 0.5% and 0.3% in Algeria and Tunisia respectively, whereas yields in Egypt have been declining at 1.7% per annum over this period.

Among the main producers in Subsahara 1, acreage declined in Ethiopia (-3.1% annually), Kenya (-0.1%) and Lesotho (-6.5%) and increased in Sudan (10.6% annually), Zimbabwe (17.7%) and Tanzania (3.4%), whereas yields increased more than 3% annually in Zimbabwe and Lesotho, more than 1% annually in Tanzania and Kenya and 0.8% annually in Ethiopia. In Sudan, yields increased by only about 0.1% annually during the period 1966-68 to 1978-80.

Overall, wheat yields are low in North African as well as Subsahara 1 countries and there is considerable potential to reach higher yields. Acreage in all groups increased more for coarse grains than for wheat except in Subsahara 2 where wheat area is very small. However, in contrast, yields of wheat increased much more rapidly than that of coarse grains. These results on the one hand suggest that wheat has not displaced coarse grain but on the other hand, the changes in yields imply that more resources (e.g. fertilizers) may have been put into wheat.

Table 2.6 presents data on relative wheat and coarse grains producer prices and yields and irrigation share for North African and Subsahara 1 countries. The 1975 producer prices for wheat were generally higher than coarse grains prices except for Egypt. Similarly, wheat yields were higher than coarse grain yields except in Libya and Lesotho. In Sudan, Zambia and Zimbabwe, wheat yields were more than twice the coarse grain yields since wheat was grown under irrigation unlike coarse grains. It is also interesting to note that in Tanzania, on the average, rainfed wheat yields tended to be more than 2.8 times the coarse grain yields. In many of the Subsahara 1 countries, wheat yields have been relatively high due to the fact that wheat has tended to be grown under commercially large-scale conditions and also often under better ecological conditions. Overall, these results show that the producer prices are generally higher and hence wheat would be a comparatively attractive crop to grow. It should also be noted that the differences in the producer prices of wheat and coarse grains (Table 2.6) were generally much higher than the differences in the world market prices of these two cereals.

Table 2.6. Ratio of Wheat to Coarse Grains Producer Prices and Yield and Share of Area Irrigated - Year 1975

| | Ratio of wheat to coarse grains | | Share (%) of area of crop which is irrigated | |
|---|---|---|---|---|
| | Producer price | Yields | Wheat | Coarse grains |
| Tunisia | 1.58 | 1.61 | <1 | 0 |
| Algeria | 1.56 | 1.00 | 1 | 1 |
| Morocco | 1.53 | 1.01 | 9 | 2 |
| Libya | 1.17 | 0.60 | <1 | 9 |
| Egypt | 0.93 | 1.10 | 100 | 100 |
| Lesotho | 1.08 | 0.88 | n.a. | n.a. |
| Sudan | 1.71 | 4.64 | 100 | 3 |
| Zambia | 1.85 | 2.23 | 100 | 0 |
| Ethiopia | 1.24 | 1.23 | <1 | <1 |
| Zimbabwe | 1.91 | 3.67 | 72 | 0 |
| Kenya | 1.52 | 1.16 | 0 | 0 |
| Angola | 1.69 | 1.73 | 0 | 0 |
| Tanzania | 1.50 | 2.78 | 0 | 2 |

A major factor affecting the low level of wheat yields in African countries is related to the availability of inputs. In this context there is need for the design of relevant input policy packages to ensure timely and economical (e.g. credit and insurance) availability of inputs. The issue of ecological suitability of wheat and the scope of acreage expansion/yield increases in African countries is discussed in detail in Section 3.

### 2.3.2. Rice

Rice production in Africa increased from 4.4 mill.mT to 5.5 mill.mT in the period 1966-68 to 1977-78. Unlike wheat, the production of rice is more Sub-sahara 1, Subsahara 2, Subsahara 3 and North Africa respectively accounted for 3.6, 17.0, 49.8 and 29.3% of Africa's rice production in 1978-80. Among the 10 major producers, i.e. countries producing more than 20kg per capita in 1978-80 (Table 2.7), the highest annual production increases occurred in Liberia (4.7% annually) and Ivory Coast (3.1%) over the period 1966-68 to 1978-80. Total

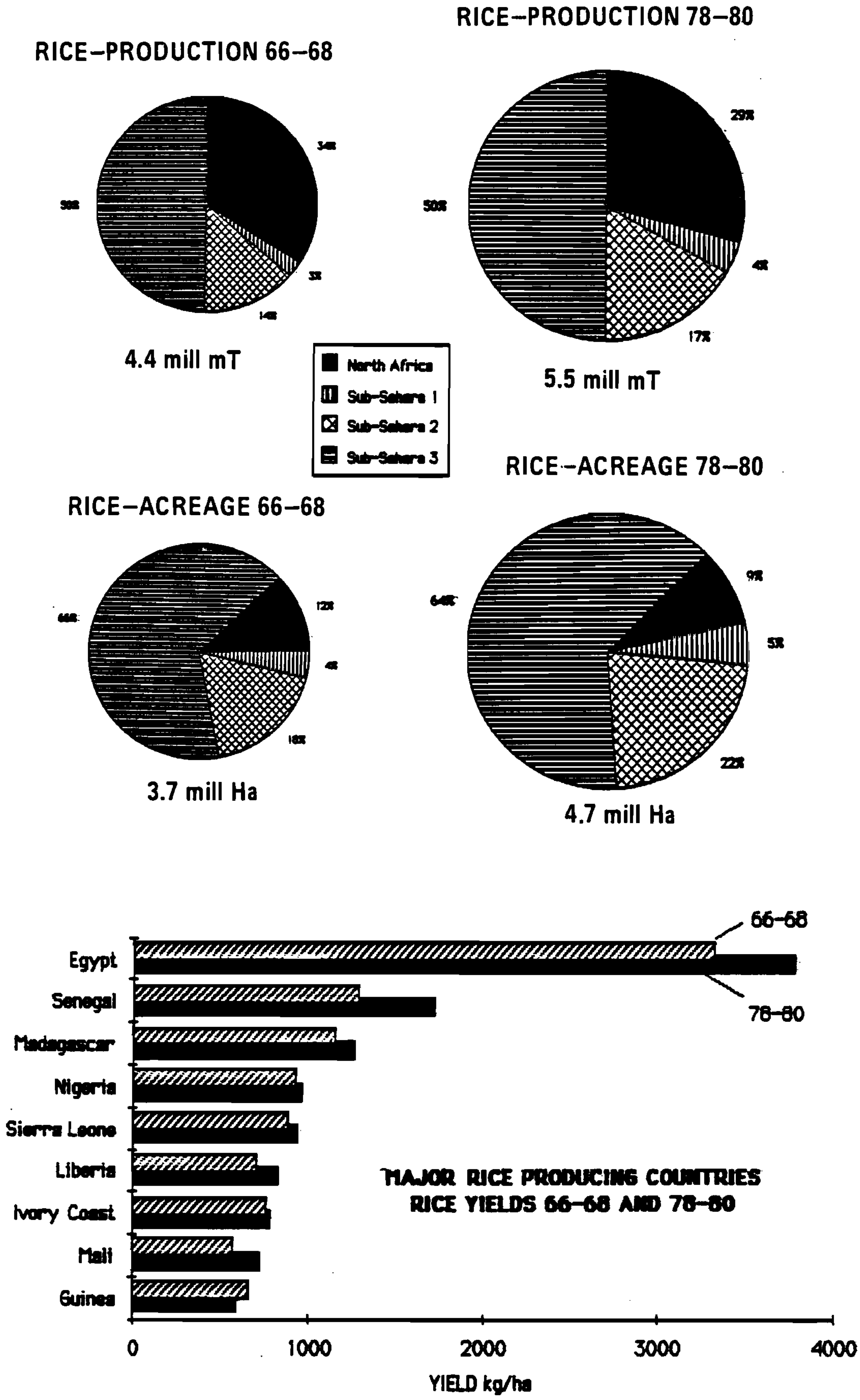



Fig.2.5. Area, yield and production of rice in Africa (1966-68 and 1978-80)

Table 2.7. Rice Production in Major Rice Producing African Countries

| | 1978-80 per capita production | Annual change 1966-68 to 1978-80 | | | |
|---|---|---|---|---|---|
| | | Area | Yield | Production | Per capita production |
| | kg | % | % | % | % |
| Madagascar | 170 | 1.25 | 0.76 | 2.02 | -0.44 |
| Sierra Leone | 110 | 1.38 | 0.54 | 1.93 | -0.56 |
| Liberia | 93 | 3.36 | 1.30 | 4.70 | 1.30 |
| Guinea | 49 | 1.44 | -0.89 | 0.51 | -1.85 |
| Ivory Coast | 41 | 2.88 | 0.24 | 3.10 | -1.20 |
| Guinea Bissau | 39 | 0.08 | -3.07 | -2.81 | -3.77 |
| Egypt | 39 | -0.23 | 1.08 | 0.81 | -1.49 |
| Gambia | 27 | -0.96 | -1.29 | -2.33 | -5.23 |
| Comoros | 27 | 2.14 | -1.20 | 0.88 | -1.33 |
| Senegal | 24 | -1.49 | 2.40 | 0.85 | -2.10 |

production in Madagascar and Sierra Leone increased by about 2% annually whereas production in Guinea, Egypt, Comoros and Senegal increased in the range of 0.5 to 0.9 annually. During this period, production in Guinea Bissau and Gambia declined by more than 2.3% annually. In terms of per capita production, there was a decline in all these countries except for Liberia. As shown in Table 2.7 the production increases in all countries have been realized mainly through area expansion except for Senegal and Egypt.

As in the case of wheat, demand for rice is likely to increase rapidly in Africa. A number of African countries have a large rainfed potential for rice production and there is considerable scope for acreage expansion and yield increases (Fischer and Shah, 1984).

### 2.3.3. Coarse Grains

Coarse grains, comprising of maize, sorghum, millet and barley, are the most important cereal crops in Africa. Fig.2.6 shows the distribution of the production of coarse grains among various regions in Africa. In 1978-80, produc-

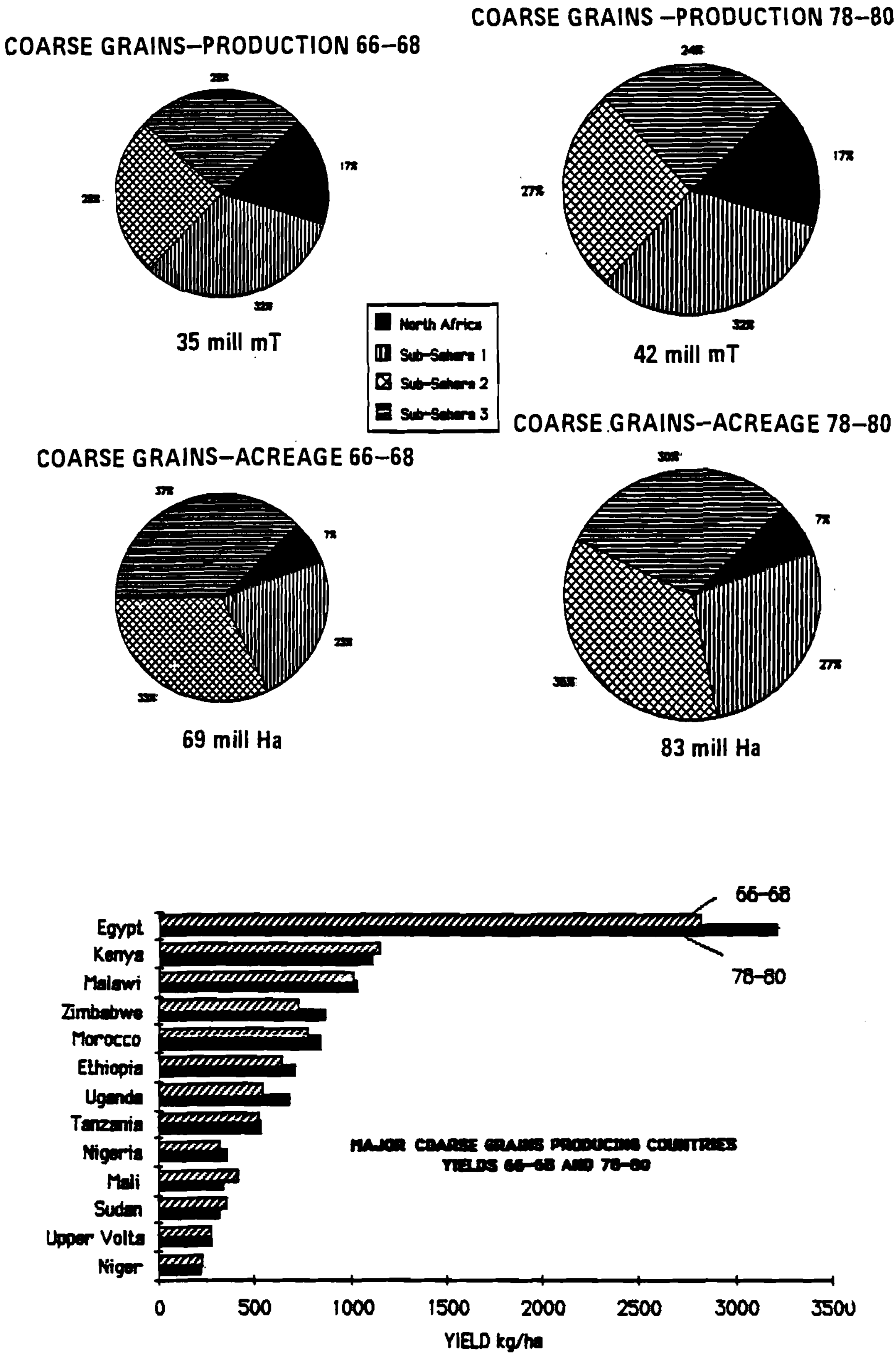



Fig.2.6. Area, yield and production of coarse grains in Africa (1966-68 and 1978-80)

tion of coarse grains was higher than 35kg per capita in all countries in Africa except for Zaire, Guinea, Reunion, Guinea Bissau Botswana, Sierra Leone, Madagascar, Comoros, Gabon, Cape Verde, Mauritania, Congo, Sao Tome, Mauritius and Liberia.

During the period 1966-68 to 1978-80, total coarse grain production increased in the majority of African countries but in fifteen countries it declined as follows:

- Cape Verde, Mauritania, Botswana and Liberia (more than 3% annual decrease)
- Mozambique and Guinea Bissau (2 to 3% annual decrease)
- Angola, Somalia, Gambia, Madagascar and Guinea (1 to 2% annual decrease)
- Zambia, Ghana, Central African Empire and Chad (up to 1% annual decrease).

Generally, the increases in coarse grain production in most countries have been realized through area expansion. In North African countries average yields increased by 0.7% annually; Morocco recorded the lowest average annual yield increase of 0.6% and Tunisia the highest annual yield increase of 1.7%. In contrast, yields have generally declined in many Subsahara countries. The major exceptions were Lesotho, Gabon, Reunion, Benin, Togo and Swaziland, where coarse grain yields have increased by more than 2.4% annually over the period 1966-68 to 1978-80.

Coarse grains provide the major share of food intake in many Subsahara African countries and the inadequate growth of production and declining yields is a cause for serious concern. A large ecological potential exists and there is considerable scope for area expansion and yield increases. The present yield levels in most countries are extremely low. Application of fertilizers and chemicals as well as improved farming methods and policies that promote these will be essential to meet the future demand of an increasing population, especially in many Subsahara countries in Africa.

## 2.4. Trade: Import and Aid Trends

### 2.4.1. Wheat

Table 2.8 shows the distribution and growth of wheat imports, aid and exports among various regions in Africa in 1966-68 and 1978-80. All countries in Africa are net importers of wheat. The small amounts of exports (e.g. total African exports of 209000mT in 1978-80) as reported in the supply utilization accounts have been the exports of processed wheat to neighbouring countries. During the period 1966-68 to 1978-80 commercial imports and aid increased by 9.0% and 3.0% annually for the countries of North Africa. Subsahara African countries also increased rapidly their commercial imports (8.4% annually) and received increasing amounts of aid (12.7% annual increase in aid over the period 1966-68 to 1978-80).

During the period 1966-68 to 1978-80, wheat aid to Subsahara African countries has increased faster than commercial imports of wheat whereas in North Africa commercial wheat imports have grown much more rapidly than wheat. In 1966-68, 28.0% and 11.5% of total wheat imports to North and Subsahara Africa respectively was wheat aid whereas in 1978-80, the share of wheat aid in total imports had declined to 16.6% for North Africa and increased to 17.2% for Subsahara Africa. It has been suggested in the literature that wheat aid in a sense creates a market for wheat. At first sight it may appear from the above results that this may have happened in North Africa. However for Subsahara Africa, past wheat aid could not be considered to have created a market for wheat.

Table 2.8. African Trade and Aid in Cereals: 1978-80 Levels and Annual Growth Rates 1966-68 to 1978-80

| | 1978-80 | | | | Annual Growth Rate 1966-68 to 1978-80 | | | |
|---|---|---|---|---|---|---|---|---|
| | Exports* Mill.mT | Total Imports* Mill.mT | Commercial Imports* Mill.mT | Aid Mill.mT | Export % | Total Imports % | Commercial Imports % | Aid % |
| **Wheat:** | | | | | | | | |
| Subsahara 1 | 0.01 | 0.93 | 0.70 | 0.23 | -12.02 | 6.23 | 4.52 | 15.86 |
| Subsahara 2 | 0.18 | 1.98 | 1.81 | 0.17 | 14.47 | 12.20 | 11.97 | 15.08 |
| Subsahara 3 | 0.01 | 0.58 | 0.38 | 0.20 | -0.19 | 5.68 | 4.42 | 8.83 |
| Subsahara Total | 0.20 | 3.49 | 2.89 | 0.60 | 5.51 | 8.95 | 8.35 | 12.67 |
| North Africa | 0.01 | 9.84 | 8.21 | 1.63 | -22.48 | 7.63 | 8.96 | 3.02 |
| Total Africa | 0.21 | 13.32 | 11.10 | 2.22 | -1.85 | 7.95 | 8.79 | 4.70 |
| **Rice:** | | | | | | | | |
| Subsahara 1 | - | 0.07 | 0.05 | 0.02 | -16.22 | 6.14 | 3.34 | - |
| Subsahara 2 | - | 1.13 | 1.12 | 0.01 | -12.30 | 8.86 | 9.30 | -6.98 |
| Subsahara 3 | 0.01 | 0.57 | 0.53 | 0.04 | -15.34 | 11.24 | 12.79 | 0.90 |
| Subsahara Total | 0.01 | 1.78 | 1.71 | 0.07 | -15.44 | 9.41 | 9.94 | 1.56 |
| North Africa | 0.10 | 0.05 | 0.05 | 0.00 | -10.74 | 9.91 | 9.91 | - |
| Total Africa | 0.11 | 1.83 | 1.76 | 0.07 | -11.20 | 9.42 | 9.94 | 1.56 |
| **Coarse Grains:** | | | | | | | | |
| Subsahara 1 | 0.50 | 0.53 | 0.52 | 0.01 | -2.73 | 8.98 | 12.41 | -14.32 |
| Subsahara 2 | 0.01 | 0.83 | 0.76 | 0.07 | 5.77 | 10.29 | 10.09 | 12.85 |
| Subsahara 3 | 0.03 | 0.73 | 0.68 | 0.05 | -14.06 | 10.03 | 9.49 | 23.44 |
| Subsahara Total | 0.34 | 2.09 | 1.96 | 0.14 | -4.24 | 9.85 | 10.42 | 4.35 |
| North Africa | 0.02 | 1.59 | 1.37 | 0.22 | -10.36 | 13.30 | 13.44 | 12.41 |
| Total Africa | 0.56 | 3.68 | 3.33 | 0.35 | -4.56 | 11.17 | 11.54 | 8.32 |
| **All Grains:** | | | | | | | | |
| Subsahara 1 | 0.52 | 1.53 | 1.27 | 0.26 | -3.25 | 7.07 | 6.84 | 8.32 |
| Subsahara 2 | 0.19 | 3.94 | 3.69 | 0.25 | 13.72 | 10.71 | 10.68 | 11.11 |
| Subsahara 3 | 0.05 | 1.89 | 1.59 | 0.29 | 13.10 | 8.71 | 8.76 | 8.48 |
| Subsahara Total | 0.75 | 7.35 | 6.55 | 0.80 | -2.93 | 9.31 | 9.33 | 9.15 |
| North Africa | 0.13 | 11.48 | 9.64 | 1.84 | -12.41 | 8.23 | 9.47 | 3.69 |
| Total Africa | 0.88 | 18.83 | 16.19 | 2.64 | -5.33 | 8.63 | 9.41 | 5.00 |

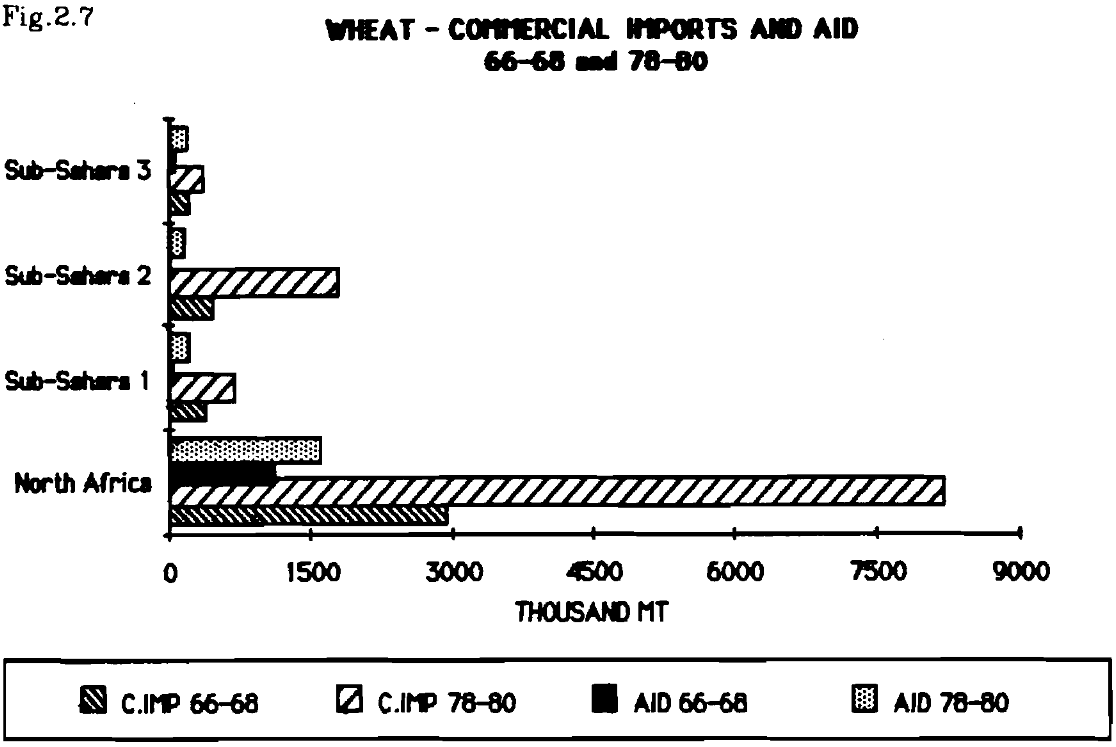
*Including trade with countries within the group.

Fig.2.7 to Fig.2.9 show the 1966-68 to 1978-80 changes in wheat commercial imports, aid and total imports. In Fig.2.8 and Fig.2.9 the data is presented in map-form by individual countries. The changes in import and aid patterns at the regional level are discussed below.

### 2.4.1.1. North Africa

In 1966-68, per capita imports averaged 64kg in North Africa; all countries

Fig.2.7




in the region were importing more than 50kg per capita. These imports amounted to 53% of wheat consumption in the region - for Tunisia, Morocco and Algeria this share was 36 to 43% and for Egypt and Libya more than 70%. By 1978-80, per capita imports to North Africa had increased by more than 75%. These imports contribute almost 90% of the per capita consumption in Libya and Egypt and between 50 and 68% for the other three countries.

Wheat aid to North African countries has declined substantially during the last two decades: for example in 1966-68, 28% of North African wheat imports came as aid whereas this share had dropped to 16% by 1978-80. Libya, a high income oil exporting country, did not receive any wheat aid during the past. For Tunisia, Algeria and Morocco, wheat aid as share of total wheat imports fell from 51, 18 and 61% in 1966-68 to 14, 1 and 6% in 1978-80. In contrast, the share of wheat aid in total imports increased from 20 to 28% in Egypt during this perod. The decline in wheat aid in the three former countries was compensated by a rapid increase in per capita commercial imports - rising by more

Fig.2.8

## WHEAT - COMMERCIAL IMPORTS

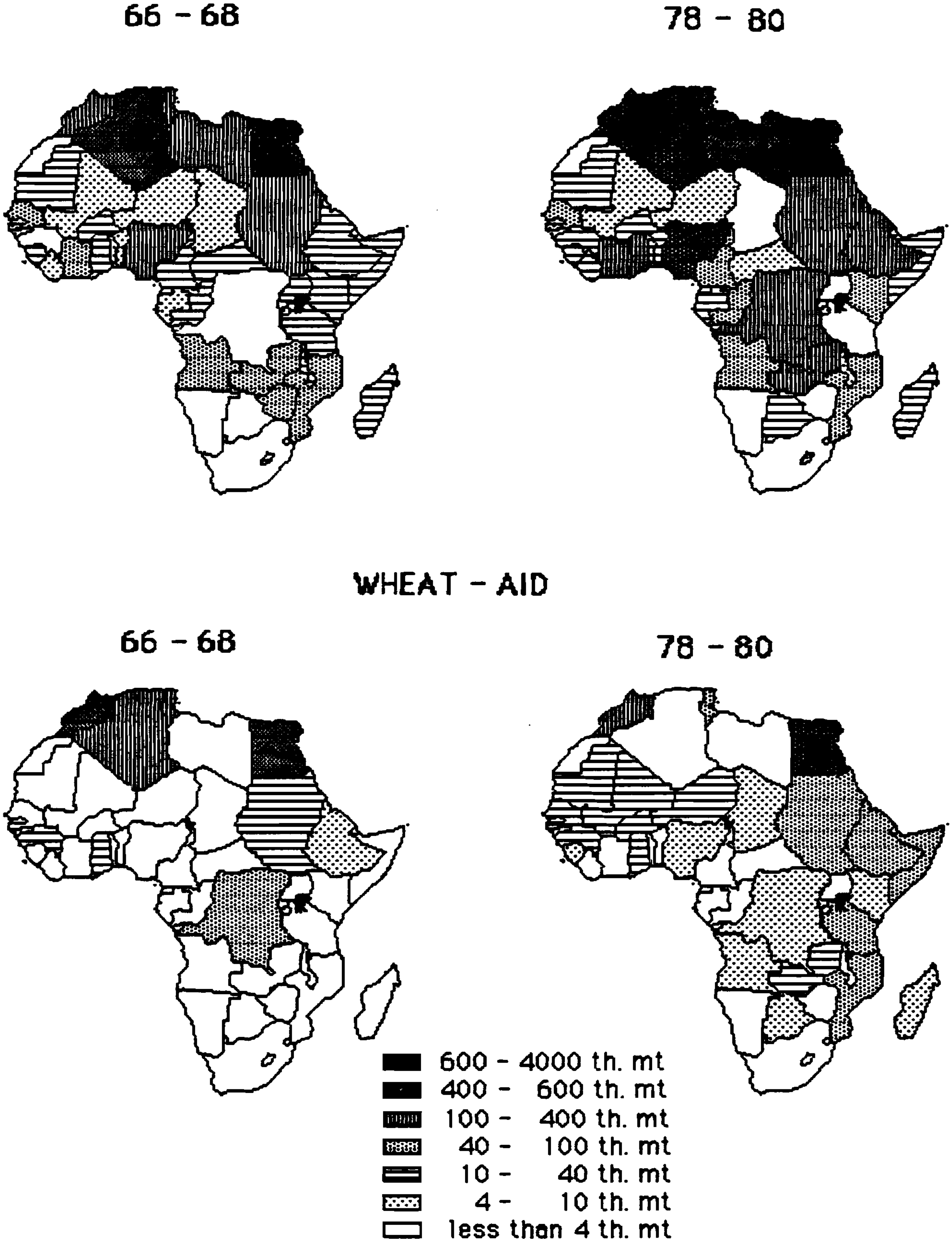
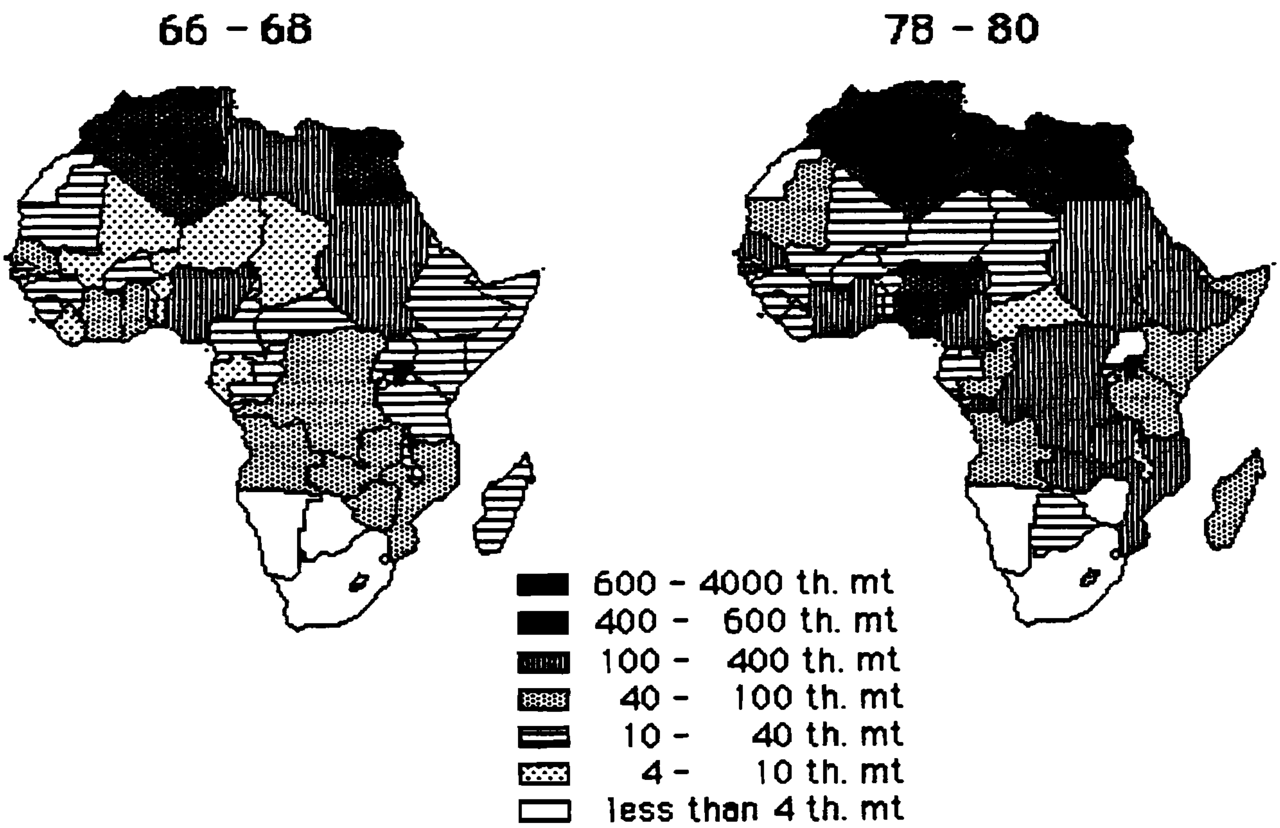


Fig.2.9

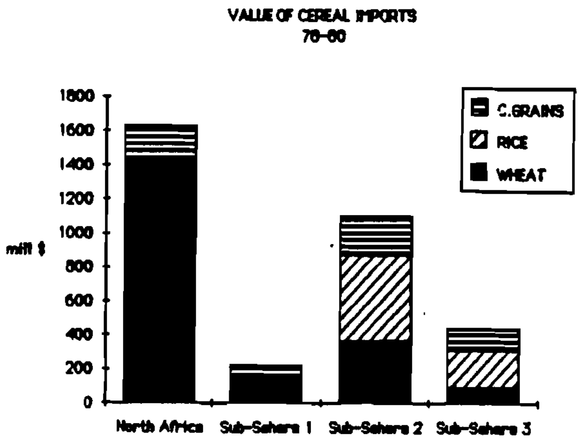
## WHEAT - TOTAL IMPORTS

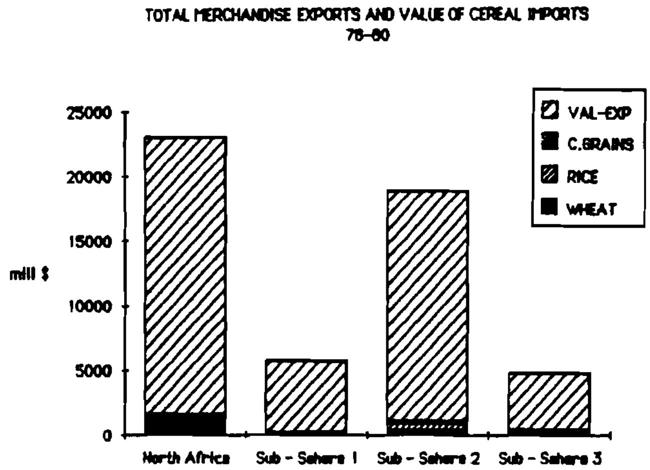


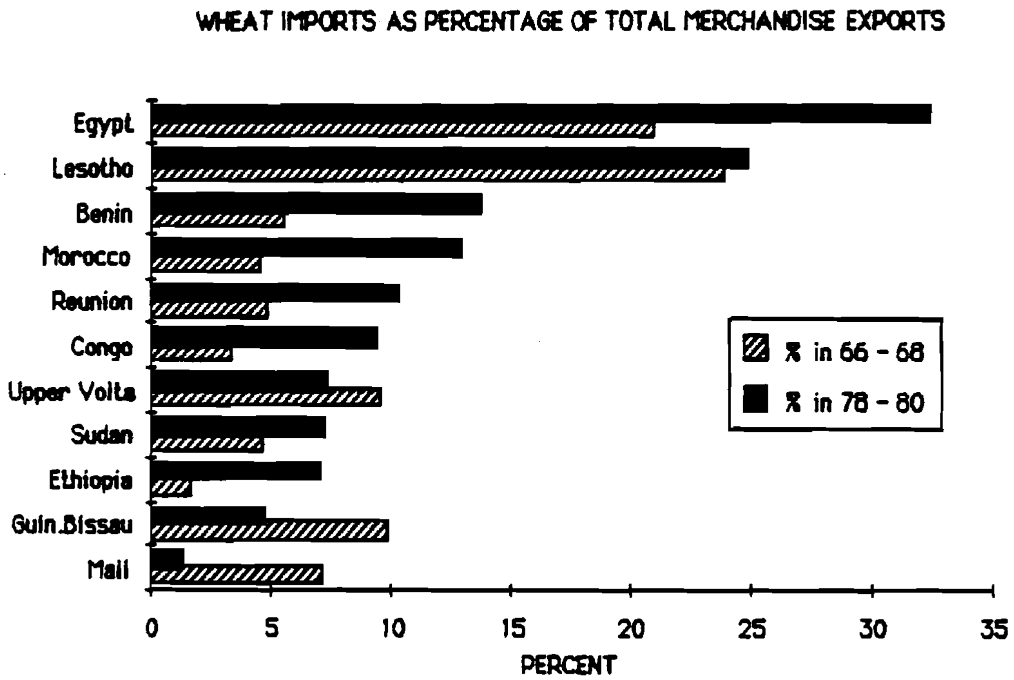

than 6.0% annually over the period 166-68 to 1978-80. Even in Egypt, per capita commercial imports have increased from 57kg in 1966-68 to 91kg in 1978-80. As a percentage of total merchandise imports, wheat imports accounted for 12% for Egypt, 7% in Morocco, 4% in Tunisia and 3% in Algeria in 1978-80. In export terms, 32%, 13%, 5% and 5% respectively of total merchandise exports respectively in these countries were required to finance these imports. Wheat consumption levels in these four countries has reached a stable level and future imports to meet the needs of a growing population will not be a financial burden provided the past momentum in growth of export earnings is maintained.

Fig.2.10 shows the average 1978-80 value of wheat (also rice and coarse grains) imports and the share of cereal imports in total merchandise exports.

Figs.2.10 and 2.11



At the regional level, these results show that financing of cereal imports does not appear to be burdensome. However at the country level, the situation may be problematic in a number of countries, especially if the need for capital and other essential imports is large. Fig.2.11 shows the share of wheat imports in total merchandise exports for selected countries, i.e. countries where wheat imports accounted for more than 7% of total merchandise exports in 1966-68 and 1978-80 respectively.

**2.4.1.2. Subsahara 1**

In all Subsahara 1 countries except for Ethiopia, Angola and Zimbabwe, per capita wheat consumption increased by more than 2% annually during the period 1966-68 to 1978-80. Per capita consumption levels in 1978-80 in these countries varied from 7 to 26kg except for Lesotho with a consumption of 67kg per capita. Wheat imports contributed to more than 85% of wheat consumption in Angola and Ethiopia, 50-60% in Sudan and Lesotho, 38% in Tanzania and Ethiopia and 26% in Kenya. Zimbabwe is the only country in this group where wheat demand was met from domestic production (irrigated). As shown in Fig.2.8, in 1966-68 only two countries in Subsahara 1, namely Sudan and Ethiopia, received wheat aid. The quantities of wheat aid involved were small, respectively 35000 and 4000mT and for Sudan this amounted to a wheat aid of 3kg per capita in comparison to commercial wheat imports of 9kg per capita. By 1978-80, all countries in Subsahara 1 except for Lesotho and Zimbabwe were wheat aid recipients. However this aid amounted to only 1 to 4kg per capita. Wheat aid as a share of total wheat imports accounted for 100% in Tanzania, 38%in Ethiopia, 25% in Sudan, 20% in Kenya and 9% in Zambia and Angola. Commercial wheat imports have increased annually by 19% in Ethiopia, 12% in Kenya and 10% in Lesotho, 7% in Zambia and 5% in Sudan during the period 1966-68 to 1978-80. In 1966-68 commercial wheat imports amounted to 1-2% of total merchandise imports in all countries except for Sudan where the share was 4%. These countries were able to finance these imports from a similar share of total merchandise exports. By 1978-80, Ethiopia and Sudan required almost 7% of total merchandise export earnings to finance wheat imports (see Fig.2.11).

In this region, the critical food situation in Ethiopia is worrying. Among the factors responsible for this situation are the poor weather and the political situation.

**2.4.1.3. Subsahara 2**

In the fourteen countries considered in this group, per capita consumption ranged from 31 to 59kg in Mauritania, Cape Verde, Reunion, Congo, Sao Tome, Gabon and Mauritius and 10 to 23kg in Cameroon, Ghana, Nigeria, Somalia, Ivory Coast, Senegal and Botswana in 1978-80. Most of the wheat consumption in these countries has to be imported since there is hardly any domestic production. Nigeria was by far the largest wheat importer in this region - in 1978-80 1.1 mill.mT were imported. Senegal, Ghana and Ivory Coast imported 12000, 159000 and 169000mT of wheat.

In 1966-68 Subsahara 2 countries except for Ghana did not receive any wheat aid. In the case of Ghana wheat aid amounted to 4kg per capita. By 1978-80 there were six wheat aid recipient countries: Mauritius, Mauritania and Somalia receiving about 15kg per capita, and Ghana, Botswana and Senegal receiving 3 to 6kg per capita. In volume terms, about a third of the 1978-80 imports of 486000mT in these countries was wheat aid.

In 1966-68 as well as 1978-80, commercial wheat imports as a share of total merchandise imports amounted to 1.6% for the region as a whole. Commercial wheat imports in the region increased at 12% annually over the period 1966-68 to 1978-80; in the earlier period 1.5% of the total merchandise exports could finance the wheat imports whereas by 1978-80, this value had increased to 1.9%. As shown in Fig.2.11, the situation worsened particularly for Benin, Morocco, Reunion and Congo where increasing shares of total merchandise export earnings were required to finance wheat imports in 1978-80. The countries of this region generally lack the ecological land resources suitable for wheat production. Although present levels of commercial imports (15kg per capita for the region) are low, if past trends in wheat consumption continue, an increasing share of merchandise export earnings will be required to finance wheat imports.

**2.4.1.4. Subsahara 3**

There is hardly any wheat production in the twenty-two countries included in this group. The exception are Chad, Burundi, Swaziland, Rwanda, Uganda and Namibia. However, even in these countries, per capita production amounted to less than 2kg in 1978-80. For the region as a whole, total wheat imports increased from 300000mT in 1966-68 to 582000mT, i.e. an annual growth rate of 5.7%. In 1978-80, total wheat imports were about 135000mT in both Mozambique and Zaire. All other countries imported well below 50000mT of wheat. In per capita terms, wheat imports for the region amounted to 5kg in 1978-80 in comparison to 3kg in 1966-68.

Wheat aid in 1966-68 amounted to 72000mT and 80.6% and 16.7% of this was received by Zaire and Mali respectively. In 1978-80 Mozambique received wheat aid of 85000mT out of a total regional wheat aid of 200000mT. Other wheat aid recipients were Mali, Niger, Upper Volta and Guinea which received 10000 to 20000mT of wheat aid in 1978-80. For the region as a whole per capita wheat aid accounted for 40% of total wheat imports of about 5kg per capita.

In 1978-80, commercial wheat imports as a share of total merchandise imports amounted to less than 2.3% for all countries except Burundi, Central Africa Empire and Zaire where the value was 4 to 5%. In export terms, 1.4% of total merchandise exports in the region were required to finance wheat imports in comparison to 1.6% in 1978-80. In the case of Benin, 13.8% of total merchandise exports were required to finance wheat imports (see Fig.2.11). Other Subsahara 3 countries where more than 5-7% of exports were required to finance wheat imports were Burundi and Upper Volta.

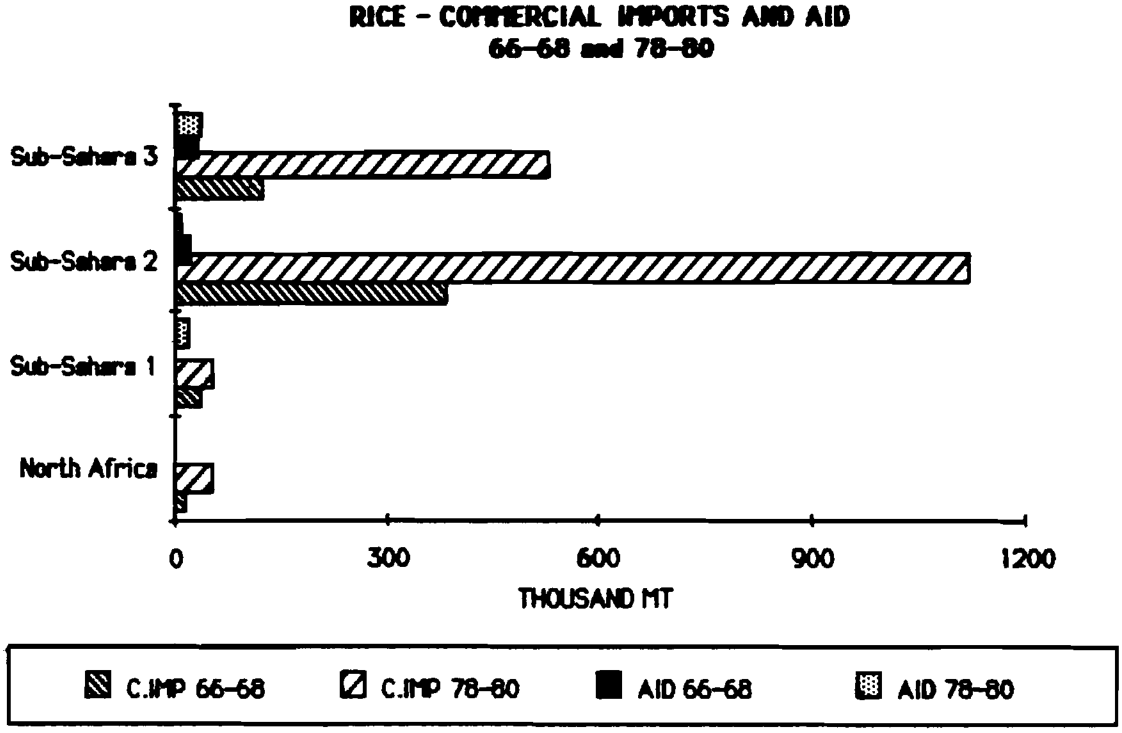
In conclusion, the past levels of wheat imports and wheat consumption in Subsahara 3 as a whole are not significant. However, in this region the share of wheat in per capita grain consumption (see Fig.2.3) amounted to more than 7% in Mozambique, Central African Empire, Gambia, Benin, Togo, Liberia, Guinea and Zaire and financing of future imports may be a strain in specific countries, especially since wheat production possibilities hardly exist.

### 2.4.2. Rice

Fig.2.12 and Table 2.8 show the distribution and growth of commercial rice imports, aid, total imports and exports among various regions in Africa in 1966-68 and 1978-80. In North Africa, Libya and to a lesser extent Morocco are the main rice importers. In 1978-80 total rice imports to these two countries amounted to 39000 and 13000mT respectively. Although Egypt is a rice exporting country, its exports fell from 389000T in 1966-68 to about 100000mT in 1978-80. In Egypt per capita rice consumption has been increasing at 0.8% annually during this period and Egyptian rice selfsufficiency can probably be maintained if past trends in yield increases (1% growth annually) can be continued in the future.

During the period 1966-68 to 1978-80, rice imports to Subsahara countries

Fig.2.12




have increased threefold to 1.8 mill.mT, i.e. annual growth rate of 9.4%. In comparison wheat imports grew by 9.0% annually. The main (more than 100000mT in 1978-80) rice importing countries in Subsahara Africa were Nigeria, Senegal, Ivory Coast, and Madagascar, accounting for 54.7% of Subsahara rice imports. Additionally Guinea, Mauritius, Mozambique, Liberia, Somalia and Reunion imported more than 50000mT of rice in 1978-80. Except for Nigeria, Mozambique and Somalia, the total rice imports in the above seven countries exceeded total wheat imports in 1978-80. In six of these seven countries, per capita rice consumpton in 1978-80 was more than three times the level of wheat consumption. The exception was Mauritius where 69kg per capita of rice was consumed compared to 59kg per capita of wheat.

For Subsahara African countries rice aid amounted to 55000mT compared to commercial imports of 548000mT in 1966-68. The corresponding figures for

1978-80 where 67000 and 1,710,000mT. In 1966-68 Ivory Coast, Ghana, Guinea and Zaire received wheat aid of 10000 to 20000mT whereas in 1978-80 Tanzania and Guinea received about 20000mT and Somalia, Zaire and Mozambique received just under 10000mT of rice aid.

In 1978-80 on a per capita basis commercial imports of rice exceeded 100kg in Reunion, 30-75kg in Mauritania, Liberia, Gambia, Comoros, Senegal, Guinea Bissau and Mauritius. Among these countries, annual growth rate of per capita commercial rice imports was in the range 6.8 to 11.9% for Gambia, Mauritania and Guinea Bissau, 1.3 to 2.4 in Liberia and Comoros and almost zero in Reunion, Mauritius and Senegal.

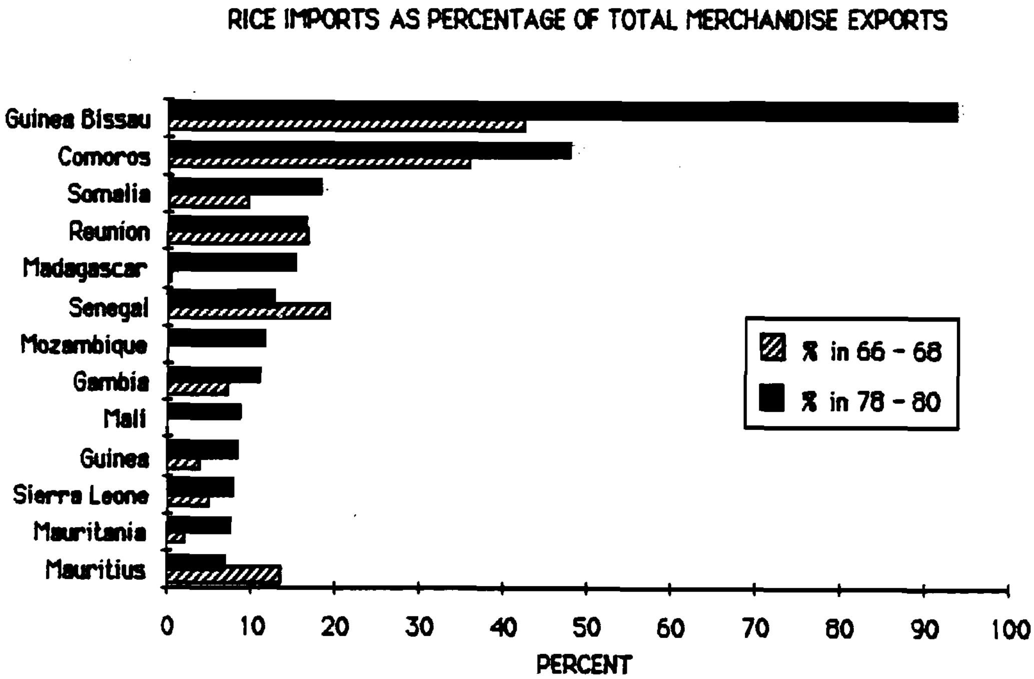
The share of rice imports in total merchandise exports for the four African subgroups is shown in Fig.2.10. In 1978-80, fourteen countries in Subsahara Africa required more than 7% their respective merchandise export earnings to finance commercial imports of rice, Fig.2.13. In this group of countries, the situation in the poorer countries, namely Mozambique, Somalia, Gambia and Mauritania, is of particular concern since a rather large share of export earnings has been required to finance rice imports; in future, increased levels of rice aid will be required for these countries unless domestic production can be expanded rapidly.

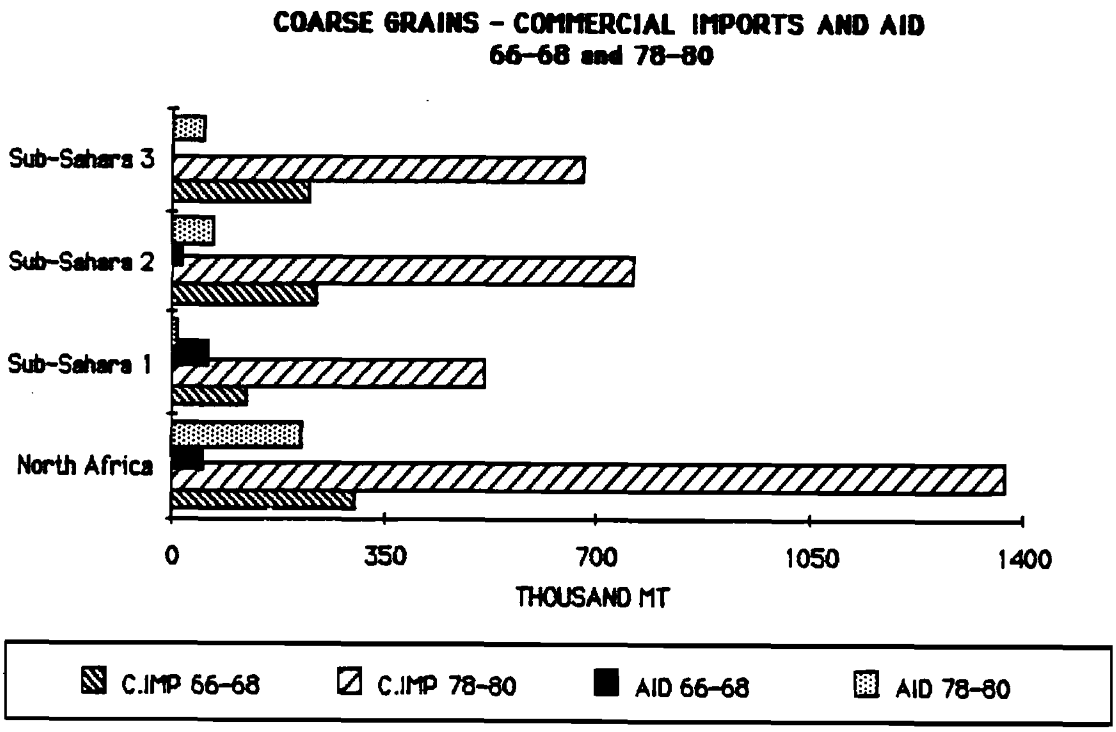
### 2.4.3. Coarse Grains

Fig.2.14 and Table 2.8 show the distribution and growth of coarse grain commercial imports, aid, total imports and exports among various regions in Africa in 1966-68 and 1978-80.

As a share of total grain imports, coarse grains accounted for 14.8% and 19.5% in 1966-68 and 1978-80 respectively. The annual growth rate of total coarse grain imports for North Africa as well as Subsahara Africa has been

Fig.2.13 and 2.14



higher than the corresponding growth rates of wheat as well as rice imports. The countries of North Africa accounted for 43.1% of Africa's imports of coarse grains in 1978-80. Egypt imported 725000mT and of this about a third was aid. An increasing proportion of coarse grain imports to the countries of North Africa are being utilized as feed; for example in 1966-68 feed accounted for 28.8% of coarse grain utilization whereas by 1978-80 this share had increased to 41.9%. On a per capita basis, 29kg and 42kg of coarse grains were utilized as feed in 1966-68 and 1978-80 respectively in North Africa.

In many of the Subsahara countries, coarse grains is the major component of human cereal consumption. In 1978-80, per capita consumption for Subsahara Africa was 83kg. This compares to 93kg per capita in 1966-68. Over this period per capita imports doubled from 3 to 6kg.

In 1978-80, Nigeria, Zaire, Mozambique and Zambia commercially imported more than 100,000mT of coarse grains. These four countries accounted for 40% of Subsahara coarse grain imports of 2.1 million mT. Other countries with commercial total imports in the range 50000 to 100000mT were Lesotho, Kenya, Angola, Tanzania, Botswana, Ivory Coast, Ghana, Cameroon, Malawi and Namibia. In contrast, in 1966-68 only four countries imported 50000 to 10000mt of coarse grains. These were Kenya, Botswana, Nigeria and Zaire. Commercial coarse grain imports to Subsahara Africa have increased by almost 10.4% annually over the period 1966-68 to 1978-80. A declinding trend in production over the last two decades is the main cause for this apparently rapid increase in imports. However, coarse grain imports for Subsahara Africa amounted to only 6.0% of total utilization in 1978-80. These imports amounted to about 1.5% of the total Subsahara merchandise export earnings in 1978-80. Apart from Cape Verde (hardly any merchandise exports), Mozambique, Upper Volta, Reunion, Guinea Bissau and Lesotho required more than 7% of their merchandise exports to finance commercial imports of coarse grains. Here the shares were respectively 8.8, 8.9, 11.4, 16.5 and 28.8%.

In 1978-80 aid accounted for 6.5% of total coarse grain imports. This total aid of 137000mT amounted to less than 0.5kg per capita. Six countries, namely Ghana, Senegal, Mauritania, Somalia, Upper Volta and Niger received 10000 to 25000mT of coarse grain aid, i.e. these countries thus accounting for almost 72% of Subsahara coarse grain aid in 1978-80.

Subsahara Africa can be selfsufficient in coarse grains provided the present low yields (448kg/ha in 1978-80) are increased. Ecological potential for coarse grains production is not only high in many African countries but also often there is a comparative advantage in growing these cereals especially in Subsahara Africa (see Section 3).

## 2.5. Concluding Remarks

The major findings of the analysis of past trends and Africa's growing dependance on imported wheat presented in this section, are summarized below.

### Consumption

- Over the period 1966-68 to 1978-80, 19 Subsahara countries have had a decline in per capita calorie intake; the total population of these countries was 177 million, i.e. 52.3% of the population of Subsahara Africa..
- Importance of wheat consumption varies from country to country in Africa. Generalizations cannot be easily made. Yet one can group some countries together as they paint a broadly similar picture.
- During the period 1966-68 to 1978-80, consumption of wheat in almost all countries in Africa has gone up absolutely as well as in terms of percentage

of total calorie intake obtained from wheat. However, the total calories obtained from wheat are not very much for most of the African countries. For example, wheat consumption amounting to more than 20% of calorie intake occurred in only seven countries and of these, five are North African countries, who are traditional wheat eaters.

- The North African countries are the major wheat consumers – getting 35 to 55% of their calorie intake from wheat. In these countries the share of wheat calories has more or less remained unchanged during the period 1966-68 and 1978-80.
- In Subsahara Africa, wheat accounted for between 10 to 25% of total calorie intake in 12 countries. The total population of these countries in 1978-80 was 63 million. The remaining countries, with a population of 276 million in 1978-80, on the average had wheat consumption amounting to about 4% of total calories consumed.
- In Subsahara Africa, with the exception of Ethiopia, wheat consumption tended to be higher in the countries with relatively higher incomes as well as levels of urbanization.

**Selfsufficiency Ratio (SSR)**

- Over the period 1966-68 to 1978-80, SSR for wheat declined for all four country groups, namely North Africa and Subsahara 1 to 3, in Africa. However this has to be considered along with the changes in SSRs of other cereals.
- SSR for all country groups also declined for rice as well as for coarse grains. The highest rates of decline in SSR are for wheat, followed by rice and then coarse grains.

- Given that SSR for all cereals declined, the pattern is understandable,
  - with higher income, demand for wheat and rice can be expected to increase more than for coarse grains. In fact, per capita consumption of coarse grains declined for all country groups over the period 1966-68 to 1978-80. Since production potential for rice in Africa is better than that for wheat, SSR for rice would decline less than for wheat. Also wheat is more easily available on the world market than rice which is more expensive and most coarse grains traded (mainly for feed) on the world market are not suitable for African tastes.

**Production**

- The area under coarse grains in Subsahara Africa in 1978-80 was 77.28 million hectares whereas for wheat it was only 1.07 million hectares and for rice 4.21 million hectares.
- Area under coarse grains increased faster than under wheat (except in Subsahara 2 where the total area under wheat in 1978-80 was only 0.02 million hectares). The area under rice increased at a higher rate than the area under coarse grains. In fact, 14.7 million hectares were added under coarse grains, 0.99 million hectares for rice, and only 0.17 million hectares for wheat over the period 1966-68 to 1978-80 in Africa.
- Yields on the other hand increased faster in all country groups other than Subsahara 2 for wheat, followed by rice and yields for coarse grains actually declined. In Subsahara 2, yields of coarse grains increased and wheat declined.
- Thus wheat production has not displaced coarse grain production nor does wheat seem to have diverted significant amounts of inputs in Subsahara Africa.

- In North Africa, where areas under wheat and coarse grains are comparable (around 5.5 million hectares each), coarse grain area has grown faster (especially in Algeria) but wheat yields have grown a bit faster than coarse grains.
- Of the 13 wheat growing countries, only in Egypt producer price was lower for wheat than for coarse grains. In all other countries it was higher and in most countries significantly higher, the differences being much larger than on the world market. However, during the last two decades coarse grain producer prices have been rising faster than wheat producer prices in many African countries.
- Wheat yields are generally higher than coarse grains and with higher prices this difference is likely to be further increased. In Subsahara Africa the relatively high wheat yields are due to the fact that wheat is produced under large-scale commercial conditions.
- Thus production of wheat does not seem to have been hampered by relatively poor prices. If price incentives were inadequate for wheat, they must have been even more so for coarse grains.
- Thus low growth in production of wheat has to be explained by either poor ecological possibilities or just poor incentives for food production in general.

**Trade and Aid**

- Total imports (commercial and aid) of all grains have increased in Africa. At the country group levels , all groups increased imports of grains at annual rates varying from 7 to 10 percent over the period 1966-68 to 1978-80. Total imports of coarse grains, rice and wheat have all increased at similar and rapid rates:

- In 1978-80, African countries together imported 18.83 million mT of grains of which 16.19 million mT were commercial imports and only 2.64 million mT were aid imports (grant and concessional rates imports).

- Five countries of North Africa accounted for 11.48 million mT of imports, 9.64 million mT of commercial imports and 1.84 million mT of aid imports. For the Subsahara African countries the total quantity of grain aid was 0.8 million mT of which wheat aid was 0.6 million mT. Thus the extent of grain aid for the Subsahara African countries has been miniscule in 1978-80 -- and was even smaller in the past.

- There is also an increasing use of imported coarse grains as feed especially in North Africa where feed use doubled from 1.8 to 3.7 million mT over the period 1966-68 to 1978-80.

- It should be noted that for a number of countries, financing of commercial cereal imports is beginning to take a significant share of merchandise export earnings, Table 2.9. These results show not only that in an increasing number of countries a growing share of exports is spent on cereal imports but also that countries with relatively large populations are being affected. Furthermore, this trend, particularly for the low income countries (less than US$250 GNP per capita in 1979), namely Ethiopia, Mozambique, Mali, Upper Volta, Burundi, Somalia, Benin and Sierra Leone, is of particular concern. It is important that wherever possible domestic food production needs to be stepped up to ensure that export earnings can be channelled into the financing of much needed capital and essential goods.

- Of the five North African countries, no wheat aid has been or is given to Libya. In Tunisia, Algeria and Morocco, wheat aid has declined but commercial imports have gone up whereas in Egypt wheat aid has gone up over this period by a million tonnes whereas commercial imports have

Table 2.9. Number of countries, population and share of merchandise exports required to finance commercial cereal imports (1966-68 and 1978-80)

| | 1966-68 | | 1978-80 | |
|---|---|---|---|---|
| | Number of Countries | Total Population Million | Number of Countries | Total Population Million |
| **Share of Merchandise export earnings required to finance commercial imports of:** | | | | |
| **Wheat** | | | | |
| More than 20% | 3 | 32.1 | 3 | 42.5 |
| 10 to 20% | - | - | 3 | 23.5 |
| 7 to 10% | 3 | 10.4 | 4 | 57.9 |
| **Rice** | | | | |
| More than 20% | 3 | 1.0 | 3 | 1.2 |
| 10 to 20% | 3 | 5.1 | 6 | 28.8 |
| 7 to 10% | 2 | 3.0 | 5 | 17.4 |
| **Coarse Grains** | | | | |
| More than 20% | 3 | 1.8 | 2 | 1.6 |
| 10 to 20% | - | - | 2 | 1.1 |
| 7 to 10% | 1 | 0.5 | 2 | 16.9 |
| **All Cereals** | | | | |
| More than 20% | 9 | 38.7 | 10 | 67.7 |
| 10 to 20% | 6 | 16.4 | 10 | 52.6 |
| 7 to 10% | 4 | 22.9 | 5 | 88.3 |

gone up by 2 million tonnes. Thus only for North Africa, one could perhaps say that past wheat aid may have created a market for wheat. However, these countries were wheat consuming countries to begin with and the share of calories derived from wheat in 1966-68 was comparable or even higher than in 1978-80.

In Summary:

- Increasing consumption and imports of wheat by African countries are more likely to be the outcome of poor growth of agricultural production rather than wheat being pushed on the Africans by wheat exporters through attractive aid offers.

- Increasing imports of wheat may be a reasonable response given domestic production short-falls and availability on the world market.
- The amount of grain aid to Africa is small and considering that the per capita calorie intakes have gone down in many countries, aid should be stepped up.

African agricultural production must be stepped up. What are the production potentials and in what direction does scope exist to step up food production in Africa? In particular, how much wheat production potential exists? What is the opportunity cost of increasing wheat production? To this we turn in the next section.

# 3. EVALUATION OF AGRO-CLIMATIC ADVANTAGE FOR PRODUCTION OF WHEAT AND ALTERNATIVE FOOD CROPS

As discussed in the previous Section, many African countries have in recent years been unable to expand their cereal production fast enough to keep up with population growth. In still more of them the increase in cereal production has fallen behind that in total demand, stemming from rising incomes as well as population. This diminishing selfsufficiency and food security and the consequent increase in their import requirements is a cause for concern. What are the long-term possibilities of sustainable production from its own land resources of various countries in Africa. Any shortfalls in production will have to be made up by imports which in turn will have to be financed by appropriate exports. Wheat is one cereal where production levels have been particularly low and the increasing demand has been met through ever rising imports.

The extent to which land resources of terrain, soil, climate and water, can be utilized to produce wheat is limited. The ecological limits of production are set by soil and climatic conditions as well as by the specific inputs and management applied. In this section we not only assess the potential for wheat production in Africa but its comparative advantage (vis-a-vis other food crops) as well. This is done using the agro-ecological zone (AEZ) based methodology. The essence of the AEZ approach is to use data on climatic conditions, soil characteristics and genetic properties of crops and through hierarchic application of agronomic principles derive an estimate of the crop yield for a particular land unit.

The computerized land resources (climate and soil data) inventory for Africa comprises of a mosaic of unique land units (referred to as agro-ecological cells) with particular combinations of soil and climatic conditions by location in each country. Potential crop productivity is assessed at three different levels of inputs. The low level of inputs uses traditional crop varieties, minimum fallow periods, no fertilizers or other agricultural chemicals and manual labour with hand tools. The intermediate level of inputs introduces limited use of improved crop varieties, some use of fertilizers and agricultural chemicals, increased fallow periods and animal traction as well as manual labour. At the high level of inputs there is a move to high-yielding crop varieties, optimum use of fertilizers and agricultural chemicals, maximum fallow periods and full mechanization.

As the aim of the present study is to assess the production potential of wheat and any competing crops, we first assess the extent of land areas in Africa where wheat can be grown. The agronomic growth requirements of spring and winter wheat were matched with each of the agro-ecological cells in the land resources inventory for each country in Africa. From this assessment at each of three levels of inputs, an inventory of land resources where wheat can be grown was created. It turned out that altogether 22 countries in Africa have land areas where rainfed wheat can be produced.

The production potential of wheat and any competing crops obviously depends on the criterion of crop choice. We have used three alternative criteria:

1. Maximization of wheat output, i.e. growing wheat on all land on which it is possible to grow wheat.
2. Maximization of food production in terms of calorie production, i.e. the choice of whether to grow wheat or another* crop in a particular land unit is made according to whichever yields the maximum calorie production.

*Alternative crops considered are sorghum, millet, maize, barley, paddy and upland rice, soyabean, phaselous bean, sweet potato, cassava, white potato, sugarcane, groundnut, banana/plantain and oil palm.

3. Maximization of income, i.e. value of production minus cost of inputs at given prices. To facilitate cross-country comparison these net values are calculated at 1975 relative international prices.

Criteria one would give us the maximum supply possibility of wheat in each country. Comparison of the cropping patterns and levels of crop production under criteria one and two give us information on the cost of supplying wheat in terms of calorie selfsufficiency targets.

Similarly comparison of cropping patterns and levels crop production under criteria one and three give us the economic cost of supplying wheat. This cost includes cost of growing wheat on a unit of land plus the opportunity cost of not growing some other more revenue yielding crop. This opportunity cost in terms of net revenue foregone is the difference between the net revenues of growing wheat rather than growing some other crop.

It should be noted that the potential production is determined on basis of cultivation of all land areas where rainfed wheat can be grown. At the present time, the level of agricultural land use in each country may or may not have reached the limits of land availability. For countries where the latter applies (and especially for countries with large reserves of agricultural land), the rate at which new land can be brought under cultivation will be limited by the availability of labour, investments, etc. These aspects are not taken into account; the study results should be interpreted in the context of the fact that the potential production is estimated on the assumption that all suitable and available land where wheat can be grown is brought under cultivation.

In Section 3.1 we summarize the agro-ecological zone methodology for the assessment for potential wheat and alternative competitive food crops production in African countries. Those familiar with the AEZ methodology may skip Sections 3.1.1 to 3.1.5. The results of the assessment are given in Section 3.2

and concluding observations in Section 3.3.

### 3.1. FAO Agro-ecological land resource data base and methodology (FAO, 1978)

The starting point of this evaluation is the computerized land and climate resource data base for each country in Africa, derived by an overlay of a specially compiled climatic inventory (providing spatial information on temperature and moisture conditions) onto the FAO/UNESCO Soil Map of Africa (FAO, 1971-81) (providing spatial data on soil, texture, slope and phase). The procedure involved the measurement of each soil mapping unit as it occurs in each length of growing period zone and major climate in each country. This measurement was achieved by a 2 mm (100 $km^2$) grid count (corrected for reported areas of countries' land masses) of the land inventory map, i.e. overlay of the climate map onto the soil map for each country. Information on the extents and composition of each mapping unit according to the listings given in the texts of the soil map were used to derive the individual extents of each soil type in each mapping unit, by slope, texture class and phase.

#### 3.1.1. Climate Inventory

The choice of the parameters used in the climatic inventory was based on climatic adaptability attributes of the crops considered in the study. Crop adaptability is temperature dependent: prevailing temperature conditions determine which crops can be grown and which cannot. The climatic inventory was therefore designed to match compiled information on the climatic requirements of plants according to crop adaptability groups (Kassam, 1977a), Table 3.1.

The climatic information was compiled from the FAO Climate Data Bank (FAO, 1976) consisting of monthly records from some 700 African weather stations of rainfall, maximum and minimum temperatures, vapour pressure, wind speed and sunshine duration. Nine temperature regimes referred to as ***major climates*** were delineated in Africa as shown in Table 3.1. Of these nine major climates, five climates, namely moderately cool and cool tropics, moderately cool and cool subtropics (summer rainfall) and cool subtropics (winter rainfall) are relevant for wheat production.

Table 3.1. Characteristics of major climates

| MAJOR CLIMATES | Major climates during growing period: Descriptive name | 24-hr mean (daily) temperature ($^oC$) regime during the growing period | Suitable crop group* |
|---|---|---|---|
| TROPICS All months with monthly mean temperatures, corrected to sea level, above 18$^oC$ | Warm tropics | More than 20$^o$ | II and III |
| | Moderately cool tropics | 15$^o$-20$^o$ | I and IV |
| | Cool tropics | 5$^o$-15$^o$ | I |
| | Cold tropics | Less than 5$^o$ | None |
| SUB-TROPICS One or more months with monthly mean temperatures, corrected to sea level, below 18$^oC$ but all months above 5$^oC$ | Warm sub-tropics (summer rainfall) | More than 20$^o$ | II and III |
| | Moderately cool sub-tropics (summer rainfall) | 15$^o$-20$^o$ | I and IV |
| | Cool sub-tropics (summer rainfall) | 5$^o$-15$^o$ | I |
| | Cold sub-tropics (summer rainfall) | Less than 5$^o$ | None |
| | Cool sub-tropics (winter rainfall) | 5$^o$-20$^o$ | I |
| | Cold sub-tropics (winter rainfall) | Less than 5$^o$ | None |

* Crop Adaptability Group I with photosynthesis pathway $C_3$: Spring wheat, winter wheat, highland phaselous bean, white potato, winter barley.
Crop Adaptability Group II with photosynthesis pathway $C_3$: Paddy rice, lowland phaselous bean, soyabean, sweet potato, cassava, upland rice, groundnut, banana/plantain, oil palm.
Crop Adaptability Group III with photosynthesis pathway $C_4$: Pearl millet, lowland sorghum, lowland maize, sugar cane.
Crop Adaptability Group IV with photosynthesis pathway $C_4$: Highland sorghum, highland maize.

Providing that temperature requirements are met, the degree of success in the growth of a crop is largely dependent on how well its optimum length of growth cycle fits within the period when sufficient water is available for growth. Quantification of moisture conditions was based on a water balance model comparing precipitation (P) with potential evapotranspiration (PET) and allowing for a reference value of 100 mm of soil moisture storage (S).

The moisture availability period (i.e. the period where P+S is greater than 0.5 PET) with mean daily temperatures above $5^{o}C$ was considered suitable for crop growth, and defined as the length of *growing period* (LGP). Two major types of length of growing period zones (LGP zones) were inventorized: a *normal* LGP zone with a humid (an excess of P over PET) period and an *intermediate* LGP zone without a humid period. These lengths of growing period zones were delineated by isolines of 0, 75, 90, 120, 150, 180, 210, 240, 270, 300, 330 and 365 days of growing period (Table 3.2).

Table 3.2. Classification of length of growing period (LGP) zones

| | Number of days when water is available for plant growth |
|---|---|
| Normal LGP | 1-74, 75-89, 90-119, 120-149, 150-179, 180-209, 210-239, 240-269, 270-299, 300-329, 330-364, $365^-$, $365^+$ |
| Intermediate LGP | 1-74, 75-89, 90-119, 120--149, 150-179, 180-209 |

**Notes:**
A normal LGP has a humid period, i.e. excess of precipitation over potential evapotranspiration.
An intermediate LGP has no humid period.
$365^-$ year round humid growing period.
$365^-$ year round growing period.
Isolines of 0 days dry and 0 days cold are also delineated.

Spring wheat can be produced in the length of growing periods 75-365 days with 150-210 days LGP providing the best conditions. Winter wheat can be produced in 75-270 days LGP with the highest yields occurring in the 180-240 days LGP. At the low level of production inputs (see Section 3.1.5), the total extent of land suitable for wheat in Africa amounts to 37.7 million hectares in twenty-two

African countries. This total extent of land comprises of 19% very suitable, 44% suitable and 37% marginally suitable land for wheat production. In comparison, at the high level of production inputs 39.0 million hectares of land would be suitable for the cultivation of wheat: comprising of 27% very suitable, 48% suitable, and 25% marginally suitable. It should be noted that the above extents of land cannot all be used on a sustainable annual basis. If fallow (rest period) is taken into account, then about 64% and 79% of the total extent of wheat lands at the low and high level of production inputs would be available for cultivation on an annual basis; the balance of land being under fallow.

### 3.1.2. Soil Map

The FAO/UNESCO Soil Map of Africa (FAO, 1971-81), provides data on the distribution of 106 soil units of 26 major soils inventorized in soil mapping units. The map also provides information on the texture (coarse, medium or fine) of the dominant soil in the mapping unit, the slope characteristic (level to gently undulating, rolling to hilly and steeply dissected to mountainous) and phases of land characteristics which are of significance in land use – for example, stoniness, salinity or alkalinity. Soils particularly suitable for wheat in Africa are Eutric, Calcaric and Dystric Regosols, Pellic and Chromic Vertisols, Haplic Xerosols, Chromic, Eutric, Ferralic and Calcic Cambisols, Plinthic, Ferric and Plinthic Luvisols, Calcic Xerosols, Ferric and Orthic Acrisols, Dystric and Eutric Nitosols, Cambric and Luvic Arenosols and Orthic Solonetz. The total extent of these soils in Africa is almost 1100 mill.Ha, i.e. 37% total land area. Note that other soil characteristics (e.g. slope, phase and texture) as well as local water moisture considerably reduce the above land area where wheat can be grown.

### 3.1.3. Land Resources Inventory

Overlay of the climatic inventory on the soil map allowed delineation of land units each with a specific combination of soil and climatic conditions (Higgins and Kassam, 1980). These land units were registered in a computerized land inventory (Fig.3.1, Step 1) of extents of soil units, by slope, texture class and phase, as they occurred in each length of growing period zone, in each major climate and in each country. These unique land units, referred to as agro-ecological cells, provide the smallest (10,000 ha) unit of analysis in the study. The African land inventory consisted of some 35 000 agro-ecological cells.

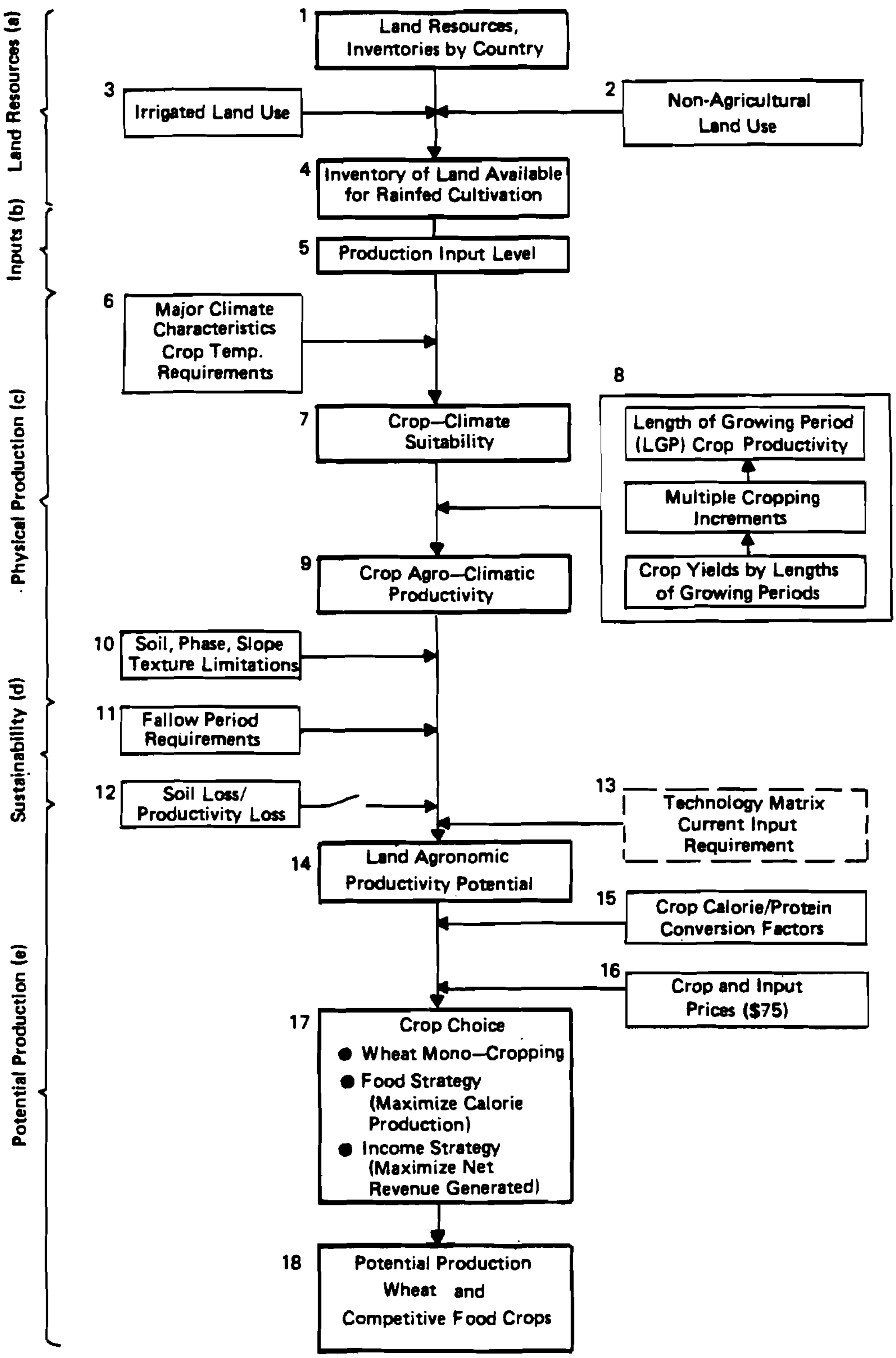
The computerized land resources inventory includes all land available in each country. Land requirements for non-agricultural land use and irrigated land use need to be taken into account in deriving the balance of land available for rainfed agricultural production and subsequently land where wheat can be grown.

### 3.1.4. Non-Agricultural and Irrigated Land Use

Non-agricultural land uses (Fig.3.1, Step 2) include areas for habitation, transportation, industry, mining, conservancy, recreation, etc. These requirements depend largely on population pressures, land-use practices and environmental conditions. No comprehensive estimates of non-agricultural land use in Africa are available. In the study, allowance for non-agricultural land uses equivalent to a per capita requirement of 0.05 hectare per person was made on the basis of some compiled data (Hyde, 1980).

Production from irrigated areas (Fig.3.1, Step 3) is an important component of national agricultural production, particularly in arid and semi-arid areas. Accordingly all land under irrigation needs to be taken into account in

Fig. 3.1. FAO AGRO–ECOLOGICAL ZONE METHODOLOGY FOR ASSESSMENT OF WHEAT AND COMPETITIVE CROPS PRODUCTION POTENTIALS



the assessment of land resources available for rainfed agricultural production.

Data on land under irrigation in each country, FAO AT2000 study (FAO, 1981), were allocated to particular land units in the country land inventory by a consideration of soil and climatic conditions (Wood, 1980).

### 3.1.5. Rainfed Production Potential

The above "deductions" for non-agricultural and irrigated land use in the total land inventory for each country resulted in the quantification of the land resources available for rainfed cultivation (Fig.3.1, Step 4).

The physical wheat production potential (Fig.3.1, Steps 6-17) of any given land area depends on the soil and climatic conditions as well as the production inputs utilized (Fig.3.1, Step 5). Three alternative levels of production inputs are considered in the study as follows:

- *Low Level:* Traditional seeds, no fertilizer or chemicals, no soil conservation, no improved power implements or mechanization and minimum rest (fallow) periods.
- *High Level:* Improved seeds, recommended fertilizers and chemicals, full soil conservation measures, complete mechanization including harvesting and maximum rest (fallow) periods.
- *Intermediate Level:* A mix of the low and high levels.

The aim of the present study is to assess the potential for wheat production as well as alternative competitive food crops. The latter crops include rice, maize, barley, sorghum, pearl millet, white potato, sweet potato, cassava, phaselous bean, soybean, groundnut, sugarcane, banana/plantain, oil palm and grassland (livestock). Evaluating the potential production of wheat and competitive crops involves two sequential steps:

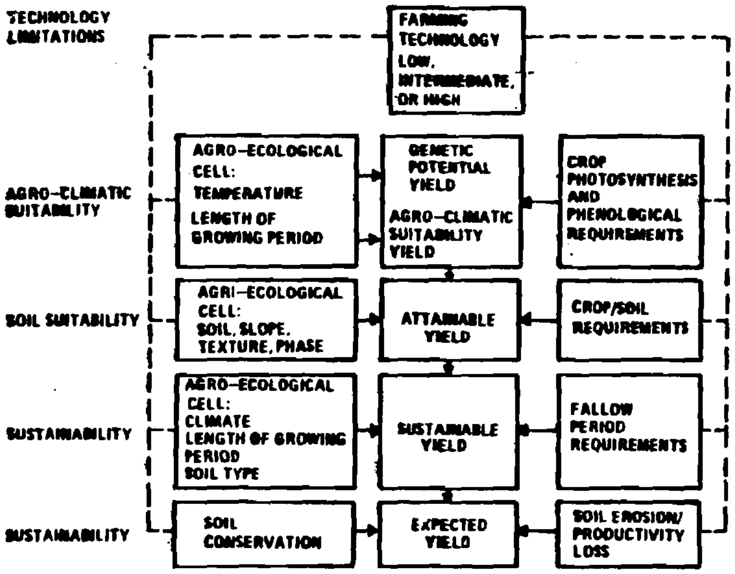
- First, the rainfed land resource inventory for each country in Africa is analyzed to identify those agro-ecological cells where wheat can be grown. This leads to the creation of a "wheat land resource inventory" for each country.* The potential for wheat production on this land area is assessed for each of the above three input levels. Note that in this assessment wheat is the only crop considered and hence these results represent the maximum potential for wheat production assuming wheat mono-cropping on all suitable land.
- In the second step, the "wheat land resource inventory" is analyzed to quantify the potential for wheat and any competitive crops. This comparative advantage of the competitive crops depends on the criterion of crop-choice (e.g. maximize calories, revenue, etc.).

The above assessment of the land resource inventory is carried out on the basis of crop production models (Fig.3.2). The three main components of a crop production model are: agro-climatic suitability, soil suitability and sustainability of production.

*Altogether twenty-two countries in Africa have land areas where wheat can be grown.

Fig.3.2.

Fig.3.2 CROP PRODUCTION MODEL




### 3.1.5.1. Agro-Climatic Suitability

For each crop that can be grown in a particular unit of land, there is a maximum agro-climatic yield potential dictated by climatic conditions. The photosynthetic and phenological requirements (Kassam, 1979) were matched to the climatic attribute of each agro-ecological cell in quantifying the agro-climatic yield potential (Table 3.3) of each crop. It should be noted that agro-climatic yield constraints due to pest, disease, weeds, workability and rainfall variability have been considered in arriving at these potentials, as have increases in yield from sequential cropping as well as intercropping.

Table 3.3. Examples of Rainfed Crop Yields (Metric Tons per Hectare Dry Weight) – Intermediate Level of Inputs

| Length of Growing Period Zone (Days) | Crop | | |
|---|---|---|---|
| | Wheat | Maize | White Potato |
| 75-89 | 0.1 | 0.1 | 0.9 |
| 120-149 | 1.7 | 1.4 | 3.3 |
| 180-209 | 4.0 | 3.6 | 7.1 |
| 330-364 | 0.5 | 2.1 | 0.8 |

### 3.1.5.2. Soil Suitability

Soil characteristics (soil, slope, texture and phase) may constrain the agro-climatic yield potentials and determine attainable yield. Crop-specific soil limitation ratings (Table 3.4) – for main soils – (Sys and Riquier, 1980), were formulated by matching the properties of all soil units to the soil requirements of crops and applying these to the soil characteristics of each agro-ecological cell in the land inventory, the attainable yields for all crops that can be grown in the cell were estimated.

Table 3.4. Limitation Soil Ratings for Maize by Level of Farming Technology.

| Soil | Low Level | Intermediate Level | High Level |
|---|---|---|---|
| Orthic Acrisols | S2 | S2 | S1/S2 |
| Cambic Arenosols | N2 | S2/N2 | S2 |
| Calcaric Regosols | S2 | S1/S2 | S1/S2 |
| Eutric Cambisols | S1 | S1 | S1 |
| Aeric Ferralosols | N2 | N1 | S2/N1 |

S1: very suitable
S2: marginally suitable
N1: not suitable but can be improved
N2: not suitable
e.g. "S2/N2" means 50% of area is of class S2 and 50% of area is of class N2

**3.1.5.3. Sustainability of Production**

The crop yield potential on the basis of agro-climatic and soil suitability assessment can be obtained on a sustainable basis only if the necessary fallow period requirements and soil conservation are taken into account.

Many soils cannot be continuously cultivated with annual crops without undergoing some degradation. Such degradation is marked by a decrease in crop yields and a deterioration in soil structure, nutrient status and other physical, chemical and biological attributes. Accordingly, account must be taken of the fallow period requirement in estimating land productivity. On the basis of regional survey data, fallow period requirements for each of the farming technology levels have been estimated by major climate, length of growing period zone and major soils (Young and Wright, 1980). The application of these fallow period requirements (Table 3.5) according to the climatic and soil attributes of the agro-ecological cell enables an estimate of long-term sustainable crop yields.

In addition to the effect of crop fallow period requirements on sustainability of production, the climatic and soil conditions also greatly influence the rate of soil loss by erosion. Such soil loss results in decreased productivity and these reductions (in productivity) must be taken into account in reliable assessments of sustainable production potentials. In the present study, the effects of water and wind erosion on soil loss are explicitly considered. This has been achieved by developing and applying a methodology for estimating rates of soil and productivity loss under the specific climatic, soil, crop and level of production inputs (FAO/UNEP/UNESCO, 1979). The methodology used for estimating rates of soil loss is a parametric approach using climatic (rainfall and wind erosivity indices), soil, topograhic, texture and vegetation/land use factors. The soil loss is related to productivity loss on the basis of functional

Table 3.5. Fallow Period Requirements (Cultivation Factors)* for Some Major Soils in the Tropics According to Level of Farming Technology.

| Soil | Low Level | | Intermediate Level | | High Level | |
|---|---|---|---|---|---|---|
| | Humid** Tropics | Semi-Arid† Tropics | Humid Tropics | Semi-Arid Tropics | Humid Tropics | Semi-Arid Tropics |
| Arenosols | 10 | 20 | 30 | 45 | 50 | 50 |
| Ferrasols | 15 | 20 | 35 | 40 | 70 | 75 |
| Acrisols | 15 | 20 | 40 | 60 | 65 | 75 |
| Luvisols | 25 | 35 | 50 | 55 | 70 | 75 |
| Cambisols | 35 | 40 | 65 | 60 | 85 | 80 |
| Nitosols | 40 | 75 | 55 | 70 | 90 | 90 |
| Vertisols | 40 | 45 | 70 | 75 | 90 | 90 |
| Gleysols | 60 | 80 | 80 | 90 | 90 | 90 |

* The cultivation factor is the number of years in which it is possible to cultivate the land as a percentage of the total cultivation and non-cultivation cycle.

** Humid: more than 269 days of growing period

† Semi-arid: less than 120 days of growing period

relationships derived from empirical cross-country experimental data as well as theoretical consideration (Shah et al, 1984).

#### 3.1.5.4. Input Requirements

Crop-specific yield-input relationships for various land types from the Global Technology Matrix (GTM) of the AT2000 Study (FAO, 1981) have been used to quantify input requirements for seed - traditional and improved, fertilizer N-P-K, pesticides and power. The GTM for a particular crop, Table 3.6, gives the yield-input relation at four discrete yield levels; for yield in between these levels a linear interpolation procedure has been used to estimate the input requirements (Fig. 3.1, Step 14).

Table 3.6. Global Technology Matrix for Wheat

| | lgra | | | | llre | | | | prob | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ulow | low | high | uhigh | ulow | low | high | uhigh | ulow | low | high | uhigh |
| Seed Traditional (kg/ha) | 110.00 | 109.86 | 11.00 | 0.00 | 88.00 | 87.90 | 8.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Seed Improved (kg/ha) | 0.00 | 6.00 | 110.18 | 120.00 | 0.00 | 6.00 | 109.34 | 120.00 | 100.00 | 103.97 | 99.62 | 100.00 |
| Power (Man Day Equivalent) | 25.03 | 39.89 | 47.23 | 53.37 | 20.35 | 29.09 | 32.59 | 36.49 | 30.37 | 45.39 | 53.97 | 69.02 |
| Fertilizer Nitrogenous (kg/ha) | 0.00 | 1.75 | 34.15 | 76.07 | 0.00 | 0.76 | 14.99 | 38.37 | 0.00 | 0.85 | 17.39 | 60.18 |
| Fertilizer Phosphatic (kg/ha) | 0.00 | 2.45 | 47.81 | 106.50 | 0.00 | 1.33 | 26.24 | 67.15 | 0.00 | 1.90 | 38.88 | 134.53 |
| Fertilizer Potassium (kg/ha) | 0.00 | 0.61 | 11.83 | 26.35 | 0.00 | 0.57 | 11.25 | 28.78 | 0.00 | 0.85 | 17.39 | 60.18 |
| Pesticides ($75) | 0.00 | 0.83 | 1.92 | 3.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.63 | 6.26 | 20.75 |
| Yield (mT/ha) | 0.30 | 1.52 | 2.48 | 3.50 | 0.20 | 0.86 | 1.34 | 2.00 | 0.20 | 0.78 | 1.32 | 2.50 |

**Source**:Global Technology Matrix for Wheat. Agriculture Towards Year 2000, FAO, Rome, Italy, 1979.

**Notes**:
lgra: 120-270 days length of growing period zone and very suitable/suitable soils
llra: 75-120 days length of growing period and very suitable, suitable and marginally suitable soils
prob: More than 270 days length of growing period zone, all soils plus that part of the 120-270 days length of growing period zone where soil rating is only marginally suitable
ulow: Ultralow technology
low: Low technology
high: High technology
uhigh: Ultrahigh technology

### 3.1.6. Crop Choice: Wheat and Alternative Food Crops

The application of the crop production models (Fig.3.2) to the characteristics of the agro-ecological cells in the land inventory results in an estimate of land agronomic potential production (Fig.3.1, step 15) of wheat as well as alternative crops that can be grown in a particular cell.

In assessing the comparative advantage of growing wheat, two alternative crop choice criteria are considered as follows:

- *Food Strategy:* Maximize calorie production in each agro-ecological cell*, i.e. the crop yielding the highest calorie production in a particular cell is chosen as the crop to be grown in that cell.
- *Income Strategy:* Maximize net revenue in each agro-ecological cell*, i.e. the crop yielding the highest net revenue in a particular cell is chosen as the crop to be grown in that cell. Here the net revenue for crop i is defined as:

*The African land inventory where wheat can be grown amounts to some 3000 agro-ecological cells.

$$\text{Net Revenue} = [\text{Gross Revenue}] - [\text{Production costs}]$$
$$= [p_i Q_i] - [p_f Q_f - Q_p - p_l Q_l - p_i (Q_{trad_i} + 1.3 Q_{impr_i})]$$

where

$p_i$ is the crop i producer price

$Q_i$ is the crop i production

$p_f$ is the fertilizer price

$Q_f$ is the quantity of fertilizer (nutrients) used

$Q_p$ is the quantity (measured in $ terms) of pesticides used

$p_l$ is the labour (man-day equivalent) price

$Q_l$ is the quantity of labour used (man-day equivalent)

$Q_{trad_i}$ is the quantity of traditional seed used

$Q_{impr_i}$ is the quantity of improved seed used.

To allow for a cross-country comparison, the 1975 international prices (Table 3.7) have been used for the crops and inputs in all countries. It should also be noted that the labour costs have been included in the estimation of net revenue. In general, labour would be considered as a factor of production; however we have explicitly taken account of labour costs due to the fact that wheat production in Africa has tended to be under conditions of mechanization. Additionally the inclusion of labour costs in the estimation of net revenue also enables a more realistic comparison of the results under low, intermediate and high level of production inputs. The latter assumes complete mechanization of all activities in wheat production.

In the next section, while discussing the results of the various alternative assessments, we will refer not only to the value of net revenue generated but also to the economic attractiveness of wheat production in terms of gross reve-

Table 3.7. Crop Producer and Input* Prices $/mT (1975)

| | |
|---|---|
| **Crops:** | |
| Millet | 145 |
| Sorghum | 115 |
| Maize | 134 |
| Soybean | 225 |
| Phaselous Bean | 409 |
| White Potato | 90 |
| Sweet Potato | 88 |
| Cassava | 73 |
| Rice | 230 |
| Wheat | 169 |
| Barley | 140 |
| Groundnut | 359 |
| Banana/Plantain | 103 |
| Sugarcane | 26 |
| Oil Palm | 454 |

*Inputs:
Fertilizers at 450$ per mT,
Seed traditional at the crop producer price
Seed Improved at 1.3 times the crop producer price
Pesticides measured in $ equivalent
Power at 495$ per 1000 man-days

nue to cost ratios.

## 3.2. Results

In this section the production potentials of wheat and competitive crops on the basis of a food strategy (maximizing calorie production) and an income strategy (maximizing net value of production) are presented for the low, intermediate and high level of production inputs. While evaluating and interpreting these results, it is important to bear in mind the following aspects:

- The assumption underlying the level of input. For example,

  (a) high level of inputs assumes complete mechanization of all production activities; this would not be feasible if land slope limited the use of tractors (see results for Ethiopia under intermediate and high levels of inputs);

  (b) The average yield levels associated with each level of input may vary in a particular country due to local disease/pest problems, availability of high yielding local varieties, yield response to inputs on localized sites, etc.

- In assessing the comparative advantage of growing wheat, fourteen alternative food crops (Table 3.7) have been considered. For realistic country assessment it is important to recognize that other relevant local food crops have to be taken into account. An example of such a crop that is important in terms of production as well as consumption is teff in Ethiopia. Hence the results for Ethiopia have to be evaluated within this context.

- The present level and productivity of land under cultivation and the farming technology practiced; the results of the study quantifies the potential production of all suitable land at each of the three levels of production inputs. These results for a particular country provide a hypothetical frame within which the practically feasible possibilities of acreage expansion and updating of farming technology can be assessed. It is important to note that practical constraints would limit acreage expansion to a maximum of 3 to 4% annually whereas a higher level of annual yield increases would generally be feasible through improvements in farming technology.

- The results of the income strategy (maximizing net value of production) are based on assumed crop and input prices. International 1975 crop and input prices have been used for all countries to provide for a cross-country comparison of the profitability of wheat production. In a sense these prices are used only as accounting units. In reality the country-level producer crop prices as well as prices of inputs will be different and these relative crop prices as well as input prices need to be considered to more realistically assess the level and profitability of wheat production in a particular country.

- Estimates of the production potential of wheat and competitive crops in all the alternative assessments have been calculated under the assumption that full soil conservation measures are implemented. In a number of countries soil degradation has already begun to affect yields and at a country level this aspect has to be incorporated in the assessment. For Africa as a whole the total potential wheat production (on a mono-cropped basis) would decrease by 16.7% at the intermediate level of inputs if soil conservation measures were not to be adopted.

### 3.2.1. Low Level of Inputs

*Rainfed Wheat Potential:* The total land area in Africa (column 1, Table 3.8) where rainfed wheat can be grown amounts to 24.0 million hectares and total wheat production under mono-cropping would be 14.9 million metric tons at an average yield of 622 kg per hectare. It should be noted that in this evaluation no chemical inputs or improved power sources are applied. For Africa as a whole, the total net revenue from mono-cropping of wheat on all suitable land (columns 1-3, Table 3.9) would amount to 1293 million $1975 in comparison to the production costs of 1026 million $1975. For all countries, except Algeria, Ethiopia, Kenya, Lesotho, Morocco, Sudan, Tanzania, Tunisia, and Zambia, the ratio of gross revenue to cost of wheat production is less than 2.0. For these eight countries, the ratio of gross revenue to cost of production varies between 2.11 for Tanzania to 2.92 for Algeria. In Tanzania, the average net revenue and cost per hectare of wheat would be 46.4 and 51.4 $1975 respectively if wheat was mono-cropped on all suitable land whereas the corresponding values for Algeria would be 37.3 and 71.6 $1975 respectively.

In terms of food value the production of wheat alone on all suitable land would yield 29466 billion calories and this could support a population of 33 million at average per capita intake of 2370 calories per day.

Table 3.8. Low Level of Inputs - Potential Rainfed Wheat and Competitive Crops: Area ('000 Ha) and Production ('000 mT)

| | Wheat only | Wheat and competitive crops on the basis of maximizing calorie production | | | | | | Wheat and competitive crops on the basis of maximizing net value of production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wheat | Barley | Sorghum | Maize | Beans | W.Pot. | Wheat | Barley | Maize | Beans | W.Pot. |
| **AREA:** | | | | | | | | | | | | |
| **Algeria** | 3833 | 2570 | 1263 | | | | | 2465 | 1368 | | | |
| **Libya** | 453 | 110 | 344 | | | | | 126 | 328 | | | |
| **Morocco** | 3306 | 1728 | 1594 | | | | | 1916 | 1406 | | | |
| **Tunisia** | 916 | 710 | 206 | | | | | 671 | 245 | | | |
| **North Africa** | 8508 | 5118 | 3407 | | | | | 5178 | 3347 | | | |
| **Angola** | 2001 | 38 | 113 | 1 | 1370 | | 479 | 2 | 224 | 965 | 2 | 808 |
| **Burundi** | 518 | 16 | 10 | | 344 | | 148 | | 47 | 290 | | 181 |
| **Cameroon** | 269 | 87 | | | 182 | | | | 152 | 118 | | |
| **Comoros** | 1 | | | | | | | | 1 | | | |
| **Ethiopia** | 7248 | 996 | 910 | 46 | 3284 | | 2012 | 581 | 1352 | 1498 | 556 | 3260 |
| **Kenya** | 1110 | 165 | 169 | | 353 | | 423 | 125 | 213 | 151 | 35 | 587 |
| **Lesotho** | 411 | 115 | 23 | | 80 | 12 | 182 | 98 | 72 | 1 | 69 | 171 |
| **Madagascar** | 401 | 18 | 27 | | 197 | | 159 | 1 | 73 | 94 | 9 | 223 |
| **Malawi** | 76 | 5 | 2 | | 33 | | 35 | | 13 | 18 | | 44 |
| **Nigeria** | 83 | 27 | | | 56 | | | | 27 | 56 | | |
| **Reunion** | 2 | 1 | | | 1 | | | | 2 | | | |
| **Rwanda** | 312 | 66 | | | 216 | | 31 | | 156 | 86 | 2 | 68 |
| **Somalia** | 20 | | 15 | 1 | 4 | | | | 12 | | 5 | 2 |
| **Sudan** | 87 | 7 | 7 | | 50 | | 22 | 7 | | 32 | 7 | 41 |
| **Tanzania** | 1443 | 73 | 355 | 1 | 307 | | 707 | 75 | 315 | 70 | 36 | 948 |
| **Uganda** | 219 | 13 | 43 | | 80 | | 83 | 12 | 53 | 22 | 21 | 111 |
| **Zaire** | 901 | 246 | 19 | | 603 | | 33 | | 739 | 75 | 1 | 87 |
| **Zambia** | 376 | 1 | 1 | | 20 | | 353 | 1 | 4 | 6 | | 365 |
| **Subsahara Africa** | 15476 | 1875 | 1693 | 49 | 7180 | 12 | 4667 | 902 | 3451 | 3481 | 744 | 6897 |
| **Total** | 23984 | 6993 | 5100 | 49 | 7180 | 12 | 4667 | 6080 | 6798 | 3481 | 744 | 6897 |
| **PRODUCTION:** | | | | | | | | | | | | |
| **Algeria** | 2698 | 2255 | 571 | | | | | 2222 | 592 | | | |
| **Libya** | 177 | 95 | 121 | | | | | 103 | 114 | | | |
| **Morocco** | 1952 | 1360 | 703 | | | | | 1460 | 611 | | | |
| **Tunisia** | 525 | 446 | 90 | | | | | 435 | 96 | | | |
| **North Africa** | 5352 | 4156 | 1485 | | | | | 4220 | 1413 | | | |
| **Angola** | 878 | 12 | 21 | 1 | 1317 | | 1791 | 1 | 47 | 931 | | 3215 |
| **Burundi** | 215 | 5 | 2 | | 356 | | 546 | | 9 | 296 | | 743 |
| **Cameroon** | 81 | 26 | | | 154 | | | | 30 | 123 | | |
| **Comoros** | | | | | | | | | | | | |
| **Ethiopia** | 5063 | 632 | 480 | 34 | 3949 | | 13633 | 525 | 352 | 1949 | 195 | 21035 |
| **Kenya** | 829 | 176 | 99 | | 335 | | 2663 | 179 | 65 | 160 | 9 | 3384 |
| **Lesotho** | 340 | 132 | 8 | | 30 | 3 | 1176 | 126 | 14 | 1 | 26 | 1111 |
| **Madagascar** | 224 | 6 | 7 | | 183 | | 773 | 1 | 16 | 91 | 2 | 1067 |
| **Malawi** | 42 | 2 | | | 34 | | 165 | | 3 | 19 | | 211 |
| **Nigeria** | 25 | 8 | | | 67 | | | | 5 | 67 | | |
| **Reunion** | | | | | | | | | | | | |
| **Rwanda** | 129 | 20 | | | 205 | | 156 | | 31 | 103 | | 374 |
| **Somalia** | 11 | | 10 | | 2 | | | | 8 | | 2 | 9 |
| **Sudan** | 65 | 5 | 2 | | 70 | | 134 | 5 | | 33 | 1 | 272 |
| **Tanzania** | 906 | 52 | 199 | 1 | 196 | | 3515 | 74 | 106 | 62 | 10 | 4379 |
| **Uganda** | 122 | 6 | 18 | | 60 | | 424 | 11 | 14 | 21 | 9 | 520 |
| **Zaire** | 309 | 74 | 5 | | 338 | | 148 | | 152 | 83 | | 381 |
| **Zambia** | 336 | 2 | | | 18 | | 1987 | 2 | 1 | 5 | | 2041 |
| **Subsahara Africa** | 9574 | 1158 | 851 | 36 | 7312 | 3 | 27131 | 924 | 852 | 3944 | 255 | 38740 |
| **Total** | 14926 | 5314 | 2336 | 36 | 7312 | 3 | 27131 | 5144 | 2265 | 3944 | 255 | 38740 |

| | Wheat only | | | Wheat and competitive crops on the basis of maximizing calorie production | | | Wheat and competitive crops on the basis of maximizing net value of production | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 |
| ALGERIA | 5706. | 142.9 | 274.5 | 6158. | 129.9 | 291.2 | 6151. | 126.8 | 291.8 |
| ANGOLA | 1549. | 85.2 | 52.6 | 4467. | 202.3 | 114.9 | 3854. | 276.1 | 117.9 |
| BURUNDI | 372. | 21.1 | 12.7 | 1218. | 57.1 | 33.4 | 1133. | 63.5 | 36.6 |
| CAMEROON | 144. | 12.5 | 0.2 | 492. | 17.8 | 5.0 | 431. | 11.4 | 7.4 |
| COMOROS | 0. | 0.0 | 0.0 | 1. | 0.0 | -0.0 | 0. | 0.0 | 0.0 |
| ETHIOPIA | 9864. | 342.0 | 443.8 | 19845. | 872.4 | 908.7 | 17093. | 1141.5 | 1057.0 |
| KENYA | 1631. | 53.2 | 75.3 | 2725. | 153.1 | 152.1 | 2449. | 180.4 | 162.5 |
| LESOTHO | 678. | 19.3 | 33.3 | 908. | 59.3 | 65.3 | 868. | 55.1 | 68.7 |
| LIBYA | 349. | 14.0 | 13.7 | 470. | 11.5 | 18.7 | 470. | 11.7 | 18.8 |
| MADAGASCAR | 417. | 18.4 | 16.6 | 845. | 56.7 | 32.8 | 698. | 69.7 | 34.8 |
| MALAWI | 79. | 3.5 | 3.1 | 165. | 11.3 | 7.0 | 142. | 13.0 | 7.5 |
| MOROCCO | 4045. | 119.2 | 183.7 | 4515. | 99.8 | 200.4 | 4500. | 102.7 | 201.3 |
| NIGERIA | 43. | 3.9 | 0.1 | 207. | 6.2 | 3.2 | 206. | 5.2 | 3.6 |
| REUNION | 1. | 0.1 | 0.0 | 1. | 0.1 | -0.0 | 1. | 0.0 | 0.0 |
| RWANDA | 234. | 14.4 | 5.9 | 679. | 27.3 | 13.8 | 512. | 29.4 | 18.9 |
| SOMALIA | 20. | 0.8 | 0.9 | 29. | 0.5 | 1.0 | 25. | 1.0 | 1.4 |
| SUDAN | 127. | 3.9 | 6.2 | 272. | 10.2 | 10.6 | 224. | 15.3 | 12.9 |
| TANZANIA | 1713. | 66.9 | 74.1 | 2535. | 204.3 | 149.2 | 2329. | 244.6 | 161.2 |
| TUNISIA | 1064. | 34.0 | 47.4 | 1123. | 30.4 | 50.2 | 1120. | 29.1 | 50.5 |
| UGANDA | 227. | 10.2 | 8.9 | 395. | 27.2 | 19.0 | 343. | 31.1 | 21.9 |
| ZAIRE | 530. | 42.3 | 6.2 | 1144. | 56.6 | 9.4 | 708. | 39.6 | 22.6 |
| ZAMBIA | 675. | 18.3 | 33.7 | 894. | 96.1 | 73.3 | 878. | 98.6 | 73.9 |
| TOTAL | 29466. | 1026.2 | 1292.8 | 49088. | 2130.2 | 2159.2 | 44135. | 2545.8 | 2371.3 |

Table 3.9 Low Level of Inputs: Total calorie production, cost of production and net revenue generated -- potential rainfed wheat and competitive props production from land areas where wheat can be grown

If the crop choice is based on maximizing food production, i.e. maximum caloric value, then the results in Table 3.8 show that white potato and maize in the Subsahara African countries and barley in the North African countries would be the main competitive crops. Sorghum in Ethiopia* and beans in Lesotho would be very minor alternative crops. In this evaluation the total rainfed wheat potential in Africa amounts to 7.0 million hectares with a production of 5.3 million mT at an average yield of 760kg per hectare. Overall the total calorie production, for Africa as a whole, has increased from 29466 billion calories for the pure wheat alternative to 49088 billion calories, growing the most calorie productive crops (Table 3.9). In terms of population, this implies that the minimum food needs of 55 million people could be met when wheat and competitive crops are grown in comparison to a population supporting potential of 33 million in the case when wheat alone is grown on all the land area. Note also that in this assessment, the net revenue generated has increased to 2159 million $1975, i.e. a 67% increase over the total net revenue if wheat alone were to be grown. However, these results also show that the ratio of gross** value of production to production costs for all countries except Algeria, Ethiopia, Libya, Lesotho, Morocco, Somalia, Sudan and Tunisia is less than 2.0. Here the ratio of gross revenue generated to cost of production for the eight countries varies from 2.04 for Ethiopia to 3.24 for Algeria. In comparison to the results where wheat is monocropped, for Algeria the competitive crop is barley and here the net revenue per hectare has increased to 76.0 $1975 at a cost of 33.9 $1975 per hectare.

As in the case of the above results, when crop choice is made on the basis of maximizing net revenue, barley, maize and white potato remain as the main competitive crops. However note that there is a greater (in comparison to the

*Teff (not included in the AEZ study) would be a major competing crop in Ethiopia.
**Value of production of all crops

results when calories are maximized) shift in acreage from maize to white potato (Table 3.8). For example, comparing the results of crop choice on the basis of maximizing calories and maximizing net revenue, the total area allocated to maize has declined from 7.2 million hectares to 3.5 million hectares whereas for white potato the acreage has increased from 4.7 to 6.9 million hectares. When net revenue is maximized, total wheat production in Africa amounts to 5.1 million mT from a land area of 6.0 million hectares, i.e. an average yield of 846kg per hectare.

The average potential wheat yields for the above three assessments at the low level of inputs are shown in Table 3.10. For comparison the yield levels for the intermediate and high level of inputs are also shown in this table. In general, the wheat yields increase as wheat mono-cropping is substituted by crop choice based on food strategy (maximizing calories) and income strategy (maximizing net revenue). This is to be expected since in the latter two cases only that land area is allocated to wheat on which it can compete successfully in calorie production or economically.

Generally, the above results under the assumption of low level of inputs are not particularly attractive in economic or food-value terms especially and draw attention to potential problems from the increasing wheat demand due to both population and income growth. It points to the desirability that most countries in Africa reach near to an intermediate level of inputs by the year 2000.

### 3.2.2. Intermediate Level of Inputs

Under these conditions the total land area in Africa where wheat can be grown amounts to 28.3 million hectares, Table 3.11. The total production would be 46.6 million mT at a more than doubled average yield of 1645 kg per hectare. The net value of production amounts to 5057.2 million $1975 and the cost of

Table 3.10. Potential Rainfed Wheat Yields (mT per Hectare) in Africa: Results of Alternative Evaluations under Low, Intermediate and High Level of Inputs

| | Low Level Input | | | Intermediate Level Input | | | | High Level Input | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat only | Wheat and competitive crops on the basis of maximizing | | Wheat only | Wheat and competitive crops on the basis of maximizing | | | Wheat only | Wheat and competitive crops on the basis of maximizing | |
| | | Calories | Net Revenue | | Calories | Net Revenue | Net Revenue (Wheat Price Doubled) | | Calories | Net Revenue |
| **Algeria** | 0.704 | 0.878 | 0.901 | 1.835 | 2.381 | 2.347 | 1.835 | 3.041 | 3.743 | 3.696 |
| **Libya** | 0.390 | 0.863 | 0.817 | 1.062 | 1.045 | 1.485 | 1.071 | 1.706 | 2.081 | 2.849 |
| **Morocco** | 0.590 | 0.787 | 0.762 | 1.619 | 1.909 | 1.942 | 1.619 | 2.774 | 3.303 | 3.290 |
| **Tunisia** | 0.573 | 0.628 | 0.649 | 1.635 | 1.726 | 1.762 | 1.665 | 2.769 | 2.915 | 2.979 |
| **North Africa** | 0.629 | 0.812 | 0.815 | 1.685 | 2.073 | 2.079 | 1.690 | 2.820 | 3.429 | 3.416 |
| **Angola** | 0.439 | 0.321 | 0.700 | 1.068 | 0.500 | | 1.101 | 1.457 | 0.934 | |
| **Burundi** | 0.416 | 0.300 | | 1.208 | 1.921 | | 1.507 | 1.568 | 0.800 | |
| **Cameroon** | 0.300 | 0.300 | | 0.500 | 0.500 | | 0.500 | 0.700 | 0.700 | |
| **Comoros** | 0.300 | 0.300 | | 0.500 | | | | 0.700 | | |
| **Ethiopia** | 0.699 | 0.635 | 0.903 | 1.841 | 2.026 | 2.966 | 1.697 | 2.942 | 4.176 | 3.714 |
| **Kenya** | 0.746 | 1.064 | 1.433 | 2.073 | 3.098 | 3.000 | 2.354 | 3.223 | 5.094 | |
| **Lesotho** | 0.827 | 1.148 | 1.284 | 1.927 | 0.800 | 0.800 | 0.800 | 2.983 | | |
| **Madagascar** | 0.558 | 0.329 | 0.700 | 1.667 | 1.643 | | 1.636 | 2.323 | 1.322 | |
| **Malawi** | 0.559 | 0.301 | | 1.410 | 0.782 | | 1.123 | 1.968 | 1.000 | |
| **Nigeria** | 0.300 | 0.300 | | 0.600 | | | | 0.800 | | |
| **Reunion** | 0.300 | 0.300 | | 0.500 | | | | 0.700 | 0.700 | |
| **Rwanda** | 0.414 | 0.300 | | 0.943 | 1.657 | | 1.484 | 1.267 | 0.760 | |
| **Somalia** | 0.550 | | | 1.320 | | | 1.394 | 2.092 | | |
| **Sudan** | 0.747 | 0.700 | 0.700 | 1.869 | 1.688 | | 1.674 | 3.134 | 4.000 | |
| **Tanzania** | 0.627 | 0.716 | 0.997 | 1.957 | 2.842 | 3.000 | 1.971 | 3.100 | 5.498 | |
| **Uganda** | 0.559 | 0.468 | 0.938 | 1.456 | 1.806 | | 1.890 | 2.225 | 1.739 | |
| **Zaire** | 0.343 | 0.300 | | 0.744 | 0.655 | | 1.136 | 1.188 | 0.856 | |
| **Zambia** | 0.894 | 1.800 | 1.800 | 2.078 | 2.102 | | 1.046 | 2.918 | 3.826 | |
| **Subsahara Africa** | 0.619 | 0.618 | 1.024 | 1.621 | 2.023 | 2.911 | 1.625 | 2.485 | 3.735 | 3.714 |
| **Total Africa** | 0.622 | 0.760 | 0.846 | 1.645 | 2.057 | 2.187 | 1.653 | 2.605 | 3.489 | 3.420 |

production to 2092.6 million $1975, i.e. an economically attractive ratio (gross* revenue to cost of production) of 3.42, (Table 3.12). This ratio is greater than 2.0 for all countries except for Cameroon, Nigeria, Comoros and Reunion. The latter two states have negligible land area where wheat can be grown and for the former two countries rainfed wheat may not be an ecologically viable crop since yields are very low. For all countries except the four mentioned above as well as Zaire, Rwanda and Angola, the ratio of net revenue to cost turned out to

*Gross revenue = net revenue + production costs be greater than 3.0. Morocco had the highest value of this ratio (3.80) and in this case net revenue per hectare for wheat production was 182.8 $1975 in comparison to cost per hectare of 65.3 $1975.

The results, Table 3.11, for the case when crop choice is on the basis of maximizing calorie production show that the total wheat production in Africa would be 16.3 million mT from a land area of 7.9 million hectares, i.e. an average yield level of 2057 kg per hectare. As in the case of the low input assessment, the competitive crops are white potato, maize, barley and to a lesser extent beans. The ratio of gross revenue to cost of production, Table 3.12, has also improved, e.g. for Africa as a whole this ratio is 3.09 compared to 2.01 for low inputs. As in the results for the production of wheat alone, the ratio of gross revenue to cost is less than 2.0 for Nigeria and Cameroon. For seven additional countries this ratio is between 2.0 and 3.0 whereas for the remaining eleven countries the ratio falls between 3.1 and 4.1. Here again Morocco had the highest return, namely net revenue of 181.7 $1975 per hectare in comparison to cost of production of 57.9 $1975 per hectare. The main competing crop in Morocco would be barley, occupying 56.6% of the land area where wheat could be grown. There is an almost 60% increase in the number of calories generated in this food strategy evaluation in comparison with the results if wheat alone is grown at an intermediate level of inputs. Also note that net revenue generated in this evaluation is 8701.3 million $1975, i.e. more than 70% higher than the results for the wheat alone case above.

The results of the evaluation where crop choice is made on the basis of maximizing net value of production, Table 3.11, show that wheat production in Africa would amount to 17.6 million mT from a land area of 8.1 million hectares, i.e an average yield of 2187kg per hectare. White potato, barley, maize and beans are competitive crops and as previously, there is a shift in produc-

Table 3.11. Intermediate Level of Inputs - Potential Rainfed Wheat and Competitive Crops: Area ('000 Ha) and Production ('000 mT)

| | Wheat only | Wheat and competitive crops on the basis of maximizing calorie production | | | | | | Wheat and competitive crops on the basis of maximizing net value of production | | | | | Wheat and competitive crops on the basis of maximizing net value of production (wheat price doubled) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wheat | Barley | Sorghum | Maize | Beans | W.Pot. | Wheat | Barley | Maize | Beans | W.Pot. | Wheat | Barley | Maize | Beans | W.Pot. |
| **AREA:** | | | | | | | | | | | | | | | | | |
| Algeria | 4877 | 2009 | 2308 | | | | | 3158 | 1739 | | | | 4877 | | | | |
| Libya | 686 | 210 | 467 | | | | | 316 | 363 | | | | 647 | 6 | | | |
| Morocco | 4018 | 1762 | 2299 | | | | | 2638 | 1423 | | | | 4018 | | | | |
| Tunisia | 1069 | 823 | 266 | | | | | 918 | 170 | | | | 1066 | 23 | | | |
| **North Africa** | 10689 | 6364 | 6330 | | | | | 7009 | 3686 | | | | 10607 | 31 | | | |
| Angola | 3081 | 196 | 1 | | 2033 | 14 | 943 | | | 330 | 319 | 2841 | 1112 | | 96 | 17 | 1969 |
| Burundi | 614 | 12 | | | 334 | 9 | 169 | | | 19 | 16 | 460 | 28 | | 19 | 9 | 468 |
| Cameroon | 341 | 6 | | | 230 | 104 | | | | 161 | 169 | | 6 | | 161 | 163 | |
| Comoros | | | | | | | | | | | | | | | | | |
| Ethiopia | 6478 | 1869 | 720 | | 2800 | 230 | 1964 | 819 | 314 | 694 | 1648 | 3416 | 4647 | | 664 | 262 | 3012 |
| Kenya | 1107 | 206 | 139 | | 267 | 27 | 442 | 70 | 17 | 66 | 70 | 627 | 402 | | 69 | 32 | 602 |
| Lesotho | 872 | 10 | 49 | | 31 | | 163 | 50 | | | 9 | 233 | 30 | | | 9 | 233 |
| Madagascar | 373 | 24 | | | 160 | 9 | 161 | | | 39 | 26 | 306 | 99 | | 34 | 12 | 226 |
| Malawi | 86 | 2 | | | 34 | 3 | 46 | | | 10 | 8 | 87 | 23 | | 6 | 3 | 62 |
| Nigeria | 92 | | | | 62 | 30 | | | | 62 | 30 | | | | 62 | 30 | |
| Reunion | 1 | | | | | | | | | | 1 | | | | | | |
| Rwanda | 262 | 18 | | | 186 | 41 | 30 | | | 69 | 65 | 98 | 42 | | 66 | 68 | 63 |
| Somalia | 20 | | 14 | | 4 | | 2 | | 7 | | | 13 | 12 | | | | 8 |
| Sudan | 162 | 36 | | | 68 | | 28 | | | | 54 | 44 | 114 | | | | 39 |
| Tanzania | 1464 | 169 | 649 | 6 | 196 | 2 | 762 | 122 | 127 | 16 | 76 | 1084 | 463 | | 10 | 63 | 697 |
| Uganda | 199 | 7 | 32 | | 52 | 7 | 101 | | 3 | 11 | 24 | 161 | 26 | | 11 | 20 | 143 |
| Zaire | 716 | 29 | | | 466 | 144 | 181 | | | 147 | 406 | 197 | 196 | | 147 | 353 | 74 |
| Zambia | 667 | 3 | | | 28 | | 648 | | | 3 | 6 | 665 | 126 | | | | 446 |
| **Subsahara Africa** | 17704 | 2546 | 1304 | 6 | 6933 | 622 | 6469 | 1040 | 466 | 1666 | 2644 | 10036 | 7344 | | 1260 | 1026 | 6222 |
| **Total Africa** | 28343 | 7910 | 6634 | 6 | 6933 | 622 | 6469 | 8049 | 4163 | 1666 | 2644 | 10036 | 17951 | 31 | 1260 | 1026 | 6222 |
| **PRODUCTION:** | | | | | | | | | | | | | | | | | |
| Algeria | 6962 | 6117 | 3361 | | | | | 7364 | 2167 | | | | 6962 | | | | |
| Libya | 696 | 220 | 604 | | | | | 467 | 367 | | | | 694 | 6 | | | |
| Morocco | 6604 | 3362 | 3611 | | | | | 6124 | 1923 | | | | 6604 | | | | |
| Tunisia | 1780 | 1420 | 416 | | | | | 1618 | 223 | | | | 1774 | 23 | | | |
| **North Africa** | 17931 | 11119 | 7979 | | | | | 14673 | 4670 | | | | 17924 | 31 | | | |
| Angola | 3292 | 161 | 1 | | 4718 | 7 | 9143 | | | 611 | 122 | 23654 | 1226 | | 247 | 6 | 19249 |
| Burundi | 621 | 23 | | | 961 | 6 | 1646 | | | 68 | 7 | 4984 | 42 | | 68 | 6 | 4787 |
| Cameroon | 170 | 3 | | | 641 | 46 | | | | 419 | 76 | | 3 | | 419 | 77 | |
| Comoros | | | | | | | | | | | | | | | | | |
| Ethiopia | 16604 | 3766 | 1418 | | 11818 | 163 | 33147 | 2428 | 664 | 3722 | 1923 | 61484 | 7687 | | 2319 | 161 | 46067 |
| Kenya | 2296 | 643 | 246 | | 640 | 14 | 7121 | 210 | 26 | 263 | 60 | 10636 | 946 | | 221 | 16 | 6660 |
| Lesotho | 624 | 6 | 62 | | 41 | | 2900 | 24 | | | 3 | 3229 | 24 | | | 3 | 3229 |
| Madagascar | 622 | 39 | | | 606 | 7 | 1976 | | | 107 | 19 | 3426 | 162 | | 96 | 11 | 2724 |
| Malawi | 122 | 2 | | | 97 | 2 | 607 | | | 31 | 4 | 724 | 26 | | 28 | 2 | 613 |
| Nigeria | 66 | | | | 220 | 16 | | | | 220 | 16 | | | | 220 | 16 | |
| Reunion | | | | | | | | | | | | | | | | | |
| Rwanda | 237 | 21 | | | 499 | 20 | 302 | | | 292 | 89 | 1019 | 65 | | 292 | 87 | 716 |
| Somalia | 26 | | 26 | | 7 | | 16 | | 11 | | | 66 | 17 | | | | 66 |
| Sudan | 266 | 61 | | | 261 | | 341 | | | | 64 | 636 | 190 | | | | 696 |
| Tanzania | 2646 | 396 | 676 | 6 | 434 | 1 | 10491 | 366 | 209 | 44 | 61 | 13069 | 962 | | 33 | 26 | 11621 |
| Uganda | 290 | 13 | 36 | | 116 | 3 | 1451 | | | 31 | 9 | 1697 | 46 | | 31 | 6 | 1742 |
| Zaire | 633 | 19 | | | 936 | 62 | 1166 | | | 423 | 172 | 1779 | 222 | | 423 | 142 | 633 |
| Zambia | 1176 | 7 | | | 64 | | 6660 | | | 3 | 2 | 7093 | 131 | | | | 6375 |
| **Subsahara Africa** | 28700 | 6160 | 2369 | 6 | 21432 | 336 | 77087 | 3027 | 606 | 6166 | 2660 | 123940 | 11937 | | 4396 | 601 | 109194 |
| **Total Africa** | 46631 | 16269 | 10336 | 6 | 21432 | 366 | 77087 | 17600 | 6476 | 6166 | 2660 | 123940 | 29861 | 31 | 4396 | 601 | 109194 |

| | Wheat only | | | Wheat and competitive crops on the basis of maximizing calorie production | | | Wheat and competitive crops on the basis of maximizing net value of production | | | Wheat and competitive crops on the basis of maximizing net value of production wheat price doubled | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 |
| ALGERIA | 20584. | 376.0 | 994.9 | 22308. | 352.7 | 1008.2 | 22254. | 369.4 | 1030.9 | 20584. | 484.7 | 2257.1 |
| ANGOLA | 7057. | 179.6 | 327.4 | 18668. | 514.5 | 840.2 | 13334. | 893.0 | 1180.5 | 12782. | 784.0 | 1225.3 |
| BURUNDI | 1360. | 31.0 | 64.5 | 3680. | 98.3 | 158.5 | 2690. | 178.3 | 246.3 | 2684. | 172.9 | 247.3 |
| CAMEROON | 362. | 17.6 | 8.9 | 1741. | 43.6 | 39.0 | 1472. | 39.9 | 39.9 | 1473. | 40.0 | 40.1 |
| COMOROS | 0. | 0.0 | 0.0 | 1. | 0.0 | 0.0 | 1. | 0.0 | 0.0 | 1. | 0.0 | 0.0 |
| ETHIOPIA | 34704. | 707.8 | 1683.5 | 63567. | 1643.5 | 3245.1 | 51457. | 1883.7 | 3955.1 | 51070. | 1875.2 | 4834.7 |
| KENYA | 5140. | 101.8 | 249.7 | 8504. | 254.0 | 567.2 | 7355. | 325.4 | 655.6 | 7558. | 293.7 | 742.7 |
| LESOTHO | 1160. | 22.2 | 58.1 | 1862. | 73.2 | 177.7 | 1820. | 83.6 | 186.8 | 1820. | 84.4 | 189.7 |
| LIBYA | 1545. | 32.0 | 74.9 | 1928. | 29.2 | 81.2 | 1918. | 32.6 | 85.6 | 1560. | 44.1 | 170.0 |
| MADAGASCAR | 1393. | 27.9 | 67.5 | 2648. | 80.4 | 152.0 | 2147. | 113.8 | 189.6 | 2107. | 96.3 | 194.0 |
| MALAWI | 267. | 5.6 | 13.1 | 559. | 19.8 | 34.7 | 477. | 24.5 | 40.6 | 467. | 21.5 | 41.3 |
| MOROCCO | 14926. | 262.3 | 734.6 | 16570. | 235.1 | 737.7 | 16489. | 258.3 | 770.4 | 14926. | 348.9 | 1645.0 |
| NIGERIA | 119. | 5.0 | 3.6 | 697. | 18.1 | 14.4 | 697. | 18.1 | 14.4 | 697. | 18.1 | 14.4 |
| REUNION | 1. | 0.0 | 0.0 | 2. | 0.0 | 0.0 | 1. | 0.0 | 0.1 | 1. | 0.0 | 0.1 |
| RWANDA | 529. | 15.0 | 21.6 | 1740. | 44.0 | 52.1 | 1470. | 59.3 | 71.5 | 1457. | 51.4 | 72.7 |
| SOMALIA | 57. | 1.0 | 3.0 | 90. | 1.4 | 4.0 | 66. | 3.7 | 5.0 | 65. | 3.0 | 7.1 |
| SUDAN | 630. | 11.8 | 31.8 | 1057. | 22.3 | 45.4 | 592. | 23.1 | 60.4 | 740. | 26.1 | 81.3 |
| TANZANIA | 6357. | 119.5 | 316.5 | 9292. | 319.4 | 730.9 | 8543. | 386.2 | 791.8 | 8524. | 360.3 | 893.4 |
| TUNISIA | 4049. | 78.5 | 194.2 | 4240. | 74.9 | 195.0 | 4231. | 77.6 | 198.7 | 4092. | 103.5 | 443.1 |
| UGANDA | 642. | 13.0 | 31.6 | 1253. | 44.0 | 95.5 | 1140. | 56.5 | 107.7 | 1160. | 53.3 | 111.6 |
| ZAIRE | 1173. | 37.3 | 45.1 | 3611. | 104.4 | 132.8 | 2669. | 112.8 | 150.1 | 2614. | 87.6 | 153.7 |
| ZAMBIA | 2614. | 47.6 | 132.8 | 3891. | 186.0 | 389.6 | 3806. | 191.0 | 394.6 | 3746. | 168.2 | 396.6 |
| TOTAL | 104669. | 2092.6 | 5057.2 | 167908. | 4158.9 | 8701.3 | 144629. | 5130.8 | 10175.6 | 140129. | 5117.4 | 13761.3 |

Table 3.12 Intermediate Level of Inputs: Total calorie production, cost of production and net revenue generated -- potential rainfed wheat and competitive props production from land

tion from maize to white potato. Total net revenue generated in this case amounts to 10.2 million $1975 in comparison to 8.7 million $1975 for the food strategy evaluation. However note that while net revenue increases by 17.2%, total calorie production decreases by 13.9% for Africa as a whole in the case of net revenue strategy vis-a-vis the food strategy assessment. It is interesting to note that the ratio of gross revenue to cost has decreased to 2.98 in comparison to a value of 3.09 in the food strategy assessment. This aspect, applying to most countries, suggests that in the context of limited availability of inputs, crop choice on the basis of maximizing calorie production may be a more attractive alternative in comparison to an income strategy on the basis of maximizing net revenue.

As it is desirable that most African countries, within the next two decades, should attempt to reach near an intermediate level of inputs in rainfed agriculture, these results are interesting and relevant. Therefore, to explore the sensitivity of results at the intermediate level of inputs, the evaluation of wheat and competitive crops under the assumption of maximizing net revenue were repeated to assess the effect of economic incentive to produce wheat. Here the producer price of wheat is assumed to double. It should be noted that doubling of the wheat price relative to other crops (especially other cereals) is in a sense unrealistic, unless subsidies to consumers are given, since wheat demand would decline if not disappear. However this price assumption has been made to assess the sensitivity of production under an extreme producer price incentive. The results of this evaluation at the intermediate level of inputs have been included in Tables 3.11 and 3.12. A comparison of the results for the two levels of wheat price under the assumption of maximizing net revenue indicate the following:

- Wheat acreage and production increase by a factor of 2.23. The relative fall in average yield is due to the fact that land which was submarginal for wheat production is now profitable under wheat use in comparison to the production of barley in North Africa and to a lesser extent maize, beans and white potato in Subsahara Africa; barley goes out of production whereas maize and beans production declines by more than half and white potato production declines by more than 10%.
- For Africa as a whole, total net revenue increases from 10176 million $1975 to 13761 million $1975 whereas total cost of production hardly changes. The ratio of gross value to cost of production increases from 2.98 to 3.69.

Intermediate level of input results for Africa as well as seven selected countries, namely Algeria, Morocco, Tunisia, Ethiopia, Tanzania, Kenya and Angola, are graphically presented in detail.

Figs.3.3a, 3.3b and 3.4 show the results for the food strategy (maximum calorie production). The results for the income strategy (maximum net revenue) are presented in Fig.3.5 for Africa as a whole and for the seven selected countries in Figs.B1-B7, Annex B.

Fig.3.3a depicts the relationship between total calorie production and land use if wheat alone is grown (curve marked 1) and if wheat as well as other competitive crops are grown (curve marked 2). The extent to which wheat would be the "best" crop (forking of curve 1 and curve 2) is marked M. The difference in area between the two curves shows the additional calories (marked AC) that would be produced if the crop-mix is chosen on the basis of competitiveness in terms of maximizing food (calorie) production. Also note that the end point (marked MW) of curve 1 represents the total maximum calorie production from mono-cropping of wheat and the end point (marked MC) of curve 2 represents the total maximum calorie production from wheat and competitive crops.

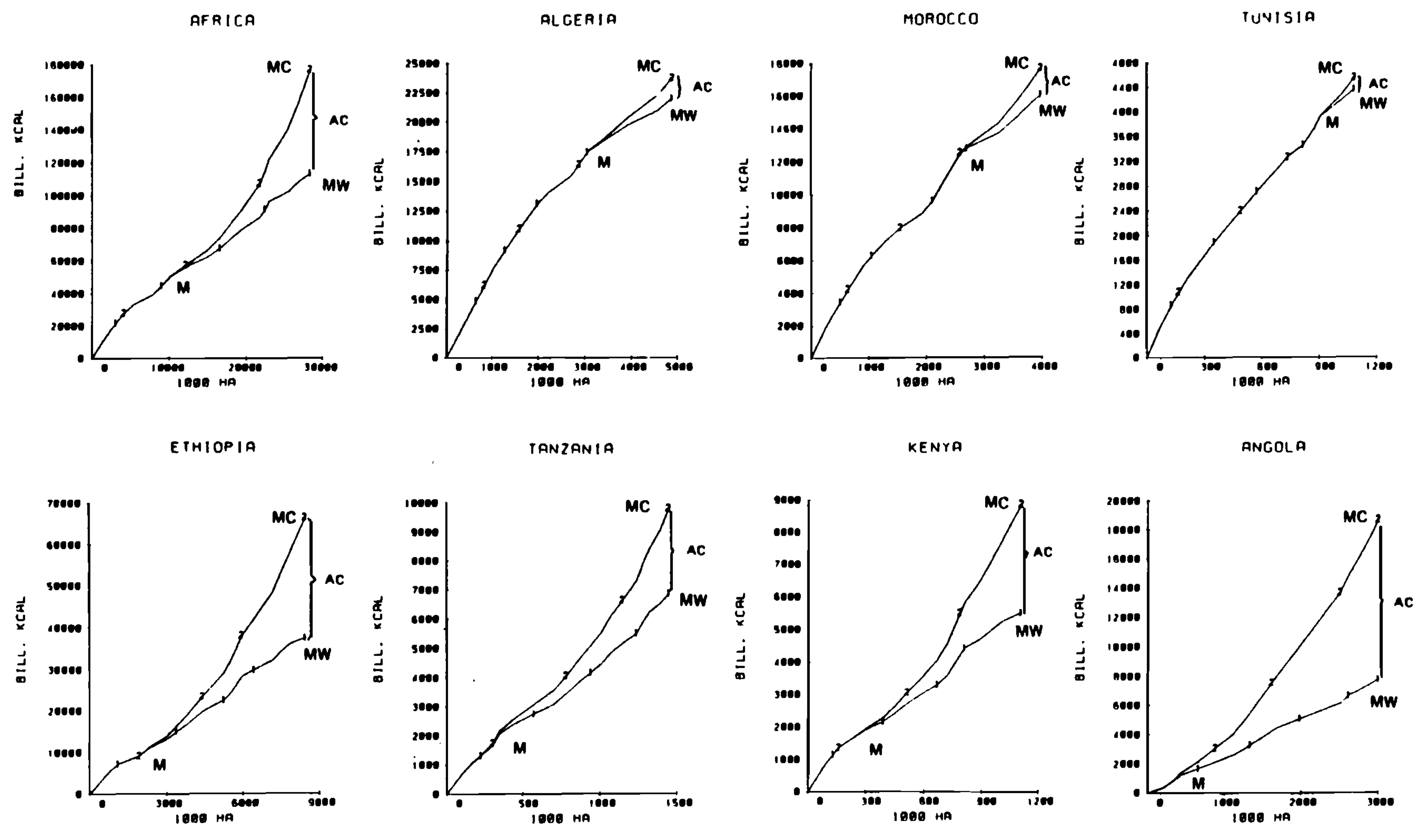



Fig.3.3a.

Alternative results for food production and land use: Results sorted by first using land areas where the loss in calorie (AC) is least; Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing calorie production – Africa Total, Algeria, Morocco, Tunisia, Ethiopia, Tanzania, Kenya and Angola. (Curve marked 1 is mono-cropping of wheat and curve marked 2 is optimal crop-mix, i.e. wheat and competitive crops.)

AC: Additional calorie production,ie.difference of calories produced from wheat and competitive crops and calories produced from mono cropping of wheat on all land areas where wheat can be grown.

MC: Total maximum calories production from mono cropping of wheat

MW: Total maximum calories production from mono cropping of wheat

M: Calorie production and average up to which wheat would be most productive crop.

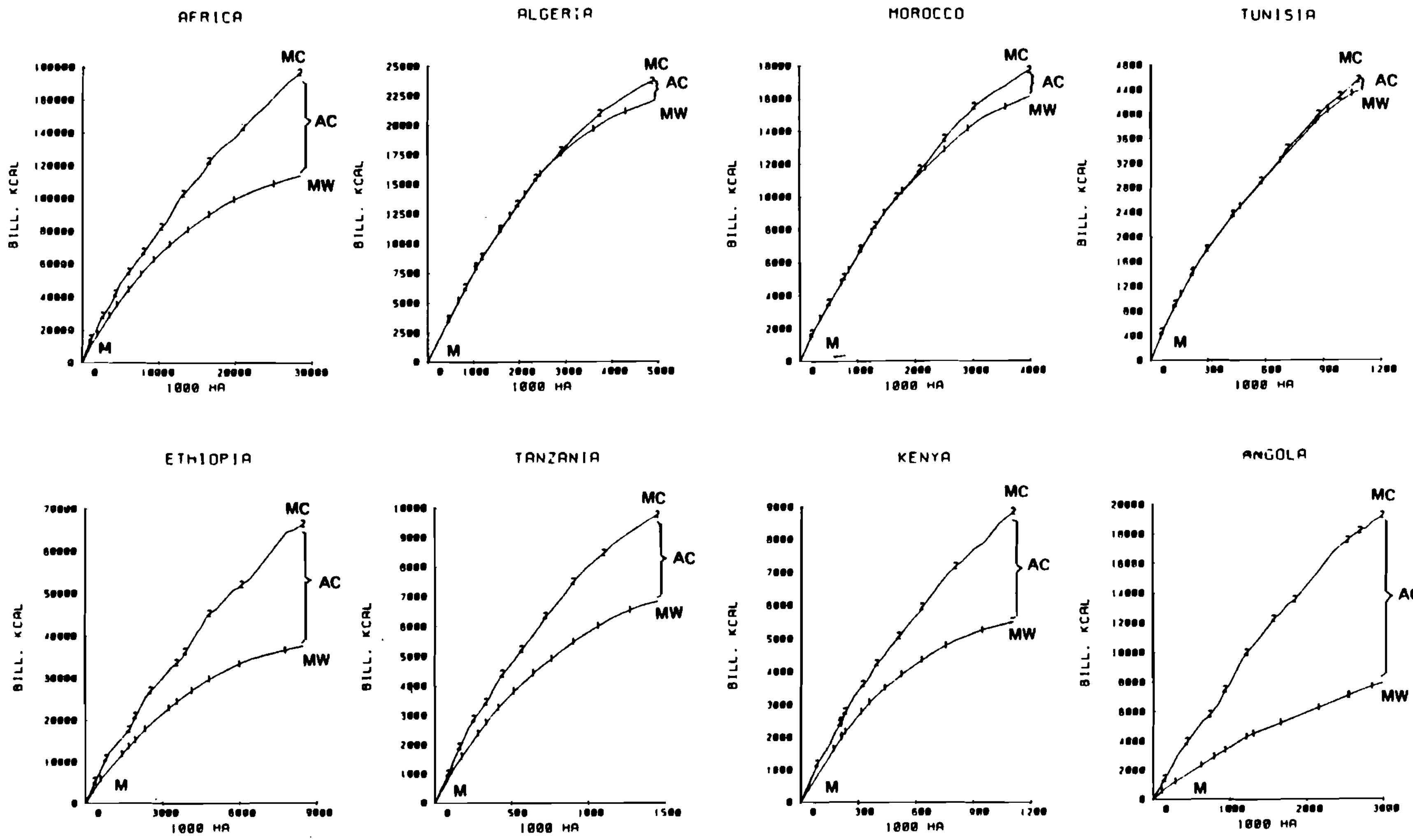



Fig.3.3b.

Alternative results for food production and land use: Results sorted by first using the most productive land areas where the loss in calorie (AC) is least; Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing calorie production -- Africa Total, Algeria, Morocco, Tunisia, Ethiopia, Tanzania, Kenya and Angola. (Curve marked 1 is mono-cropping of wheat and curve marked 2 is optimal crop-mix, i.e. wheat and competitive crops.)

AC: Additional calorie production, ie. difference of calories produced from wheat and competitive crops and calories produced from mono cropping of wheat on all land areas where wheat can be grown.

MC: Total maximum calories production from mono cropping of wheat

MW: Total maximum calories production from mono cropping of wheat

M: Calorie production and average up to which wheat would be most productive crop.

These results show that in the case of the North African countries, namely Algeria, Morocco and Tunisia, wheat is generally the best crop on a relatively large proportion of the land area potentially suitable for wheat. In North Africa, the additional calorie production originates from barley (see Table 3.11). In contrast, in the case of the Subsahara countries, namely Ethiopia, Tanzania, Kenya and Angola, the share of land area best suited to wheat in total land area where wheat could be grown is relatively small. Here the main competing crops are white potato, maize and beans (see Table 3.11).

It should be recognized that the potential calorie production has been derived on the assumption that all land areas (where wheat can be grown) are cultivated. In Fig.3.3a the individual agro-ecological cell results have been sorted to minimize the loss (AC) in calorie production which would result if wheat instead of the optimal mix of crops were to be grown. In countries where reserves of land suitable for wheat are limited, i.e. most of the land areas where wheat can be grown are already under cultivation or has to be cultivated, then the optimal use of land on the basis of food strategy (maximizing calorie production) would be as shown in Fig.3.3a. The underlying consideration here is to first use land areas where the loss in calorie production from growing wheat vis-a-vis another competing crop will be least. Hence, up to the point M in Fig.3.3a, wheat would be the best crop to produce.

On the other hand, if the reserves of land where wheat can be grown are large, then a decision on which land areas to put under cultivation first becomes important. This aspect can be introduced by sorting the results such that land areas yielding maximum calorie production are used first. Fig.3.3b depicts these results; note that sequentially cultivating the best land first results in the standard convex-shaped production functions. Note also that the decline in curve 1 is much more pronounced than that in curve 2. Here the loss in food (calorie) production increases rapidly as AC grows. This aspect shows the negative implications of forcing the production of wheat, especially in the Subsahara countries. These results provide useful information for the formulation of policies on domestic wheat production.

It should be recognized that both in Figs.3.3a and 3.3b, the calorie production and extent of land area are associated with particular agro-ecological cells which can be spatially identified in a particular country's land resource inventory and thereby provide a geographical frame.

Fig.3.4 shows the relationship between average obtainable wheat yields and land use at the intermediate level of inputs for Africa as a whole and the seven selected African countries. The results sorted on the basis of using the best (most productive) wheat areas first as well as on the basis of using the least loss areas first are shown. For Africa as a whole these results show that at the intermediate level of inputs, maximum obtainable yield of wheat is 4000kg/Ha. As the best land is used the average obtainable wheat yield decreases monotonically with increasing extents of wheat acreage. If all the 28 million hectares of land potentially suitable for rainfed wheat production in Africa were used, the average yield would approach 1650kg/Ha as a result of inferior yields (e.g. 250kg/Ha in Uganda) in low productivity marginal wheat lands.

In the case when least loss land is used first (i.e. land planted with wheat depends on whether a competing crops is superior or not), also the low productivity land where wheat would be the best crop would be used earlier. This means that here the average obtainable wheat yield will be lower than in the case where the best land is used first. Consequently, the monotonicity of the resulting yield function is lost (Fig.3.4) with the exception of North African countries. Note that when all suitable wheat land is used for wheat production alone, then the eventually obtainable average wheat yields are the same

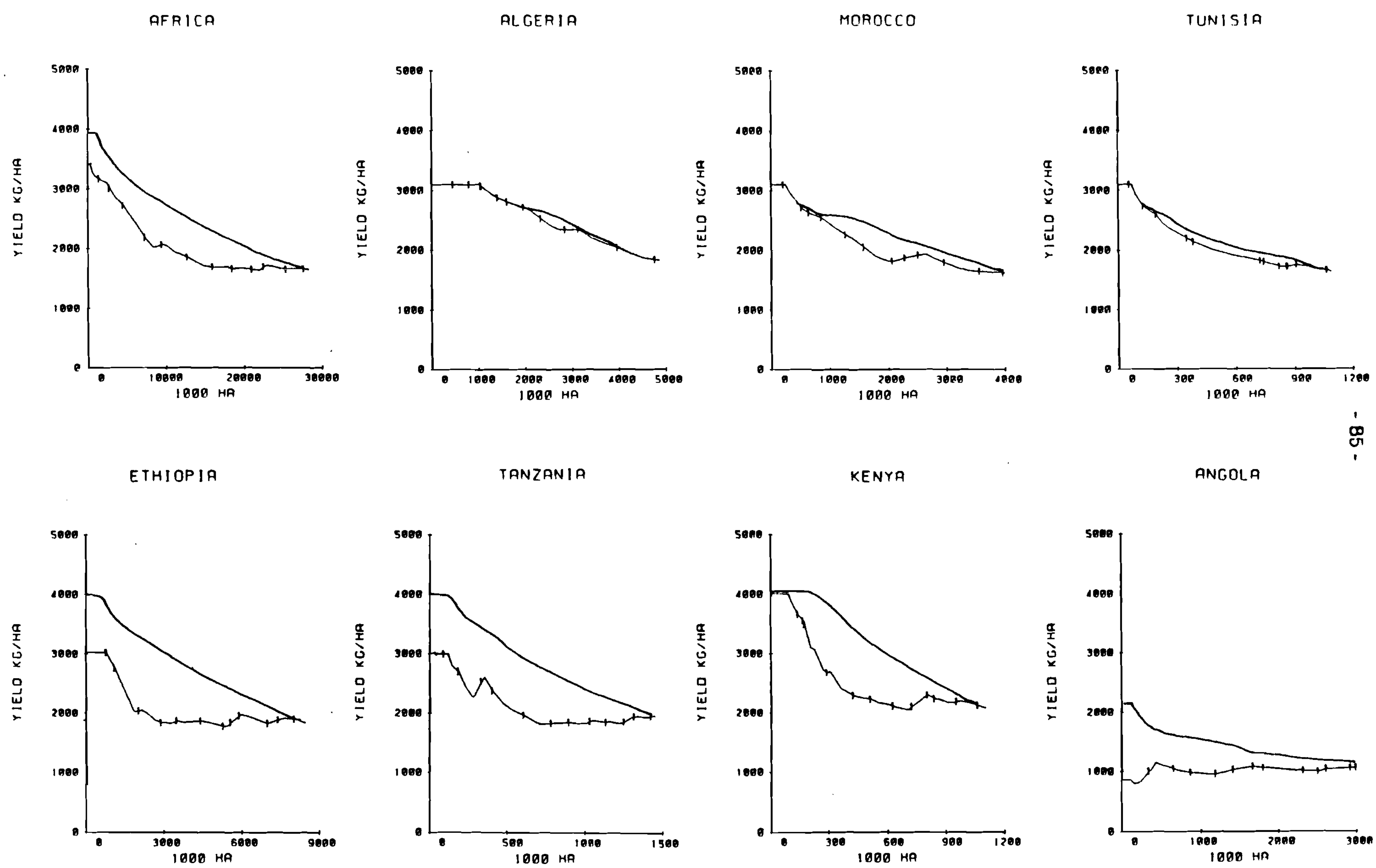



Fig.3.4. Average obtainable wheat yield and land use: Intermediate level of input Africa Total, Algeria, Morocco, Tunisia, Ethiopia, Tanzania, Kenya and Angola.

—— Results sorted on the basis of using best (most productive) land areas first.

-+-+-+- Results sorted on the basis of using least loss land areas first.

whether the best land is used first or the least loss land is used first.

In the case of Algeria, Morocco and Tunisia, the two curves are fairly close together and this is to be expected since wheat would be the best crop on a relatively large proportion of the land area where wheat can be grown. In contrast, for the four Subsahara countries there is a relatively large difference in the average obtainable yield on the basis of using best land first and of using least loss land first. In Ethiopia, Tanzania and Kenya, at the intermediate level of inputs, the best land would provide a wheat yield of 4000kg/Ha and the overall average yield would be about 1800kg/Ha. Note the pronounced decrease and increase in average yield in the results for Tanzania. This response is due to the fact that white potato would be more competitive on the land where wheat yield would be high (4000kg/Ha). Using this high productive wheat land at a latter stage results in the increase in average yield as depicted in Fig.3.4 for Tanzania.

For Angola, climatic and soil conditions restrict the maximum obtainable yield to about 2200kg/Ha. Overall the average wheat yield on all land where wheat can be grown would be about 1100kg/Ha. As mentioned previously, it should be recognized that land use on the horizontal axis in Fig.3.4 is associated with particular agro-ecological cells which can be identified in the land resources inventory for each country and thus provide a spatial (geographical) frame.

Fig.3.5 presents for Africa as a whole the results of the intermediate level of input assessment when crop choice is made on the basis of maximizing net revenue. Here the results at the 1975 wheat price as well as at twice the 1975 wheat price are presented. Note that the results presented in Fig.3.5 (as well as Figs.B1-B7 in Annex B) are derived on the basis of using least loss land first.

The first graph, marked (a) in Fig.3.5 shows the relationship between land use and potential wheat production under 1975 and twice the 1975 prices. The curve marked 2 represents wheat acreage with moderate to high productivity (i.e. "good" wheat land) whereas the curve marked 1 refers to all land where wheat can be grown. The difference between the two curves provides a measure of the wheat production from marginal (i.e. low productivity) land areas. Note that curve marked 1 has an S-shape due to the fact that part of the high productivity wheat land would be used later. Up to a land use of 8 million hectares, wheat would be the most profitable crop and the shape of the curve up to this point reflects decreasing returns. At this level of land use, wheat production would amount to 18 mill.mT.

For wheat selfsufficiency in Africa, about 29 mill.mT would be required from rainfed production (see Table 3.17). At this production target, about 20 million hectares would be required and of this 12 million hectares would be moderate to high productivity wheat land.

The results for the case when wheat price is assumed to double are similar except that the point up to which wheat would be the most profitable crop is more than doubled at 18 million hectares with a wheat production of 30 mill.mT.

Graph marked (b) in Fig.3.5 shows the relationship between revenue and land use. Three curves are shown: curve marked 1 refers to production costs of wheat, curve marked 2 refers to gross revenue from wheat. The difference between curve 2 and curve 1, therefore, indicates the net revenue from wheat production. Similarly, the difference between curve 3 and curve 2 shows the additional net revenue which would result from an optimal crop-mix compared to wheat mono-cropping.

Graph marked (c) shows the revenue and production costs as functions of the level of wheat production. Finally, graph marked (d) shows the average

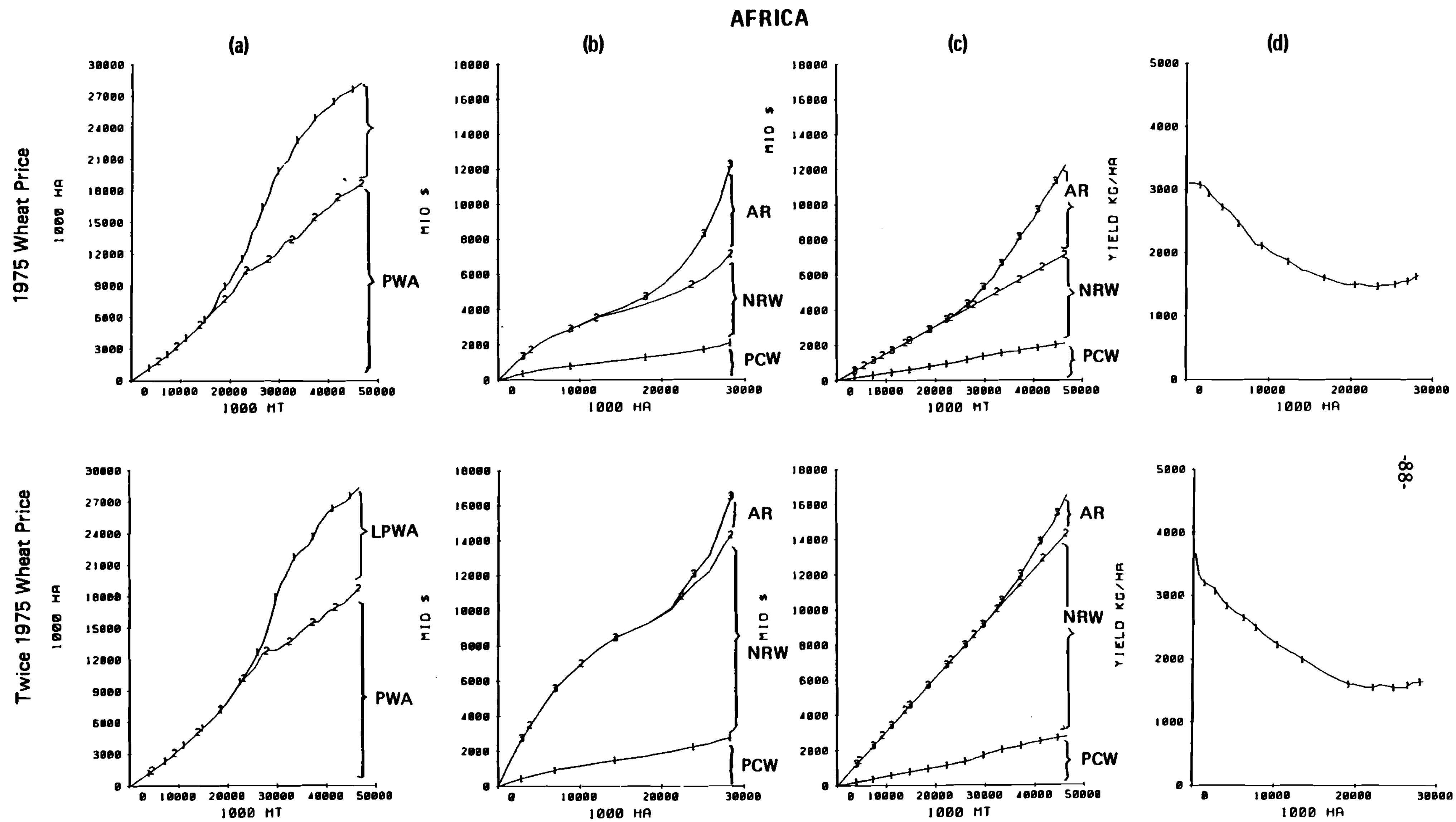



Fig.3.5. Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Africa

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

obtainable wheat yield as a function of total land use. This figure has been described earlier (Fig.3.4). It is interesting to note that the average wheat yields increase at the tail end of the curve. This is due to the fact that moderate to high productive land where a competing crop (maize) would be superior is used at the end.

Graphical, detailed results – similar to the above results for Africa -- for Algeria, Morocco, Tunisia, Ethiopia, Kenya, Tanzania and Angola are given in Annex B.

### 3.2.3 High Level of Inputs

It is unlikely that many countries in Africa can expect to reach a high level of inputs in all rainfed agriculture by the year 2000. However, this is not to say that for particular crops, e.g. wheat, governments may not make a special effort to bring about an adoption of high level of input in particular countries. The results, Table 3.13, shows that mono-cropping of wheat in all suitable land would yield a production of 74.2 million mT from a total land area of 28.5 million hectare. If crop choice is on the basis of maximizing calorie production or maximizing net value of production, wheat production would amount to about 23 to 24 million mT in both these cases. White potato, maize, barley and beans would be the main competitive crops. As in the case of the results for the intermediate level of inputs, wheat would be an attractive crop up to a limit (6 to 7 million hectares) and beyond this the alternative crops would be more profitable. It is interesting to note that when crop-choice is based on maximizing net revenue (ignoring potential demand limitations), most of the land area where wheat can be grown in Ethiopia is allocated* to white potato which apparently would be the most profitable crop to grow under the assumption of

*Teff, an important competing (with wheat) crop in Ethiopia has not been included.

high level of inputs.

Comparing the cost and net value of production in the high level of input assessment (Table 3.14) with the values for the intermediate level of input (Table 3.12), it is interesting to note the following results for Africa as a whole:

- *Wheat Mono-cropping:* Cost of production increases by 64.4% whereas net revenue generated increases by 56.3%
- *Food Strategy and Income Strategy:* Cost of production increases by 45 to 50% whereas total net revenue as well as total calorie production increases by 65 to 70%.

These results suggest that relative economic returns from wheat mono-cropping are higher at the intermediate level of inputs in comparison to high level of inputs. This may partly be due to the assumption of complete mechanization of all production activities in the high level of inputs. For some countries, the slope constraints of mechanized production considerably reduces the acreage. This aspect brings out the approximate nature of assumptions underlying the level of inputs. Also note that average obtainable wheat yields (see Table 3.10) at the high level of inputs are very high, particularly in the case of Tanzania and Kenya. The AEZ wheat yields at the high level of inputs in a sense reflect a theoretical maximum level since yield constraining factors, e.g. rainfall variability, are not taken into account. It should be stressed that in Tanzania and Kenya maximum wheat yields of up to 4.5 mT per hectare have been realized only under experimental conditions.

In each country, relevance and feasibility of the level of farming technology will very much depend on the local environment and availability of resources (e.g. human labour). It should also be noted that the feasibility of adoption of high level of inputs would require extensive development of infrastructure, credit facilities, extension services, crop insurance, etc. In the

Table 3.13. High Level of Inputs - Potential Rainfed Wheat and Competitive Crops: Area ('000 Ha) and Production ('000 mT)

| | Wheat only | Wheat and competitive crops on the basis of maximizing calorie production | | | | | | Wheat and competitive crops on the basis of maximizing net value of production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wheat | Barley | Sorghum | Maize | Beans | W.Pot. | Wheat | Barley | Maize | Beans | W.Pot. |
| **AREA:** | | | | | | | | | | | | |
| Algeria | 4521 | 2706 | 1815 | | | | | 3198 | 1323 | | | |
| Libya | 690 | 142 | 563 | | | | | 261 | 444 | | | |
| Morocco | 3911 | 1678 | 2288 | | | | | 2605 | 1361 | | | |
| Tunisia | 1131 | 873 | 258 | | | | | 961 | 170 | | | |
| **North Africa** | 10253 | 5399 | 4924 | | | | | 7025 | 3298 | | | |
| Angola | 3636 | 100 | | | 2576 | 33 | 1075 | | | 142 | 648 | 2994 |
| Burundi | 363 | 2 | | | 233 | 6 | 123 | | | 13 | 12 | 338 |
| Cameroon | 357 | 43 | | | 241 | 72 | | | | 225 | 128 | 3 |
| Comoros | - | | | | | | | | | | | |
| Ethiopia | 8804 | 827 | 539 | 1 | 4706 | 595 | 2139 | 96 | 2 | 1367 | 976 | 6367 |
| Kenya | 1080 | 170 | 88 | 3 | 350 | 35 | 434 | | | 91 | 107 | 883 |
| Lesotho | 212 | | | | 5 | | 207 | | | | | 212 |
| Madagascar | 304 | 10 | | | 151 | 9 | 134 | | | 31 | 22 | 252 |
| Malawi | 93 | 1 | | | 34 | 2 | 66 | | | 5 | 11 | 77 |
| Nigeria | 71 | | | | 48 | 23 | | | | 48 | 23 | |
| Reunion | - | | | | | | | | | | | |
| Rwanda | 191 | 8 | | | 125 | 26 | 31 | | | 71 | 44 | 76 |
| Somalia | 18 | | 10 | | 2 | 4 | 3 | | 1 | | | 17 |
| Sudan | 163 | 22 | 38 | | 104 | | | | | | | 163 |
| Tanzania | 1347 | 60 | 200 | 30 | 266 | 1 | 799 | | 24 | 3 | 21 | 1298 |
| Uganda | 188 | 8 | 26 | 2 | 61 | 3 | 88 | | | 8 | 51 | 129 |
| Zaire | 726 | 71 | | | 522 | 82 | 107 | | | 179 | 264 | 339 |
| Zambia | 682 | 3 | | 1 | 33 | | 655 | | | | 9 | 683 |
| **Subsahara Africa** | 18237 | 1315 | 863 | 39 | 9460 | 889 | 5888 | 96 | 27 | 2183 | 2316 | 13831 |
| **Total Africa** | 28490 | 6714 | 5787 | 39 | 9460 | 889 | 5888 | 7122 | 3325 | 2183 | 2316 | 13831 |
| **PRODUCTION:** | | | | | | | | | | | | |
| Algeria | 13751 | 10131 | 4277 | | | | | 11821 | 2631 | | | |
| Libya | 1177 | 294 | 1133 | | | | | 744 | 696 | | | |
| Morocco | 10849 | 5544 | 6116 | | | | | 8572 | 3168 | | | |
| Tunisia | 3132 | 2546 | 679 | | | | | 2863 | 371 | | | |
| **North Africa** | 28909 | 18515 | 12205 | | | | | 23999 | 6866 | | | |
| Angola | 5298 | 93 | | | 8454 | 29 | 13807 | | | 501 | 407 | 40220 |
| Burundi | 570 | 1 | | | 992 | 6 | 1961 | | | 74 | 9 | 5461 |
| Cameroon | 250 | 30 | | | 791 | 48 | | | | 743 | 75 | 11 |
| Comoros | | | | | | | | | | | | |
| Ethiopia | 25902 | 3454 | 1809 | 1 | 26244 | 624 | 47484 | 355 | 3 | 7580 | 1078 | 107708 |
| Kenya | 3482 | 864 | 290 | 10 | 1670 | 31 | 9286 | | | 487 | 145 | 15771 |
| Lesotho | 631 | | | | 29 | | 4005 | | | | | 4109 |
| Madagascar | 707 | 13 | | | 643 | 9 | 2585 | | | 126 | 22 | 4335 |
| Malawi | 183 | 1 | | | 129 | 2 | 830 | | | 28 | 7 | 1144 |
| Nigeria | 57 | | | | 269 | 24 | | | | 269 | 24 | |
| Reunion | | | | | | | | | | 1 | | 1 |
| Rwanda | 242 | 6 | | | 546 | 23 | 458 | | | 330 | 33 | 1141 |
| Somalia | 37 | | 30 | 1 | 12 | | 33 | | 2 | | | 154 |
| Sudan | 511 | 86 | | | 833 | | 642 | | | | | 2139 |
| Tanzania | 4175 | 277 | 547 | 73 | 1035 | 2 | 16208 | | 37 | 20 | 14 | 22389 |
| Uganda | 418 | 14 | 67 | 4 | 188 | 2 | 1561 | | | 28 | 64 | 2036 |
| Zaire | 862 | 61 | | | 1584 | 59 | 1310 | | | 575 | 175 | 3872 |
| Zambia | 1991 | 11 | | 3 | 107 | | 11712 | | | | 5 | 12081 |
| **Subsahara Africa** | 45317 | 4912 | 2744 | 92 | 43326 | 759 | 111681 | 355 | 42 | 10742 | 2059 | 222652 |
| **Total Africa** | 74226 | 23427 | 14949 | 92 | 43326 | 759 | 111681 | 24354 | 6908 | 10742 | 2059 | 222652 |

| | Wheat only | | | Wheat and competitive crops on the basis of maximizing calorie production | | | Wheat and competitive crops on the basis of maximizing net value of production | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 | Tot.Cal. Billion | Tot.Cost Mil.$75 | Net Rev. Mil.$75 |
| ALGERIA | 32912. | 629.4 | 1471.4 | 35032. | 625.2 | 1463.1 | 34910. | 642.2 | 1496.2 |
| ANGOLA | 11880. | 226.9 | 585.9 | 32418. | 754.4 | 1414.3 | 24411. | 1131.4 | 2393.7 |
| BURUNDI | 1369. | 23.3 | 64.0 | 4106. | 93.7 | 189.9 | 3330. | 143.2 | 318.4 |
| CAMEROON | 607. | 20.3 | 18.3 | 2615. | 61.8 | 56.1 | 2492. | 60.1 | 58.3 |
| COMOROS | 0. | 0.0 | 0.0 | 1. | 0.0 | 0.0 | 0. | 0.0 | 0.0 |
| ETHIOPIA | 59355. | 1238.9 | 2719.1 | 118819. | 2512.5 | 5487.1 | 87081. | 3077.4 | 7133.3 |
| KENYA | 8026. | 162.9 | 369.0 | 13189. | 325.5 | 816.3 | 10847. | 393.1 | 1009.0 |
| LESOTHO | 1441. | 27.5 | 68.9 | 2403. | 85.5 | 245.7 | 2376. | 86.6 | 249.6 |
| LIBYA | 2713. | 54.0 | 126.3 | 3438. | 59.8 | 128.9 | 3406. | 64.0 | 137.9 |
| MADAGASCAR | 1678. | 32.1 | 76.0 | 3491. | 89.1 | 205.4 | 2935. | 113.2 | 265.9 |
| MALAWI | 418. | 8.2 | 19.8 | 858. | 26.0 | 58.7 | 747. | 30.1 | 70.0 |
| MOROCCO | 25986. | 482.6 | 1175.4 | 28703. | 469.5 | 1151.4 | 28480. | 500.9 | 1209.6 |
| NIGERIA | 146. | 4.6 | 4.2 | 886. | 18.3 | 22.9 | 886. | 18.3 | 22.9 |
| REUNION | 1. | 0.0 | 0.0 | 2. | 0.0 | 0.0 | 2. | 0.1 | 0.0 |
| RWANDA | 614. | 13.7 | 23.5 | 2014. | 45.9 | 67.3 | 1767. | 54.2 | 91.8 |
| SOMALIA | 85. | 1.6 | 4.1 | 131. | 2.6 | 5.5 | 85. | 4.7 | 8.3 |
| SUDAN | 1170. | 22.5 | 55.6 | 2421. | 45.2 | 97.1 | 1155. | 55.6 | 120.6 |
| TANZANIA | 9610. | 189.6 | 448.3 | 14685. | 417.4 | 1152.2 | 13016. | 501.8 | 1344.5 |
| TUNISIA | 7407. | 148.4 | 330.3 | 7718. | 145.8 | 329.2 | 7696. | 148.9 | 335.5 |
| UGANDA | 973. | 19.2 | 44.8 | 1684. | 46.5 | 115.8 | 1442. | 56.1 | 138.1 |
| ZAIRE | 2083. | 48.1 | 84.4 | 5852. | 133.8 | 196.9 | 4431. | 165.4 | 288.7 |
| ZAMBIA | 4522. | 87.0 | 217.3 | 7014. | 264.0 | 710.0 | 6881. | 269.1 | 722.3 |
| TOTAL | 172997. | 3441.0 | 7906.7 | 287480. | 6222.6 | 13914.0 | 238375. | 7516.4 | 17414.7 |

Table 3.14 High Level of Inputs: Total calorie production, cost of production and net revenue generated -- potential rainfed wheat and competitive props production from land areas where wheat can be grown

context of present level of agricultural development in Africa, especially in many Subsahara countries, widespread adoption of high farming technology within the next two decades would be difficult.

### 3.2.4. Irrigated Wheat Production

In addition to the rainfed potential wheat production in Africa, irrigated production of wheat also has to be taken into account in quantifying the total potential wheat production.

Information on the potential for irrigated wheat production in Africa is not available. Here we utilize the data on planned year 2000 irrigated wheat production in African countries as reported by the FAO AT2000 study (FAO, 1981). Table 3.15 shows the year 1975 and year 2000 irrigated areas, yield and production by country. In the final production assessment these are added to areas and volumes of rainfed wheat production.

Table 3.15 Year 1975 and projected year 2000 irrigated area, yield and production in African countries

| | WHEAT 1975 IRRIGATED LAND | | | SCENARIO A WHEAT 2000 IRRIGATED LAND | | | SCENARIO B WHEAT 2000 IRRIGATED LAND | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area 000ha | Yield mt/ha | Prod 000mt | Area 000ha | Yield mt/ha | Prod 000mt | Area 000ha | Yield mt/ha | Prod 000mt |
| ALGE | 13.6 | 1.85 | 25.3 | 0. | 0. | 0. | 7.5 | 1.01 | 7.5 |
| MORO | 160.1 | 2.29 | 366.4 | 217.2 | 3.98 | 864.7 | 197.1 | 3.31 | 651.5 |
| TUNI | 3.2 | 2.22 | 7.2 | 8.1 | 3.50 | 28.5 | 8.1 | 3.50 | 28.4 |
| BENI | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| GAMB | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| GHAN | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| GUIN | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| IVOR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| LIBE | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| MALI | 1.5 | 1.33 | 2.0 | 11.7 | 1.70 | 20.0 | 4.2 | 1.41 | 5.9 |
| MAUA | 0. | 0. | 0. | 15.3 | 3.43 | 52.5 | 4.3 | 1.00 | 4.3 |
| NIGE | 1.1 | 1.13 | 1.3 | 22.9 | 2.01 | 46.0 | 15.9 | 1.73 | 27.5 |
| NIGA | 12.5 | 1.49 | 18.7 | 16.5 | 2.71 | 44.8 | 14.7 | 2.15 | 31.7 |
| SENE | 0. | 0. | 0. | 23.9 | 3.51 | 84.0 | 0. | 0. | 0. |
| SIER | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| TOGO | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| UPPE | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| ANGO | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| CAME | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| CAR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| CHAD | 1.6 | 3.71 | 6.1 | 15.9 | 3.39 | 54.0 | 6.5 | 3.54 | 23.0 |
| CONG | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| GABO | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| ZAIR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| BURU | 0.7 | 1.78 | 1.3 | 1.2 | 1.66 | 1.9 | 0.7 | 1.78 | 1.3 |
| ETHI | 0.8 | 1.63 | 1.3 | 5.3 | 2.49 | 13.1 | 2.6 | 1.62 | 4.2 |
| KENY | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| MADA | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| MALA | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| MAUS | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| MOZA | 4.7 | 1.00 | 4.7 | 10.3 | 1.26 | 13.0 | 6.9 | 1.03 | 7.1 |
| ZIMB | 21.7 | 3.32 | 71.8 | 42.8 | 4.68 | 200.0 | 42.8 | 4.67 | 200.0 |
| RWAN | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| SOMA | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| TANZ | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| UGAN | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| ZAMB | 0.8 | 3.46 | 2.7 | 27.5 | 3.02 | 83.3 | 27.5 | 3.03 | 83.3 |
| EGYP | 582.4 | 3.36 | 1958.9 | 602.7 | 4.70 | 2833.3 | 602.4 | 4.70 | 2833.3 |
| LIBY | 42.2 | 1.17 | 49.4 | 66.9 | 2.79 | 186.4 | 67.9 | 2.74 | 186.1 |
| SUDA | 241.3 | 1.07 | 258.7 | 609.1 | 2.17 | 1320.0 | 482.5 | 1.81 | 873.0 |
| TOTAL | 1088.4 | 2.55 | 2775.5 | 1697.4 | 3.44 | 5845.5 | 1491.6 | 3.33 | 4968.0 |

Scenario A is the High Economic Growth Scenario and Scenario B is the Moderate Economic Growth Scenario of the FAO AT2000 study.

### 3.3. Implications and Review

The results for the potential rainfed wheat production in North and Subsahara Africa together with planned year 2000 irrigated production are summarized in Table 3.16. According to the FAO AT2000 Study, Africa's total wheat production and net imports in the year 2000 would amount to 13.0 and 21.3 million mT respectively, i.e. 34.3 million mT total demand. Comparing these results with the potential wheat production, it is clear that selfsufficiency for wheat in Africa as a whole is not viable. At the low, intermediate and high level of inputs, total wheat production in Africa (Table 3.16), would amount to 11.1, 22.1 and 29.2 million mT if crop choice is on the basis of maximizing food production and irrigated production is assumed to be 5.8 million mT in year 2000 (high economic growth scenario of FAO AT2000 study). Furthermore, if crop choice is on the basis of maximizing net value of production (at 1975 relative prices) then production levels would also be similar, at 10.9, 23.4 and 30.2 million mT respectively. These results imply that wheat selfsufficiency in Africa as a whole could be increased more than two-fold, namely from 38% to more than 65% if all African countries, where wheat can be competitively grown, were to reach at least an intermediate level of input. Apart from the benefits of reducing imports, this would be attractive in terms of food security as well.

The wheat only estimate of potentials is much higher, but needs to be seen as a theoretical one, as it has little likelihood of realization. The estimates based on doubled wheat price represent also a scenario of small chances of becoming a reality.

Table 3.17 shows the possible level of wheat selfsufficiency in the year 2000 in individual African countries on the basis of cultivating all land areas where wheat can be competitively grown.

Table 3.16. Summary of Potential Rainfed and Planned Irrigated Wheat Production in North and Subsahara Africa

| | Wheat only | Wheat and competitive crops on the basis of maximizing calorie production | Wheat and competitive crops on the basis of maximizing net value of production | Wheat and competitive crops on the basis of maximizing net value of production** |
|---|---|---|---|---|
| **NORTH AFRICA:** | | | | |
| **Rainfed (Potential)** | | | | |
| *Low Level of Inputs* | | | | |
| Wheat Area mill.Ha | 8.508 | 5.118 | 5.178 | |
| Wheat Yield mT/Ha | 0.629 | 0.812 | 0.815 | |
| Wheat Production mill.mT | 5.352 | 4.156 | 4.220 | |
| *Intermediate Level of Inputs* | | | | |
| Wheat Area mill.Ha | 10.639 | 5.364 | 7.009 | 10.607 |
| Wheat Yield mT/Ha | 1.685 | 2.073 | 2.079 | 1.690 |
| Wheat Production mill.mT | 17.931 | 11.119 | 14.573 | 17.924 |
| *High Level of Inputs* | | | | |
| Wheat Area mill.Ha | 10.253 | 5.399 | 7.025 | |
| Wheat Yield mT/Ha | 2.820 | 3.429 | 3.416 | |
| Wheat Production mill.mT | 28.909 | 18.515 | 23.999 | |
| **Irrigated (Planned: Year 2000)** | | | | |
| *Scenario * A* | | | | |
| Wheat Area mill.Ha | 0.292 | | | |
| Wheat Yield mT/Ha | 3.695 | | | |
| Wheat Production mill.mT | 1.080 | | | |
| *Scenario * B* | | | | |
| Wheat Area mill.Ha | 0.281 | | | |
| Wheat Yield mT/Ha | 3.113 | | | |
| Wheat Production mill.mT | 0.873 | | | |
| **SUBSAHARA AFRICA** | | | | |
| **Rainfed (Potential)** | | | | |
| *Low Level of Inputs* | | | | |
| Wheat Area mill.Ha | 15.476 | 1.875 | 0.902 | |
| Wheat Yield mT/Ha | 0.619 | 0.618 | 1.024 | |
| Wheat Production mill.mT | 9.574 | 1.158 | 0.924 | |
| *Intermediate Level of Inputs* | | | | |
| Wheat Area mill.Ha | 17.704 | 2.548 | 1.040 | 7.344 |
| Wheat Yield mT/Ha | 1.621 | 2.023 | 2.911 | 1.625 |
| Wheat Production mill.mT | 28.700 | 5.160 | 3.027 | 11.937 |
| *High Level of Inputs* | | | | |
| Wheat Area mill.Ha | 18.237 | 1.315 | 0.096 | |
| Wheat Yield mT/Ha | 2.486 | 3.735 | 3.714 | |
| Wheat Production mill.mT | 45.317 | 4.912 | 0.355 | |
| **Irrigated (Planned: Year 2000)** | | | | |
| *Scenario A* | | | | |
| Wheat Area mill.Ha | 1.405 | | | |
| Wheat Yield mT/Ha | 3.391 | | | |
| Wheat Production mill.mT | 4.765 | | | |
| *Scenario B* | | | | |
| Wheat Area mill.Ha | 1.211 | | | |
| Wheat Yield mT/Ha | 3.382 | | | |
| Wheat Production mill.mT | 4.095 | | | |
| **TOTAL AFRICA** | | | | |
| **Rainfed (Potential)** | | | | |
| *Low Level of Inputs* | | | | |
| Wheat Area mill.Ha | 23.984 | 6.993 | 6.080 | |
| Wheat Yield mT/Ha | 0.622 | 0.760 | 0.846 | |
| Wheat Production mill.mT | 14.926 | 5.314 | 5.144 | |
| *Intermediate Level of Inputs* | | | | |
| Wheat Area mill.Ha | 28.343 | 7.910 | 8.049 | 17.951 |
| Wheat Yield mT/Ha | 1.645 | 2.057 | 2.187 | 1.653 |
| Wheat Production mill.mT | 46.631 | 16.269 | 17.600 | 29.861 |
| *High Level of Inputs* | | | | |
| Wheat Area mill.Ha | 28.490 | 6.714 | 7.122 | |
| Wheat Yield mT/Ha | 2.605 | 3.489 | 3.420 | |
| Wheat Production mill.mT | 74.226 | 23.427 | 24.354 | |
| **Irrigated (Planned: Year 2000)** | | | | |
| *Scenario A* | | | | |
| Wheat Area mill.Ha | 1.697 | | | |
| Wheat Yield mT/Ha | 3.444 | | | |
| Wheat Production mill.mT | 5.845 | | | |
| *Scenario B* | | | | |
| Wheat Area mill.Ha | 1.492 | | | |
| Wheat Yield mT/Ha | 3.333 | | | |
| Wheat Production mill.mT | 4.968 | | | |

* FAO AT2000 Study
Scenario A: High Economic Growth Scenario
Scenario B: Moderate Economic Growth Scenario

** In this assessment wheat price has been doubled. Results for intermediate level of inputs only are reported.

**Table 3.17.** Year 2000 Total Wheat Demand, Imports and Irrigated Production and Potential Selfsufficiency in Wheat

| | FAO AT2000 Study Moderate Economic Growth Scenario YEAR 2000 | | | Potential Selfsufficiency Level for Wheat Food Strategy[1] | | Potential Selfsufficiency Level for Wheat Income Strategy[2] | |
|---|---|---|---|---|---|---|---|
| | Demand | Imports | Irrigated Production | Int. Input | High Input | Int. Input | High[3] Input |
| | '000mT | '000mT | '000mT | % | % | % | % |
| **Tunisia** | 1974 | 269 | 28 | 73 | 130 | 83 | 146 |
| **Algeria** | 8801 | 4600 | 8 | 93 | 154 | 112 | 179 |
| **Morocco** | 6437 | 2855 | 852 | 74 | 114 | 106 | 170 |
| **Libya** | 850 | 613 | 186 | 48 | 56 | 77 | 109 |
| **Egypt†** | 8033 | 6200 | 2833 | 35 | 35 | 35 | 35 |
| **North Africa** | 22895 | 13337 | 3707 | 65 | 97 | 80 | 121 |
| **Lesotho*** | 215 | 189 | 26 | 16 | 12 | 23 | 12 |
| **Sudan** | 1222 | 349 | 873 | 76 | 78 | 71 | 71 |
| **Zambia** | 276 | 195 | 83 | 32 | 34 | 30 | 30 |
| **Ethiopia** | 2009 | 894 | 4 | 188 | 172 | 121 | 18 |
| **Zimbabwe** | 223 | 22 | 201 | 90 | 90 | 90 | 90 |
| **Kenya** | 843 | 260 | 100 | 100 | 134 | 38 | 16 |
| **Angola** | 251 | 239 | | 60 | 37 | | |
| **Tanzania** | 481 | 138 | | 82 | 58 | 76 | |
| **Subsahara 1** | 6322 | 2086 | 1186 | 117 | 112 | 79 | 29 |
| **Mauritius** | 126 | 126 | | | | | |
| **Gabon** | 55 | 55 | | | | | |
| **Sao Tome*** | 6 | 6 | | | | | |
| **Congo** | 76 | 76 | | | | | |
| **Reunion*** | 51 | 51 | | | | | |
| **Cape Verde*** | 29 | 29 | | | | | |
| **Mauritania†** | 85 | 81 | 4 | 5 | 5 | 5 | 5 |
| **Botswana†** | 52 | 50 | 4 | 8 | 8 | 8 | 8 |
| **Senegal** | 296 | 296 | | | | | |
| **Ivory Coast** | 415 | 415 | | | | | |
| **Somalia** | 90 | 88 | | | | | |
| **Nigeria** | 2625 | 2593 | 32 | 1 | 1 | 1 | 1 |
| **Ghana** | 384 | 384 | | | | | |
| **Cameroon** | 180 | 180 | | 2 | 17 | | |
| **Subsahara 2** | 4450 | 4410 | 40 | 2 | 2 | 1 | 1 |
| **Mozambique†** | 275 | 268 | 7 | 3 | 3 | 3 | 3 |
| **Gambia** | 12 | 12 | | | | | |
| **Benin** | 79 | 79 | | | | | |
| **Togo** | 40 | 40 | | | | | |
| **Liberia** | 20 | 20 | | | | | |
| **Sierra Leone** | 94 | 94 | | | | | |
| **Madagascar** | 35 | 35 | | 111 | 37 | | |
| **Comoros*** | 3 | 3 | | | | | |
| **Guinea*** | 57 | 57 | | | | | |
| **Zaire** | 431 | 424 | | 4 | 14 | | |
| **Guinea Bissau** | 60 | 60 | | | | | |
| **Upper Volta** | 47 | 47 | | | | | |
| **Central Afr.Emp.** | 26 | 26 | | | | | |
| **Niger†** | 32 | 4 | 28 | 86 | 88 | 86 | 88 |
| **Chad†** | 37 | 14 | 23 | 62 | 62 | 62 | 62 |
| **Burundi** | 38 | 28 | 1 | 63 | 5 | 3 | 3 |
| **Mali†** | 86 | 80 | 6 | 7 | 7 | 7 | 7 |
| **Swaziland*†** | 4 | 0 | 4 | 100 | 100 | 100 | 100 |
| **Rwanda** | 23 | 9 | | 91 | 26 | | |
| **Malawi** | 109 | 108 | | 2 | 1 | | |
| **Uganda** | 104 | - 40 | | 13 | 13 | | |
| **Namibia*†** | 2 | 0 | 2 | 100 | 100 | 100 | 100 |
| **Subsahara 3** | 1614 | 1448 | 71 | 12 | 12 | 4 | 4 |
| **Subsahara Total** | 11386 | 7944 | 1297 | 57 | 65 | 36 | 15 |
| **AFRICA** | 34281 | 21281 | 8004 | 62 | 83 | 66 | 86 |

* Countries not included in FAO AT2000 Study. Year 2000 demand and irrigated production is derived on the basis of past time trends.

† Irrigated wheat production only. Rainfed land areas where wheat could be grown do not exist in these countries.

1. Food Strategy: Crop choice on the basis of maximizing calories
2. Revenue Strategy: Crop choice on the basis of maximizing net revenue
3. Note that the occasionally much lower potential SSR (e.g. Ethiopia and Kenya) for wheat is the result of the definition of high input level being fully mechanized, which makes much steep sloping land unsuitable.

In the North African region, all wheat production in Egypt is under fully irrigated conditions. If wheat is grown on the basis of a food strategy (maximizing calorie production), the results show that Tunisia, Algeria and Morocco could theoretically* reach between 73 and 93% selfsufficiency in wheat by achieving intermediate level of inputs for the production of wheat and competing crops on all land areas where wheat can be grown. By moving to the high level of inputs, these three countries could significantly increase their level of wheat selfsufficiency; however it should be noted that the realizability of relatively high average wheat yields may be difficult to achieve in practice due to rainfall variability and also the fact that the most productive wheat land may be allocated to other competing crops (e.g. olive). The results for the case where wheat is grown on the basis of an income strategy (maximizing net revenue) are similar except that levels of potential selfsufficiency in wheat are generally higher than the food strategy results (Table 3.17).

For North Africa as a whole, full selfsufficiency in wheat in the year 2000 would be theoretically viable only at the high level of inputs in the income strategy results. This is due to the high wheat demand and the relatively low level of wheat production in Egypt and Libya. Comparing the rainfed potential for competitive wheat production with the present (1978-80 average) wheat production, Table 3.18, it is interesting to note the following:

- In Tunisia and Libya, the present extent of rainfed wheat acreage is higher than the potential wheat acreage under the assumption of a food strategy. However note that the potential rainfed wheat acreage under the assumption of an income strategy would be higher than the present (1978-80) wheat acreage. Hence, as one would expect, it appears that wheat produc-

*"Theoretically" since important North African competing crops, namely citrus and olive, have not been considered in the present study. Additionally, yield constraining factors, such as rainfall variability, have also not been taken into account.

tion in these countries at present may be more in line with an income strategy; the domestic producer price of wheat relative to coarse grains in these counries was almost 50% higher in 1978-80 (see Table 2.6, Section 2).

- In Algeria and Morocco there may be scope for expansion of wheat acreage.
- The average rainfed wheat yields in 1978-80 are considerably less than the potential obtainable yields; in fact if intermediate level of inputs were to be achieved in wheat production, wheat yields could be more than doubled in Algeria, Libya, Morocco and Tunisia. The average yield at the high level of inputs represents a maximum level under ideal conditions.

In the Subsahara 1 region, Ethiopia, Tanzania, Kenya and Angola have relatively large rainfed potential for wheat production whereas most of the wheat production in Lesotho, Sudan, Zambia, and Zimbabwe would be under irrigated conditions. If wheat is grown on the basis of a food strategy (maximizing calorie production), and also assuming that all suitable land areas are cultivated at the intermediate level of inputs, Ethiopia would be well above selfsufficiency in wheat, whereas Kenya would just reach selfsufficiency. For Angola and Tanzania potential wheat selfsufficiency would be at 60% and 82% respectively. It is interesting to note that by moving to high level of inputs wheat selfsufficiency in these countries would decline. This occurs since fully mechanized wheat production at the high level of inputs is not feasible due to slope constraints. In contrast to the results for the North African countries, the potential selfsufficiency in wheat is lower in the case of wheat production on the basis of an income strategy as compared to a food strategy.

The Subsahara 1 region as a whole could be selfsufficient in wheat at the intermediate level of inputs on the basis of growing wheat only in those areas where it would be the most calorie yielding crop. The two potential wheat surplus countries would be Kenya and Ethiopia. It should, however, be

Table 3.18. Wheat acreage and yield: 1978-80 average and potential - Results for crop choice on the basis of calorie maximization (Food Strategy) and net revenue maximization (Income Strategy) for selected African countries with substantial wheat production

| | Average 1978-80 Rainfed Wheat | | Rainfed Potential Area and Yield | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low Input | | Int.Input | | High Input | |
| | Area '000Ha | Yield mT/Ha | Area '000Ha | Yield mT/Ha | Area '000Ha | Yield mT/Ha | Area '000Ha | Yield mT/Ha |
| **Food Strategy Results** | | | | | | | | |
| Tunisia | 941 | 0.815 | 710 | 0.628 | 823 | 1.726 | 873 | 2.915 |
| Algeria | 1953 | 0.615 | 2570 | 0.878 | 2569 | 2.381 | 2706 | 3.743 |
| Morocco | 1533 | 0.951 | 1728 | 0.787 | 1762 | 1.909 | 1678 | 3.303 |
| Libya | 225 | 0.302 | 110 | 0.863 | 210 | 1.045 | 142 | 2.081 |
| Ethiopia | 507 | 0.885 | 996 | 0.635 | 1859 | 2.026 | 827 | 4.176 |
| Kenya | 119 | 1.586 | 165 | 1.064 | 208 | 3.098 | 170 | 5.094 |
| Angola | 13 | 0.769 | 38 | 0.321 | 198 | 0.500 | 100 | 0.934 |
| Tanzania | 52 | 1.402 | 73 | 0.716 | 139 | 2.842 | 50 | 5.498 |
| **Income Strategy Results** | | | | | | | | |
| Tunisia | | | 671 | 0.649 | 918 | 1.762 | 961 | 2.979 |
| Algeria | | | 2465 | 0.901 | 3138 | 2.347 | 3198 | 3.696 |
| Morocco | | | 1916 | 0.762 | 2638 | 1.942 | 2605 | 3.290 |
| Libya | | | 126 | 0.817 | 315 | 1.485 | 261 | 2.849 |
| Ethiopia | | | 581 | 0.903 | 819 | 2.966 | 96 | 3.714 |
| Kenya | | | 125 | 1.433 | 70 | 3.000 | | |
| Angola | | | 2 | 0.700 | | | | |
| Tanzania | | | 75 | 0.997 | 122 | 3.000 | | |

recognized that regional wheat selfsufficiency would be hindered by the limited transport links among the countries in Subsahara 1.

Comparing the present (1978-80 average) rainfed wheat acreage and yields in the four major wheat producing countries in Subsahara 1, namely Ethiopia, Kenya, Angola and Tanzania, the results in Table 3.18 show:

- There is considerable scope for expanding rainfed wheat acreage in these countries in the context of a food strategy whereas on the basis of an income strategy, in general, wheat would not be a competitive crop.

- At present the average rainfed yields are in between the low and intermediate levels of input; wheat production in Kenya and Tanzania is mainly under large scale commercial conditions whereas in Ethiopia wheat production is partially mechanized through widespread use of working animals.

The results show that in Ethiopia the average obtainable wheat yield is much lower in the case of food strategy assessment in comparison to the income strategy at the low level of input. In fact, in the former case the average wheat yield is almost 30% below the 1978-80 average yield. This occurs because out of the 996000 hectares of land devoted to wheat, 494000 hectares is low production wheat land under the assumption of the food strategy at the low level of inputs, whereas in the case of the income strategy assessment, the low productivity land amounts to only 28000 hectares out of 581000 hectares of land allocated to wheat.

It should be noted that the average wheat yields (Table 3.18) at the intermediate level of inputs would be practically feasible if the necessary inputs (e.g. fertilizers) are available and wheat is grown on land where it would be a competitively superior crop.

As mentioned previously, international crop producer prices as well as input prices have been used to allow for a cross-country comparison of the results. Table 3.19 shows a comparison of the inputs and economics of wheat production in Kenya with the actual 1975 Kenyan data. The latter is based on domestic producer and input prices in 1975.

Among the fourteen countries included in Subsahara 2, irrigated wheat acreage in the year 2000 would amount to only 40,000 Ha in three countries, namely Botswana, Senegal and Nigeria; the latter country accounting for 80% of this extent of irrigated area. Very limited potential rainfed land areas for

Table 3.19. Comparison of inputs and economics of wheat production in Kenya on the basis of net revenue maximization and 1975 Kenyan data

| | Net Revenue Maximization | | | 1975 Actual Kenya Data |
|---|---|---|---|---|
| | Low Input | Intermediate Input | Low/Int.* Input | |
| Wheat area (Ha) | 125000 | 70000 | - | 110000 |
| Wheat yield (mT/Ha) | 1.43 | 3.00 | 1.72 | 1.72 |
| **Inputs per Ha** | | | | |
| Fertilizer (kg) | 4 | 168 | 34 | 41 |
| Power (MDE) | 53 | 63 | 55 | 68 |
| Seed (kg) | 133 | 123 | 131 | 115 |
| Pesticides ($1975) | 1 | 3 | 1 | n.a. |
| Gross Rev./Cost | 4.48 | 4.01 | 4.18 | 3.07 |
| Net Rev.($1975)/Ha | 188 | 381 | 221 | 79** |

* The results for low and intermediate input levels have been linearly interpolated for a yield level of 1.72 mT/Ha.

** 1975 Kenya wheat producer price 63$/mT (c.f. International price 169$/mT)

MDE = Man Day Equivalent

wheat occur in Nigeria and Cameroon; however as the results in Section 3.2 showed, rainfed wheat production in these two countries would generally not be competitive with alternative food crops in the context of a food strategy as well as an income strategy.

The year 2000 projected demand for this region amounts to 4.5 million mT of wheat with Nigeria accounting for 59.0%, and Senegal, Ivory Coast, Ghana and Mauritius additionally accounting for 27.0% of the total regional demand. In general, it is likely that these five countries will be able to finance the future imports of wheat through oil exports (Nigeria) and agricultural non-food exports (Ivory Coast, Senegal, Ghana and Mauritius).

In the Subsahara 3 region, irrigated wheat acreage in year 2000 would amount to 71,000 Ha. Niger and Chad account for 71.8% of this irrigated area and the remainder is accounted for by Mozambique, Mali, Swaziland, Namibia and Burundi. There is hardly any viable and competitive (in terms of maximizing calorie production as well as maximizing net revenue) potential for rainfed wheat production in Burundi, Madagascar, Zaire, Rwanda, Swaziland, Malawi and Uganda.

Assuming that all countries in Africa are able to achieve an intermediate level of inputs in agriculture, the total wheat production in Africa would be 16 to 18 million mT in year 2000, provided wheat is cultivated on all competitive (in terms of maximizing food production as well as maximizing net revenue) rainfed land areas by the year 2000. In this case there would still be a deficit of some 11 to 13 million mT to be imported in the year 2000. Additionally, if the economic incentive (e.g. doubled wheat producer prices) for wheat production is introduced, then theoretically the total potential production of 30 million mT together with 5 million mT of irrigated production would make Africa as a whole selfsufficient in wheat.

Increased selfsufficiency of wheat in a number of individual countries as well as at the regional level would be a viable proposition especially if farming technology is upgraded and appropriate price policies implemented. However, these results have to be interpreted in the context of the limitations of the AEZ methodology as used in the study. For example:

- due to practical constraints, it may not be possible (by the year 2000) to bring under cultivation all land areas where wheat can be competitively grown
- important country-specific competing crops have not been considered (e.g. citrus and olive in North Africa, teff in Ethiopia, etc.)
- variability of rainfall has not been accounted for.

The maximum potential for wheat production (39 and 64 million mT under intermediate and high level of inputs respectively, see Tables 3.11 and 3.13) in Africa is well above the demand for the year 2000 and beyond. However it would not be in Africa's comparative advantage and operationally nearly impossible to grow wheat on all land areas where wheat could be grown.

### 3.4. Concluding Remarks

Rainfed production potential of growing wheat in Africa has been estimated on the basis of the agro-ecological zone methodology.

The total area agroclimatically suitable for growing wheat under rainfed conditions was identified. All this land is not likely to be devoted to wheat cultivation unless wheat prices are sufficiently attractive relative to other crops and unless necessary infrastructure facilities are created. Monocropping with wheat would also not be a technically feasible proposal. However, it gives an idea of the maximum rainfed wheat production potential in Africa.

Depending on the technology and input intensities used, the wheat production potential is as follows:

| Technology | Rainfed Potential<br>Area<br>$10^6$Ha | <br>Production<br>$10^6$Tonnes |
|---|---|---|
| Low | 24.0 | 14.9 |
| Intermediate | 28.4 | 46.6 |
| High | 28.5 | 74.2 |

Economically viable production depends on relative prices and on alternative crop production potentials on the same land. Using 1975 world relative prices, rainfed production potentials for wheat when net revenue is maximized are lower (Table 3.17). For North Africa, under net revenue maximization, less than 70 percent of the potential wheat land would be devoted to wheat and production would be around 80 percent of the total wheat potential. This shows that North African soil and climate are in general suitable for wheat. This is also confirmed by the findings that when wheat prices are doubled (this was explored only under intermediate level of inputs) the net revenue maximizing wheat area and production equal the total potential.

The agro-climatic suitability for wheat is much poorer for Subsahara Africa. Under intermediate technology, of the 17.7 million Ha of potential wheat land only 1 million Ha (less than 6 percent) gets allocated to wheat production under income strategy and the production is only 3 million mT, i.e. 11 percent of the total wheat potential production of 28.7 million mT. With doubling of wheat prices, 41% of potential wheat land is allocated to wheat and wheat production is also 41% of the potential.

The areas under rainfed wheat in 1978-80 in major wheat producing countries (with the exception of Tunisia and Libya) were smaller than land areas where wheat can be competitively grown under a food as well as an income strategy. This indicates that scope exists to increase wheat production in Africa, through policies that increase farmers' incentives to do so.*

The extent to which selfsufficiency in wheat for Africa can be realized depends on the magnitude of demand, based on the economic and demographic growth scenario and on the price and incentive policies pursued to promote acreage expansion and, in particular, yield increases through intensive cultivation. Based on the AT2000 moderate economic growth scenario wheat demand in 2000 would be 34.3 million mT and imports 21.3 million mT. When 5 million mT of irrigated production is subtracted 29 million mT of rainfed wheat production is needed for Africa to be selfsufficient.

Though theoretically with intermediate technology Africa could produce 47 mT of rainfed wheat and be selfsufficient for this commodity, this would be at substantial opportunity cost. The rainfed wheat potential under income

*Keeping in mind the qualifications mentioned in Section 3.3.

strategy is only 17.6 mT with intermediate technology and 24.4 mT with high technology. Thus trying to push production above these limits to 29 mT would cause a loss of income for African farmers.

Even when relative price structures are modified and a food strategy is pursued to further food security through calorie maximization, rainfed wheat output is also around 17 million mT and 24 million mT under intermediate and high technologies. So here again selfsufficiency in wheat would be expensive for Africa. If wheat production is pushed beyond the food strategy limits, imports of other foods would have to be increased.

Looking at the country level results wheat selfsufficiency is not economically viable for most African countries, the exceptions being Algeria, Morocco and Ethiopia under intermediate technology. With high technology Tunisia and Libya can in addition become selfsufficient but Ethiopia does not remain selfsufficient as other crops become more attractive.

Since the theoretical, technically defined rainfed wheat production potential is high, selfsufficiency could be attained with appropriate incentives and this is shown when relative wheat prices are doubled. The rainfed production potential under intermediate technology becomes 29.9 million mT, slightly more than the needed 29 million mT. Though relative price of wheat may be doubled by 2000, if the world prices do not change similarly, this could involve a substantial cost to African countries for attaining selfsufficiency. In any case world price relatives are not likely to change so radically and the more likely course is a lower relative wheat price, as can be seen from the alternative future scenarios of the World Food and Agriculture model of IIASA.

It may be noted that in this section we have introduced economic considerations in the AEZ assessments and have generated rainfed wheat supply and cost curves for the different African countries. These curves relate yields to total area and to total production, costs of wheat production to different levels of output as also opportunity costs in terms of revenue as well as food (calories) foregone for producing wheat. These curves are of considerable theoretical interest and one can briefly point out some thought-provoking observations.

- Yield does not fall monotonically with area when net revenues are maximized. This is understandable, as a high yield-higher input cost land may be selected later than a low yield-lower input land which gives higher net revenue.
- Similarly cost per tonne does not change monotonically when production is increased.

These observations question some of the assumptions traditionally made in econometric estimations of yield and cost functions.

Future production of wheat in Africa will depend not only on demand but also on the availability of wheat on the world market. In terms of production, consumption and trade, wheat has to be considered in the light of alternative food crops as well as non-food crops. Furthermore, the agricultural sector in a country is embedded in the country's national economy and nations are interlinked through the international market. Hence a realistic assessment for the future outcomes of wheat in Africa has to be considered within this global economic framework. In the next section we present the results on the basis of alternative future scenarios using the IIASA World Food and Agriculture model. Three African countries, namely Egypt, Kenya and Nigeria are considered explicitly and results for the rest of the African countries are presented in terms of five broad groups.

# 4. IMPLICATIONS OF CHANGES IN WORLD MARKET PRICE OF WHEAT AND WHEAT AID IN AFRICA: FAP BASIC LINKED SYSTEM

## 4.1. Introduction

Though wheat selfsufficiency is not viable for most of the African countries, the growing imports of wheat are more a question of inadequate development of domestic food grain production. To what extent wheat imports will be continued in the future depends on the development of the whole economy, in particular of the agricultural sector, as well as on prices in the world market at which wheat and other agricultural products may be traded.

Also the consequences of wheat aid and continued reliance on it in the future raise some questions. How does wheat aid affect domestic production and consumption? What would be the consequences of a sudden discontinuation of wheat aid? How would countries adjust to such a shock?

In order to explore these issues we have used some of the national models developed within the framework of the Basic Linked System of the Food and Agriculture Programme (FAP)at IIASA.

The effect of changes in the world market price of wheat and possible consequences of international wheat aid on production and demand has been studied with the help of three country models for Egypt, Kenya, and Nigeria. For this study various scenarios with different levels of international wheat prices and alternative specifications of food aid and import restrictions have been tested. In addition to the country models, five broader regional models covering most of the rest of Africa and which are based on FAO's AT2000 study have been employed using different assumptions on the world price of wheat as described below.

### 4.2. Country Coverage

The three selected African countries, Egypt, Kenya, and Nigeria differ significantly in their wheat production potential, level of imports, and per capita consumption of wheat. In addition, five regional models comprising most of the rest of Africa have been analyzed. The baseline demand, supply and trade of these regional aggregates is based on Scenario B (moderate economic growth) of FAO's AT2000 study. The five regional groups as used in FAP's BLS consist of the following countries:

*African Oil Exporters* (AFR 1):

Algeria, Angola, Congo, Gabon, Libya

*African Medium Income /Food Exporters* (AFR 2):

Ivory Coast, Ghana, Senegal, Cameroon, Mauritius, Zimbabwe

*African Medium Income /Food Importers* (AFR 3):

Morocco, Tunisia, Liberia, Mauritania, Zambia

*African Low Income /Food Exporters* (AFR 4):

Benin, Gambia, Togo, Ethiopia, Malawi, Mozambique, Uganda, Sudan

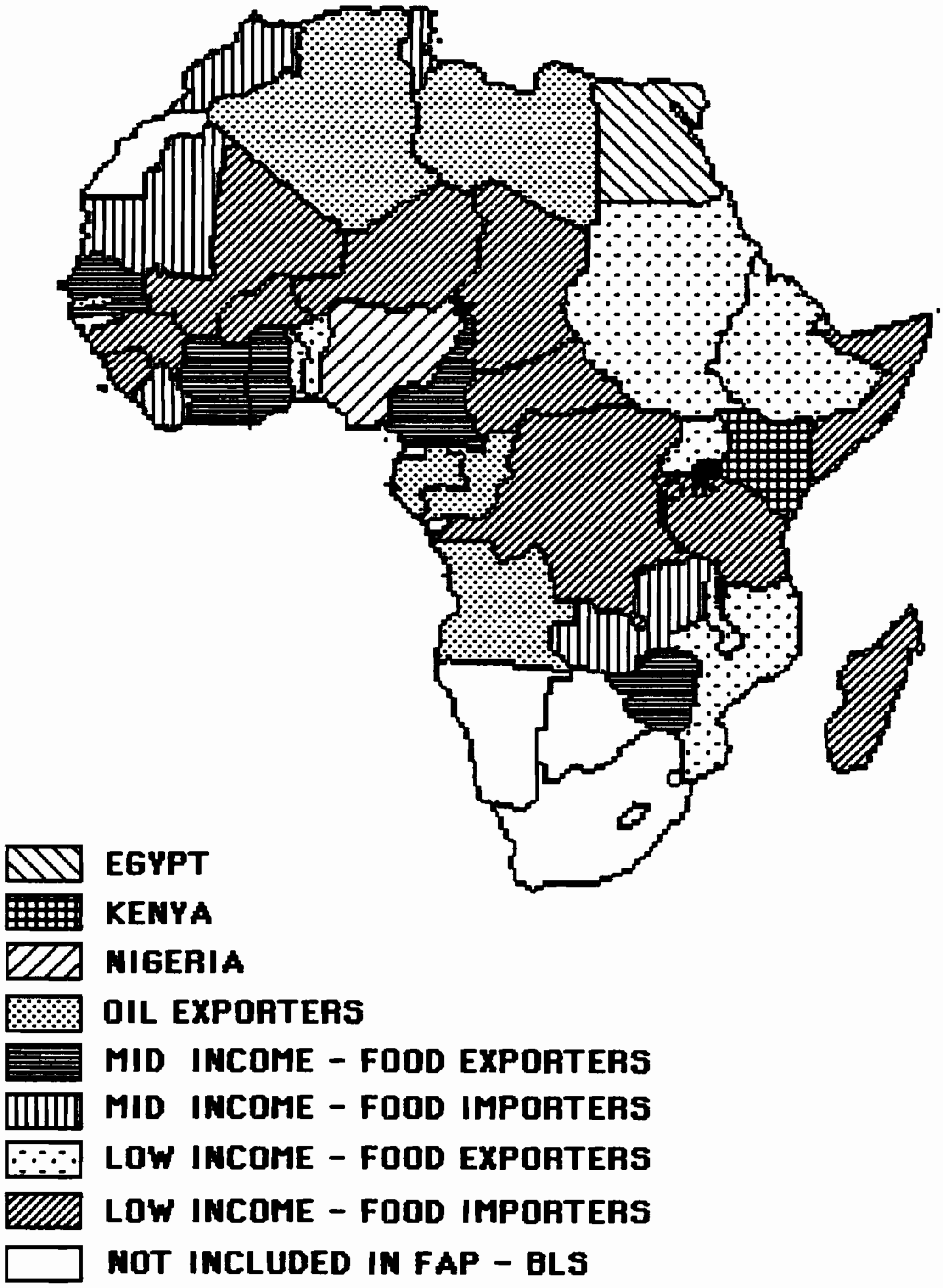
*African Low Income /Food Importers* (AFR 5):

Guinea, Mali, Niger, Sierra Leone, Upper Volta, Central African Empire, Chad, Zaire, Burundi, Madagascar, Rwanda, Somalia, Tanzania.

The grouping has been motivated by the need to reflect the level of income and selfsufficiency in food production for the purpose of the trade analysis to be carried out with the Basic Linked System.It does not reflect any geographical and/or political considerations. Countries not represented in the AT2000 study had to be omitted. A geographical representation of the country grouping used in the BLS is given in Fig.4.1.

The economic performance and the role of wheat in the local diet vary

Fig.4.1. AFRICA - REGIONAL GROUPING IN BASIC LINKED SYSTEM



widely among these countries and regional aggregates. A detailed overview on supply, imports, aid, and utilisation of cereals in African countries for the years 1966 to 1980 is given in Annex A. Even though urbanization and a tight food supply situation have pushed up the utilization of imported wheat in most African countries in the last decade, the contribution of wheat to the average daily calorie intake is still fairly small except for the Northern African countries. Table 4.1 shows a few selected indicators on the historical performance of the eight countries and country groups considered in FAP's Basic Linked System.

Fig 4.2 shows the widely differing importance of wheat as a share of total cereal consumption. All countries, however, show an upward trend in wheat utilisation. Especially the North African countries (Algeria and Libya in AFR 1, Morocco and Tunisia in AFR 3, and Egypt) highly depend on wheat in their diet. For these countries wheat has historically been and still is the main staple food.

Fig 4.2

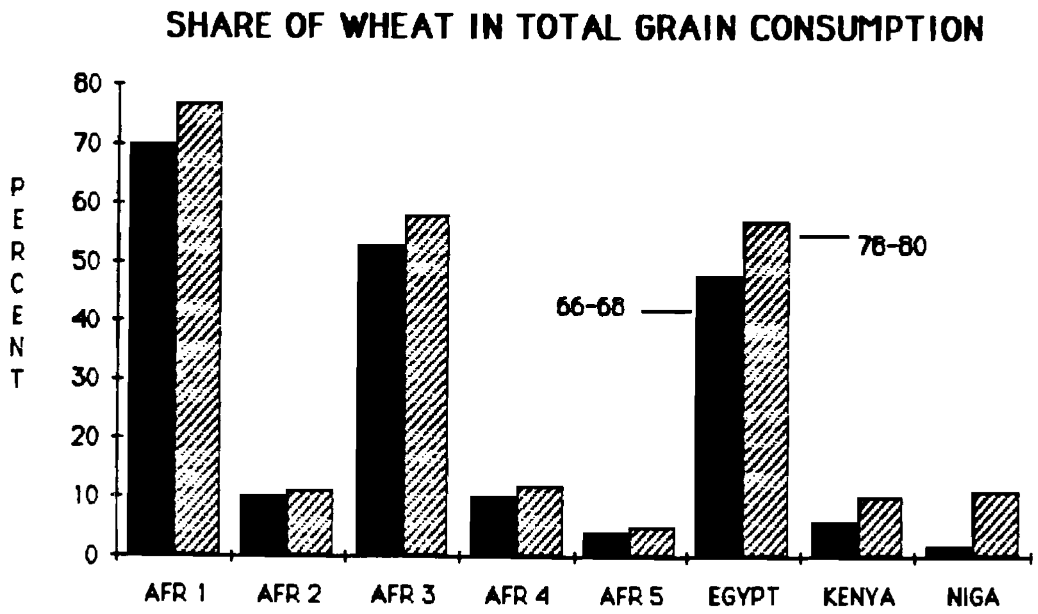


Table 4.1. Selected Indicators 1966-80

| | Population Mill. | Wheat Production 1000 metric tons | Wheat Net Imports 1000 metric tons | Wheat Aid 1000 metric tons | Wheat SSR % | Cereals Production 1000mT | Cereals SSR % | Calories Wheat kcal/cap/day | Calories Cereals kcal/cap/day | Calories Wheat % |
|---|---|---|---|---|---|---|---|---|---|---|
| **AFR 1:** | | | | | | | | | | |
| 66-68 | 20.8 | 1226 | 882 | 128 | 58 | 2191 | 72 | 699 | 996 | 70 |
| 72-74 | 24.8 | 1365 | 1718 | 57 | 44 | 2557 | 58 | 795 | 1099 | 72 |
| 78-80 | 30.0 | 1331 | 2813 | 27 | 34 | 2507 | 43 | 913 | 1187 | 77 |
| % Growth | 3.1 | 0.7 | 9.5 | -12.2 | -4.4 | 1.1 | -4.2 | 2.3 | 1.5 | 0.8 |
| **AFR 2:** | | | | | | | | | | |
| 66-68 | 28.6 | 15 | 336 | 30 | 4 | 3820 | 88 | 117 | 1141 | 10 |
| 72-74 | 34.2 | 86 | 431 | 64 | 17 | 4983 | 89 | 127 | 1136 | 11 |
| 78-80 | 41.0 | 177 | 554 | 85 | 24 | 4832 | 81 | 144 | 1069 | 13 |
| % Growth | 3.1 | 22.6 | 4.3 | 9.0 | 16.1 | 2.0 | -0.7 | 1.7 | -0.5 | 2.2 |
| **AFR 3:** | | | | | | | | | | |
| 66-68 | 24.9 | 2336 | 974 | 574 | 71 | 5907 | 85 | 824 | 1569 | 53 |
| 72-74 | 29.1 | 2767 | 1103 | 331 | 72 | 6817 | 68 | 973 | 1672 | 58 |
| 78-80 | 34.7 | 2587 | 2432 | 225 | 52 | 6444 | 68 | 973 | 1672 | 58 |
| % Growth | 2.8 | 0.9 | 7.9 | -7.5 | -2.6 | 0.7 | -1.8 | 1.4 | 0.5 | 0.9 |
| **AFR 4:** | | | | | | | | | | |
| 66-68 | 59.6 | 681 | 290 | 40 | 70 | 9015 | 99 | 126 | 1220 | 10 |
| 72-74 | 69.7 | 843 | 372 | 36 | 69 | 10582 | 98 | 131 | 1237 | 11 |
| 78-80 | 81.8 | 738 | 781 | 245 | 51 | 10859 | 81 | 136 | 1174 | 12 |
| % Growth | 2.7 | 0.7 | 8.2 | 16.4 | -2.6 | 1.6 | -0.7 | 0.7 | -0.3 | 1.0 |
| **AFR 5:** | | | | | | | | | | |
| 66-68 | 73.0 | 61 | 230 | 72 | 21 | 8567 | 96 | 34 | 926 | 4 |
| 72-74 | 84.4 | 113 | 334 | 84 | 25 | 8560 | 88 | 43 | 897 | 5 |
| 78-80 | 99.2 | 94 | 471 | 208 | 17 | 10163 | 89 | 48 | 887 | 5 |
| % Growth | 2.6 | 3.7 | 6.2 | 9.2 | -1.8 | 1.4 | -0.6 | 2.9 | -0.4 | 3.3 |
| **EGYPT:** | | | | | | | | | | |
| 66-68 | 30.9 | 1430 | 2201 | 437 | 39 | 6127 | 76 | 807 | 1671 | 48 |
| 72-74 | 35.4 | 1781 | 2218 | 245 | 45 | 6743 | 76 | 821 | 1661 | 50 |
| 78-80 | 40.9 | 1865 | 5125 | 1419 | 27 | 7295 | 56 | 1064 | 1869 | 57 |
| % Growth | 2.4 | 2.2 | 7.3 | 10.3 | -3.0 | 1.5 | -2.5 | 2.3 | 0.9 | 1.4 |
| **KENYA:** | | | | | | | | | | |
| 66-68 | 10.1 | 169 | -36 | 2 | 127 | 2362 | 106 | 88 | 1478 | 6 |
| 72-74 | 12.6 | 158 | -17 | 0 | 90 | 2829 | 103 | 102 | 1448 | 7 |
| 78-80 | 15.8 | 189 | 67 | 9 | 74 | 2577 | 96 | 127 | 1252 | 10 |
| % Growth | 3.8 | 1.0 | - | - | -4.4 | 0.7 | -0.8 | 3.1 | -1.4 | 4.5 |
| **NIGERIA:** | | | | | | | | | | |
| 66-68 | 51.6 | 20 | 138 | 0 | 13 | 6554 | 97 | 22 | 996 | 2 |
| 72-74 | 61.7 | 18 | 357 | 0 | 5 | 7405 | 94 | 43 | 957 | 5 |
| 78-80 | 74.6 | 21 | 989 | <1 | 2 | 8924 | 84 | 110 | 1034 | 11 |
| % Growth | 3.1 | 0.3 | 17.8 | - | -14 | 2.6 | -1.2 | 14.4 | 0.3 | 14.0 |

**4.3. Scenario Description**

The analysis presented in the following sections has been carried out with the help of the Basic Linked System, a general equilibrium world model focussing on production and trade of agricultural commodities, which has been built within the Food and Agriculture Program at IIASA. A short description of the main features of this policy analysis tool can be found in Annex C. At present the model consists of 35 national and regional models covering all of the world. The BLS distinguishes nine agricultural sectors and one nonagricultural sector. World market prices for wheat, rice, other grains, bovine and ovine meat, dairy products, other animal products and fish, protein feeds, other food commodities, nonfood agricultural commodities and the nonagricultural sector are calculated annually so as to clear the trade of the ten sectors at the world level.

World market prices for the Reference Scenario have been calculated assuming a continuation of historical trends in factors underlying production and in agricultural policies. Under these premises the relative price of wheat declines by about 1.2 percent annually between 1980 and 2000 as shown in chart 4.3. In the second decade the decline reduces to 0.5 percent annually.

To test the sensitivity of wheat demand and supply with respect to prices four world price scenarios have been specified :

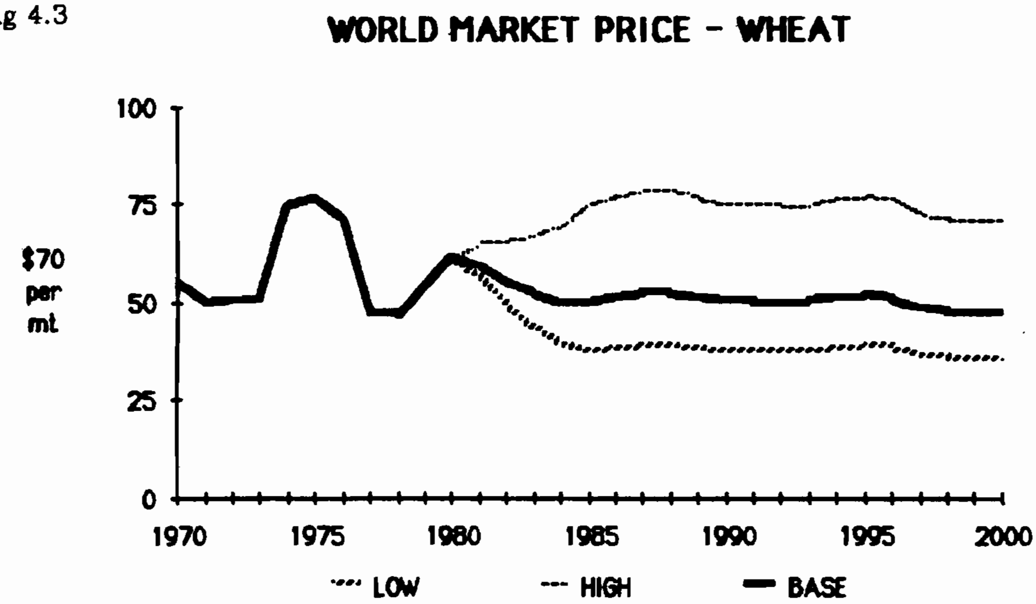
SC VLP: Very Low Wheat Price Scenario.

The world market price of wheat is assumed to fall to 50 percent of the levels in the Reference Scenario from 1985 onwards.

SC LP: Low Wheat Price Scenario.

The world market price of wheat is assumed to be 25 percent below the Reference Scenario price level from 1985 onwards.

Fig 4.3




SC HP: High Wheat Price Scenario.

The world market price of wheat is assumed to rise 50 percent above the Reference Scenario from 1985 onwards.

SC VHP: Very High Wheat Price Scenario.

The world market price of wheat in this run is doubled in comparison to the Reference Scenario after 1985.

Wheat prices for scenarios LP and HP are shown in Fig 4.3 above together with the price from the Reference Scenario. All prices in the graph are relative to the nonagricultural price. The base year price in 1970 is 55$/mT of wheat. The projected wheat price for the year 2000 is 47.6$/mT some 13.5% below the 1970 level. At prices of 1980 this would amount to 151$/mT and 131$/mT respectively. It has to be pointed out that the very high and the very low price scenarios VHP and VLP are considered to be quite unrealistic as such massive price distortions would most likely affect the other cereal prices.

In addition to the wheat price scenarios, alternative trade and aid scenarios have been analyzed for the three African country models available in the BLS (Kenya, Egypt, Nigeria). The effects of a severe import restriction have been studied by imposing wheat import quota at a level similar to the 1980 commercial imports. In the case of Kenya full selfsufficiency in wheat has been enforced. The consequences of international wheat aid have been explored with and without accompanying government actions. Apart from aid for the full simulation period from 1980 to 2000 also possible effects of an abrupt discontinuation of aid after 1990 has been tested. These scenarios have been named as follows :

QUTA: Import restriction on wheat.

Imports of wheat have been limited to 2.6 mill. mT and 1 mill. mT for Egypt and Nigeria respectively from 1985 onwards. Full selfsufficiency in wheat has been enforced in the case of Kenya.

AID1: Food Aid.

2 mill. mT and 1 mill. mT of wheat are given to Egypt and Nigeria respectively in form of international food aid from 1985 onwards. No additional policy action (such as subsidized food distribution or producer subsidies) is taken to improve the domestic food situation.

AID2: Food Aid + Maintaining commercial wheat import levels from BLS Reference Scenario.

2 mill. mT and 1 mill. mT of wheat are given to Egypt and Nigeria respectively in form of international food aid from 1985 onwards. Commercial imports are kept at level of Reference scenario to improve the domestic food supply situation.

AID3: Food Aid discontinued after 1989.

Aid is given as in scenario AID2 above but discontinued after 1989.

AID4: Food Aid discontinued after 1989 + Maintaining commercial wheat import levels from BLS Reference Scenario.

Aid is given as in scenario AID2 but discontinued after 1989. Between

1990 to 2000 the level of commercial wheat imports is reduced to the level observed in the BLS Reference Scenario.

Aid runs have not been specified for Kenya since during the historical period Kenya was a wheat exporter until the mid seventies and did not receive any substantial food aid.

### 4.4. Simulation Results

In the following section the simulation results from the different scenarios will be summarized. First we present a few details from the Reference Run followed by results from the low and high price scenarios. Finally, a short section on each of the country models will highlight the country simulation results.

#### 4.4.1. Reference Run

As mentioned earlier the world market prices for the ten sectors used in the analysis comprise the general equilibrium solution from the Reference Scenario of the Basic Linked System. The models generally follow historical trends of the period 1961 to 1976. The aggregate regional groups have been built based on Scenario B (moderate economic growth) of FAO's AT2000 study.

*Remark:* The models for Egypt, Kenya and Nigeria have been estimated on time series for the period 1961 to 1976. Therefore the sharp increase in food aid for Egypt in the late 1970's is not captured by the estimates. Similarly, the simulated imports of wheat to Nigeria in 1980 are underestimated.

Projections for some of the key variables are shown in Tables 4.2 and 4.3. In these tables growth rates refer to average annual growth for the period 1980 to 2000.

In Table 4.3 quantities are in thousand metric tons and selfsufficiency ratios SSR in percent of total domestic disappearance. Africa as a whole shows

Table 4.2. BLS Reference Scenario - General Indicators

| | AFR 1 | AFR 2 | AFR 3 | AFR 4 | AFR 5 | Egypt | Kenya | Nigeria |
|---|---|---|---|---|---|---|---|---|
| **Population** (thousand) | | | | | | | | |
| 1980 | 30800 | 42100 | 35800 | 87600 | 102000 | 41200 | 15700 | 88800 |
| 2000 | 56900 | 73200 | 62500 | 153800 | 176400 | 61200 | 31000 | 160400 |
| % Growth 1980-2000 | 3.1 | 2.8 | 2.8 | 2.9 | 2.8 | 2.0 | 3.4 | 3.0 |
| **GDP** | | | | | | | | |
| % Growth 1980-2000 | 6.0 | 4.8 | 4.7 | 4.4 | 3.4 | 5.0 | 4.2 | 5.1 |
| **GDP/CAP** | | | | | | | | |
| % Growth 1980-2000 | 2.9 | 2.0 | 1.9 | 1.5 | 0.6 | 3.0 | 0.8 | 2.1 |
| **CAL/CAP** (kcal/cap/day) | | | | | | | | |
| 1980 | 2451 | 2509 | 2773 | 2133 | 2188 | 2810 | 2538 | 2266 |
| 2000 | 2798 | 2705 | 2894 | 2427 | 2366 | 3098 | 2724 | 2544 |
| % Growth 1980-2000 | 0.67 | 0.38 | 0.22 | 0.65 | 0.39 | 0.49 | 0.36 | 0.58 |

Table 4.3. BLS Reference Scenario - Cereal Indicators

| | AFR 1 | AFR 2 | AFR 3 | AFR 4 | AFR 5 | Egypt | Kenya | Nigeria | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **Cereals** | | | | | | | | | |
| **Production** | | | | | | | | | |
| 1980 | 2452 | 4311 | 6533 | 11181 | 10956 | 9302 | 2718 | 9014 | 56467 |
| 2000 | 4080 | 10298 | 11952 | 22264 | 21290 | 12242 | 4042 | 14796 | 100964 |
| % Growth | 2.6 | 4.5 | 3.1 | 3.5 | 3.4 | 1.4 | 2.0 | 2.5 | 2.9 |
| **SSR** | | | | | | | | | |
| 1980 | 49 | 58 | 82 | 81 | 76 | 79 | 99 | 85 | 74 |
| 2000 | 38 | 72 | 80 | 80 | 76 | 65 | 70 | 70 | 69 |
| % Growth | -1.3 | 1.1 | -0.2 | 0.0 | 0.0 | -1.0 | -1.7 | -1.0 | -0.3 |
| **Wheat** | | | | | | | | | |
| **Production** | | | | | | | | | |
| 1980 | 1391 | 100 | 2432 | 719 | 86 | 2074 | 207 | 23 | 7032 |
| 2000 | 2090 | 187 | 4249 | 2121 | 407 | 2464 | 290 | 26 | 11834 |
| % Growth | 2.1 | 3.2 | 2.8 | 5.6 | 8.1 | 0.9 | 1.7 | 0.6 | 2.6 |
| **Demand** | | | | | | | | | |
| 1980 | 4350 | 679 | 4921 | 1538 | 578 | 4640 | 243 | 606 | 17555 |
| 2000 | 7977 | 1675 | 7901 | 3956 | 1525 | 7615 | 543 | 2230 | 33422 |
| % Growth | 3.1 | 4.6 | 2.4 | 4.8 | 5.0 | 2.5 | 4.1 | 6.7 | 3.3 |
| **Imports** | | | | | | | | | |
| 1980 | 2959 | 579 | 2489 | 819 | 492 | 2566 | 36 | 584 | 10524 |
| 2000 | 5887 | 1487 | 3652 | 1835 | 1118 | 5148 | 253 | 2204 | 21584 |
| % Growth | 3.5 | 4.8 | 1.9 | 4.1 | 4.2 | 3.5 | 10.2 | 6.9 | 3.7 |
| **SSR** | | | | | | | | | |
| 1980 | 32 | 15 | 49 | 47 | 15 | 45 | 85 | 3 | 40 |
| 2000 | 26 | 11 | 54 | 54 | 27 | 32 | 53 | 1 | 35 |
| % Growth | -1.0 | -1.5 | 0.5 | 0.7 | 3.0 | -1.7 | -2.3 | - | -0.6 |

a growing dependence on wheat and also other cereal imports in the Reference Scenario. Projected selfsufficiency levels fall from 74 to 69 percent for all cereals, and from 40 to 35 for wheat alone. Estimated wheat imports for the year 2000 reach almost 22 mill.mT out of some 46 mill.mT total cereal imports compared to about 11 mill.mT of wheat and 20 mill.mT of total cereal imports as simulated for 1980. On the average cereal production grows annually by 2.9 percent between 1980 to 2000 slightly more than the average 2.8 percent annual population increase. Estimated cereal demand grows at 3.3 percent per annum. The respective growth rates for wheat are an average 2.6 percent production growth and 3.3 percent demand growth per year.

#### 4.4.2. Wheat Price Scenarios

The importance of wheat in the diet varies substantially in the regional groups considered in the study. In Fig 4.4 the daily calorie intake as projected for the year 2000 together with calories from cereals and wheat are presented.

Fig 4.4

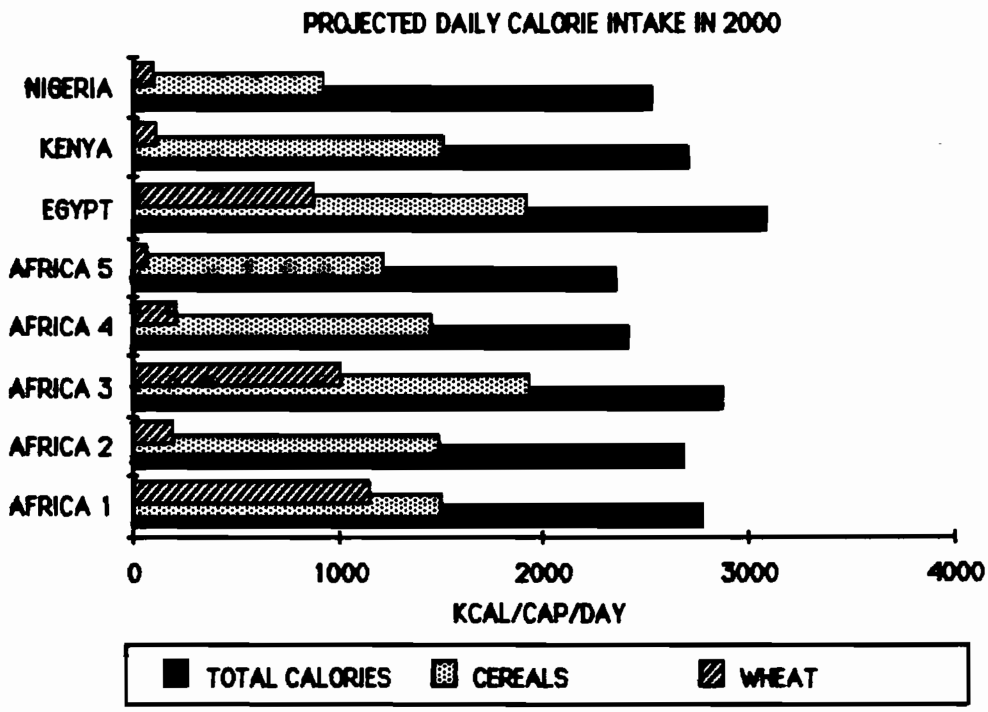


Table 4.4. Projected Wheat Production and Imports for 2000 under alternative wheat price scenarios

| | Projected Wheat Production (1000 mT) | | | | | Projected Wheat Imports (1000 mT) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | REF | VLP | LP | HP | VHP | REF | VLP | LP | HP | VHP |
| AFRICA 1 | 2090 | 1205 | 1660 | 2943 | 3727 | 5887 | 7281 | 6526 | 4790 | 3837 |
| AFRICA 2 | 187 | 121 | 156 | 251 | 318 | 1487 | 1760 | 1594 | 1333 | 1205 |
| AFRICA 3 | 4249 | 2633 | 3471 | 5790 | 7421 | 3652 | 5626 | 4569 | 1930 | 178 |
| AFRICA 4 | 2121 | 1502 | 1637 | 2663 | 3246 | 1835 | 2834 | 2260 | 1121 | 422 |
| AFRICA 5 | 407 | 310 | 365 | 486 | 572 | 1118 | 1385 | 1223 | 965 | 828 |
| EGYPT | 2464 | 967 | 1681 | 4036 | 5389 | 5148 | 7485 | 6203 | 3299 | 1803 |
| KENYA | 290 | 109 | 194 | 495 | 705 | 253 | 533 | 387 | 1 | -234 |
| NIGERIA | 26 | 18 | 22 | 31 | 36 | 2204 | 2678 | 2400 | 1937 | 1752 |
| TOTAL | 11834 | 6865 | 9186 | 16695 | 21414 | 21584 | 29555 | 25162 | 15376 | 9791 |
| % CHANGE | | -42 | -22 | 41 | 81 | | 37 | 17 | -29 | -55 |

Table 4.5. Projected Wheat Demand in the Year 2000

| | Projected Wheat Disappearance (1000 mT) | | | | | Human Wheat Consumption (kg/cap/year) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | REF | VLP | LP | HP | VHP | REF | VLP | LP | HP | VHP |
| AFRICA 1 | 7977 | 8486 | 8168 | 7733 | 7564 | 126.5 | 134.8 | 129.6 | 122.5 | 119.7 |
| AFRICA 2 | 1675 | 1881 | 1749 | 1584 | 1523 | 22.3 | 25.0 | 23.3 | 21.1 | 20.2 |
| AFRICA 3 | 7901 | 8260 | 8040 | 7720 | 7599 | 111.8 | 117.0 | 113.8 | 109.1 | 107.4 |
| AFRICA 4 | 3956 | 4336 | 4097 | 3784 | 3669 | 23.8 | 26.1 | 24.6 | 22.7 | 22.0 |
| AFRICA 5 | 1525 | 1695 | 1587 | 1450 | 1400 | 8.3 | 9.2 | 8.6 | 7.9 | 7.6 |
| EGYPT | 7615 | 8430 | 7889 | 7338 | 7194 | 97.7 | 99.3 | 98.4 | 96.5 | 95.3 |
| KENYA | 543 | 642 | 581 | 496 | 471 | 14.1 | 15.9 | 14.9 | 12.8 | 11.9 |
| NIGERIA | 2230 | 2696 | 2422 | 1968 | 1787 | 12.5 | 14.4 | 13.3 | 11.2 | 10.2 |
| TOTAL | 33422 | 36426 | 34543 | 32073 | 31207 | 37.7 | 40.4 | 38.8 | 36.3 | 35.1 |
| % CHANGE | | 9.0 | 3.4 | -4.0 | -6.6 | | 7.2 | 2.9 | -4.8 | -6.9 |

The graph shows the continued significant contribution of wheat in the diet of the North African countries (Egypt, Algeria and Libya in AFRICA1, and Morocco and Tunisia in AFRICA3). Accordingly, the impact of changes in the world market price of wheat on the calorie intake levels varies substantially. In general, national and regional responses of supply and imports are much more pronounced than the response of total disappearance of wheat. Tables 4.4 to 4.6 show a comparison of the various world wheat price scenarios and their effects

Table 4.6. Projected calorie intake in 1990 and 2000

| | Calorie Intake 1990 (kcal/cap/day) | | | | | Calorie Intake 2000 (kcal/cap/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | REF | VLP | LP | HP | VHP | REF | VLP | LP | HP | VHP |
| AFRICA 1 | 2655 | 2757 | 2693 | 2606 | 2571 | 2798 | 2876 | 2830 | 2761 | 2735 |
| AFRICA 2 | 2610 | 2643 | 2622 | 2596 | 2586 | 2705 | 2730 | 2714 | 2693 | 2686 |
| AFRICA 3 | 2833 | 2896 | 2858 | 2802 | 2780 | 2894 | 2944 | 2914 | 2869 | 2852 |
| AFRICA 4 | 2274 | 2302 | 2284 | 2261 | 2252 | 2427 | 2450 | 2436 | 2417 | 2411 |
| AFRICA 5 | 2269 | 2280 | 2273 | 2264 | 2260 | 2366 | 2375 | 2369 | 2362 | 2359 |
| EGYPT | 2944 | 2962 | 2951 | 2933 | 2917 | 3098 | 3118 | 3105 | 3084 | 3066 |
| KENYA | 2684 | 2694 | 2688 | 2679 | 2679 | 2724 | 2735 | 2729 | 2713 | 2719 |
| NIGERIA | 2400 | 2408 | 2403 | 2394 | 2390 | 2544 | 2554 | 2548 | 2537 | 2532 |
| TOTAL | 2475 | 2503 | 2485 | 2461 | 2452 | 2590 | 2613 | 2600 | 2580 | 2569 |
| % CHANGE | | 1.13 | 0.40 | -0.57 | -0.93 | | 0.89 | 0.39 | -0.39 | -0.81 |
| mill.PEOPLE | | 7.2 | +2.6 | -3.6 | -5.9 | | 7.7 | +3.4 | -3.4 | -7.1 |

on demand and supply. It should be pointed out that the overall balance of trade constraint as specified for the Reference Run has been maintained in all these scenarios. A more detailed discussion of these results will be contained in the country-specific Sections 4.4.3 to 4.4.6.

Table 4.6 indicates that a 50 percent reduction in international wheat prices would increase the average African calorie intake by about 1.13 percent in 1990 and 0.89 precent in 2000. Even though this seems to be a negligible amount, this level of excess calories would be equivalent to the food needs of about 7.7 million people in the year 2000. Similarly a doubling of the wheat price might create a calorie gap equivalent to the minimum consumption of about 7.1 million people. This calculation assumes a minimum calorie requirement of 2300 kcal per caput per day. The respective figures for the other scenarios are shown in the last row of Table 4.6.

The broad picture that emerges from the results of these scenario comparisons is as follows:

Response of domestic wheat production to prices is significant, Table 4.7. A supply elasticity w.r.t. price of 0.8 is indicated. African imports of wheat also adjust to world prices and the indicated import elasticity is around -0.55 for price increases and -0.74 for price decreases. However, the demand for wheat is not so price elastic. Elasticity of Human consumption w.r.t. price is -0.07 for price increases and -.14 for price decreases.

Table 4.7. Elasticities of supply, trade and demand: Results of very low (VLP) and very high (VHP) wheat price scenarios

| | Supply | | Trade | | Demand | |
|---|---|---|---|---|---|---|
| | VLP | VHP | VLP | VHP | VLP | VHP |
| Africa 1 | 0.85 | 0.78 | -0.47 | -0.35 | -0.13 | -0.05 |
| Africa 2 | 0.71 | 0.70 | -0.37 | -0.19 | -0.25 | -0.09 |
| Africa 3 | 0.76 | 0.75 | -1.08 | -0.95 | -0.09 | -0.04 |
| Africa 4 | 0.58 | 0.53 | -1.09 | -0.77 | -0.19 | -0.07 |
| Africa 5 | 0.48 | 0.41 | -0.48 | -0.26 | -0.22 | -0.08 |
| Egypt | 1.22 | 1.19 | -0.91 | -0.65 | -0.21 | -0.06 |
| Kenya | 1.25 | 1.43 | -2.21 | -1.92 | -0.36 | -0.13 |
| Nigeria | 0.62 | 0.38 | -0.43 | -0.21 | -0.42 | -0.20 |
| Total Africa | 0.84 | 0.81 | -0.74 | -0.55 | -0.18 | -0.07 |

These differences between the aggregate figures of low demand elasticity and still lower calorie elasticity w.r.t. wheat price should be interpreted with care. If imported wheat is directed to selected groups, such as poor urban consumers, then the fall in their calorie intake could be severe unless transport and distribution infrastructure exists and administrative measures are taken to ensure that substitute foods are available to such vulnerable groups.

We now turn to three specific country case studies, Kenya, Egypt and Nigeria. These countries offer different prototypical situations. Kenya has wheat production potential, has in recent years turned from an exporter to an importer of wheat but does not receive significant wheat aid. Egypt on the other hand has sizeable production potential, gets large amounts of wheat aid and also imports a lot. Moreover, wheat is an important part of the diet in

Egypt. Nigeria on the other hand gets no wheat aid, has very little wheat production potential and wheat consumption is a marginal part in total cereal consumption.

We explore the impact of prices and aid changes in these countries.

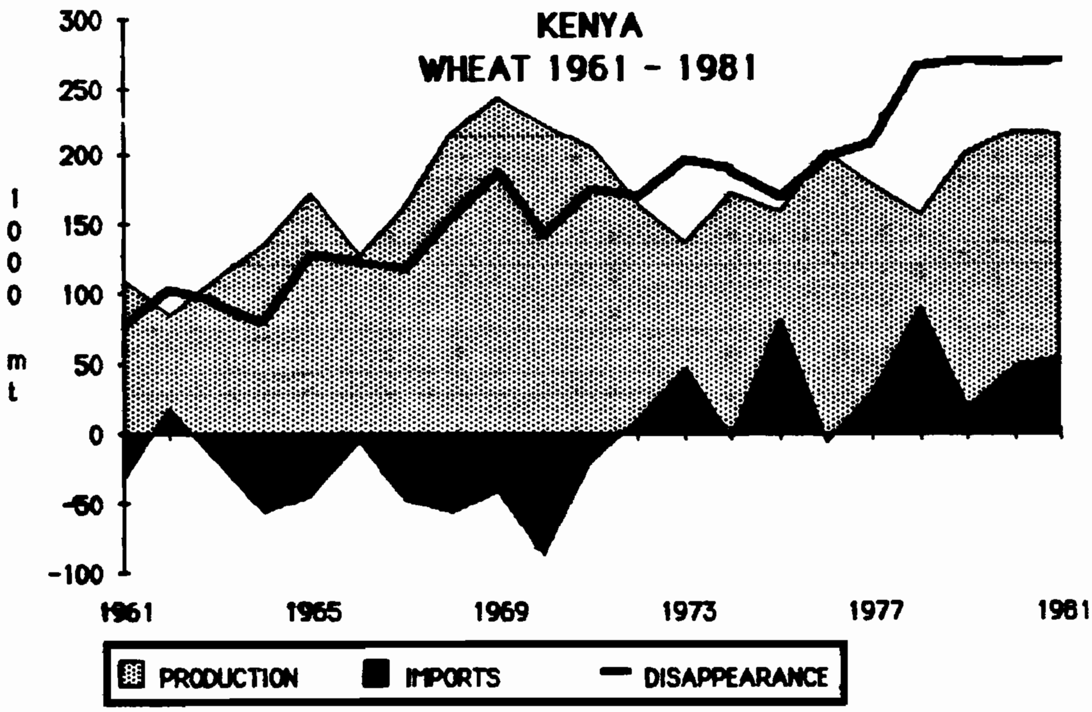
The per capita calorie intake elasticities are very small, but they should be carefully interpreted. These elasticities are very low because wheat consumption is small in most countries. In fact, the fall in total calorie intake is almost entirely due to the fall in wheat calorie consumption. For example, in Table 4.5 for Egypt, the consumption of wheat under the very high price, VHP, scenario is 95.3 kg/cap/year which is 2.4 kg less than in the reference scenario. The calorie content of this wheat is 22 kcal/cap/day. In Table 4.6 the total calorie intake for the VHP scenario for Egypt is 3066 kcal/cap/day compared to 3098 kcal in the reference run, a fall of 32 kcal/cap/day.

The additional fall in calorie intake is due to lowered imports of food grains (other than wheat) under the very high wheat price as not enough foreign exchange is available now.

#### 4.4.3. KENYA

Between 1970 and 1980 the Kenyan economy has been growing annually by 5.4% on the average. For the period 1974 to 1982 the corresponding growth was 4.5%. In 1980 and 1981 there was a decline in real GDP of about 1.5 % each. Per capita income showed an even slower growth because of the rapid increase in population (3.5 % per annum between 1970 - 1980, 3.9 % in 1983). Thus, Kenya is on top of the list of countries with high population growth. Since independence in 1963, wheat production has been growing at an average annual rate of about 2.8 % compared to an average 6 % increase of wheat demand. The latter resulted from increasing urbanization, high population growth and moderate increases in per capita intake. Accordingly, Kenya has turned from a net wheat exporter during the 1960 - 1970 period to an importer in the last decade. The selfsufficiency ratio for wheat has changed from 1.12 in 1961-1963 - after a peak of 1.63 in 1970 - to about 0.79 in 1979-1981. The subdivision of large farms after independence lead to a decline in wheat acreage and consequently to lower production levels. Recently, the Kenyan government is trying to promote cultivation of 'new wheat lands' by small farmers in the Narok district. Food aid in wheat has been insignificant during the 1960's and 1970's. The dynamics of the transition in wheat selfsufficiency during 1961 to 1981 is shown in Fig. 4.5.

Fig 4.5




Some indicators of the model simulation for the year 2000 obtained from the Reference Scenario have been presented in Tables 4.2 and 4.3 earlier in this paper. A few selected results are summarized in Table 4.8.

Wheat production increases only moderately to the level of 290 thousand metric tons in 2000, about half of the projected consumption. Wheat imports

Table 4.8. Reference Scenario - Kenya

| | POP 1000 | GDP mill.$70 | GDP/CAP $70 | CAL kcal/cap/day | Wheat PROD 1000mT | Wheat DEM 1000mT | Wheat IMPORT 1000mT | Wheat SSR % |
|---|---|---|---|---|---|---|---|---|
| 1970 | 11247 | 1591 | 141 | 2382 | 221 | 135 | -86 | 163 |
| 1980 | 15712 | 2688 | 171 | 2538 | 207 | 243 | 36 | 85 |
| 2000 | 30954 | 6140 | 198 | 2724 | 290 | 543 | 253 | 53 |
| % Growth 1980-2000 | 3.4 | 4.2 | 0.8 | 0.36 | 1.7 | 4.1 | 10.2 | -2.3 |

reach 253 thousand metric tons compared to 260 thousand mT as projected by the AT2000 study (scenario B, moderate economic growth). As there is enough potential for wheat production in Kenya the projected production quantities vary substantially between 109 thousand mT in the VLP scenario and 705 thousand mT in the VHP scenario. Production, demand and imports for the various scenarios are shown in Table 4.9.

Table 4.9. WHEAT Production, Demand and Imports in 2000 - Kenya

| 1000 mT | REF | VLP | LP | HP | VHP | QUTA |
|---|---|---|---|---|---|---|
| Production | 290 | 109 | 194 | 495 | 705 | 495 |
| Demand | 543 | 642 | 581 | 496 | 471 | 494 |
| Imports | 253 | 533 | 387 | 1 | -234 | -1 |

It is worth noting that the BLS model for Kenya arrives at very similar results for the HP scenario (50 percent higher wheat prices) and the QUTA scenario (enforced wheat selfsufficiency).

Because of the relatively pessimistic assumptions on economic growth in the BLS model, projected demand in the year 2000 is about 15 percent below the assumptions in AT2000 (scenario B, moderate economic growth).

Table 4.10. Comparison of Simulation Results - Kenya 1990 and 2000

| | Percentage Difference compared to Reference Scenario* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | | | | | 2000 | | | | |
| | VLP | LP | HP | VHP | QUTA | VLP | LP | HP | VHP | QUTA |
| PARITY | -0.04 | -0.10 | 0.66 | 1.98 | 0.58 | 0.04 | -0.05 | 0.57 | 1.76 | 0.53 |
| CAL/CAP | 0.37 | 0.15 | -0.19 | -0.19 | -0.54 | 0.40 | 0.18 | -0.18 | -0.18 | -0.27 |
| WHEAT/CAP | 13.3 | 5.9 | -9.6 | -15.6 | -13.1 | 12.8 | 5.7 | -9.2 | -15.6 | -11.00 |
| CEREALS/CAP | 0.75 | 0.31 | -0.37 | -0.44 | -0.99 | 0.74 | 0.31 | -0.41 | -0.55 | -0.45 |
| WHEAT | | | | | | | | | | |
| PRICE | -50 | -25 | 50 | 100 | 63 | -50 | -25 | 50 | 100 | 51 |
| PRODUCTION | -62 | -33 | 70 | 139 | 20 | -62 | -33 | 71 | 143 | 70 |
| IMPORTS | 163 | 79 | -149 | -288 | -100 | 111 | 53 | -100 | -193 | -100 |
| DISAPPEAR. | 17.9 | 6.9 | -8.0 | -12.6 | -16.2 | 18.2 | 7.0 | -8.7 | -13.3 | -8.9 |
| CEREALS | | | | | | | | | | |
| PRODUCTION | -1.7 | -0.8 | 0.9 | 1.1 | 0.6 | -1.8 | -0.8 | 1.0 | 1.8 | 1.2 |
| IMPORTS | 9.3 | 3.8 | -4.6 | -6.6 | -7.1 | 6.9 | 2.9 | -3.5 | -5.1 | -4.0 |

*A scenario description is given in Section 4.3.

In Table 4.10 we present a comparison of the BLS simulation results for the various wheat price and selfsufficiency scenarios. Percent differences of some key indicators for 1990 and 2000 are shown relative to the Reference Scenario. It indicates that a selfreliance strategy in wheat seems a feasible proposition for Kenya. As outlined later in this section, also the AEZ results on potential wheat production in Kenya support this statement. The results for the year 1990 indicate, however, that a sufficiently long transition period (longer than 5 years as assumed in the QUTA scenario) should be allowed for. It should be noted that price changes shown in Table 4.10 refer to producer prices, whereas the impact on retail prices would be about half the indicated size. If no subsidies were given to consumers (as in the QUTA run) the BLS model estimates an average 0.45 percent decrease in calorie intake. As income parity, i.e. the ratio of agricultural to nonagricultural income per caput, improves by about half a percent due to higher agricultural prices, the negative impact is likely to be felt mainly by poor urban consumers.

Since wheat accounts for less than 2 percent of GDP in the agricultural sector, the substitution and income effect are not dramatic in the BLS wheat selfreliance scenario. The calculations indicate that wheat production would increase by 70 percent, other grain production would decrease by about 4.2 percent resulting in net increase of total grain production of about 1.2 percent. In addition, other food and nonfood production from crops would be reduced by roughly 0.8 and 0.4 percent respectively. The overall effect calculated in the BLS model for Kenya is a 0.15 percent increase of agricultural GDP at prices of 1970 compared to the BLS Reference Scenario.

These runs show that the general pattern we saw for Africa also applies to Kenya.

Domestic wheat production responds to prices, that imports of wheat adjusts to international prices. Production and consumption of substitute cereals also responds to changes in wheat prices and the final impact on total calorie intake per capita is very small. We hasten to add once again that such impact could be localized to specific groups and could be severe for them unless appropriate administrative measures are taken to protect the vulnerable groups when wheat prices rise.

Domestic selfsufficiency in wheat is feasible for Kenya to attain. It increases domestic agricultural production, improves income parity for the farmers, but of course marginally reduces average calorie intake. The adverse impact of selfsufficiency constraint on calorie intake is much larger when the policy is introduced. This indicates that such policy changes, if desired, should be gradually introduced.

Now we turn to examine a related aspect of these scenarios. How do these scenario results compare with the AEZ assessments?

The production range for wheat (as shown in Table 4.9) lies very well within the production potential of Kenya as calculated using the AEZ methodology and data base described in section 3. In Table 4.11 a summary of AEZ results together with projections from the AT2000 study is given.

Table 4.11. Rainfed Wheat Potential in Kenya

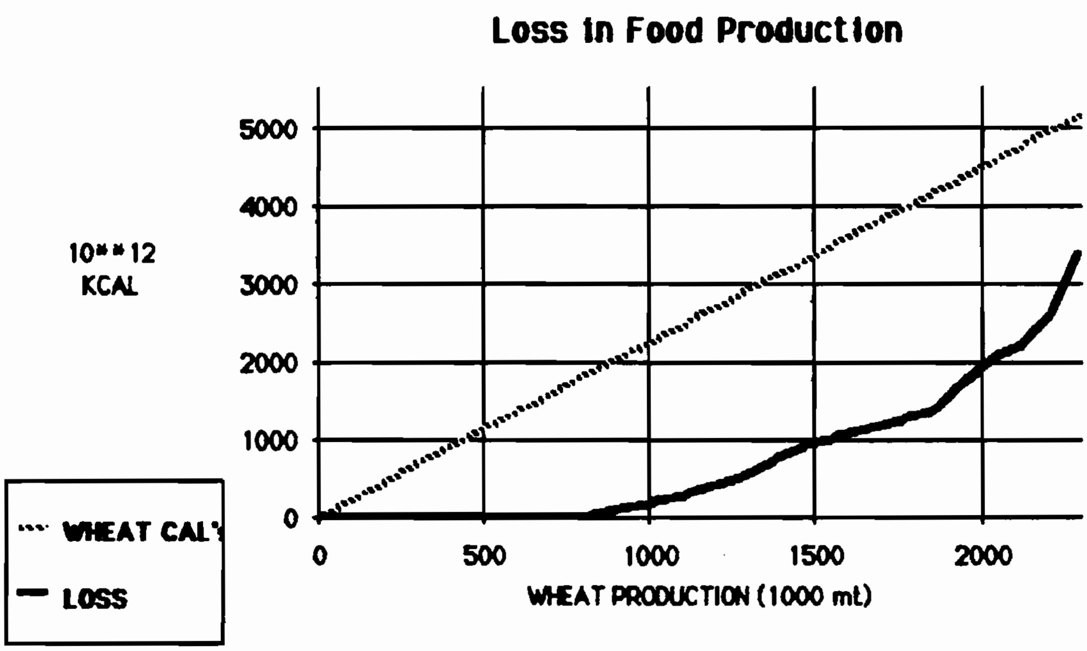
| SCENARIO | AREA 1000 ha | YIELD kg/ha | WHEAT 1000 mT | CEREALS 1000 mT |
|---|---|---|---|---|
| AEZ - LWW | 1110 | 747 | 829 | Low Tech.: Kenyan Wheat Potential |
| AEZ - LWC | 165 | 1067 | 176 | Low Tech.: maximizing food prod. |
| AEZ - IWW | 1107 | 2073 | 2295 | Intm.Tech.: Kenyan Wheat Potential |
| AEZ - IWC | 208 | 3091 | 643 | Intm.Tech.: maximizing food prod. |
| AEZ - IWR | 70 | 3000 | 210 | Intm.Tech.: maximizing revenue |
| AEZ - IWRH | 402 | 2353 | 946 | Intm.Tech.: max.rev.- high wheat price |
| AEZ - HWW | 1080 | 3224 | 3482 | High Tech.: Kenyan Wheat Potential |
| AEZ - HWC | 170 | 5082 | 864 | High Tech.: maximizing food prod. |
| AT2000 A | 339 | 2480 | 841 | High economic growth |
| AT2000 B | 214 | 1790 | 383 | Moderate economic growth |

In the presentation of AEZ results above a specific notation has been used. The first character (L, I, or H) of the scenario name refers to the technology level, i.e low, intermediate, or high level of inputs. The subsequent 'W' indicates that only land potentially suitable for wheat production has been taken into account in the calculations. The final character or sequence of characters identifies the mode of calculation. 'C' always refers to maximizing food production in terms of net calorie output. Character 'R' indicates maximization of net revenues. Letter 'H' in scenario IWRH is used to indicate that a high wheat price (twice compared to other scenarios) has been used in the calculations.

The results in Table 4.11 indicate that wheat production at about 25 % of the maximum potential in Kenya represents the optimum with respect to maximizing food production (21 % under low, 28 % under intermediate, and 25 % under high technology). Under revenue maximization the optimal wheat output is, of course, highly dependent on prices. As revenue maximization under the two wheat price scenarios shows, the economic optimum seems to be between

10 percent (9.2 % in IWR) and 40 percent (41.2 % in IWRH) of the potential wheat output. If the calculations are restricted to only cereal crops the optimal wheat production level under maximum food production increases to 990 thousand mT, i.e about 43 percent of the maximum potential of around 2.3 mill. mT. Alternative crops under this assumption would be maize (1.4 mill mT), barley (457 thousand mT), and sorghum (8 thousand mT). Thus, total cereal production under scenario IWCG would exceed 2.8 mill. mT compared to 2.3 mill. mT under wheat monocropping. For the high and low input levels only wheat output under maximum food production from potentially suitable wheat land is shown together with the ultimate potential as this measure is independent of prices. The economics of wheat production can best be presented by the charts in Fig. 4.6 and 4.7 showing the loss in calories as well as the implied revenue loss as a function of the level of wheat output under the intermediate technology level.

Fig 4.6



In Fig. 4.6 the dashed diagonal represents calories from wheat production. The bold graph underneath shows the implied loss in calorie production due to wheat monocropping compared to the optimal crop-mix (optimal with respect to net calorie production). The chart indicates that about 0.7 mill. mT of wheat could be produced at the intermediate input level without incurring any significant loss in net calorie production with respect to the optimal crop-mix. This production would require about 230 thousand ha of wheat land at an average yield of 3065 kg per ha. Above this production level and land use, maize, barley, beans, and white potatoes would be superior crops in terms of net calorie production on the remaining 880 thousand ha of land potentially suitable for wheat. It has to be noted that these results were obtained by bringing in land in a way so as to minimize the implied calorie loss. This procedure becomes especially meaningful assuming full utilization of all potential wheat land for crop production, a situation most likely for Kenya in the year 2000.

Fig 4.7

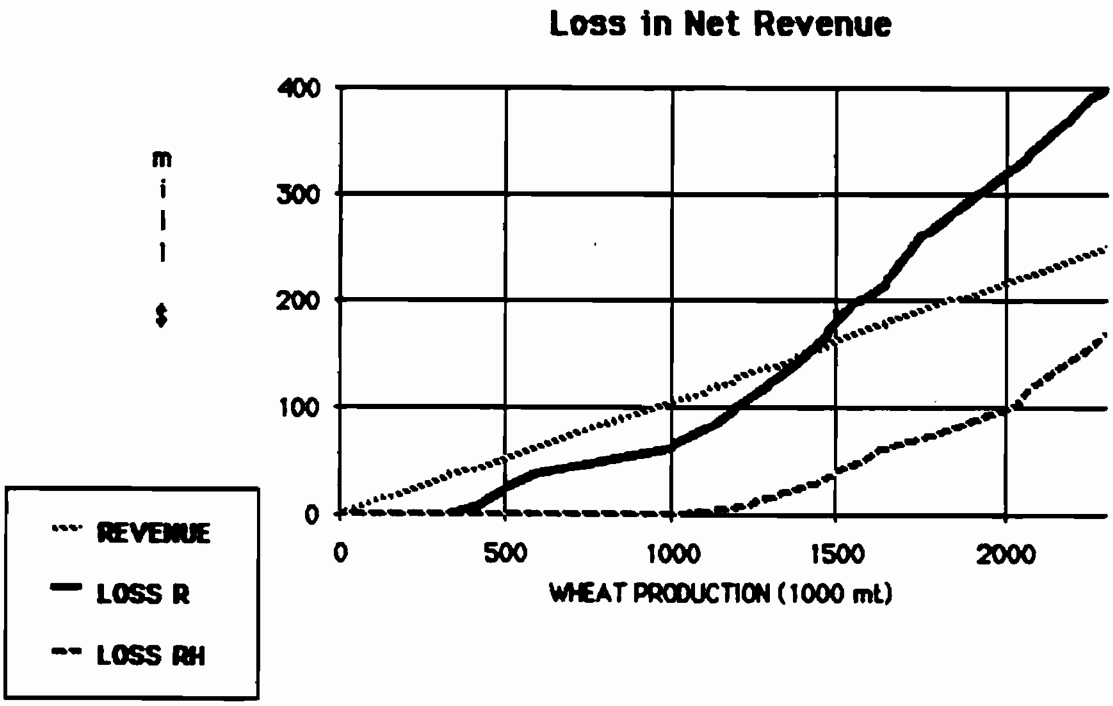
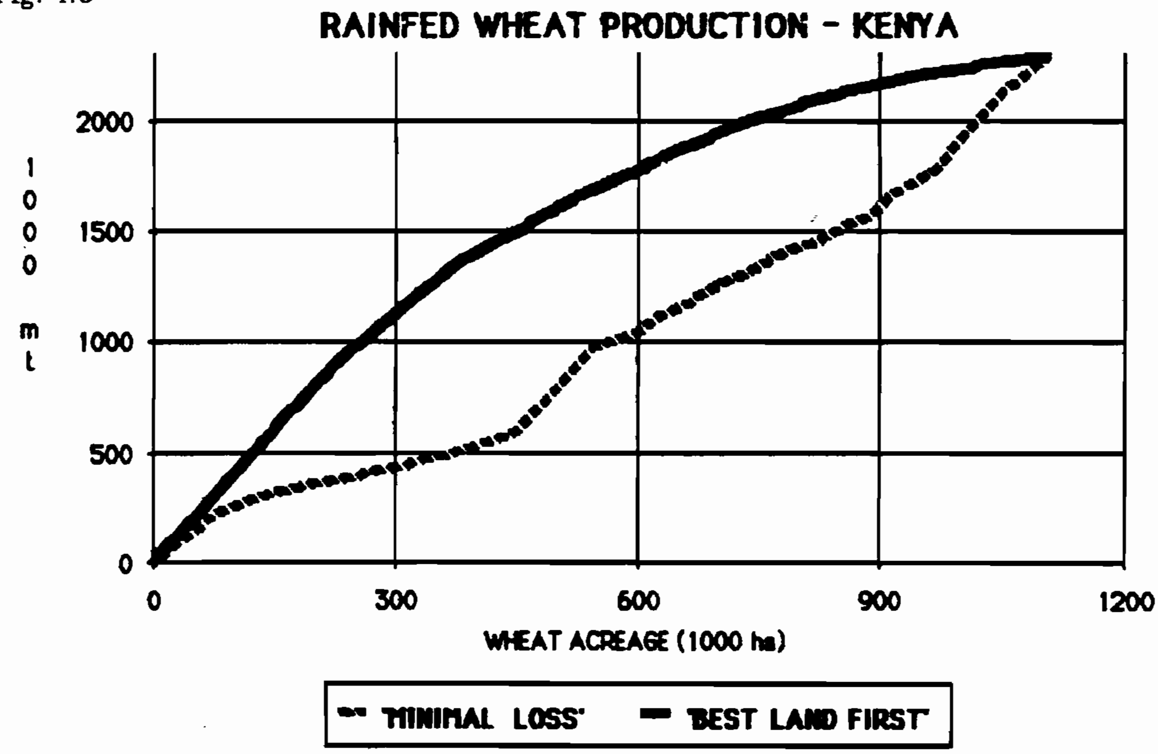


Fig 4.7 shows net revenue from wheat production as well as loss in net revenue due to monocropping of wheat compared to the optimal crop-mix (with respect to maximizing net revenue) as a function of wheat production. As discussed earlier the ultimate potential for rainfed wheat production under intermediate input levels in Kenya is about 2.3 mill. mT. Fig. 4.7 indicates that the encountered loss in net revenue due to producing wheat instead of the most profitable crop would equal the net revenue from wheat at an output level of about 1.4 mill. mT, whereas around 330 thousand mT could be produced with almost no reduction of the achieved revenue (the respective loss curve has been labeled 'LOSS R' in the above chart). This production would use around 145 thousand ha, i.e 13 percent of potentially suitable wheat land in Kenya. Doubling the wheat price would shift this economically producable wheat output level to about 1.0 mill. mT (labeled 'LOSS RH' in Fig. 4.7). Around 500 thousand ha, i.e. about 45 % of the land potentially suitable for rainfed wheat production in Kenya would then be required. We have to emphasize that the above observations result from bringing land into wheat production so as to minimize the incurred loss with respect to the optimal crop-mix. This way of allocating land markedly differs from bringing in best land (maximum net revenue per ha) first, a procedure which would be preferable only if the land potentially available for crop production is not fully utilized. Given the limited land resources for rainfed agriculture in Kenya the latter assumption would seem highly unrealistic. Fig. 4.8 compares wheat production under the 'minimal loss' and 'best land first' strategies. It seems worth noting that only the 'best land first' strategy results in a classical convex shaped production function. Similarly, no a priori statement can be made on the form of the aggregate yield function for wheat under 'minimal loss' allocation of land, whereas the 'best land first' strategy ensures a monotonically decreasing average yield.

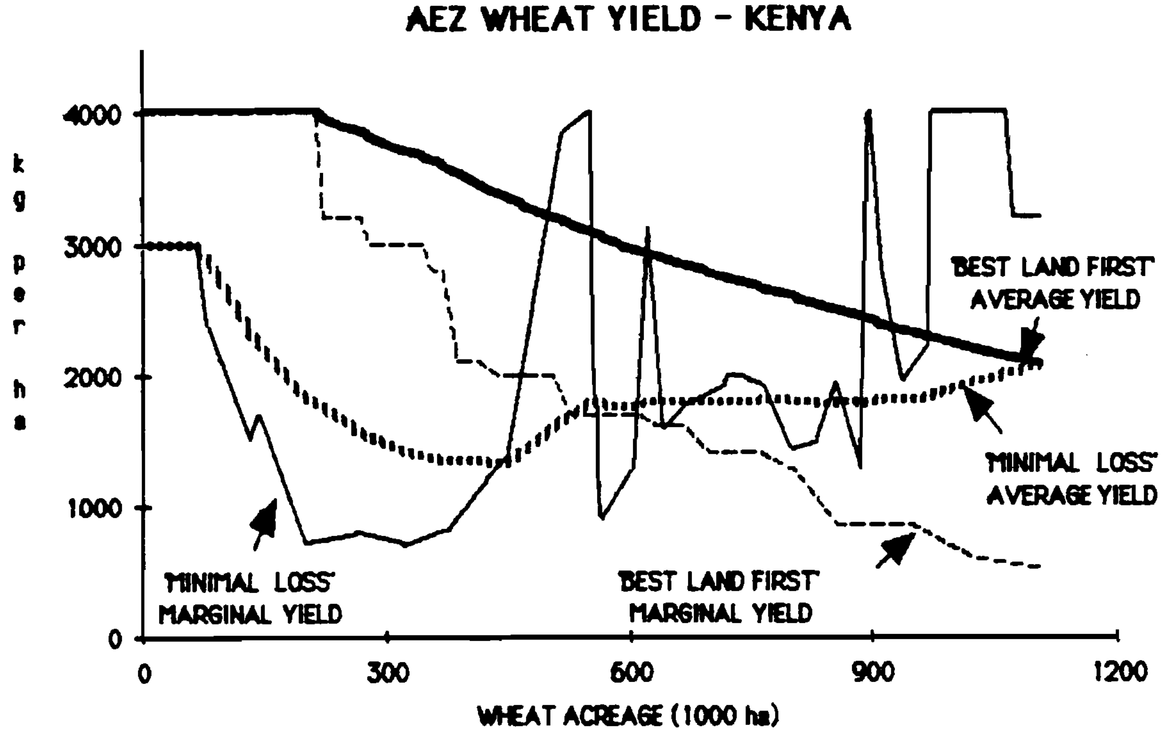
Fig. 4.8




In Fig.4.8 the full dark line indicates the AEZ wheat production function under rainfed conditions at intermediate level of inputs when best suitable land is used first. The dashed line denotes wheat production under the 'minimal loss' strategy explained above. The flat part of this latter curve implies that a sizeable extent of low productivity wheat land would be brought into production at an early stage whereas the high productivity land could still be retained for other competitive crops. This fact is very well illustrated in Fig. 4.9 showing the average and marginal yield for the two land use strategies. By marginal yield we denote the wheat yield in the last agro- ecological cell brought into production at the indicated land use level.

As mentioned earlier, both the average and marginal 'best land first' yield functions are monotonically decreasing. These curves do not depend on the suitability of the allocated land for other competitive crops. The 'minimal loss' variant, on the other hand, is only meaningful under crop competition.

Fig. 4.9

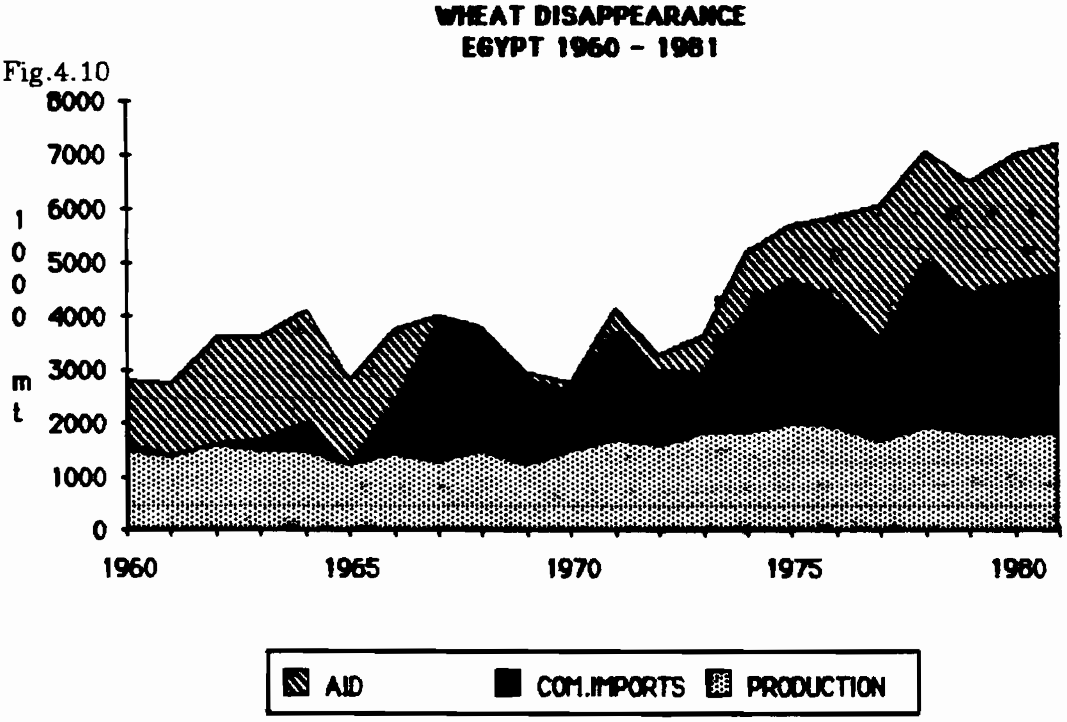



#### 4.4.4. EGYPT

Between 1970 and 1981 the Egyptian economy has on the average been growing annually by 8.1 %. For the same period the population growth was in the order of 2.5 % per year. For the last decade the wheat sector in Egypt shows stagnant production, heavy consumer price subsidies and, due to political reasons, massive increase in food aid. In the period 1969-1971 45 % of the domestic disappearance of wheat originated from production, 42 % from commercial imports and 13 % from food aid. In the late 1970's these percentages increased for imports and aid substantially. For the period 1978 - 1980 the sources of wheat disappearance were 21 % from production, 54 % commercial imports, and 25 % food aid. The dynamics of this transition is shown in Figure 4.10.

The decrease in wheat consumption between 1967 and 1973 reflects the effort of the Egyptian government to discourage wheat consumption as a consequence of the diversion of considerable resources to the military sector during

Fig.4.10




the Arab-Iraeli war periods, thus limiting foreign exchange reserves available for financing wheat imports. As the graph shows, wheat aid shipments (from the US) had been stopped at the same time.

The massive increase of wheat consumption and wheat imports after 1973 resulted from the rapid economic development improving per capita incomes, a significant decrease of real wheat price to consumers, and resumption of US wheat aid to Egypt. An attempt to reduce consumer price subsidies in 1977 caused serious riots, so that the government ended up subsidizing wheat prices even more.

As the BLS model used for Egypt has been estimated using time series data covering the period 1961 to 1976 the vast increase in imports and aid in the late 1970's is not captured. Nevertheless, the response to the various policy scenarios still highlights qualitative aspects of wheat policies and prices in Egypt. Before we turn to the policy scenarios a few selected results from the Reference Scenario are shown in Table 4.12 (indicators from the model simulation for the year 2000 obtained in the Reference Run have been presented in Table 4.2 and 4.3 earlier in this paper).

Table 4.12. Reference Scenario - EGYPT

| | POP 1000 | GDP mill.$70 | GDP/CAP $70 | CAL kcal/cap/day | Wheat PROD 1000mT | DEM 1000mT | IMPORT 1000mT | SSR % |
|---|---|---|---|---|---|---|---|---|
| 1970 | 33329 | 7196 | 216 | 2628 | 1519 | 3444 | 1074 | 44 |
| 1980 | 41209 | 12711 | 277 | 2810 | 2074 | 4640 | 2566 | 45 |
| 2000 | 61174 | 33430 | 491 | 3098 | 2464 | 7615 | 5148 | 32 |
| % Growth 1980-2000 | 2.0 | 5.0 | 2.9 | 0.49 | 0.9 | 2.5 | 3.5 | -2.0 |

Wheat production shows fairly slow increase to 2464 thousand metric tons in 2000, about 32 % of the projected consumption. Wheat imports reach 5148 thousand metric tons similar to 5199 thousand mT as projected by the AT2000 study (scenario B, moderate economic growth).

Following we present two tables comparing the simulation results for the various wheat price and aid scenarios. Table 4.13 shows percent differences of some key indicators for 1990 and Table 4.14 for the year 2000 relative to the Reference Run.

A comparison of absolute levels of production, demand and imports as obtained for the year 2000 is presented in Fig.4.11.

It is interesting to note that implementing an import quota for wheat at the 1985 level is likely to create a politically unacceptable tension by the year 2000. The BLS model estimates a reduction in average calorie intake of 2.3 percent compared to the Reference Scenario. The wheat price would rise by almost 70 percent. In the light of the 1977 food riots this policy alternative seems unlikely to be persued.

The AID 1 scenario, in which additional wheat aid is given without any policy changes, shows results similar to the reference scenario. Aid wheat displaces commercial imports of wheat, and production changes are negligible.

Table 4.13. Comparison of Simulation Results - EGYPT 1990

| | Percentage Difference compared to Reference Scenario* 1 9 9 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | VLP | LP | HP | VHP | QUTA | AID1 | AID2 | AID3 |
| PARITY | -2.9 | -1.3 | 3.8 | 8.8 | 2.5 | -1.9 | -3.7 | -3.3 |
| CAL/CAP | 0.6 | 0.2 | -0.4 | -0.9 | -0.6 | 0.2 | 1.2 | 1.1 |
| WHEAT/CAP | 1.7 | 0.8 | -1.2 | -2.4 | -1.0 | 0.2 | 2.6 | 2.4 |
| CEREALS/CAP | 0.6 | 0.3 | -0.5 | -2.1 | -0.4 | 0.1 | 1.2 | 1.0 |
| WHEAT | | | | | | | | |
| PRICE | -51 | -26 | 53 | 104 | 35 | 0 | -59 | -50 |
| PRODUCTION | -53 | -27 | 47 | 91 | 26 | -0.1 | -61 | -61 |
| IMPORTS | 54 | 25 | -40 | -74 | -25 | 0.4 | 58 | 57 |
| DEMAND | 10.7 | 3.6 | -3.6 | -5.5 | -2.6 | 0.3 | 8.0 | 7.8 |
| CEREAL | | | | | | | | |
| PRODUCTION | -11 | -5.7 | 4.4 | 6.9 | 3.5 | -0.1 | -13.8 | -13.8 |
| IMPORT | 39 | 18 | -14 | -22 | -12 | 0.5 | 52 | 49 |

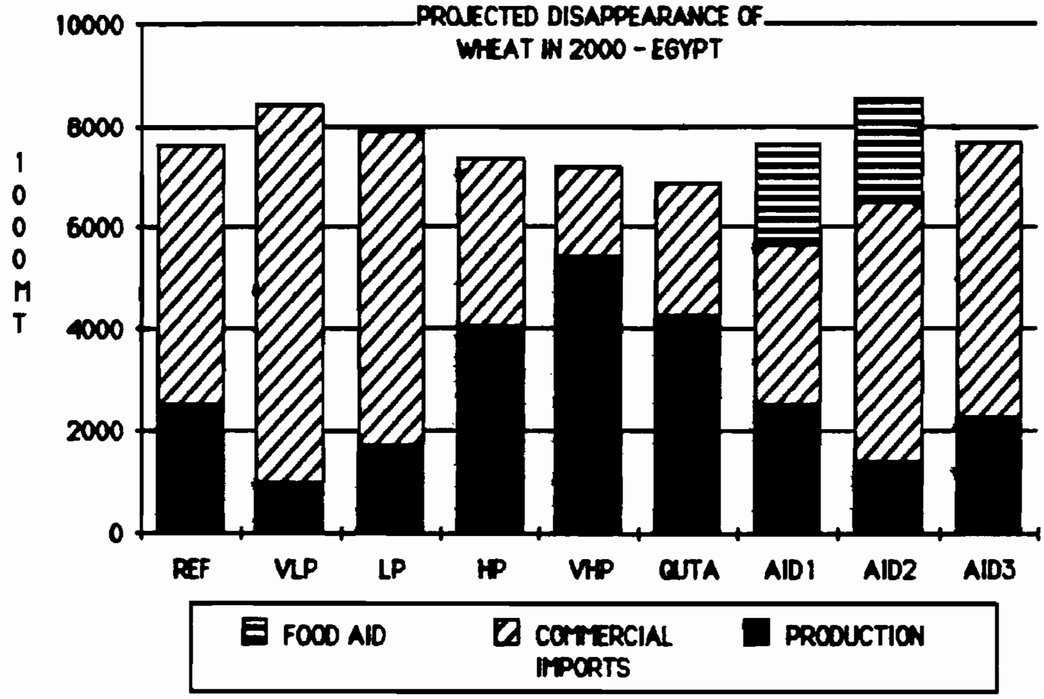
*A scenario description is given in Section 4.3.

Table 4.14. Comparison of Simulation Results - EGYPT 2000

| | Percentage Difference compared to Reference Scenario* 2 0 0 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | VL | L | H | VH | QUTA | AID1 | AID2 | AID3 |
| PARITY | -2.9 | -1.2 | 4.1 | 9.3 | 6.9 | -1.9 | -3.3 | -2.1 |
| CAL/CAP | 0.7 | 0.2 | -0.5 | -1.0 | -2.3 | 0.3 | 1.1 | 0.6 |
| WHEAT/CAP | 1.6 | 0.7 | -1.2 | -2.5 | -3.2 | 0.2 | 1.7 | 0.6 |
| CEREALS/CAP | 0.7 | 0.3 | -0.5 | -1.1 | -1.6 | 0.1 | 0.8 | 0.2 |
| WHEAT | | | | | | | | |
| PRICE | -52 | -27 | 54 | 110 | 68 | 0 | -28 | -5 |
| PRODUCTION | -61 | -32 | 64 | 119 | 72 | -0.2 | -45 | -10 |
| IMPORTS | 45 | 21 | -36 | -65 | -49 | 0.5 | 39 | 6 |
| DEMAND | 11 | 3.6 | -3.6 | -5.5 | -10.1 | 0.3 | 12 | 0.8 |
| CEREALS | | | | | | | | |
| PRODUCTION | -13 | -6.6 | 13 | 17 | 17.2 | -0.2 | -12 | -3.3 |
| IMPORTS | 30 | 14 | -24 | -32 | -34 | 0.6 | 32 | 6.6 |

*A scenario description is given in Section 4.3.

Fig.4.11




However, since commercial wheat imports are reduced, the released foreign exchange permits larger imports of other foods which in turn somewhat lowers their prices and production and reduces income parity by 1.9 percent.

Additional food aid at maintained commercial import levels (as observed in the Reference Scenario) would further increase food consumption in AID 2 by 1.2 percent. However, the agricultural sector would experience a deterioration of income parity (i.e. ratio of income per caput in agriculture over income per caput in the nonagricultural sector) of more than 3 percent and domestic producer prices and production will go down by 60% in 1990; in 2000 production is down by 45% and producer price by 28%. Thus this has a depressing effect on domestic agriculture.

In AID 3 additional wheat aid is given with a condition that commercial imports be maintained at the referece run levels as in AID 2, till 1980 and suddenly in 1990 additional wheat aid is withdrawn. Comparison of AID 3 with AID 2 and with the reference run shows how Egypt would be affected by such a shock of aid withdrawal and how it would adjust. Imports are adjusted, prices are raised to AID 2, consumption is lowered and the country is able to adjust. It may be noted that even when caorie intake goes down in AID 3 compared to AID 2 it does go up compared with the reference run.

By 2000, 10 years after the wheat aid withdrawal shock, domstic production has increased compared to AID 2 case but has still not reached the reference run level. As a consequence of the ten years of additional wheat aid over 1980-89, agricultural investments are lower in AID 3 compared to the reference run, thus even in 2000 agricultural production and incomes are lower.

Consumers on the other hand consume more caories in AID 3 even in 2000 than in the reference run as higher food imports are made possible due to higher output of nonagriculture which in turn was the result of the investment shift due to the additional aid over the 1980's. A sudden discontinuation of wheat aid combined with import restrictions to reflect difficulties of adjusting imports, as tried out in scenario AID 4, creates a wheat supply gap of about 3.5 mill.mT compared to the Reference Scenario in 1990, the year in which aid is suddenly withdrawn before any production adjustment can take place. As a consequence, the "equilibrium price" for wheat would reach more than 10 times the level of the base run. Such a price would not be allowed in the open market and one would expect rationing or riots. Thus, sudden withdrawal of high level of wheat aid coupled with the country's inability to adjust its imports (either for want of foreign exchange or for lack of alternative supplies in the world market) can leave the country in an extremely vulnerable position.

In the low and high world wheat price scenarios VLP to VHP relative price changes on the world marked are fully passed on to producers and consumers. Since the overall trade deficit as specified in the Reference Scenario has been maintained in all these price sensitivity runs, the impact on wheat imports and domestic production levels as well as on agricultural income is substantial. Consumers are much less affected because of substitution within agriculture. In the VHP scenario total land use increases by 8 percent with respect to the Reference Scenario. Similarly, increased fertilizer use results in 8.3 percent higher wheat yields by the year 2000.

In summary, the alternative scenarios for Egypt also show high elasticity of production (nearly equal to 1.20) and imports (-0.65 for price increase and -0.91 for price decrease) w.r.t. world price of wheat, Table 4.7. The elasticity of wheat demand is much smaller (-0.06 for price increase and -0.21 for price decrease).

- Wheat aid depresses domestic agricultural production and agricultural incomes. However, with the low food prices due to wheat aid, consumers are better off and the total calorie consumption improves. Thus, if appropriate compensation can be given to farmers for lost income, wheat aid is desirable for Egypt.
- Economically Egypt should be able to adjust to sudden withdrawal of wheat aid if it can adjust its trade patterns and is able to find alternative suppliers.
- However, the development path is altered because of wheat aid withdrawal and these effects last for some years even after wheat aid is withdrawn.

### 4.4.5 NIGERIA

The economic development in Nigeria, the third African country for which a national model exists in the FAP Basic Linked System, has been strongly influenced by the availability of oil for export and the prices for oil. The high oil prices on the world market allowed for generous development programs stimulating economic growth of 10 % and more per year after 1974. With oil prices falling this economic boom causing high inflation and resulting in social tensions, almost lead to a disaster in recent years (growth of GDP -5.6 % for 1980 - 1981). Table 4.15 gives average annual growth rates of GDP, food and cereal production for the period 1960 to 1982.

Table 4.15. Average annual growth - Selected Indicators

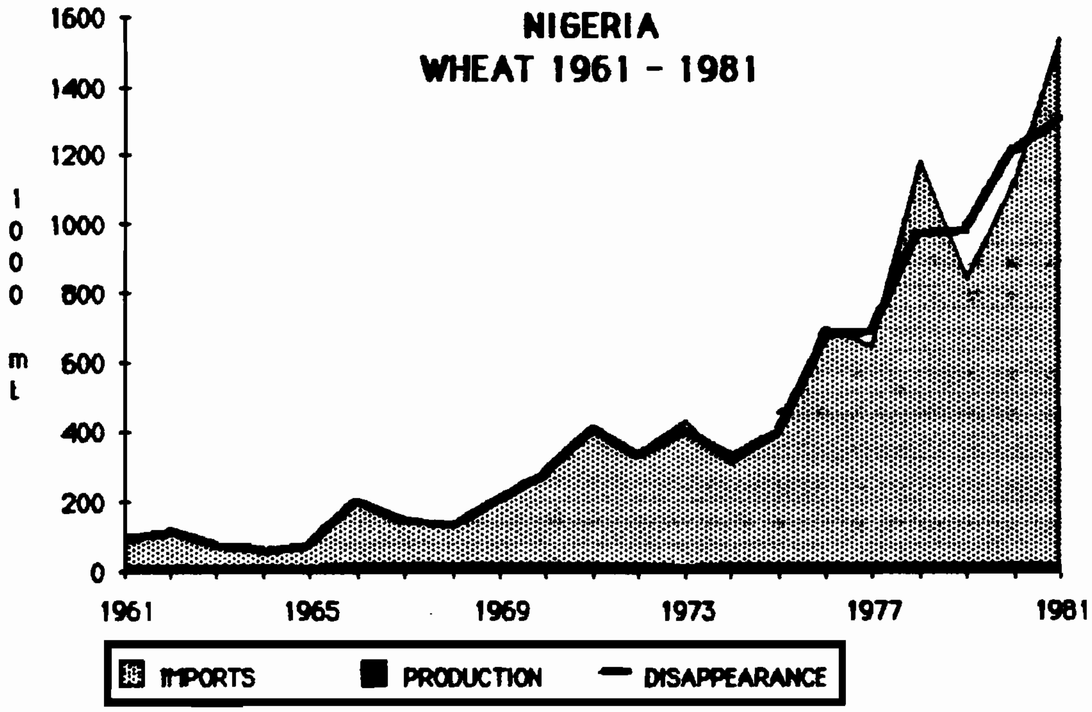
| Indicator | Period | % growth |
|---|---|---|
| GDP total economy | 1960 - 1970 : | 4.4 |
| | 1970 - 1974 : | 7.1 |
| | 1976 - 1979 : | 10.5 |
| | 1970 - 1980 : | 7.6 |
| | 1970 - 1981 : | 4.5 |
| FAO Production Index | | |
| Agriculture | 1971 - 1982 : | 2.6 |
| Food | 1971 - 1982 : | 2.6 |
| Cereals | 1971 - 1982 : | 3.8 |
| Food / cap | 1971 - 1982 : | -0.6 |
| Cereals / cap | 1971 - 1982 : | 0.6 |
| Population | 1970 - 1982 : | 3.2 |

As far as wheat is concerned, Nigeria is completely dependent on imports and therefore prices on the world market. Domestic production covers less than 2 % of wheat demand and the climatic conditions are generally not suitable for this crop. The ultimate potential for wheat production under rainfed conditions using high technology comes to 45 thousand metric tons. Under crop competition all the potentially suitable wheat land should, however, be used for production of maize and beans. Rapid urbanization and insufficient increase of domestic food production have stimulated fast growing wheat imports (18 percent per annum between 1966-68 and 1978-80). Even though the contribution of wheat to the average diet in Nigeria is still fairly low (5% of total caorie intake in 1978-

80), the share of wheat in total cereal consumption has changed from 2.6 percent in 1966 - 1968 to about 11 percent in 1978 - 1980. Food aid in wheat has been insignificant except for the period 1969 - 1971 (10.6 thousand mT in 1971).

The dynamics of wheat imports for the last two decades is shown in Figure 4.12.

Fig 4.12




As in the case of Egypt, the simulation model used for Nigeria underestimates the wheat imports in 1980. The demand level projected in the Reference Run for the year 2000 is about 15 % below the figures used in the AT2000 study (scenario B, moderate economic growth). Before we turn to the policy scenarios a few selected results from the Reference Scenario are shown in Table 4.16 (indicators from the model simulation for the year 2000 obtained in the Reference Run have been presented in Table 4.2 and 4.3 earlier in this paper).

As a consequence of the modest role of wheat in agricultural production, the price and availability of wheat only indirectly influence the agricultural

Table 4.16. Reference Scenario - NIGERIA

| | POP 1000 | GDP mill.$70 | GDP/CAP $70 | CAL kcal/cap/day | Wheat PROD 1000mT | Wheat DEM 1000mT | Wheat IMPORT 1000mT | Wheat SSR % |
|---|---|---|---|---|---|---|---|---|
| 1970 | 66088 | 8360 | 127 | 2006 | 19.0 | 286 | 267 | 7 |
| 1980 | 88817 | 19117 | 189 | 2266 | 22.5 | 606 | 584 | 3 |
| 2000 | 160413 | 51441 | 281 | 2544 | 25.7 | 2230 | 2204 | 1 |
| % Growth 1980-2000 | 3.0 | 5.0 | 2.0 | 0.58 | 0.7 | 6.7 | 6.9 | -5.7 |

incomes through price increases caused by increased demand for domestic food production in the case of reduced wheat imports. In Table 4.17 we present a comparison of the simulation results for the various wheat price and aid scenarios. The table shows percent differences of some key indicators for the year 2000 relative to the Reference Scenario. Interpreting the results one should not forget that the presentation of country averages does not show the probably strong impact on urban consumers largely relying on imported wheat.

As was to be expected, Nigeria would profit from lower wheat prices on the world market and, of course, from food aid in addition to keeping the level of commercial imports high. Similarly, a forced reduction of wheat imports to 1980 levels (QUTA scenario) of about 1 million tons would create a calorie gap equivalent to the basic requirements of 3.7 million people in Nigeria and would therefore probably create political instability (which is also indicated by the extremely high equilibrium price of wheat). The induced pressure on domestic food production would, however, slightly improve the incomes in the rural areas. The results of scenario AID1 indicate that wheat aid to Nigeria without accompanying policy measures would not affect the economic or nutritional situation significantly. Results from scenarios AID3 and AID4 did not substantially differ from the Reference Scenario because of the very limited role of

Table 4.17. Comparison of Simulation Results - NIGERIA 2000

| | Percentage Difference compared to Reference Scenario* 2000 | | | | | | |
|---|---|---|---|---|---|---|---|
| | VLP | LP | HP | VHP | QUTA | AID1 | AID2 |
| PARITY | -0.2 | -0.1 | 0.2 | 0.3 | 0.2 | -0.1 | -0.2 |
| CAL/CAP | 0.4 | 0.2 | -0.3 | -0.5 | -2.1 | 0.05 | 1.5 |
| WHEAT/CAP | 15.2 | 6.4 | -10.4 | -18.4 | -57.4 | 0.10 | 45. |
| CEREALS/CAP | 1.5 | 0.7 | -1.1 | -1.9 | -6.8 | -0.1 | 5.0 |
| WHEAT | | | | | | | |
| PRICE | -50 | -25 | 50 | 100 | > 2000 | 0 | -45 |
| PRODUCTION | -30 | -14 | 21 | 38 | 85 | 0 | -21 |
| IMPORTS | 22 | 9 | -12 | -21 | -55 | 0 | 45 |
| DEMAND | 21 | 9 | -12 | -20 | -53 | < 1 | 63 |
| CEREALS | | | | | | | |
| PRODUCTION | -0.4 | -0.2 | 0.2 | 0.4 | 0.1 | -0.1 | -0.5 |
| IMPORT | 5.9 | 2.5 | -3.4 | -5.6 | -18 | -0.1 | 19 |

*A scenario description is given in Section 4.3.

wheat in the Nigerian agriculture. Absolute levels of production, demand and imports as obtained for the year 2000 are shown in Table 4.18.

Table 4.18. Projected WHEAT Production, Demand and Imports in 2000

| 1000 mT | REF | VLP | LP | HP | VHP | QUTA | AID1 | AID2 |
|---|---|---|---|---|---|---|---|---|
| Production | 25.7 | 18.1 | 22.2 | 31.1 | 35.5 | 47.5 | 25.7 | 20.3 |
| Demand | 2230 | 2696 | 2422 | 1968 | 1787 | 1048 | 2230 | 3224 |
| Com.Imports | 2204 | 2678 | 2400 | 1937 | 1752 | 1000 | 1204 | 2204 |
| Aid | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 |

### 4.4.6. Regional Groups

Before discussing the results for the African regional models included in FAP's Basic Linked System it should be pointed out again that the regional groups have been formed mainly on the basis of economic considerations rather than geographical or political similarities. It should also be noted that it was necessary to keep the number of regional aggregates in the BLS as small as possible to minimize the computational burden. Apart from the more than twenty country models built for the BLS, fourteen regional groups have been formed out of which five cover most of the African countries. As the regional models were built on the basis of Scenario B (moderate economic growth) of FAO's AT2000 study the country coverage had to be limited to the countries dealt with in that study. The economic criteria for grouping were the income level and the level of selfsufficiency in food production; these two aspects are considered to be essential for a world model stressing international trade in agricultural commodities. As wheat is only one of the ten sectors modelled within the BLS, the chosen country grouping is not always ideal with respect to the emphasis of this present study. This point is especially valid for the group 'African Oil Exporters' (AFRICA 1) and the 'Medium Income Food Importers' (AFRICA 3) where both the potential for wheat production and the observed wheat consumption levels vary widely. In the following, the BLS results for each of the African regional groups are discussed separately.

It should be emphasized that the regional models are much simpler than the country models. Whereas the domestic production in the national models is determined as an outcome of a factor and input allocation procedure, in the regional models production responds around the AT2000 scenario B levels to relative prices by prescribed supply elasticities.

#### 4.4.6.1. African Oil Exporters (AFR 1)

This aggregate combines Algeria, Angola, Congo, Gabon and Libya. The common feature of the countries in this group is their ability to export oil and thus earn foreign currency. Except for Angola where agriculture still contributes almost half of GDP, the share of agriculture in gross domestic product is generally below ten percent. A few selected indicators for the African Oil Exporters are given in Table 4.19.

Table 4.19. African Oil Exporters - Selected Indicators

| Country | 1980 Population Million | 1979 GNP/CAP $1979 | W H E A T (78-80 average) PROD 1000mT | NET IMP. 1000mT | CONS/CAP kg/cap | % CAL |
|---|---|---|---|---|---|---|
| Algeria | 18.9 | 1590 | 1204 | 2012 | 135 | 52 |
| Angola | 7.1 | 440 | 10 | 6 | 11 | 5 |
| Congo | 1.5 | 630 | 0 | 53 | 35 | 6 |
| Gabon | 0.5 | 3280 | 0 | 18 | 47 | 7 |
| Libya | 3.0 | 8170 | 117 | 453 | 131 | 35 |
| AFRICA 1 | 31.0 | 1944 | 1331 | 2613 | 100 | 37 |

Wheat plays an important role in the diet of the two North African countries, Algeria and Libya, where more than one third of the daily calorie intake is in form of wheat and the average yearly consumption for the period 1978 - 1980 exceeded 130 kg per caput. Because of the large weight of Algeria in this group, wheat consumption of the region as a whole for this period averages 100 kg per caput, even though it is clear from the above table that wheat is much less important in the three Subsahara oil exporting countries.

A few indicators describing the behaviour of this country group in the BLS Reference Scenario have been presented in Table 4.2 in section 4.4.1 earlier in this paper. In the Reference Scenario wheat production reaches a level of 2.1 mill. mT and imports come to 5.9 mill. mT, i.e the selfsufficiency in wheat is projected to fall from roughly one third in 1978-1980 to one fourth in 2000. It is, however, worth noting that the potential for rainfed wheat production under intermediate technology is 12.9 mill. mT out of which 7.8 mill. mT represent the economically optimal potential at 1975 world prices. If wheat price were to double (i.e twice the 1975 level), potential wheat production under revenue maximization would reach 10.9 mill. mT which would significantly exceed the demand of 8 mill. mT projected for the year 2000 in the Reference Scenario. Out of this some 82 percent, i.e about 9 mill.mT, would be produced in Algeria. A comparison of the projected production levels and the rainfed production potential under various assumptions is presented in Table 4.20.

Table 4.20. Projected and Potential Wheat Production of African Oil Exporters in the year 2000

| | Acreage 1000 ha | Yield kg/ha | Production 1000 mT | Remarks |
|---|---|---|---|---|
| **AT2000** | | | | |
| Scenario A | 3103 | 1074 | 3332 | High economic growth |
| Scenario B | 2763 | 814 | 2250 | Moderate economic growth |
| **Basic Linked System*** | | | | |
| REF | 2723 | 767 | 2090 | Reference Scenario |
| VLP | 2444 | 493 | 1205 | Very low wheat price |
| LP | 2603 | 638 | 1660 | Low wheat price |
| HP | 2913 | 1010 | 2943 | High wheat price |
| VHP | 3051 | 1221 | 3727 | Very high wheat price |
| **AEZ Potential** | | | | |
| IWW | 8613 | 1502 | 12939 | Intm.Tech.: Wheat Potential |
| IWC | 2977 | 2179 | 6488 | Intm.Tech.: maximizing food production |
| IWR | 3453 | 2268 | 7831 | Intm.Tech.: maximizing revenue |
| IWRH | 6636 | 1638 | 10871 | Intm.Tech.: max.rev. - high wheat price |

*A description of the BLS price scenarios can be found in Section 4.3.

In the period 1978-1980 this group of oil exporting countries produced about 1.3 mill. mT of wheat per year harvesting around 2.2 mill ha at an average yield of 600 kg per ha. Substantial production increases could therefore be feasible by improving on the fairly low yields and - to lesser extent - by cultivation of more land. Inspite of the high potential for wheat production in this group as a whole, wheat demand in the Subsahara countries Angola, Congo and Gabon will mainly have to be satisfied by wheat imports. Table 4.21 presents the rainfed wheat potential by country at intermediate level of inputs. For the Subsahara countries rainfed wheat production is either impossible or unprofitable at prices of 1975.

Table 4.21. Rainfed Wheat Potential of African Oil Exporters in the year 2000

| Country | Acreage 1000 ha | | | | | Production 1000 mT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IWW | IWC | IWR | IWRH | AT2000 | IWW | IWC | IWR | IWRH | AT2000 |
| Algeria | 4877 | 2569 | 3138 | 4877 | 2525 | 8952 | 6117 | 7364 | 8952 | 1994 |
| Angola | 3081 | 198 | 0 | 1112 | 11 | 3292 | 151 | 0 | 1225 | 12 |
| Congo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gabon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Libya | 655 | 210 | 315 | 647 | 151 | 695 | 220 | 467 | 694 | 51 |

### 4.4.6.2. Medium Income Food Exporters (AFR 2)

The second African aggregate region modeled in the Basic Linked System covers a few of the 'better off' countries which have been net calorie exporters in the past. The region includes Cameroon, Ghana, Ivory Coast, Mauritius, Senegal, and Zimbabwe. Table 4.22 presents a few indicators relevant in our context.

Table 4.22. Medium Income Food Exporters - Selected Indicators

| Country | 1980 Population Million | 1979 GNP/CAP $1979 | W H E A T (78-80 average) PROD 1000mT | NET IMP. 1000mT | CONS/CAP kg/cap | % CAL |
|---|---|---|---|---|---|---|
| Cameroon | 8.4 | 560 | 1 | 97 | 10 | 4 |
| Ghana | 11.7 | 400 | 0 | 152 | 11 | 5 |
| Ivory Coast | 8.0 | 1040 | 0 | 153 | 18 | 6 |
| Mauritius | 1.0 | 1030 | 0 | 58 | 59 | 20 |
| Senegal | 5.7 | 430 | 0 | 98 | 19 | 8 |
| Zimbabwe | 7.4 | 470 | 176 | -5 | 18 | 9 |
| AFRICA 2 | 42.2 | 584 | 177 | 554 | 16 | 6 |

Except for Zimbabwe and Mauritius these countries form a fairly homogenous group. They have practically no potential for rainfed wheat production. Wheat production in Zimbabwe is all irrigated. The contribution of wheat to the daily calorie intake exceeds 10 percent only in Mauritius, with an upward trend, however, in all countries. Due to the lack of wheat production potential in most of these countries, the net imports of wheat (excluding Zimbabwe) have, on the average, grown by 7 percent annually during the period 1966-68 to 1978-80. In the BLS Reference Scenario wheat imports are projected to reach a level of 1.5 mill. mT in 2000, almost three times the 1978 - 1980 average. Under the very low and very high world price scenarios, VLP and VHP, wheat imports amount to 1.8 and 1.2 mill. mT respectively. Under VLP the increased imports would improve the average calorie intake by 0.9 percent with respect to the Reference Scenario, i.e an amount equivalent to the basic calorie requirements of about 0.8 million people. Similarly, doubling the wheat price would reduce the calorie intake by about 0.7 percent.

#### 4.4.6.3. Medium Income Food Importers (AFR 3)

The countries subsumed in this regional model differ a lot in both consumption and production of wheat. Wheat consumption in Morocco and Tunisia was 129 and 157 kg of wheat per caput per year in 1978 - 1980 compared to an average of less than 20 kg per caput in the three Subsahara countries included in this group. Before discussing projected and potential wheat supply and demand a few selected indicators for 1978 - 1980 are presented in Table 4.23.

Table 4.23. Medium Income Food Importers - Selected Indicators

| Country | 1980 Population Million | 1979 GNP/CAP $1979 | W H E A T (78-80 average) PROD 1000mT | NET IMP. 1000mT | CONS/CAP kg/cap | % CAL |
|---|---|---|---|---|---|---|
| Liberia | 2.0 | 500 | 0 | 16 | 8 | 3 |
| Mauritania | 1.6 | 320 | 1 | 55 | 31 | 14 |
| Morocco | 20.3 | 740 | 1824 | 1650 | 129 | 45 |
| Tunisia | 6.4 | 1120 | 756 | 590 | 157 | 52 |
| Zambia | 5.8 | 500 | 6 | 121 | 21 | 10 |
| AFRICA 3 | 36.1 | 737 | 2587 | 2432 | 106 | 37 |

For the group as a whole, selfsufficiency in wheat for the period 1978 to 1980 was just over 50 percent ranging from 0 in Liberia to 56 percent in Tunisia. Because of the vast climatic differences, potentials for rainfed wheat production in these countries vary accordingly, as shown in Table 4.24.

Table 4.24. Rainfed Wheat Potential - Mid Income Food Imp.

| Country | Acreage 1000 ha | | | | | Production 1000 mT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IWW | IWC | IWR | IWRH | AT2000 | IWW | IWC | IWR | IWRH | AT2000 |
| Liberia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maurit. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Morocco | 4018 | 1762 | 2638 | 4018 | 1764 | 6504 | 3362 | 5124 | 6504 | 2131 |
| Tunisia | 1089 | 823 | 918 | 1065 | 996 | 1780 | 1420 | 1618 | 1774 | 1677 |
| Zambia | 567 | 3 | 0 | 126 | 0 | 1178 | 7 | 0 | 131 | 0 |

In 1978-1980 the average acreage under wheat was 0.9 mill. ha in Tunisia and 1.7 mill. ha in Morocco. Average yields for that period were 815 and 1077 kg/ha respectively. Again, most of the production increases will have to come from improving yields. Table 4.25 presents some of the simulation results and AEZ production potentials for the year 2000.

In the BLS Reference Scenario projected disappearance of wheat in the year 2000 reaches 7.9 mill.mT resulting in a 54 percent selfsufficiency in wheat. The above table also shows that an extreme price incentive - like doubling the international price of wheat - could even under purely economic considerations lead to selfsufficiency in wheat in Morocco and Tunisia. Because of the high share of wheat in the diet of these countries, a doubling of the wheat price would, however, reduce the average projected calorie intake of nearly 2900 kcal/cap/day by about 1.5 percent, an amount which would be equivalent to the minimum energy requirements of about 1.1 mill. people. A food rather than profit oriented strategy could still produce about 4.8 mill. mT of wheat, i.e

Table 4.25. Projected and Potential Wheat Production of Medium Income Food Importers in Year 2000

| | Acreage 1000 ha | Yield kg/ha | Production 1000mT | Remarks |
|---|---|---|---|---|
| **AT2000** | | | | |
| Scenario A | 3059 | 1713 | 5241 | High economic growth |
| Scenario B | 2997 | 1527 | 4576 | Moderate economic growth |
| **Basic Linked System** | | | | |
| REF | 2963 | 1434 | 4249 | Reference Scenario |
| VLP | 2751 | 957 | 2633 | Very low wheat price |
| LP | 2871 | 1209 | 3471 | Low wheat price |
| HP | 3108 | 1863 | 5790 | High wheat price |
| VHP | 3230 | 2297 | 7421 | Very high wheat price |
| **AEZ Potential** | | | | |
| IWW | 5674 | 1668 | 9462 | Intm.Tech.: Wheat Potential |
| IWC | 2588 | 1850 | 4789 | Intm.Tech.: maximizing food production |
| IWR | 3556 | 1896 | 5697 | Intm.Tech.: maximizing revenue |
| IWRH | 5209 | 1614 | 8409 | Intm.Tech.: max.rev. - high wheat price |

around 70 percent of the BLS Reference demand in the year 2000.

#### 4.4.6.4. Low Income Food Exporters (AFR 4)

As in the case of medium income countries, the poorest nations in Africa have also been grouped into two categories, net food exporters dealt with in this section, and net food importers described later in section 4.4.6.5. Countries classified as low income food exporters include Benin, Ethiopia, Gambia, Malawi, Mozambique, Sudan, Togo, and Uganda. It should be noted that the food selfsufficiency of Ethiopia has become substantially worse since 1975 which has turned Ethiopia into a net importer. Even though widely spread on the African continent, the country profiles with respect to economic performance and importance of wheat are comparable enough to be meaningful in this study. Some relevant indicators as used for the other African groups above are given in Table 4.26.

In 1978-1980, three countries, Ethiopia, Sudan, and Uganda covered more

Table 4.26. Low Income Food Exporters - Selected Indicators

| Country | 1980 Population Million | 1979 GNP/CAP $1979 | W H E A T (78-80 average) PROD 1000mT | NET IMP. 1000mT | CONS/CAP kg/cap | % CAL |
|---|---|---|---|---|---|---|
| Benin | 3.5 | 250 | 0 | 28 | 8 | 3 |
| Ethiopia | 31.5 | 130 | 449 | 263 | 19 | 10 |
| Gambia | 0.6 | 250 | 0 | 6 | 10 | 4 |
| Malawi | 6.2 | 200 | 1 | 8 | 1 | 1 |
| Mozambique | 10.5 | 250 | 3 | 133 | 11 | 5 |
| Sudan | 18.4 | 370 | 271 | 282 | 26 | 10 |
| Togo | 2.6 | 350 | 0 | 25 | 8 | 4 |
| Uganda | 13.2 | 290 | 15 | 0 | 1 | 1 |
| AFRICA 4 | 86.5 | 237 | 739 | 745 | 15 | 7 |

than 70 percent of population and more than 99 percent of wheat production in this aggregate group. Income levels varied between 130 dollars per caput in Ethiopia to 370 dollars per caput in Sudan. In none of the low income food exporting countries the share of wheat in total calorie intake has exceeded 10 percent. Average annual wheat aid given to the countries in this group amounted to 246 thousand mT in 1978-80, i.e one third of average annual total net wheat imports during that period. Turning to the potential for wheat production under rainfed conditions, Ethiopia accounts for more than 95 percent of land potentially suitable for wheat production in this group. At first glance this production level seems very high compared to the 1978 - 1980 production of less than 0.45 mill mT tons. It turns out that, unlike the North African countries where the economic optimum is more than 80 percent of the potential rainfed wheat production under intermediate level of inputs, the optimal wheat production in Ethiopia under revenue maximization at 1975 prices comes to only 2.4 mill. mT, i.e about 15 percent of total potential rainfed wheat production in Ethiopia. In none of the other countries in this region, rainfed wheat production is feasible under economic competition. Regional results on potential as well as projected wheat production for the year 2000 are presented in

Table 4.27.

Table 4.27. Projected and Potential Wheat Production of Low Income Food Exporters in the year 2000

| | Acreage 1000 ha | Yield kg/ha | Production 1000mT | Remarks |
|---|---|---|---|---|
| **AT2000** | | | | |
| Scenario A | 2382 | 1747 | 4162 | High economic growth |
| Scenario B | 1636 | 1381 | 2260 | Moderate economic growth |
| **Basic Linked System** | | | | |
| REF | 1570 | 1351 | 2121 | Reference Scenario |
| VLP | 1254 | 1198 | 1502 | Very low wheat price |
| LP | 1366 | 1234 | 1637 | Low wheat price |
| HP | 1820 | 1463 | 2663 | High wheat price |
| VHP | 2070 | 1568 | 3246 | Very high wheat price |
| **AEZ Potential** | | | | |
| IWW | 8915 | 1828 | 16301 | Intm.Tech.: Wheat Potential |
| IWC | 1904 | 2018 | 3842 | Intm.Tech.: maximizing food production |
| IWR | 819 | 2965 | 2428 | Intm.Tech.: maximizing revenue |
| IWRH | 4809 | 1695 | 8151 | Intm.Tech.: max.rev. - high wheat price |

It should be noted that around 40 percent of the wheat production shown in the AT2000 Scenario B come from irrigated production mainly in Sudan and Mozambique. Rainfed wheat production as projected in AT2000 amounts to 1.4 mill. mT in Scenario B (moderate economic growth) and 2.8 mill mT in Scenario A (high economic growth). As a result of the unfavorable climatic conditions for wheat production in most of these countries, wheat imports in the year 2000 reach 1.8 mill. mT in the BLS Reference Scenario compared to 0.75 mill. mT in 1978 - 1980. The VLP and VHP low and high price scenarios emphasize the sensitivity of wheat imports with respect to the level of the world market price for wheat. The extreme price levels result in 2.8 and 0.4 mill. mT of wheat imports respectively in 2000. Projected disappearance of wheat varies between 3.7 mill. mT under the VHP (doubling wheat price) to 4.3 mill. mT under VLP (wheat price half compared to BLS Reference Scenario). The implied effect on the average per caput calorie intake would be -0.7 percent at high price (equivalent to minimum calorie requirements of 1.1 mill. people) and +0.9 percent (i.e food for 1.5 mill. people) at the very low wheat price, reflecting the small share of wheat in total cereal consumption.

#### 4.4.6.5. Low Income Food Importers (AFR 5)

The fifth African regional group used in FAP's Basic Linked System combines most of the poorest African countries which have been net calorie importers in the past. Table 4.28 shows a set of relevant indicators for these low income countries.

Table 4.28. Low Income Food Importers - Selected Indicators

| Country | 1980 Population Million | 1979 GNP/CAP $1979 | W H E A T (78-80 average) PROD 1000mT | NET IMP. 1000mT | CONS/CAP kg/cap | % CAL | 71-82 FOOD/CAP % change |
|---|---|---|---|---|---|---|---|
| Burundi | 4.2 | 180 | 3 | 12 | 3 | 1 | -2.6 |
| C.Afr.Emp. | 2.3 | 290 | 0 | 9 | 4 | 2 | -1.4 |
| Chad | 4.5 | 110 | 6 | 12 | 4 | 2 | -2.4 |
| Guinea | 5.0 | 280 | 0 | 30 | 6 | 3 | -10.7 |
| Madagascar | 8.7 | 290 | 1 | 47 | 6 | 2 | -9.7 |
| Mali | 6.9 | 140 | 2 | 20 | 3 | 2 | -8.4 |
| Niger | 5.3 | 270 | 2 | 20 | 4 | 2 | -2.9 |
| Rwanda | 4.8 | 200 | 3 | 7 | 2 | 1 | 0.5 |
| Sierra Leone | 3.5 | 250 | 0 | 25 | 7 | 3 | -12.8 |
| Somalia | 4.6 | 230 | 1 | 67 | 18 | 8 | -36.6 |
| Tanzania | 17.9 | 260 | 72 | 49 | 7 | 3 | -9.8 |
| Upper Volta | 6.9 | 180 | 0 | 32 | 4 | 2 | 0.5 |
| Zaire | 28.3 | 280 | 5 | 138 | 4 | 2 | -11.4 |
| AFRICA 5 | 102.9 | 242 | 94 | 468 | 5 | 2 | -9.1 |

As the penultimate column of Table 4.28 shows, the average share of wheat in the daily calorie intake for the group as a whole is 2 percent with a maximum of 8 percent in Somalia. Apart from this fairly minor role of wheat as a staple food in these low income African countries, wheat has become increasingly important in closing calorie gaps caused by droughts and political instability in the recent past. In the period 1978-80 out of the total of 468 thousand mT net imports of wheat 206 thousand mT, i.e about 45 percent, were given as wheat aid to members of this country group. 104 thousand mT, more than half of total wheat aid to the aggregate group, were shipped to Somalia and Tanzania. The last column of Table 4.27 presenting the percent change in the FAO index of food production per caput between 1971 to 1982 shows that in most of the poor African countries treated in this group, population growth exceeded the increases in food production during the last decade. In the BLS Reference Scenario the food situation improves only slightly until the year 2000. Between 1980 and 2000 the average per caput calorie intake is projected to increase by a total of only 8 percent, wheat demand would reach 1525 thousand mT, i.e more than 2.5 times the level in 1980, out of which 1.1 mill. mT would be covered from imports. In 1978-80 almost 80 percent of total wheat output in this country group has been produced in Tanzania, a situation which is projected to persist up to 2000. It is worth noting that Tanzania is the only country in this group with an economically feasible potential for wheat production. Table 4.29 shows the wheat potential compared to the AT2000 projection under moderate economic growth for the year 2000.

As mentioned earlier, out of this country group only Tanzania has a potential for rainfed wheat production. 122 thousand ha, which is roughly eight percent of the total land potentially suitable for wheat production in Tanzania, could produce some 365 thousand mT of wheat (under intermediate level of inputs), about five times the 1978-80 observed production level. Under the hypothetical yet unlikely assumption of doubling the price of wheat relative to other crops, 483 thousand ha (i.e one third of total suitable wheat land) could produce 952 thousand mT of wheat, almost twice the projected disappearance of wheat in the year 2000 (AT2000 Scenario B). As a probably more realistic projec-

Table 4.29. Rainfed Wheat Potential - Low Income Food Imp.

| Country | Acreage 1000 ha | | | | | Production 1000 mT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IWW | IWC | IWR | IWRH | AT2000 | IWW | IWC | IWR | IWRH | AT2000 |
| Burundi | 514 | 12 | 0 | 28 | 9 | 621 | 23 | 0 | 42 | 9 |
| C.Afr.Emp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Guinea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Madagas. | 373 | 24 | 0 | 99 | 0 | 622 | 39 | 0 | 162 | 0 |
| Mali | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Niger | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rwanda | 252 | 13 | 0 | 42 | 8 | 237 | 21 | 0 | 63 | 14 |
| Sier.Leone | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| Somalia | 20 | 0 | 0 | 12 | 4 | 26 | 0 | 0 | 17 | 2 |
| Tanzania | 1454 | 139 | 122 | 483 | 233 | 2845 | 396 | 365 | 952 | 343 |
| Upp.Volta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Zaire | 716 | 29 | 0 | 195 | 9 | 533 | 19 | 0 | 222 | 6 |

tion - relative wheat price is slightly falling - the FAP Basic Linked System estimates average per caput consumption of wheat for the 'Low Income Food Importers' to remain well under 10 kg/cap (8.3 kg/cap in BLS Reference Scenario) in the year 2000 which would still provide only a very small fraction (about 3.2 percent) of the total calorie intake. Thus wheat imports and wheat aid will most likely continue to be important only in filling calorie gaps in case of failures of the domestic food production.

#### 4.4.6.6. Remarks on Country Groups

Interpreting the results of Sections 4.4.6.1. to 4.4.6.5., it should be noted that the models used for the regional groups in the Basic Linked System are conceptually simpler than the individual country models. As has been mentioned earlier, the results for the regional groups in the Reference Scenario basically reflect the projections of scenario B (moderate economic growth) from the AT2000 study.

It should also be emphasized that the response of wheat supply in the different world wheat price scenarios (VLP to VHP) is supported by the results on the economically producible wheat potential as calculated from the AEZ study.

Wheat is the main staple food in the North African countries of the BLS groups AFRICA 1 ("Oil Exporters") and AFRICA 3 ("Medium Income Food Importers"). In AFRICA 1 the AEZ potential for rainfed wheat production under intermediate technology and net revenue maximization (scenario AEZ-IWR) is more than twice the level of wheat production projected in AT2000. The difference is mainly due to differences in the assumed yield levels. If the economic wheat production potentials derived from AEZ could be realized, and there may be many economic and socio-political obstacles to it, the region would almost be selfsufficient in wheat compared to a selfsufficiency of only 30 percent as estimated in AT2000 scenario B.

In the countries of AFRICA 3 the AEZ-IWR rainfed wheat production potential is a bit higher but similar to the BLS Reference Scenario results. Selfsufficiency in wheat does not seem possible at the intermediate level of inputs.

The countries of AFRICA 2 ("Medium Income Food Exporters") have practically no rainfed wheat production potential. In 1978-80 Zimbabwe was the only substantial wheat producer (from irrigated land) in this group. If past trends continue, all the other countries in AFRICA 2 will increasingly depend on wheat imports.

Similarly, none of the countries grouped in AFRICA 4 ("Low Income Food Exporters") except Ethiopia have a rainfed wheat production potential feasible under economic food crop competittion (AEZ-IWR). There is a sizeable economic potential for rainfed wheat production under intermediate level of inputs in Ethiopia (2.4 million mT in AEZ-IWR). Reaching the intermediate technology level by the year 2000 may, however, be well beyond Ethiopia's development possibilities. The uncertainty about the economic development and the resulting wide range of projected wheat production levels in the year 2000 is also reflected in the AT2000 study where estimated wheat output in Ethiopia in 2000 is 1.3 million mT under moderate economic growth (scenario B) and 2.8 million mT under high economic growth (scenario A).

Finally, in AFRICA 5 ("Low Income Food Importers") the analysis of historical data seems to indicate that the rapidly growing imports of wheat (6.2% per annum over the period 1966-68 to 1978-80) are a consequence of the insufficient development of the domestic food production. Except for Tanzania wheat plays a very minor role in the local diets as reflected by a less than 2 percent share of wheat in the average calorie intake in 1978-80. Wheat has become increasingly important only in closing calorie gaps caused by production failure due to droughts or political instability, and it may continue to do so if the individual countries do not succeed in developing their domestic food production sectors sufficiently. Out of this country group, only Tanzania has a potential for economically feasible rainfed wheat production (AEZ-IWR). The AEZ results for Tanzania obtained at the intermediate level of inputs (365 thousand mt) are similar to the projected wheat output in AT2000 (scenario B). Again, it is highly questionable whether a period of 15 to 20 years is sufficient to more than double both, yield and harvested area of wheat.

### 4.7. Concluding Observations

The relative world prices remain more or less on historical trends on the reference scenario of our linked system of models. With these prices cereal import in Africa continues to rise till 2000, the end of our simulation period and reaches a level of about 30 million tonnes. So do the imports of wheat which would constitute two thirds of the cereal imports in Africa in 2000. African wheat imports react significantly to world price. The price elasticity of wheat imports is around -0.55 when price increases and -0.75 when price decreases.

These significant responses of wheat imports to world market prices get transferred to domestic wheat prices and in turn leads to significant production response. Response of domestic wheat production to prices is significant and a price elasticity of wheat production in Africa of 0.8 is indicated.

The demand for wheat, however is not as price elastic as supply and imports. The price elasticity of demand for Africa is -0.07 when price increases and -0.18 when price decreases. Of course these elasticities vary from country to country and is much higher for some countries.

These significant responses to prices underline the importance of price policies for Africa. The scope of the present study is limited and we have not tried to find specific price policies for specific countries.

Increases in domestic prices, however, have to be considered in the light of the impact on consumers as well. The impact of world wheat price on average per capita calorie consumption is low as wheat is of relatively minor importance in consumption in most African countries. Only in Africa 1 where it is an important item of consumption, average per capita calorie intake goes down by 2.25 percent when world wheat prices double. Though this is still a small reduction unless transport, trade and administrative infrastructure are adequate to protect the vulnerable classes in rural and urban areas. The development of such infrastructure is particularly important for countries who depend on wheat aid significantly or where aid and imports contribute a major supply for some groups of the economy.

Wheat self-sufficiency and wheat aid affect domestic agricultural production and consumption. We have explored these impacts as well as impacts of sudden withdrawal of aid with our national models for Kenya, Egypt and Nigeria.

Domestic selfsufficiency in wheat is feasible for Kenya to attain. It increases domestic agricultural production, improves income parity for the farmers, but of course marginally reduces average calorie intake. The adverse impact of selfsufficiency constraint on calorie intake is much larger when the policy is introduced. This indicates that such policy changes, if desired, should be gradually introduced.

The aid scenarios for Egypt which gets sizeable wheat aid, showed the following:

- Wheat aid depresses domestic agricultural production and agricultural incomes. However, with the low food prices due to wheat aid, consumers are better off and the total calorie consumption improves. Thus, if appropriate compensation can be given to farmers for lost income, wheat aid is desirable for Egypt.
- Economically, Egypt should be able to adjust to sudden withdrawal of wheat aid if it can adjust its trade patterns and is able to find alternative suppliers.
- However, the development path is altered because of wheat aid withdrawal and these effects last for some years even after wheat aid is withdrawn.

As was to be expected, Nigeria would profit from lower wheat prices on the world market and, of course, from food aid in addition to keeping the level of commercial imports high. Similarly, a forced reduction of wheat imports to 1980 levels of about 1 million tons would create (in 2000) a calorie gap equivalent to the basic requirements of 3.7 million people in Nigeria and would therefore probably create political instability (which is also indicated by the extremely high equilibrium price of wheat). The induced pressure on domestic food production would, however, slightly improve the incomes in the rural areas.

Finally, the scenarios show that the economically viable rainfed wheat production limits as identified in the AEZ study are not exceeded by our model scenarios which is as it should be as in the model scenarios the realization of production potentials are constrained by availability of resources. The scenarios do indicate that in most African countries wheat selfsufficiency is not a feasible or a desirable goal. This should indicate that the development of agriculture should be pushed in a direction that is appropriate for the economic reality and agro-ecological potential of the country.

**REFERENCES**

FAO (1976b). Climate Data Bank. Data held as Agro-climatic Summaries by Plant Production and Protection Division, FAO, Rome.

FAO (1978-81). Reports of the Agro-ecological Zones Project. World Soil Resources Report No.48, Vol.1 - Africa, Vol.2 - Southwest Asia, Vol.3 - South and Central America, Vol.4 - Southeast Asia. FAO, Rome.

FAO/UNEP/UNESCO (1979). A Provisional Methodology for Soil Degradation Assessment, FAO, Rome.

FAO (1981). Agriculture: Toward 2000. FAO, Rome.

Fischer, G. and Frohberg K. (1982). The Basic Linked System of the Food and Agriculture Program at IIASA: An Overview of the Structure of the National Models. Mathematical Modelling, Vol.3.

Fischer, G., Frohberg, K. and Shah, M.M. (1984). Global Food Perspective: Assessing Agronomic Potential and Exploring Economic Policies. 10th Triennial Conference on Operations Research, IFORS, Washington.

Fischer, G. and Shah, M.M. (1984). Agro-economic Potential for Food Crop Production in Africa (forthcoming).

Higgins, G.M. and Kassam, A.H. (1980). The Agro-ecological Zone Land Inventory. In: Report on the Second FAO/UNFPA Expert Consultation on Land Resources for Populations of the Future. FAO, Rome.

Huddleston, B. (1984). Closing the Cereals Gap with Trade and Food Aid. IFPRI Research Report No.43, IFPRI, Washington, D.C.

Hyde, R.F., Vesper, N.J., Moore, R.S. and Goldblatt, I.A. (1980). Measurement of Non-agricultural Uses of Land for Nine Selected Areas in Africa by Means of Landsat MSS Data. Holecombe Research Institute, Indianapolis, USA.

Kassam, A.H., Kowal, J.M. and Sarraf, S. (1977a). Climatic Adaptability of Crops. Consultants' Report, Agro-ecological Zones Project, AGLS, FAO, Rome.

Kassam, A.H. (1979b). Multiple Cropping and Rainfed Crop Productivity in Africa. Consultant's Report, AGLS, FAO, Rome.

Keyzer, M. (1981). The International Linkage of Open Exchange Economies. Vrije Universiteit te Amsterdam.

Parikh, K.S. and Rabar, F. (eds.). Food for All in a Sustainable World: The IIASA Food and Agricultural Program, Status Report 81-002, Laxenburg, Austria.

Shah, M.M., Fischer, G., Higgins, G.M., Kassam, A.H. and Naiken, L. (1984). People, Land and Food Production - Potentials in the Developing World. FAP, IIASA, Laxenburg, Austria.

Shah, M.M., Fischer, G., Higgins, G.M. and Kassam, A.H. (1984). Estimates of Soil Erosion Losses/Productivity Losses in Agriculture: Methodology and Results for Developing Countries (forthcoming).

Sys, C. and Riquier, J. (1980). Ratings of FAO/UNESCO Soil Units for Specific Crop Production. FAO/UNFPA Project INT/75/P13, FAO, Rome.

Wood, S.R. (1980). The Allocation of Irrigated Areas and Production of Agro-ecological Zones. Consultant's Report, AGLS, FAO, Rome.

Young, A. and Wright, A.C.S. (1980). Rest Period Requirements of Tropical and Sub-tropical Soils under Annual Crops. Consultants' Report, AGLS, FAO, Rome.

# ANNEX A

## Statistical Annex

The statistical annex provides information on the main variables concerning cereal consumption, production and trade in Africa. Wheat, rice and coarse grains are treated separately. Country-level data for average 1976-78 and 1978-80 as well as average annual growth rates 1976-78 to 1978-80 are presented for 49 countries in Africa. The two remaining countries/territories, namely Equatorial Guinea and Western Sahara are not included because of lack of data. Countries have been grouped into five subgroups, namely North Africa and Subsahara 1 to 3. Average values of all data for these four groups are also included in the statistical tables.

**LIST OF TABLES**

COMMODITY: Wheat

| country | 66-68 average area 1000 ha | 66-68 average yield kg/ha | 66-68 average product. 1000 mt | 78-80 average area 1000 ha | 78-80 average yield kg/ha | 78-80 average product. 1000 mt | Average Annual Growth rates 66-68 to 78-80 area % | yield % | product. % |
|---|---|---|---|---|---|---|---|---|---|
| tunisia | 767. | 782. | 600. | 941. | 815. | 756. | 1.72 | 0.34 | 1.95 |
| algeria | 1901. | 583. | 1143. | 1953. | 615. | 1204. | 0.22 | 0.45 | 0.44 |
| morocco | 1950. | 890. | 1736. | 1693. | 1077. | 1824. | -1.17 | 1.60 | 0.42 |
| libya | 217. | 265. | 57. | 267. | 435. | 117. | 1.74 | 4.21 | 6.09 |
| Egypt | 379. | 3965. | 1430. | 575. | 3242. | 1865. | 3.53 | -1.66 | 2.24 |
| North Africa | 5215. | 948. | 4966. | 5430. | 1062. | 5767. | 0.34 | 0.96 | 1.25 |
| lesotho | 80. | 662. | 53. | 36. | 1095. | 40. | -6.49 | 4.28 | -2.28 |
| sudan | 73. | 1088. | 78. | 245. | 1104. | 271. | 10.63 | 0.12 | 10.91 |
| zambia | 0. | 1656. | 0. | 2. | 4005. | 6. | 25.61 | 7.64 | 36.00 |
| ethiopia | 737. | 801. | 590. | 507. | 885. | 449. | -3.07 | 0.84 | -2.25 |
| zimbabwe | 6. | 2630. | 15. | 40. | 4412. | 176. | 17.67 | 4.41 | 22.49 |
| Kenya * | 121. | 1383. | 169. | 119. | 1586. | 189. | -0.10 | 1.15 | 0.95 |
| angola | 20. | 1267. | 25. | 13. | 769. | 10. | -3.53 | -4.07 | -7.45 |
| tanzania | 34. | 1151. | 40. | 52. | 1402. | 72. | 3.44 | 1.65 | 5.13 |
| Sub-Sahara 1 | 1070. | 906. | 970. | 1013. | 1198. | 1214. | -0.46 | 2.36 | 1.88 |
| mauritius | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| gabon | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| sao tome etc | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| congo | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| reunion | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| cape verde | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| mauritania | 0. | 606. | 0. | 0. | 506. | 0. | 0.59 | -1.49 | -0.93 |
| botswana | 0. | 2374. | 0. | 0. | 3000. | 1. | 0.43 | 1.97 | 2.41 |
| senegal | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| ivory coast | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| somalia | 0. | 0. | 0. | 4. | 343. | 1. | - | - | - |
| Nigeria | 11. | 1848. | 20. | 14. | 1519. | 21. | 1.93 | -1.63 | 0.27 |
| ghana | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| cameroon | 0. | 0. | 0. | 3. | 508. | 1. | - | - | - |
| Sub-Sahara 2 | 12. | 1818. | 21. | 21. | 1161. | 24. | 5.00 | -3.67 | 1.13 |
| mozambique | 10. | 961. | 10. | 4. | 744. | 3. | -7.35 | -2.11 | -9.66 |
| gambia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| benin | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| togo | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| liberia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| sierra leone | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| madagascar | 0. | 0. | 0. | 0. | 1761. | 1. | - | - | - |
| comoros | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| guinea | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| zaire | 3. | 1011. | 3. | 5. | 889. | 5. | 3.63 | -1.07 | 2.54 |
| guin bissau | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| upper volta | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| cent afr emp | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| niger | 0. | 1044. | 0. | 1. | 2111. | 2. | 4.17 | 6.04 | 10.92 |
| chad | 4. | 1692. | 6. | 3. | 1889. | 6. | -1.98 | 0.92 | -0.79 |
| burundi | 12. | 717. | 9. | 5. | 634. | 3. | -7.43 | -1.02 | -8.47 |
| mali | 2. | 1333. | 2. | 2. | 1333. | 2. | 0. | 0. | 0. |
| swaziland | 0. | 0. | 0. | 0. | 3250. | 1. | - | - | - |
| rwanda | 0. | 817. | 0. | 4. | 861. | 3. | 20.87 | 0.45 | 21.31 |
| malawi | 0. | 2228. | 1. | 0. | 2500. | 1. | -3.32 | 0.97 | -2.39 |
| uganda | 1. | 2378. | 2. | 10. | 1500. | 15. | 18.76 | -3.77 | 16.48 |
| namibia | 1. | 1000. | 1. | 1. | 1000. | 1. | 2.43 | 0. | 2.43 |
| Sub-Sahara 3 | 34. | 1016. | 35. | 35. | 1183. | 41. | 0.24 | 1.28 | 1.52 |
| Sub-Sahara T | 1116. | 919. | 1026. | 1069. | 1197. | 1279. | -0.36 | 2.23 | 1.86 |
| Total | 6331. | 942. | 5992. | 6499. | 1084. | 7046. | 0.22 | 1.18 | 1.36 |

Table A1. Area, yield and production of wheat and average annual growth rates (1966-68 to 1978-80)

COMMODITY: Rice

| country | 66-68 average area 1000 ha | 66-68 average yield kg/ha | 66-68 average product. 1000 mt | 78-80 average area 1000 ha | 78-80 average yield kg/ha | 78-80 average product. 1000 mt | Average Annual Growth rates 66-68 to 78-80 area % | yield % | product. % |
|---|---|---|---|---|---|---|---|---|---|
| tunisia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| algeria | 2. | 1941. | 4. | 0. | 1447. | 1. | -12.79 | -2.42 | -14.45 |
| morocco | 6. | 3318. | 21. | 8. | 1593. | 13. | 2.52 | -5.93 | -3.61 |
| libya | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| Egypt | 438. | 3322. | 1462. | 426. | 3781. | 1611. | -0.23 | 1.08 | 0.81 |
| North Africa | 446. | 3317. | 1487. | 435. | 3737. | 1625. | -0.21 | 1.00 | 0.74 |
| lesotho | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| sudan | 1. | 493. | 1. | 4. | 1118. | 4. | 8.67 | 7.06 | 16.64 |
| zambia | 0. | 88. | 0. | 3. | 743. | 3. | 28.77 | 19.47 | 40.38 |
| ethiopia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| zimbabwe | 2. | 942. | 2. | 0. | 968. | 0. | -15.96 | 0.23 | -15.83 |
| Kenya * | 3. | 3785. | 11. | 7. | 3988. | 28. | 7.22 | 0.44 | 7.71 |
| angola | 22. | 790. | 17. | 20. | 670. | 13. | -0.82 | -1.37 | -2.18 |
| tanzania | 122. | 676. | 82. | 197. | 781. | 154. | 4.08 | 1.21 | 5.37 |
| Sub-Sahara 1 | 151. | 758. | 114. | 231. | 874. | 203. | 3.64 | 1.19 | 4.91 |
| mauritius | 0. | 846. | 0. | 0. | 2552. | 0. | 11.62 | 9.63 | 11.22 |
| gabon | 0. | 1090. | 0. | 0. | 4805. | 0. | -10.43 | 13.16 | 1.33 |
| sao tome etc | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| congo | 3. | 564. | 2. | 4. | 670. | 3. | 1.38 | 1.45 | 2.84 |
| reunion | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| cape verde | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| mauritania | 0. | 900. | 0. | 2. | 1343. | 3. | 12.66 | 3.39 | 17.86 |
| botswana | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| senegal | 91. | 1297. | 118. | 76. | 1725. | 131. | -1.49 | 2.40 | 0.85 |
| ivory coast | 286. | 765. | 220. | 403. | 787. | 317. | 2.88 | 0.24 | 3.10 |
| somalia | 0. | 0. | 0. | 2. | 2010. | 4. | - | - | - |
| Nigeria | 219. | 941. | 209. | 441. | 966. | 411. | 6.01 | 0.22 | 5.78 |
| ghana | 41. | 844. | 35. | 80. | 496. | 40. | 5.76 | -4.33 | 1.10 |
| cameroon | 15. | 820. | 12. | 24. | 1257. | 30. | 4.27 | 3.62 | 8.00 |
| Sub-Sahara 2 | 656. | 905. | 596. | 1032. | 913. | 938. | 3.85 | 0.07 | 3.85 |
| mozambique | 75. | 763. | 57. | 73. | 615. | 45. | -0.17 | -1.79 | -1.93 |
| gambia | 25. | 841. | 21. | 22. | 720. | 16. | -0.96 | -1.29 | -2.33 |
| benin | 2. | 401. | 1. | 10. | 786. | 8. | 14.29 | 5.76 | 20.81 |
| togo | 29. | 495. | 14. | 20. | 704. | 14. | -3.07 | 2.97 | -0.14 |
| liberia | 136. | 715. | 97. | 202. | 835. | 168. | 3.36 | 1.30 | 4.70 |
| sierra leone | 332. | 892. | 297. | 392. | 952. | 373. | 1.38 | 0.54 | 1.93 |
| madagascar | 984. | 1158. | 1140. | 1142. | 1268. | 1450. | 1.25 | 0.76 | 2.02 |
| comoros | 9. | 893. | 8. | 12. | 773. | 9. | 2.14 | -1.20 | 0.88 |
| guinea | 335. | 665. | 223. | 397. | 597. | 237. | 1.44 | -0.89 | 0.51 |
| zaire | 157. | 538. | 84. | 280. | 538. | 150. | 4.94 | -0.00 | 4.93 |
| guin bissau | 37. | 860. | 31. | 37. | 592. | 22. | 0.08 | -3.07 | -2.81 |
| upper volta | 39. | 682. | 26. | 40. | 484. | 19. | 0.26 | -2.82 | -2.47 |
| cent afr emp | 8. | 669. | 5. | 17. | 715. | 12. | 6.48 | 0.55 | 7.03 |
| niger | 12. | 1697. | 21. | 22. | 887. | 20. | 5.20 | -5.26 | -0.42 |
| chad | 28. | 836. | 23. | 49. | 703. | 34. | 4.69 | -1.43 | 3.25 |
| burundi | 2. | 1143. | 2. | 4. | 1620. | 6. | 7.96 | 2.95 | 11.00 |
| mali | 179. | 577. | 103. | 165. | 732. | 123. | -0.67 | 2.00 | 1.49 |
| swaziland | 2. | 1814. | 4. | 2. | 1763. | 3. | -1.54 | -0.24 | -1.76 |
| rwanda | 0. | 891. | 0. | 1. | 2010. | 3. | 20.23 | 7.01 | 23.75 |
| malawi | 14. | 505. | 7. | 47. | 712. | 33. | 10.38 | 2.90 | 13.70 |
| uganda | 5. | 881. | 4. | 18. | 430. | 8. | 11.73 | -5.80 | 6.00 |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - |
| Sub-Sahara 3 | 2409. | 900. | 2170. | 2951. | 933. | 2754. | 1.71 | 0.30 | 2.01 |
| Sub-Sahara T | 3215. | 895. | 2880. | 4214. | 924. | 3895. | 2.28 | 0.27 | 2.55 |
| Total | 3661. | 1190. | 4366. | 4649. | 1188. | 5520. | 2.01 | -0.01 | 1.97 |

Table A2. Area, yield and production of rice and average annual growt (1966-68 to 1978-80)

| COMMODITY: Coarse Gr. | 66-68 average | | | 78-80 average | | | Average Annual Growth rates 66-68 to 78-80 | | |
|---|---|---|---|---|---|---|---|---|---|
| country | area 1000 ha | yield kg/ha | product. 1000 mt | area 1000 ha | yield kg/ha | product. 1000 mt | area % | yield % | product. % |
| tunisia | 391. | 431. | 170. | 535. | 529. | 279. | 2.65 | 1.74 | 4.23 |
| algeria | 605. | 564. | 366. | 929. | 661. | 625. | 3.64 | 1.33 | 4.55 |
| morocco | 2853. | 785. | 2237. | 2904. | 844. | 2454. | 0.15 | 0.61 | 0.78 |
| libya | 360. | 295. | 105. | 347. | 348. | 126. | -0.31 | 1.36 | 1.51 |
| Egypt | 1147. | 2821. | 3235. | 1192. | 3203. | 3819. | 0.33 | 1.07 | 1.39 |
| North Africa | 5357. | 1133. | 6112. | 5907. | 1236. | 7303. | 0.82 | 0.73 | 1.49 |
| lesotho | 286. | 575. | 164. | 225. | 882. | 197. | -1.98 | 3.62 | 1.54 |
| sudan | 4161. | 360. | 1544. | 8466. | 318. | 2694. | 6.10 | -1.03 | 4.75 |
| zambia | 1327. | 716. | 950. | 1383. | 655. | 908. | 0.34 | -0.74 | -0.37 |
| ethiopia | 5344. | 643. | 3435. | 5304. | 711. | 3771. | -0.06 | 0.85 | 0.78 |
| zimbabwe | 1844. | 731. | 1368. | 1962. | 871. | 1710. | 0.51 | 1.47 | 1.88 |
| Kenya * | 1887. | 1155. | 2182. | 2126. | 1110. | 2360. | 1.00 | -0.33 | 0.66 |
| angola | 679. | 682. | 463. | 760. | 509. | 387. | 0.95 | -2.42 | -1.49 |
| tanzania | 2056. | 528. | 1082. | 2442. | 535. | 1306. | 1.45 | 0.10 | 1.58 |
| Sub-Sahara 1 | 17584. | 635. | 11188. | 22668. | 588. | 13333. | 2.14 | -0.64 | 1.47 |
| mauritius | 0. | 2133. | 0. | 1. | 2247. | 1. | 8.73 | 0.44 | 9.45 |
| gabon | 2. | 1103. | 2. | 6. | 1493. | 9. | 10.01 | 2.55 | 12.79 |
| sao tome etc | 0. | 1450. | 0. | 0. | 1528. | 1. | 3.14 | 0.44 | 3.59 |
| congo | 8. | 625. | 5. | 26. | 487. | 13. | 10.32 | -2.05 | 8.06 |
| reunion | 3. | 3729. | 13. | 3. | 5393. | 14. | -2.56 | 3.12 | 0.36 |
| cape verde | 15. | 430. | 8. | 12. | 400. | 5. | -2.33 | -0.60 | -3.75 |
| mauritania | 507. | 190. | 96. | 222. | 130. | 29. | -6.65 | -3.14 | -9.55 |
| botswana | 233. | 193. | 42. | 221. | 115. | 27. | -0.45 | -4.25 | -3.46 |
| senegal | 1058. | 553. | 585. | 1065. | 659. | 697. | 0.05 | 1.47 | 1.47 |
| ivory coast | 490. | 535. | 262. | 836. | 430. | 359. | 4.55 | -1.81 | 2.66 |
| somalia | 781. | 344. | 268. | 757. | 297. | 225. | -0.26 | -1.22 | -1.45 |
| Nigeria | 19600. | 323. | 6325. | 23766. | 357. | 8492. | 1.62 | 0.85 | 2.49 |
| ghana | 874. | 610. | 533. | 1295. | 396. | 512. | 3.33 | -3.54 | -0.33 |
| cameroon | 1073. | 629. | 669. | 1458. | 589. | 857. | 2.58 | -0.54 | 2.08 |
| Sub-Sahara 2 | 24645. | 358. | 8810. | 29666. | 379. | 11241. | 1.56 | 0.49 | 2.05 |
| mozambique | 944. | 693. | 654. | 1163. | 415. | 482. | 1.75 | -4.18 | -2.51 |
| gambia | 100. | 459. | 46. | 95. | 420. | 40. | -0.45 | -0.73 | -1.16 |
| benin | 625. | 456. | 286. | 646. | 608. | 393. | 0.27 | 2.42 | 2.69 |
| togo | 808. | 310. | 244. | 471. | 604. | 285. | -4.40 | 5.71 | 1.30 |
| liberia | 0. | 0. | 0. | 0. | 0. | 0. | - | - | -50.93 |
| sierra leone | 34. | 703. | 24. | 46. | 754. | 35. | 2.68 | 0.58 | 3.28 |
| madagascar | 146. | 998. | 146. | 127. | 981. | 124. | -1.16 | -0.15 | -1.30 |
| comoros | 3. | 1096. | 3. | 5. | 1000. | 5. | 4.09 | -0.76 | 3.30 |
| guinea | 285. | 510. | 145. | 203. | 605. | 122. | -2.80 | 1.44 | -1.41 |
| zaire | 688. | 777. | 534. | 801. | 818. | 654. | 1.27 | 0.43 | 1.70 |
| guin bissau | 66. | 377. | 25. | 58. | 310. | 18. | -1.11 | -1.60 | -2.70 |
| upper volta | 3737. | 283. | 1040. | 4050. | 281. | 1137. | 0.67 | -0.06 | 0.75 |
| cent afr emp | 164. | 497. | 81. | 238. | 335. | 80. | 3.14 | -3.25 | -0.16 |
| niger | 4795. | 238. | 1139. | 7337. | 221. | 1624. | 3.61 | -0.62 | 3.00 |
| chad | 2054. | 328. | 674. | 2319. | 260. | 602. | 1.02 | -1.93 | -0.94 |
| burundi | 406. | 641. | 260. | 459. | 682. | 313. | 1.03 | 0.52 | 1.55 |
| mali | 2178. | 421. | 917. | 2951. | 345. | 1017. | 2.56 | -1.66 | 0.86 |
| swaziland | 108. | 477. | 52. | 69. | 1200. | 84. | -3.71 | 8.00 | 4.08 |
| rwanda | 314. | 597. | 188. | 353. | 694. | 244. | 0.97 | 1.27 | 2.20 |
| malawi | 1170. | 1010. | 1166. | 1313. | 1034. | 1357. | 0.97 | 0.20 | 1.27 |
| uganda | 2087. | 546. | 1141. | 2001. | 686. | 1371. | -0.35 | 1.92 | 1.55 |
| namibia | 188. | 269. | 51. | 235. | 261. | 61. | 1.88 | -0.25 | 1.62 |
| Sub-Sahara 3 | 20901. | 422. | 8816. | 24939. | 403. | 10048. | 1.48 | -0.38 | 1.10 |
| Sub-Sahara T | 63130. | 456. | 28814. | 77272. | 448. | 34622. | 1.70 | -0.15 | 1.54 |
| Total | 68486. | 510. | 34926. | 83179. | 504. | 41925. | 1.63 | -0.09 | 1.53 |

Table A3. Area, yield and production of coarse grains and average an growth rates (1966-68 to 1978-80)

COMMODITY: All grains

| country | 66-68 average area 1000 ha | 66-68 average product. 1000 mt | 78-80 average area 1000 ha | 78-80 average product. 1000 mt | Average Annual Growth rates 66-68 to 78-80 area % | Average Annual Growth rates 66-68 to 78-80 product. % |
|---|---|---|---|---|---|---|
| tunisia | 1157. | 770. | 1476. | 1035. | 2.05 | 2.50 |
| algeria | 2508. | 1513. | 2882. | 1830. | 1.16 | 1.60 |
| morocco | 4810. | 3993. | 4605. | 4292. | -0.36 | 0.60 |
| libya | 578. | 162. | 615. | 243. | 0.52 | 3.39 |
| Egypt | 1964. | 6127. | 2194. | 7295. | 0.93 | 1.47 |
| North Africa | 11017. | 12565. | 11771. | 14695. | 0.55 | 1.31 |
| lesotho | 365. | 217. | 260. | 237. | -2.79 | 0.75 |
| sudan | 4235. | 1623. | 8715. | 2970. | 6.20 | 5.16 |
| zambia | 1328. | 950. | 1388. | 917. | 0.37 | -0.29 |
| ethiopia | 6081. | 4025. | 5810. | 4219. | -0.38 | 0.39 |
| zimbabwe | 1852. | 1385. | 2002. | 1886. | 0.65 | 2.60 |
| Kenya * | 2011. | 2362. | 2253. | 2577. | 0.95 | 0.73 |
| angola | 721. | 506. | 793. | 410. | 0.80 | -1.73 |
| tanzania | 2212. | 1204. | 2690. | 1532. | 1.65 | 2.03 |
| Sub-Sahara 1 | 18804. | 12272. | 23912. | 14749. | 2.02 | 1.54 |
| mauritius | 0. | 0. | 1. | 1. | 8.88 | 9.56 |
| gabon | 2. | 2. | 6. | 9. | 8.59 | 11.67 |
| sao tome etc | 0. | 0. | 0. | 1. | 3.14 | 3.59 |
| congo | 11. | 7. | 30. | 15. | 8.50 | 6.93 |
| reunion | 3. | 13. | 3. | 14. | -2.56 | 0.36 |
| cape verde | 15. | 8. | 12. | 5. | -2.33 | -3.75 |
| mauritania | 508. | 97. | 224. | 32. | -6.58 | -8.90 |
| botswana | 233. | 42. | 221. | 28. | -0.45 | -3.37 |
| senegal | 1149. | 703. | 1141. | 828. | -0.06 | 1.37 |
| ivory coast | 777. | 482. | 1239. | 676. | 3.97 | 2.86 |
| somalia | 781. | 268. | 762. | 230. | -0.20 | -1.26 |
| Nigeria | 19830. | 6554. | 24221. | 8924. | 1.68 | 2.60 |
| ghana | 915. | 568. | 1375. | 552. | 3.45 | -0.24 |
| cameroon | 1088. | 681. | 1484. | 888. | 2.62 | 2.23 |
| Sub-Sahara 2 | 25312. | 9427. | 30718. | 12203. | 1.63 | 2.17 |
| mozambique | 1029. | 721. | 1240. | 530. | 1.57 | -2.53 |
| gambia | 125. | 67. | 117. | 56. | -0.55 | -1.51 |
| benin | 627. | 287. | 656. | 401. | 0.37 | 2.83 |
| togo | 837. | 258. | 491. | 299. | -4.35 | 1.23 |
| liberia | 136. | 97. | 202. | 168. | 3.36 | 4.69 |
| sierra leone | 366. | 320. | 438. | 408. | 1.51 | 2.03 |
| madagascar | 1130. | 1286. | 1269. | 1574. | 0.97 | 1.70 |
| comoros | 12. | 11. | 17. | 14. | 2.68 | 1.67 |
| guinea | 619. | 368. | 600. | 360. | -0.26 | -0.20 |
| zaire | 848. | 622. | 1085. | 809. | 2.08 | 2.21 |
| guin bissau | 103. | 56. | 95. | 40. | -0.67 | -2.76 |
| upper volta | 3776. | 1066. | 4090. | 1157. | 0.67 | 0.68 |
| cent afr emp | 172. | 87. | 255. | 92. | 3.33 | 0.48 |
| niger | 4807. | 1160. | 7360. | 1645. | 3.61 | 2.95 |
| chad | 2086. | 704. | 2370. | 642. | 1.07 | -0.76 |
| burundi | 420. | 271. | 468. | 323. | 0.90 | 1.46 |
| mali | 2358. | 1023. | 3118. | 1142. | 2.35 | 0.92 |
| swaziland | 111. | 56. | 71. | 89. | -3.61 | 3.88 |
| rwanda | 315. | 188. | 358. | 250. | 1.08 | 2.38 |
| malawi | 1185. | 1174. | 1361. | 1391. | 1.16 | 1.42 |
| uganda | 2093. | 1147. | 2028. | 1394. | -0.26 | 1.64 |
| namibia | 189. | 51. | 236. | 62. | 1.88 | 1.63 |
| Sub-Sahara 3 | 23344. | 11020. | 27925. | 12844. | 1.50 | 1.28 |
| Sub-Sahara T | 67460. | 32720. | 82555. | 39796. | 1.70 | 1.64 |
| Total | 78478. | 45285. | 94326. | 54491. | 1.54 | 1.55 |

Table A4. Area and Production of all grains and average annual growth rates (1966-68 to 1978-80)

COMMODITY: Wheat

| country | 66-68 average export 1000 mt | 66-68 average import 1000 mt | 66-68 average comm impt 1000 mt | 66-68 average aid 1000 mt | 78-80 average export 1000 mt | 78-80 average import 1000 mt | 78-80 average comm impt 1000 mt | 78-80 average aid 1000 mt | Average Annual Growth rates 66-68 to 78-80 export % | import % | comm impt % | aid % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tunisia | 71. | 273. | 133. | 140. | 5. | 595. | 512. | 83. | -19.84 | 6.70 | 11.88 | -4.25 |
| algeria | 65. | 729. | 601. | 128. | 0. | 2012. | 1993. | 20. | -45.24 | 8.83 | 10.51 | -14.54 |
| morocco | 7. | 711. | 277. | 433. | 2. | 1652. | 1546. | 106. | -11.76 | 7.28 | 15.39 | -11.08 |
| libya | 0. | 146. | 146. | 0. | 0. | 453. | 453. | 0. | - | 9.88 | 9.88 | - |
| Egypt | 12. | 2214. | 1776. | 437. | 1. | 5125. | 3706. | 1419. | -21.39 | 7.25 | 6.32 | 10.31 |
| North Africa | 156. | 4073. | 2934. | 1139. | 7. | 9838. | 8211. | 1628. | -22.48 | 7.63 | 8.96 | 3.02 |
| lesotho | 4. | 19. | 19. | 0. | 0. | 59. | 59. | 0. | - | 9.76 | 9.76 | - |
| sudan | 0. | 160. | 125. | 35. | 0. | 282. | 213. | 69. | - | 4.84 | 4.57 | 5.75 |
| zambia | 0. | 50. | 50. | 0. | 0. | 121. | 110. | 11. | - | 7.59 | 6.75 | 59.07 |
| ethiopia | 0. | 26. | 22. | 4. | 0. | 263. | 180. | 83. | - | 21.38 | 19.23 | 28.97 |
| zimbabwe | 1. | 88. | 88. | 0. | 6. | 1. | 1. | 0. | 13.65 | -31.15 | -31.15 | - |
| Kenya * | 52. | 16. | 16. | 0. | 4. | 71. | 63. | 9. | -19.64 | 13.23 | 12.10 | 39.13 |
| angola | 3. | 51. | 51. | 0. | 1. | 77. | 70. | 7. | -9.22 | 3.52 | 2.70 | - |
| tanzania | 1. | 38. | 38. | 0. | 3. | 52. | 0. | 52. | 12.30 | 2.64 | - | - |
| Sub-Sahara 1 | 61. | 449. | 409. | 40. | 13. | 927. | 695. | 232. | -12.02 | 6.23 | 4.52 | 15.86 |
| mauritius | 0. | 38. | 38. | 0. | 0. | 58. | 44. | 14. | - | 3.51 | 1.22 | - |
| gabon | 0. | 8. | 8. | 0. | 4. | 22. | 22. | 0. | - | 8.96 | 8.96 | - |
| sao tome eto | 0. | 2. | 2. | 0. | 0. | 3. | 3. | 0. | - | 2.62 | 2.62 | - |
| congo | 2. | 19. | 19. | 0. | 0. | 53. | 53. | 0. | -15.53 | 8.71 | 8.71 | - |
| reunion | 0. | 10. | 10. | 0. | 0. | 23. | 23. | 0. | - | 7.08 | 7.08 | - |
| cape verde | 0. | 3. | 3. | 0. | 0. | 13. | 13. | 0. | 31.40 | 14.30 | 14.30 | - |
| mauritania | 0. | 12. | 12. | 0. | 0. | 55. | 32. | 24. | - | 13.48 | 8.34 | 58.98 |
| botswana | 0. | 2. | 2. | 0. | 1. | 20. | 14. | 5. | - | 23.53 | 20.50 | - |
| senegal | 23. | 64. | 62. | 1. | 29. | 127. | 94. | 33. | 2.07 | 5.92 | 3.45 | 30.84 |
| ivory coast | 10. | 81. | 81. | 0. | 16. | 169. | 169. | 0. | 4.04 | 6.32 | 6.32 | - |
| somalia | 0. | 21. | 21. | 0. | 0. | 67. | 16. | 52. | - | 10.07 | -2.43 | 49.53 |
| Nigeria | 0. | 138. | 138. | 0. | 120. | 1109. | 1108. | 1. | 109.62 | 18.99 | 18.98 | - |
| ghana | 0. | 62. | 33. | 29. | 7. | 159. | 125. | 34. | 106.13 | 8.10 | 11.61 | 1.35 |
| cameroon | 0. | 37. | 37. | 0. | 2. | 99. | 96. | 4. | 17.48 | 8.64 | 8.30 | - |
| Sub-Sahara 2 | 36. | 497. | 466. | 31. | 180. | 1977. | 1811. | 166. | 14.47 | 12.19 | 11.97 | 15.08 |
| mozambique | 3. | 61. | 61. | 0. | 0. | 133. | 48. | 85. | - | 6.70 | -1.95 | - |
| gambia | 0. | 2. | 2. | 0. | 0. | 6. | 4. | 2. | - | 8.52 | 5.05 | - |
| benin | 0. | 7. | 7. | 0. | 4. | 32. | 30. | 2. | - | 13.40 | 12.75 | - |
| togo | 0. | 7. | 7. | 0. | 0. | 25. | 22. | 3. | - | 11.03 | 9.91 | 31.33 |
| liberia | 0. | 6. | 5. | 0. | 0. | 16. | 14. | 1. | - | 8.95 | 8.60 | 14.11 |
| sierra leone | 0. | 24. | 22. | 2. | 0. | 25. | 16. | 8. | - | 0.41 | -2.42 | 14.23 |
| madagascar | 0. | 23. | 23. | 0. | 0. | 47. | 39. | 8. | -6.44 | 6.08 | 4.59 | 28.08 |
| comoros | 0. | 1. | 1. | 0. | 0. | 2. | 2. | 0. | - | 2.69 | 2.69 | - |
| guinea | 0. | 14. | 3. | 12. | 0. | 30. | 12. | 19. | - | 6.38 | 12.40 | 4.09 |
| zaire | 0. | 61. | 3. | 58. | 4. | 142. | 134. | 7. | 78.29 | 7.24 | 37.04 | -15.80 |
| guia bissau | 0. | 2. | 2. | 0. | 0. | 2. | 2. | 0. | - | 2.21 | 2.21 | - |
| upper volta | 0. | 14. | 14. | 0. | 0. | 32. | 18. | 15. | - | 7.31 | 1.96 | - |
| cent afr emp | 0. | 10. | 10. | 0. | 0. | 9. | 8. | 1. | - | -0.24 | -1.61 | - |
| niger | 0. | 4. | 4. | 0. | 0. | 20. | 7. | 13. | - | 14.24 | 4.60 | - |
| chad | 0. | 6. | 6. | 0. | 0. | 12. | 3. | 9. | - | 6.87 | -4.54 | - |
| burundi | 0. | 4. | 4. | 0. | 0. | 12. | 8. | 4. | - | 9.37 | 5.49 | - |
| mali | 0. | 9. | 9. | 0. | 0. | 20. | 9. | 11. | - | 7.23 | 0.21 | - |
| swaziland | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - | - |
| rwanda | 0. | 2. | 2. | 0. | 0. | 7. | 0. | 7. | - | 9.56 | -31.77 | - |
| malawi | 0. | 11. | 11. | 0. | 0. | 8. | 6. | 2. | 3.34 | -2.64 | -5.38 | 48.27 |
| uganda | 6. | 32. | 32. | 0. | 0. | 0. | 0. | 0. | - | -44.86 | -44.86 | - |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - | - |
| Sub-Sahara 3 | 9. | 300. | 228. | 72. | 9. | 582. | 382. | 200. | -0.19 | 5.68 | 4.42 | 8.83 |
| Sub-Sahara T | 106. | 1246. | 1103. | 143. | 202. | 3486. | 2888. | 597. | 5.51 | 8.95 | 8.35 | 12.67 |
| Total | 262. | 5319. | 4037. | 1282. | 209. | 13324. | 11099. | 2225. | -1.85 | 7.95 | 8.79 | 4.70 |

Table A5. Wheat exports, imports, commercial imports and aid and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: Rice | 66-68 average | | | | 78-80 average | | | | Average Annual Growth rates 66-68 to 78-80 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export % | import % | comm impt % | aid % |
| tunisia | 0. | 1. | 1. | 0. | 0. | 1. | 1. | 0. | - | -2.52 | -2.59 | - |
| algeria | 0. | 2. | 2. | 0. | 0. | 13. | 13. | 0. | - | 15.72 | 15.72 | - |
| morocco | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | -51.50 | 6.25 | -3.05 | - |
| libya | 0. | 13. | 13. | 0. | 0. | 39. | 39. | 0. | - | 9.36 | 9.36 | - |
| Egypt | 389. | 0. | 0. | 0. | 100. | 0. | 0. | 0. | -10.68 | 10.70 | 10.70 | - |
| North Africa | 392. | 17. | 17. | 0. | 100. | 53. | 53. | 0. | -10.74 | 9.91 | 9.91 | - |
| lesotho | 0. | 0. | 0. | 0. | 0. | 2. | 2. | 0. | - | - | - | - |
| sudan | 0. | 5. | 5. | 0. | 0. | 5. | 5. | 0. | - | -0.90 | -0.90 | - |
| zambia | 0. | 3. | 3. | 0. | 0. | 7. | 7. | 0. | - | 7.12 | 7.12 | - |
| ethiopia | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | - | -16.17 | -16.17 | - |
| zimbabwe | 0. | 3. | 3. | 0. | 0. | 4. | 4. | 0. | - | 1.58 | 1.58 | - |
| Kenya * | 3. | 2. | 2. | 0. | 1. | 5. | 5. | 0. | -10.80 | 6.27 | 6.27 | - |
| angola | 2. | 2. | 2. | 0. | 0. | 17. | 17. | 0. | - | 20.03 | 20.03 | - |
| tanzania | 1. | 18. | 18. | 0. | 0. | 35. | 14. | 20. | -24.61 | 5.82 | -1.73 | - |
| Sub-Sahara 1 | 6. | 36. | 36. | 0. | 1. | 74. | 54. | 20. | -16.22 | 6.14 | 3.34 | - |
| mauritius | 1. | 56. | 56. | 0. | 0. | 71. | 71. | 0. | - | 1.88 | 1.88 | - |
| gabon | 0. | 1. | 1. | 0. | 0. | 6. | 6. | 0. | - | 12.76 | 12.76 | - |
| sao tome etc | 0. | 1. | 1. | 0. | 0. | 2. | 2. | 0. | - | 3.09 | 3.09 | - |
| congo | 0. | 2. | 2. | 0. | 0. | 4. | 4. | 0. | - | 7.05 | 7.05 | - |
| reunion | 0. | 40. | 40. | 0. | 0. | 52. | 52. | 0. | - | 2.22 | 2.22 | - |
| cape verde | 0. | 1. | 1. | 0. | 0. | 5. | 5. | 0. | - | 11.01 | 11.01 | - |
| mauritania | 0. | 11. | 11. | 0. | 0. | 47. | 47. | 0. | - | 13.08 | 13.03 | - |
| botswana | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 0. | - | - | - | - |
| senegal | 0. | 185. | 185. | 0. | 0. | 257. | 257. | 0. | -12.55 | 2.78 | 2.77 | - |
| ivory coast | 0. | 49. | 39. | 10. | 0. | 174. | 174. | 0. | -2.25 | 11.23 | 13.32 | - |
| somalia | 0. | 16. | 16. | 0. | 0. | 51. | 42. | 9. | - | 10.35 | 8.64 | - |
| Nigeria | 0. | 1. | 1. | 0. | 0. | 395. | 395. | 0. | - | 63.69 | 63.69 | - |
| ghana | 0. | 39. | 26. | 12. | 0. | 35. | 35. | 0. | - | -0.88 | 2.38 | - |
| cameroon | 0. | 6. | 6. | 0. | 0. | 30. | 30. | 0. | - | 13.85 | 13.85 | - |
| Sub-Sahara 2 | 1. | 408. | 386. | 22. | 0. | 1132. | 1122. | 9. | -12.30 | 8.86 | 9.30 | -6.98 |
| mozambique | 4. | 0. | 0. | 0. | 0. | 69. | 63. | 6. | - | 78.77 | 77.46 | - |
| gambia | 0. | 8. | 8. | 0. | 0. | 27. | 26. | 2. | - | 10.53 | 10.00 | - |
| benin | 0. | 5. | 5. | 0. | 0. | 11. | 11. | 0. | - | 6.25 | 6.25 | - |
| togo | 0. | 2. | 2. | 0. | 0. | 10. | 10. | 0. | - | 13.37 | 13.28 | - |
| liberia | 0. | 37. | 34. | 3. | 0. | 60. | 60. | 0. | 23.37 | 4.00 | 4.75 | -28.30 |
| sierra leone | 0. | 28. | 27. | 1. | 0. | 23. | 23. | 0. | - | -1.70 | -1.52 | -20.46 |
| madagascar | 41. | 4. | 4. | 0. | 1. | 145. | 145. | 0. | -26.85 | 35.78 | 35.78 | - |
| comoros | 0. | 8. | 8. | 0. | 0. | 15. | 15. | 0. | - | 4.68 | 4.68 | - |
| guinea | 0. | 23. | 13. | 10. | 0. | 74. | 56. | 17. | - | 10.11 | 12.72 | 4.88 |
| zaire | 0. | 22. | 3. | 20. | 0. | 29. | 20. | 9. | - | 2.11 | 17.18 | -6.00 |
| guin bissau | 0. | 7. | 7. | 0. | 0. | 33. | 33. | 0. | - | 13.26 | 13.26 | - |
| upper volta | 0. | 3. | 3. | 0. | 0. | 10. | 10. | 0. | - | 11.00 | 10.74 | - |
| cent afr emp | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | 1.34 | 1.34 | - |
| niger | 0. | 1. | 1. | 0. | 0. | 18. | 18. | 0. | - | 29.22 | 29.22 | - |
| chad | 0. | 0. | 0. | 0. | 0. | 3. | 1. | 1. | - | 49.85 | 40.98 | - |
| burundi | 0. | 1. | 1. | 0. | 0. | 1. | 1. | 0. | - | 1.44 | 1.44 | - |
| mali | 0. | 0. | 0. | 0. | 0. | 30. | 30. | 0. | - | 64.94 | 64.78 | - |
| swaziland | 4. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | -22.04 | - | - | - |
| rwanda | 0. | 1. | 1. | 0. | 0. | 4. | 3. | 1. | - | 13.16 | 11.45 | - |
| malawi | 1. | 0. | 0. | 0. | 5. | 0. | 0. | 0. | 14.15 | -27.32 | -27.32 | - |
| uganda | 0. | 7. | 7. | 0. | 0. | 10. | 10. | 0. | - | 2.97 | 2.97 | - |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - | - |
| Sub-Sahara 3 | 51. | 159. | 126. | 33. | 7. | 570. | 533. | 37. | -15.43 | 11.24 | 12.79 | 0.90 |
| Sub-Sahara T | 57. | 604. | 548. | 55. | 8. | 1776. | 1710. | 67. | -15.44 | 9.41 | 9.94 | 1.56 |
| Total | 450. | 621. | 566. | 55. | 108. | 1829. | 1763. | 67. | -11.20 | 9.42 | 9.94 | 1.56 |

Table A6. Rice exports, imports, commercial imports and aid and average annual growth rates (1966-66 to 1978-80)

| COMMODITY: Coarse Gr. | 66-68 average | | | | 78-80 average | | | | Average Annual Growth rates 66-68 to 78-80 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export % | import % | comm impt % | aid % |
| tunisia | 7. | 60. | 14. | 45. | 0. | 196. | 189. | 7. | -31.89 | 10.46 | 24.04 | -13.98 |
| algeria | 18. | 55. | 55. | 0. | 0. | 432. | 432. | 0. | - | 18.67 | 18.67 | - |
| morocco | 41. | 40. | 34. | 6. | 18. | 117. | 117. | 0. | -6.47 | 9.34 | 10.84 | - |
| libya | 0. | 32. | 32. | 0. | 0. | 117. | 117. | 0. | - | 11.44 | 11.44 | - |
| Egypt | 5. | 168. | 167. | 1. | 0. | 725. | 517. | 207. | -30.36 | 12.96 | 9.91 | 52.23 |
| North Africa | 70. | 355. | 302. | 53. | 18. | 1587. | 1373. | 215. | -10.56 | 13.30 | 13.44 | 12.41 |
| lesotho | 0. | 36. | 36. | 0. | 0. | 79. | 79. | 0. | - | 6.82 | 6.82 | - |
| sudan | 53. | 2. | 2. | 0. | 57. | 4. | 4. | 0. | 0.53 | 5.50 | 5.50 | - |
| zambia | 109. | 21. | 21. | 0. | 20. | 120. | 120. | 0. | -13.05 | 15.65 | 15.65 | 14.00 |
| ethiopia | 0. | 7. | 2. | 5. | 0. | 40. | 39. | 0. | -13.79 | 15.55 | 26.01 | -19.31 |
| zimbabwe | 235. | 30. | 30. | 0. | 302. | 37. | 37. | 0. | 2.11 | 1.77 | 1.77 | - |
| Kenya * | 153. | 61. | 8. | 53. | 56. | 87. | 87. | 0. | -7.98 | 2.99 | 21.50 | - |
| angola | 112. | 10. | 10. | 0. | 0. | 73. | 73. | 0. | - | 18.32 | 18.32 | - |
| tanzania | 37. | 20. | 17. | 3. | 67. | 86. | 77. | 9. | 4.94 | 12.69 | 13.22 | 9.02 |
| Sub-Sahara 1 | 700. | 188. | 127. | 61. | 502. | 526. | 517. | 9. | -2.73 | 8.98 | 12.41 | -14.32 |
| mauritius | 0. | 9. | 9. | 0. | 0. | 17. | 17. | 0. | - | 5.51 | 5.34 | 16.33 |
| gabon | 0. | 2. | 2. | 0. | 0. | 14. | 14. | 0. | - | 16.08 | 16.08 | - |
| sao tome etc | 0. | 2. | 2. | 0. | 0. | 2. | 2. | 0. | - | -1.14 | -1.14 | - |
| congo | 0. | 3. | 3. | 0. | 0. | 9. | 9. | 0. | -27.09 | 9.83 | 9.83 | - |
| reunion | 0. | 22. | 22. | 0. | 0. | 48. | 48. | 0. | - | 6.73 | 6.73 | - |
| cape verde | 0. | 4. | 4. | 0. | 0. | 41. | 41. | 0. | - | 21.10 | 21.10 | - |
| mauritania | 0. | 31. | 31. | 0. | 0. | 49. | 33. | 16. | - | 3.94 | 0.53 | 59.53 |
| botswana | 1. | 69. | 69. | 0. | 5. | 82. | 82. | 0. | 12.71 | 1.49 | 1.49 | - |
| senegal | 1. | 16. | 6. | 10. | 0. | 40. | 20. | 21. | - | 7.80 | 10.56 | 5.78 |
| ivory coast | 0. | 4. | 4. | 0. | 1. | 57. | 57. | 0. | 23.32 | 24.13 | 24.13 | - |
| somalia | 1. | 2. | 2. | 0. | 0. | 19. | 10. | 10. | - | 20.75 | 14.47 | 48.22 |
| Nigeria | 0. | 66. | 66. | 0. | 0. | 314. | 314. | 0. | - | 13.85 | 13.89 | - |
| ghana | 0. | 14. | 8. | 6. | 0. | 76. | 51. | 25. | - | 15.20 | 16.62 | 12.88 |
| cameroon | 1. | 12. | 12. | 0. | 1. | 64. | 64. | 0. | -0.13 | 14.85 | 14.85 | - |
| Sub-Sahara 2 | 4. | 257. | 240. | 17. | 7. | 833. | 761. | 72. | 5.77 | 10.29 | 10.09 | 12.85 |
| mozambique | 51. | 16. | 16. | 0. | 1. | 120. | 118. | 1. | -30.77 | 18.16 | 18.07 | - |
| gambia | 0. | 0. | 0. | 0. | 0. | 13. | 8. | 4. | - | 42.61 | 45.07 | 39.06 |
| benin | 1. | 3. | 3. | 0. | 0. | 8. | 3. | 5. | - | 7.28 | -1.55 | - |
| togo | 0. | 2. | 1. | 0. | 6. | 16. | 8. | 8. | - | 21.11 | 17.09 | 27.93 |
| liberia | 0. | 4. | 4. | 0. | 0. | 10. | 10. | 0. | - | 8.25 | 8.25 | - |
| sierra leone | 0. | 3. | 3. | 0. | 0. | 9. | 9. | 0. | - | 10.15 | 10.15 | - |
| madagascar | 3. | 3. | 3. | 0. | 4. | 7. | 7. | 0. | 1.63 | 7.09 | 7.09 | - |
| comoros | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | -1.01 | -1.01 | - |
| guinea | 2. | 5. | 5. | 0. | 0. | 8. | 6. | 2. | - | 4.41 | 2.09 | 32.03 |
| zaire | 0. | 104. | 102. | 2. | 0. | 274. | 272. | 2. | 23.32 | 8.40 | 8.48 | 2.11 |
| guin bissau | 0. | 0. | 0. | 0. | 0. | 8. | 8. | 0. | - | 32.67 | 32.67 | - |
| upper volta | 1. | 3. | 3. | 0. | 0. | 45. | 33. | 12. | -14.20 | 24.51 | 21.22 | - |
| cent afr emp | 0. | 3. | 2. | 0. | 0. | 4. | 4. | 0. | - | 3.12 | 4.63 | -21.70 |
| niger | 47. | 4. | 4. | 0. | 23. | 17. | 3. | 14. | -5.81 | 12.38 | -4.08 | - |
| chad | 0. | 1. | 1. | 0. | 0. | 3. | 2. | 0. | - | 11.22 | 9.71 | - |
| burundi | 0. | 6. | 6. | 0. | 0. | 8. | 7. | 1. | - | 3.36 | 2.41 | - |
| mali | 0. | 3. | 3. | 0. | 0. | 10. | 8. | 2. | - | 11.49 | 9.29 | - |
| swaziland | 0. | 38. | 38. | 0. | 0. | 49. | 49. | 0. | - | 2.06 | 2.06 | - |
| rwanda | 1. | 2. | 1. | 1. | 0. | 10. | 8. | 2. | - | 15.32 | 18.48 | 7.97 |
| malawi | 76. | 1. | 1. | 0. | 1. | 52. | 52. | 0. | -31.54 | 37.81 | 37.81 | - |
| uganda | 28. | 7. | 6. | 1. | 0. | 13. | 13. | 0. | - | 4.92 | 6.11 | - |
| namibia | 0. | 26. | 26. | 0. | 0. | 51. | 51. | 0. | - | 5.86 | 5.86 | - |
| Sub-Sahara 3 | 209. | 233. | 229. | 4. | 34. | 733. | 678. | 55. | -14.06 | 10.03 | 9.49 | 23.44 |
| Sub-Sahara T | 912. | 677. | 596. | 82. | 543. | 2092. | 1956. | 137. | -4.24 | 9.85 | 10.42 | 4.35 |
| Total | 983. | 1032. | 898. | 135. | 561. | 3679. | 3328. | 351. | -4.56 | 11.17 | 11.54 | 8.32 |

Table A7. Coarse grains exports, imports, commercial imports and aid and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: All grains | 66-68 average | | | | 78-80 average | | | | Average Annual Growth rates 66-68 to 78-80 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export 1000 mt | import 1000 mt | comm impt 1000 mt | aid 1000 mt | export % | import % | comm impt % | aid % |
| tunisia | 78. | 334. | 149. | 186. | 5. | 793. | 702. | 91. | -20.40 | 7.46 | 13.80 | -5.79 |
| algeria | 83. | 787. | 658. | 128. | 0. | 2457. | 2438. | 20. | -46.32 | 9.96 | 11.53 | -14.54 |
| morocco | 52. | 751. | 311. | 439. | 20. | 1769. | 1663. | 106. | -7.61 | 7.40 | 14.98 | -11.18 |
| libya | 0. | 192. | 192. | 0. | 0. | 610. | 610. | 0. | - | 10.12 | 10.12 | - |
| Egypt | 406. | 2381. | 1943. | 439. | 101. | 5850. | 4224. | 1626. | -10.93 | 7.78 | 6.69 | 11.54 |
| North Africa | 619. | 4445. | 3253. | 1192. | 126. | 11478. | 9636. | 1842. | -12.41 | 8.23 | 9.47 | 3.69 |
| lesotho | 4. | 55. | 55. | 0. | 0. | 139. | 139. | 0. | - | 8.06 | 8.06 | - |
| sudan | 53. | 168. | 132. | 35. | 57. | 292. | 222. | 69. | 0.53 | 4.71 | 4.41 | 5.75 |
| zambia | 109. | 74. | 74. | 0. | 20. | 248. | 237. | 11. | -13.05 | 10.56 | 10.15 | 44.68 |
| ethiopia | 0. | 36. | 27. | 8. | 0. | 303. | 220. | 84. | -15.92 | 19.53 | 19.02 | 21.02 |
| zimbabwe | 236. | 121. | 121. | 0. | 307. | 42. | 42. | 0. | 2.23 | -8.48 | -8.48 | - |
| Kenya * | 207. | 80. | 27. | 53. | 61. | 163. | 155. | 9. | -9.72 | 6.16 | 15.79 | -13.99 |
| angola | 118. | 63. | 63. | 0. | 1. | 167. | 160. | 7. | -32.68 | 8.53 | 8.14 | - |
| tanzania | 39. | 76. | 73. | 3. | 69. | 173. | 91. | 81. | 4.98 | 7.06 | 1.89 | 31.34 |
| Sub-Sahara 1 | 766. | 672. | 572. | 100. | 516. | 1527. | 1266. | 261. | -3.25 | 7.07 | 6.84 | 8.32 |
| mauritius | 1. | 104. | 104. | 0. | 0. | 146. | 132. | 14. | - | 2.87 | 2.01 | 54.51 |
| gabon | 0. | 12. | 12. | 0. | 4. | 42. | 42. | 0. | - | 11.33 | 11.33 | - |
| sao tome etc | 0. | 6. | 6. | 0. | 0. | 7. | 7. | 0. | - | 1.37 | 1.37 | - |
| congo | 2. | 24. | 24. | 0. | 0. | 65. | 65. | 0. | -15.54 | 8.75 | 8.75 | - |
| reunion | 0. | 72. | 72. | 0. | 0. | 123. | 123. | 0. | - | 4.54 | 4.54 | - |
| cape verde | 0. | 8. | 8. | 0. | 0. | 59. | 59. | 0. | 6.37 | 17.97 | 17.97 | - |
| mauritania | 0. | 54. | 53. | 0. | 0. | 151. | 111. | 40. | - | 9.04 | 6.29 | 59.28 |
| botswana | 1. | 70. | 70. | 0. | 6. | 105. | 100. | 5. | 14.11 | 3.37 | 2.94 | - |
| senegal | 24. | 265. | 254. | 12. | 29. | 425. | 371. | 54. | 1.77 | 4.00 | 3.22 | 13.58 |
| ivory coast | 10. | 134. | 124. | 10. | 17. | 400. | 400. | 0. | 4.46 | 9.55 | 10.23 | - |
| somalia | 1. | 39. | 38. | 0. | 0. | 138. | 68. | 70. | - | 11.09 | 4.82 | 50.99 |
| Nigeria | 0. | 205. | 205. | 0. | 120. | 1818. | 1817. | 1. | 98.52 | 19.95 | 19.96 | 8.10 |
| ghana | 0. | 115. | 68. | 47. | 7. | 270. | 210. | 59. | 63.65 | 7.36 | 9.91 | 1.89 |
| cameroon | 1. | 55. | 55. | 0. | 3. | 193. | 190. | 4. | 8.42 | 11.01 | 10.83 | - |
| Sub-Sahara 2 | 40. | 1162. | 1093. | 70. | 187. | 3941. | 3694. | 247. | 13.72 | 10.71 | 10.68 | 11.11 |
| mozambique | 58. | 77. | 77. | 0. | 1. | 322. | 230. | 92. | -31.52 | 12.62 | 9.51 | - |
| gambia | 0. | 11. | 11. | 0. | 0. | 46. | 38. | 8. | - | 13.02 | 11.34 | 45.91 |
| benin | 1. | 16. | 16. | 0. | 4. | 51. | 44. | 7. | 17.42 | 10.27 | 8.88 | - |
| togo | 0. | 11. | 11. | 1. | 6. | 51. | 40. | 12. | 69.08 | 13.66 | 11.76 | 28.88 |
| liberia | 0. | 47. | 43. | 3. | 0. | 85. | 84. | 1. | 33.89 | 5.13 | 5.65 | -7.28 |
| sierra leone | 0. | 54. | 52. | 2. | 0. | 56. | 48. | 9. | - | 0.29 | -0.71 | 11.27 |
| madagascar | 44. | 30. | 29. | 0. | 5. | 199. | 191. | 8. | -16.66 | 17.11 | 16.84 | 28.08 |
| comoros | 0. | 10. | 10. | 0. | 0. | 16. | 16. | 0. | - | 4.44 | 4.44 | - |
| guinea | 2. | 42. | 21. | 21. | 0. | 112. | 74. | 38. | - | 8.44 | 11.14 | 4.88 |
| zaire | 0. | 188. | 108. | 79. | 4. | 445. | 426. | 19. | 76.94 | 7.45 | 12.08 | -11.27 |
| guin bissau | 0. | 10. | 10. | 0. | 0. | 43. | 43. | 0. | - | 13.44 | 13.44 | - |
| upper volta | 1. | 20. | 20. | 0. | 0 | 88. | 60. | 28. | -12.91 | 13.08 | 9.59 | - |
| cent afr emp | 0. | 12. | 12. | 0. | 0. | 13. | 12. | 1. | - | 0.58 | -0.11 | 10.90 |
| niger | 47. | 9. | 9. | 0. | 23. | 56. | 28. | 28. | -5.81 | 16.24 | 9.76 | - |
| chad | 0. | 6. | 6. | 0. | 0. | 18. | 7. | 11. | - | 8.98 | 0.68 | - |
| burundi | 0. | 10. | 10. | 0. | 0. | 21. | 16. | 5. | - | 6.15 | 3.72 | - |
| mali | 0. | 11. | 11. | 0. | 0. | 60. | 47. | 14. | - | 14.85 | 12.43 | - |
| swaziland | 4. | 38. | 38. | 0. | 0. | 49. | 49. | 0. | -21.41 | 2.06 | 2.06 | - |
| rwanda | 1. | 5. | 4. | 1. | 0. | 21. | 11. | 10. | - | 12.58 | 8.41 | 23.55 |
| malawi | 77. | 13. | 13. | 0. | 7. | 60. | 58. | 2. | -18.58 | 13.91 | 13.55 | 48.27 |
| uganda | 34. | 46. | 45. | 1. | 0. | 22. | 22. | 0. | - | -5.76 | -5.60 | - |
| namibia | 0. | 26. | 26. | 0. | 0. | 51. | 51. | 0. | - | 5.86 | 5.86 | - |
| Sub-Sahara 3 | 269. | 692. | 582. | 110. | 50. | 1886. | 1594. | 292. | -13.10 | 8.71 | 8.76 | 8.48 |
| Sub-Sahara T | 1075. | 2527. | 2247. | 280. | 752. | 7354. | 6554. | 800. | -2.93 | 9.31 | 9.33 | 9.15 |
| Total | 1694. | 6972. | 5500. | 1472. | 878. | 18833. | 16190. | 2643. | -5.33 | 8.63 | 9.41 | 5.00 |

Table A8. All grains exports, imports, commercial imports and aid and average annual growth rates (1966-68 to 1978-80)

486 COMMODITY: Wheat

| country | 66-68 average val com im mill $ | 66-68 average tot imp. mill $ | 66-68 average tot exp. mill $t | 78-80 average val com im mill $ | 78-80 average tot imp. mill $ | 78-80 average tot exp. mill $t | Average Annual Growth rates 66-68 to 78-80 val com im % | tot imp. % | tot exp. % |
|---|---|---|---|---|---|---|---|---|---|
| tunisia | 10. | 243. | 149. | 88. | 2557. | 1505. | 20.12 | 21.66 | 21.25 |
| algeria | 45. | 697. | 725. | 381. | 8810. | 7578. | 19.51 | 23.54 | 21.60 |
| morocco | 20. | 515. | 434. | 247. | 3531. | 1912. | 23.27 | 17.40 | 13.15 |
| libya | 12. | 509. | 1351. | 82. | 4665. | 10169. | 17.56 | 20.28 | 18.32 |
| Egypt | 124. | 843. | 592. | 616. | 4869. | 1838. | 14.32 | 15.74 | 9.89 |
| North Africa | 210. | 2807. | 3252. | 1415. | 24433. | 23002. | 17.22 | 19.76 | 17.71 |
| lesotho | 2. | 33. | 6. | 11. | 334. | 42. | 17.43 | 21.30 | 17.01 |
| sudan | 10. | 231. | 215. | 41. | 1198. | 541. | 12.57 | 14.70 | 7.99 |
| zambia | 4. | 410. | 699. | 16. | 669. | 922. | 11.47 | 4.17 | 2.33 |
| ethiopia | 2. | 159. | 104. | 27. | 553. | 383. | 25.24 | 10.93 | 11.52 |
| zimbabwe | 5. | 263. | 272. | 0. | 1040. | 1103. | -23.58 | 12.14 | 12.37 |
| Kenya * | 2. | 346. | 248. | 13. | 1747. | 1046. | 18.77 | 14.45 | 12.73 |
| angola | 4. | 262. | 243. | 13. | 820. | 1195. | 9.65 | 9.99 | 14.18 |
| tanzania | 4. | 246. | 241. | 0. | 1119. | 524. | - | 13.45 | 6.67 |
| Sub-Sahara 1 | 32. | 1950. | 2029. | 121. | 7480. | 5756. | 11.59 | 11.86 | 9.08 |
| mauritius | 3. | 74. | 66. | 14. | 559. | 369. | 12.77 | 18.33 | 15.44 |
| gabon | 1. | 66. | 115. | 7. | 752. | 1394. | 17.45 | 22.51 | 23.09 |
| sao tome etc | 0. | 169. | 146. | 1. | 877. | 477. | 7.76 | 14.73 | 10.38 |
| congo | 2. | 78. | 47. | 15. | 251. | 153. | 20.28 | 10.17 | 10.41 |
| reunion | 2. | 116. | 41. | 12. | 740. | 119. | 16.51 | 16.73 | 9.38 |
| cape verde | 0. | 9. | 1. | 2. | 47. | 2. | 12.89 | 14.74 | 3.83 |
| mauritania | 1. | 32. | 71. | 6. | 234. | 147. | 14.61 | 18.18 | 6.25 |
| botswana | 0. | 31. | 13. | 5. | 522. | 387. | 33.50 | 26.50 | 32.83 |
| senegal | 6. | 184. | 148. | 15. | 912. | 477. | 8.43 | 15.37 | 10.37 |
| ivory coast | 8. | 278. | 354. | 35. | 2440. | 2464. | 13.37 | 19.82 | 17.56 |
| somalia | 2. | 43. | 30. | 4. | 242. | 107. | 6.01 | 15.42 | 11.15 |
| Nigeria | 13. | 628. | 688. | 197. | 12949. | 10589. | 25.06 | 28.69 | 25.59 |
| ghana | 4. | 322. | 272. | 23. | 1430. | 1090. | 16.96 | 13.22 | 12.28 |
| cameroon | 4. | 170. | 152. | 22. | 1238. | 1025. | 16.21 | 18.01 | 17.22 |
| Sub-Sahara 2 | 46. | 2180. | 2141. | 358. | 23191. | 18800. | 18.66 | 21.78 | 19.85 |
| mozambique | 4. | 214. | 129. | 10. | 489. | 227. | 6.65 | 7.14 | 4.80 |
| gambia | 0. | 16. | 13. | 1. | 125. | 43. | 10.48 | 18.39 | 10.44 |
| benin | 1. | 44. | 16. | 7. | 289. | 49. | 18.33 | 17.06 | 9.68 |
| togo | 1. | 46. | 36. | 6. | 499. | 226. | 16.09 | 21.86 | 16.66 |
| liberia | 0. | 116. | 170. | 3. | 483. | 507. | 16.19 | 12.65 | 9.55 |
| sierra leone | 3. | 94. | 79. | 6. | 278. | 164. | 5.89 | 9.48 | 6.30 |
| madagascar | 2. | 152. | 106. | 7. | 574. | 394. | 11.90 | 11.69 | 11.56 |
| comoros | 0. | 7. | 4. | 1. | 26. | 13. | 12.71 | 11.46 | 10.10 |
| guinea | 0. | 50. | 54. | 2. | 255. | 299. | 16.21 | 14.53 | 15.29 |
| zaire | 0. | 301. | 468. | 31. | 616. | 1248. | 45.24 | 6.15 | 8.52 |
| guin bissau | 0. | 17. | 3. | 1. | 50. | 13. | 6.43 | 9.31 | 13.01 |
| upper volta | 2. | 38. | 18. | 4. | 259. | 59. | 7.76 | 17.30 | 10.52 |
| cent afr emp | 1. | 37. | 32. | 3. | 64. | 78. | 7.89 | 4.68 | 7.72 |
| niger | 1. | 44. | 32. | 2. | 230. | 200. | 7.60 | 14.74 | 16.41 |
| chad | 1. | 34. | 27. | 1. | 134. | 112. | -3.77 | 12.18 | 12.53 |
| burundi | 1. | 21. | 13. | 3. | 84. | 62. | 14.32 | 12.25 | 13.90 |
| mali | 1. | 35. | 13. | 3. | 272. | 173. | 8.92 | 18.73 | 23.71 |
| swaziland | 0. | 43. | 55. | 0. | 320. | 235. | - | 18.17 | 12.88 |
| rwanda | 0. | 21. | 14. | 0. | 182. | 130. | -23.01 | 19.72 | 20.65 |
| malawi | 1. | 72. | 51. | 1. | 381. | 218. | 1.24 | 14.90 | 12.82 |
| uganda | 3. | 163. | 217. | 0. | 213. | 404. | -39.55 | 2.27 | 5.31 |
| namibia | 0. | n.a. | n.a. | 0. | n.a. | n.a. | - | - | - |
| Sub-Sahara 3 | 24. | 1565. | 1550. | 89. | 8734. | 5328. | 11.68 | 11.57 | 9.98 |
| Sub-Sahara T | 102. | 5694. | 5719. | 568. | 38493. | 29407. | 15.38 | 16.74 | 14.62 |
| Total | 312. | 8501. | 8971. | 1984. | 60926. | 52408. | 16.65 | 17.84 | 15.85 |

Table A9. Value of commercial wheat imports, total merchandise imports, total merchandise exports and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: | 66-68 average Rice | 66-68 average Coarse Gr. | 66-68 average All grains | 78-80 average Rice | 78-80 average Coarse Gr. | 78-80 average All grains | Average Annual Growth rates 66-68 to 78-80 Rice | Average Annual Growth rates 66-68 to 78-80 Coarse Gr. | Average Annual Growth rates 66-68 to 78-80 All grains |
|---|---|---|---|---|---|---|---|---|---|
| country | val com im mill $ | val com im mill $ | val com im mill $ | val com im mill $ | val com im mill $ | val com im mill $ | val com im % | val com im % | val com im % |
| tunisia | 0. | 1. | 11. | 1. | 27. | 116. | 5.43 | 31.14 | 21.47 |
| algeria | 0. | 6. | 51. | 6. | 63. | 450. | 24.78 | 22.48 | 19.93 |
| morocco | 0. | 3. | 23. | 0. | 20. | 267. | 3.14 | 18.01 | 22.76 |
| libya | 3. | 3. | 17. | 16. | 19. | 117. | 16.33 | 18.07 | 17.46 |
| Egypt | 0. | 11. | 135. | 0. | 66. | 682. | 17.76 | 16.18 | 14.48 |
| North Africa | 4. | 23. | 236. | 23. | 194. | 1633. | 16.97 | 19.59 | 17.47 |
| lesotho | 0. | 3. | 4. | 1. | 13. | 24. | - | 13.17 | 15.16 |
| sudan | 1. | 0. | 11. | 2. | 1. | 44. | 4.05 | 11.77 | 11.93 |
| zambia | 1. | 2. | 7. | 3. | 23. | 42. | 13.77 | 22.38 | 16.00 |
| ethiopia | 0. | 0. | 2. | 0. | 6. | 34. | -4.12 | 33.50 | 24.41 |
| zimbabwe | 1. | 2. | 8. | 2. | 6. | 8. | 7.92 | 7.82 | -0.40 |
| Kenya * | 1. | 1. | 3. | 2. | 14. | 28. | 7.45 | 28.72 | 20.57 |
| angola | 0. | 2. | 7. | 7. | 11. | 32. | 25.91 | 16.73 | 13.99 |
| tanzania | 3. | 3. | 10. | 6. | 1. | 7. | 4.60 | -4.61 | -2.38 |
| Sub-Sahara 1 | 7. | 13. | 52. | 22. | 75. | 218. | 9.55 | 15.98 | 12.60 |
| mauritius | 9. | 1. | 14. | 27. | 5. | 45. | 9.55 | 10.63 | 10.52 |
| gabon | 0. | 2. | 3. | 4. | 7. | 18. | 24.27 | 12.51 | 16.25 |
| sao tome etc | 0. | 0. | 1. | 1. | 0. | 2. | 12.38 | -3.16 | 6.52 |
| congo | 0. | 1. | 3. | 2. | 4. | 21. | 16.82 | 15.42 | 18.77 |
| reunion | 7. | 2. | 11. | 20. | 13. | 46. | 9.19 | 15.27 | 12.32 |
| cape verde | 0. | 0. | 1. | 2. | 6. | 9. | 14.95 | 22.99 | 18.45 |
| mauritania | 2. | 2. | 5. | 11. | 6. | 24. | 17.18 | 8.50 | 13.52 |
| botswana | 0. | 9. | 9. | 1. | 20. | 26. | - | 6.84 | 9.25 |
| senegal | 29. | 0. | 35. | 62. | 3. | 80. | 6.62 | 17.14 | 7.18 |
| ivory coast | 6. | 1. | 15. | 62. | 14. | 111. | 20.88 | 23.81 | 18.01 |
| somalia | 3. | 0. | 5. | 18. | 1. | 23. | 16.11 | 13.99 | 13.11 |
| Nigeria | 0. | 6. | 20. | 273. | 127. | 597. | 75.62 | 28.37 | 32.64 |
| ghana | 5. | 1. | 10. | 15. | 11. | 50. | 9.17 | 18.97 | 14.10 |
| cameroon | 1. | 3. | 8. | 11. | 19. | 52. | 20.11 | 16.14 | 16.88 |
| Sub-Sahara 2 | 63. | 31. | 140. | 508. | 235. | 1102. | 18.94 | 18.48 | 18.75 |
| mozambique | 0. | 2. | 7. | 27. | 20. | 56. | 88.78 | 20.75 | 19.62 |
| gambia | 1. | 0. | 1. | 5. | 2. | 8. | 14.08 | 24.06 | 14.84 |
| benin | 1. | 0. | 2. | 4. | 2. | 13. | 10.41 | 17.68 | 15.25 |
| togo | 0. | 0. | 2. | 4. | 2. | 12. | 21.45 | 17.42 | 17.93 |
| liberia | 7. | 0. | 8. | 25. | 2. | 29. | 11.43 | 14.69 | 11.91 |
| sierra leone | 4. | 1. | 8. | 12. | 2. | 20. | 9.46 | 6.95 | 8.02 |
| madagascar | 1. | 0. | 3. | 61. | 1. | 69. | 44.45 | 13.46 | 30.61 |
| comoros | 1. | 0. | 2. | 6. | 0. | 6. | 11.99 | 4.71 | 11.88 |
| guinea | 2. | 0. | 3. | 26. | 1. | 29. | 22.19 | 8.88 | 20.40 |
| zaire | 1. | 9. | 10. | 4. | 56. | 90. | 13.72 | 16.57 | 20.10 |
| guin bissau | 1. | 0. | 2. | 12. | 2. | 15. | 20.80 | 19.93 | 19.30 |
| upper volta | 0. | 0. | 2. | 3. | 5. | 13. | 17.29 | 28.43 | 14.71 |
| cent afr emp | 0. | 0. | 1. | 0. | 1. | 4. | 5.31 | 11.80 | 8.91 |
| niger | 0. | 0. | 1. | 9. | 0. | 11. | 41.96 | 1.62 | 19.92 |
| chad | 0. | 0. | 2. | 1. | 1. | 2. | 41.74 | 6.37 | 2.04 |
| burundi | 0. | 1. | 1. | 1. | 4. | 8. | 13.58 | 15.45 | 14.83 |
| mali | 0. | 0. | 1. | 16. | 2. | 21. | 79.11 | 20.78 | 26.98 |
| swaziland | 0. | 4. | 4. | 0. | 8. | 8. | - | 6.68 | 6.68 |
| rwanda | 0. | 0. | 1. | 2. | 5. | 6. | 21.38 | 31.75 | 21.40 |
| malawi | 0. | 0. | 1. | 0. | 8. | 9. | -22.69 | 46.00 | 19.90 |
| uganda | 2. | 0. | 5. | 4. | 2. | 6. | 8.26 | 12.42 | 1.53 |
| namibia | 0. | 2. | 2. | 0. | 6. | 6. | - | 7.84 | 7.84 |
| Sub-Sahara 3 | 23. | 23. | 69. | 220. | 134. | 443. | 20.88 | 15.76 | 16.70 |
| Sub-Sahara T | 93. | 66. | 262. | 751. | 444. | 1763. | 18.96 | 17.14 | 17.22 |
| Total | 97. | 89. | 498. | 774. | 638. | 3395. | 18.89 | 17.82 | 17.34 |

Table A10. Value of commercial rice, coarse grains and all grains imports and average annual growth rates (1966-68 to 1978-80)

COMMODITY: Wheat

| country | 66-68 average tot util. 1000 mt | 66-68 average food 1000 mt | 78-80 average tot util. 1000 mt | 78-80 average food 1000 mt | Average Annual Growth rates 66-68 to 78-80 tot util. % | Average Annual Growth rates 66-68 to 78-80 food % |
|---|---|---|---|---|---|---|
| tunisia | 802. | 641. | 1347. | 976. | 4.41 | 3.57 |
| algeria | 1807. | 1337. | 3217. | 2434. | 4.92 | 5.12 |
| morocco | 2439. | 1544. | 3474. | 2540. | 2.99 | 4.24 |
| libya | 204. | 168. | 570. | 410. | 8.96 | 7.72 |
| Egypt | 3632. | 2726. | 6990. | 4762. | 5.61 | 4.76 |
| North Africa | 8883. | 6415. | 15598. | 11121. | 4.80 | 4.69 |
| lesotho | 68. | 50. | 98. | 87. | 3.17 | 4.77 |
| sudan | 238. | 214. | 554. | 461. | 7.27 | 6.61 |
| zambia | 50. | 42. | 127. | 114. | 8.02 | 8.73 |
| ethiopia | 616. | 504. | 712. | 604. | 1.22 | 1.52 |
| zimbabwe | 102. | 80. | 171. | 130. | 4.38 | 4.05 |
| Kenya * | 133. | 98. | 257. | 219. | 5.63 | 6.94 |
| angola | 73. | 63. | 86. | 78. | 1.39 | 1.88 |
| tanzania | 77. | 61. | 122. | 113. | 3.88 | 5.33 |
| Sub-Sahara 1 | 1358. | 1111. | 2128. | 1806. | 3.81 | 4.14 |
| mauritius | 38. | 38. | 58. | 58. | 3.52 | 3.63 |
| gabon | 8. | 8. | 18. | 26. | 7.00 | 10.55 |
| sao tome etc | 2. | 2. | 3. | 3. | 2.62 | 3.52 |
| congo | 17. | 15. | 53. | 52. | 9.78 | 11.16 |
| reunion | 10. | 9. | 23. | 17. | 7.05 | 5.80 |
| cape verde | 3. | 3. | 13. | 10. | 14.26 | 11.44 |
| mauritania | 12. | 10. | 56. | 49. | 13.35 | 14.28 |
| botswana | 2. | 2. | 19. | 19. | 20.82 | 21.33 |
| senegal | 41. | 98. | 98. | 103. | 7.56 | 0.39 |
| ivory coast | 71. | 57. | 153. | 140. | 6.60 | 7.77 |
| somalia | 21. | 23. | 68. | 64. | 10.24 | 8.96 |
| Nigeria | 158. | 122. | 1009. | 900. | 16.72 | 18.15 |
| ghana | 62. | 60. | 152. | 127. | 7.72 | 6.42 |
| cameroon | 36. | 33. | 98. | 86. | 8.62 | 8.32 |
| Sub-Sahara 2 | 483. | 478. | 1821. | 1653. | 11.70 | 10.90 |
| mozambique | 68. | 56. | 136. | 112. | 5.96 | 5.97 |
| gambia | 2. | 2. | 6. | 6. | 8.52 | 8.48 |
| benin | 7. | 7. | 28. | 28. | 12.02 | 12.27 |
| togo | 7. | 7. | 25. | 21. | 11.04 | 9.54 |
| liberia | 6. | 5. | 15. | 14. | 8.81 | 8.33 |
| sierra leone | 24. | 22. | 25. | 24. | 0.41 | 0.81 |
| madagascar | 23. | 23. | 48. | 47. | 6.18 | 6.18 |
| comoros | 1. | 1. | 2. | 2. | 2.69 | 2.69 |
| guinea | 14. | 18. | 30. | 28. | 6.38 | 3.74 |
| zaire | 65. | 62. | 142. | 124. | 6.80 | 5.87 |
| guin bissau | 2. | 2. | 2. | 2. | 2.21 | 2.21 |
| upper volta | 14. | 14. | 32. | 28. | 7.30 | 6.32 |
| cent afr emp | 10. | 8. | 9. | 9. | -0.26 | 0.79 |
| niger | 5. | 4. | 22. | 19. | 13.94 | 12.90 |
| chad | 12. | 10. | 18. | 16. | 3.57 | 4.02 |
| burundi | 13. | 11. | 15. | 14. | 1.37 | 2.33 |
| mali | 11. | 10. | 22. | 21. | 6.22 | 6.24 |
| swaziland | 0. | 0. | 1. | 1. | - | - |
| rwanda | 3. | 3. | 11. | 9. | 11.97 | 10.96 |
| malawi | 11. | 11. | 8. | 8. | -2.86 | -2.95 |
| uganda | 28. | 24. | 15. | 11. | -5.01 | -6.33 |
| namibia | 1. | 0. | 1. | 1. | 2.43 | 2.46 |
| Sub-Sahara 3 | 325. | 302. | 614. | 545. | 5.44 | 5.06 |
| Sub-Sahara T | 2166. | 1890. | 4563. | 4004. | 6.41 | 6.46 |
| Total | 11049. | 8305. | 20161. | 15125. | 5.14 | 5.12 |

Table A11. Wheat -- Total utilization and food and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: Rice | 66-68 average | | 78-80 average | | Average Annual Growth rates 66-68 to 78-80 | |
|---|---|---|---|---|---|---|
| country | tot util. 1000 mt | food 1000 mt | tot util. 1000 mt | food 1000 mt | tot util. % | food % |
| tunisia | 1. | 1. | 1. | 1. | -2.52 | -2.52 |
| algeria | 6. | 5. | 13. | 13. | 7.11 | 8.41 |
| morocco | 17. | 13. | 13. | 10. | -2.17 | -1.98 |
| libya | 13. | 13. | 39. | 35. | 9.36 | 8.94 |
| Egypt | 1073. | 779. | 1511. | 1129. | 2.89 | 3.15 |
| North Africa | 1111. | 810. | 1578. | 1189. | 2.96 | 3.25 |
| lesotho | 0. | 0. | 2. | 2. | - | - |
| sudan | 6. | 6. | 9. | 8. | 3.54 | 2.82 |
| zambia | 3. | 3. | 10. | 9. | 9.71 | 9.23 |
| ethiopia | 3. | 3. | 0. | 0. | -16.17 | -16.17 |
| zimbabwe | 5. | 5. | 4. | 4. | -2.09 | -1.59 |
| Kenya * | 11. | 9. | 32. | 28. | 9.17 | 9.63 |
| angola | 17. | 15. | 30. | 28. | 5.05 | 5.63 |
| tanzania | 99. | 77. | 189. | 150. | 5.50 | 5.75 |
| Sub-Sahara 1 | 145. | 118. | 276. | 230. | 5.54 | 5.75 |
| mauritius | 56. | 57. | 71. | 67. | 1.99 | 1.38 |
| gabon | 2. | 2. | 6. | 6. | 11.14 | 11.48 |
| sao tome etc | 1. | 1. | 2. | 2. | 3.09 | 2.65 |
| congo | 3. | 3. | 6. | 6. | 5.08 | 5.19 |
| reunion | 40. | 35. | 52. | 42. | 2.21 | 1.68 |
| cape verde | 1. | 1. | 5. | 5. | 11.03 | 11.57 |
| mauritania | 11. | 11. | 50. | 48. | 13.27 | 13.25 |
| botswana | 0. | 0. | 3. | 3. | - | - |
| senegal | 303. | 289. | 388. | 369. | 2.08 | 2.06 |
| ivory coast | 268. | 187. | 491. | 388. | 5.17 | 6.27 |
| somalia | 16. | 16. | 55. | 58. | 11.05 | 11.49 |
| Nigeria | 210. | 147. | 806. | 655. | 11.85 | 13.29 |
| ghana | 73. | 57. | 74. | 62. | 0.11 | 0.63 |
| cameroon | 18. | 17. | 60. | 58. | 10.45 | 10.87 |
| Sub-Sahara 2 | 1004. | 822. | 2069. | 1768. | 6.21 | 6.59 |
| mozambique | 53. | 42. | 114. | 103. | 6.62 | 7.74 |
| gambia | 29. | 24. | 43. | 38. | 3.28 | 3.86 |
| benin | 6. | 5. | 19. | 17. | 9.91 | 10.05 |
| togo | 17. | 11. | 24. | 22. | 3.17 | 5.41 |
| liberia | 134. | 110. | 228. | 196. | 4.50 | 4.95 |
| sierra leone | 325. | 249. | 396. | 323. | 1.66 | 2.20 |
| madagascar | 1103. | 792. | 1593. | 1132. | 3.11 | 3.02 |
| comoros | 16. | 15. | 23. | 19. | 3.01 | 2.17 |
| guinea | 246. | 198. | 311. | 292. | 1.95 | 3.31 |
| zaire | 107. | 87. | 179. | 146. | 4.41 | 4.37 |
| guin bissau | 38. | 31. | 55. | 50. | 3.05 | 4.00 |
| upper volta | 29. | 24. | 30. | 26. | 0.16 | 0.65 |
| cent afr emp | 5. | 4. | 12. | 9. | 6.93 | 8.11 |
| niger | 21. | 14. | 38. | 32. | 4.88 | 7.20 |
| chad | 23. | 17. | 37. | 26. | 3.89 | 3.41 |
| burundi | 2. | 2. | 7. | 6. | 9.17 | 8.94 |
| mali | 103. | 87. | 154. | 143. | 3.34 | 4.28 |
| swaziland | 0. | 0. | 3. | 3. | 22.42 | 26.66 |
| rwanda | 1. | 1. | 6. | 5. | 16.20 | 15.78 |
| malawi | 7. | 5. | 28. | 22. | 12.94 | 12.99 |
| uganda | 10. | 9. | 17. | 15. | 4.54 | 4.16 |
| namibia | 0. | 0. | 0. | 0. | - | - |
| Sub-Sahara 3 | 2278. | 1728. | 3318. | 2625. | 3.18 | 3.55 |
| Sub-Sahara T | 3426. | 2668. | 5663. | 4623. | 4.28 | 4.69 |
| Total | 4538. | 3478. | 7241. | 5812. | 3.97 | 4.37 |

Table A12. Rice -- Total utilization and food and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: Coarse Gr. | 66-68 average | | 78-80 average | | Average Annual Growth rates 66-68 to 78-80 | |
|---|---|---|---|---|---|---|
| country | tot util. 1000 mt | food 1000 mt | tot util. 1000 mt | food 1000 mt | tot util. % | food % |
| tunisia | 222. | 83. | 475. | 60. | 6.56 | -2.69 |
| algeria | 404. | 260. | 1057. | 317. | 8.34 | 1.67 |
| morocco | 2236. | 972. | 2553. | 1415. | 1.11 | 3.18 |
| libya | 137. | 34. | 243. | 39. | 4.88 | 1.19 |
| Egypt | 3398. | 1983. | 4544. | 2273. | 2.45 | 1.14 |
| North Africa | 6397. | 3332. | 8872. | 4104. | 2.76 | 1.75 |
| lesotho | 200. | 142. | 276. | 182. | 2.73 | 2.11 |
| sudan | 1493. | 1361. | 2642. | 2287. | 4.87 | 4.42 |
| zambia | 862. | 626. | 1008. | 708. | 1.31 | 1.03 |
| ethiopia | 3442. | 3030. | 3810. | 3432. | 0.85 | 1.04 |
| zimbabwe | 1163. | 701. | 1445. | 882. | 1.83 | 1.92 |
| Kenya | 2090. | 1460. | 2391. | 1822. | 1.13 | 1.86 |
| angola | 360. | 301. | 459. | 374. | 2.04 | 1.81 |
| tanzania | 1065. | 902. | 1325. | 1159. | 1.84 | 2.11 |
| Sub-Sahara 1 | 10676. | 8524. | 13357. | 10846. | 1.88 | 2.03 |
| mauritius | 9. | 8. | 18. | 8. | 5.73 | 0.18 |
| gabon | 4. | 4. | 23. | 15. | 14.69 | 11.77 |
| sao tome etc | 3. | 3. | 3. | 2. | -0.26 | -0.98 |
| congo | 8. | 6. | 21. | 20. | 8.73 | 9.83 |
| reunion | 35. | 10. | 61. | 13. | 4.82 | 1.65 |
| cape verde | 12. | 19. | 46. | 35. | 11.90 | 5.36 |
| mauritania | 127. | 108. | 78. | 67. | -4.03 | -3.92 |
| botswana | 109. | 82. | 104. | 86. | -0.40 | 0.34 |
| senegal | 601. | 578. | 738. | 596. | 1.73 | 0.25 |
| ivory coast | 267. | 192. | 415. | 276. | 3.76 | 3.09 |
| somalia | 269. | 237. | 244. | 198. | -0.81 | -1.49 |
| Nigeria | 6391. | 5093. | 8806. | 6520. | 2.71 | 2.08 |
| ghana | 547. | 399. | 589. | 483. | 0.61 | 1.60 |
| cameroon | 681. | 541. | 920. | 734. | 2.54 | 2.58 |
| Sub-Sahara 2 | 9063. | 7280. | 12067. | 9052. | 2.41 | 1.83 |
| mozambique | 620. | 553. | 601. | 524. | -0.25 | -0.45 |
| gambia | 46. | 36. | 53. | 39. | 1.13 | 0.68 |
| benin | 289. | 193. | 401. | 247. | 2.77 | 2.07 |
| togo | 245. | 158. | 295. | 226. | 1.55 | 3.03 |
| liberia | 4. | 4. | 10. | 7. | 8.04 | 5.65 |
| sierra leone | 26. | 22. | 44. | 38. | 4.25 | 4.42 |
| madagascar | 145. | 108. | 127. | 95. | -1.11 | -1.07 |
| comoros | 3. | 2. | 5. | 3. | 3.26 | 3.22 |
| guinea | 148. | 102. | 130. | 87. | -1.06 | -1.30 |
| zaire | 638. | 562. | 928. | 819. | 3.17 | 3.19 |
| guin bissau | 25. | 22. | 26. | 23. | 0.31 | 0.47 |
| upper volta | 1042. | 811. | 1182. | 1036. | 1.06 | 2.06 |
| cenl afr emp | 84. | 74. | 83. | 67. | -0.04 | -0.75 |
| niger | 1096. | 736. | 1618. | 934. | 3.29 | 2.00 |
| chad | 675. | 537. | 605. | 472. | -0.91 | -1.07 |
| burundi | 266. | 229. | 322. | 278. | 1.60 | 1.63 |
| mali | 920. | 709. | 1027. | 876. | 0.92 | 1.78 |
| swaziland | 90. | 54. | 133. | 80. | 3.27 | 3.24 |
| rwanda | 189. | 154. | 254. | 205. | 2.51 | 2.42 |
| malawi | 1092. | 747. | 1408. | 1108. | 2.14 | 3.33 |
| uganda | 1120. | 815. | 1384. | 1025. | 1.78 | 1.93 |
| namibia | 76. | 76. | 112. | 103. | 3.26 | 2.61 |
| Sub-Sahara 3 | 8840. | 6704. | 10748. | 8292. | 1.64 | 1.79 |
| Sub-Sahara T | 28579. | 22509. | 36171. | 28191. | 1.98 | 1.89 |
| Total | 34976. | 25840. | 45043. | 32295. | 2.13 | 1.88 |

Table A13. Coarse Grains -- Total utilization and food and average annual growth rates (1966-68 to 1978-80)

COMMODITY: All grains

| country | 66-68 average tot util. 1000 mt | 66-68 average food 1000 mt | 78-80 average tot util. 1000 mt | 78-80 average food 1000 mt | Average Annual Growth rates 66-68 to 78-80 tot util. % | Average Annual Growth rates 66-68 to 78-80 food % |
|---|---|---|---|---|---|---|
| tunisia | 1026. | 725. | 1823. | 1037. | 4.91 | 3.02 |
| algeria | 2217. | 1602. | 4287. | 2765. | 5.65 | 4.65 |
| morocco | 4692. | 2528. | 6041. | 3965. | 2.13 | 3.82 |
| libya | 354. | 215. | 852. | 485. | 7.59 | 7.03 |
| Egypt | 8102. | 5487. | 13044. | 8163. | 4.05 | 3.37 |
| North Africa | 16391. | 10557. | 26047. | 16414. | 3.94 | 3.75 |
| lesotho | 268. | 191. | 376. | 271. | 2.88 | 2.93 |
| sudan | 1738. | 1581. | 3205. | 2756. | 5.23 | 4.74 |
| zambia | 915. | 671. | 1145. | 831. | 1.88 | 1.80 |
| ethiopia | 4060. | 3537. | 4523. | 4036. | 0.90 | 1.11 |
| zimbabwe | 1271. | 787. | 1620. | 1015. | 2.05 | 2.15 |
| Kenya * | 2235. | 1568. | 2680. | 2070. | 1.53 | 2.34 |
| angola | 450. | 379. | 576. | 480. | 2.07 | 2.00 |
| tanzania | 1242. | 1040. | 1636. | 1423. | 2.32 | 2.65 |
| Sub-Sahara 1 | 12178. | 9753. | 15761. | 12882. | 2.17 | 2.35 |
| mauritius | 103. | 102. | 147. | 133. | 2.97 | 2.19 |
| gabon | 14. | 13. | 47. | 47. | 10.58 | 11.04 |
| sao tome etc | 6. | 6. | 8. | 7. | 1.53 | 1.51 |
| congo | 28. | 24. | 80. | 78. | 9.03 | 10.19 |
| reunion | 85. | 54. | 136. | 72. | 4.00 | 2.47 |
| cape verde | 16. | 23. | 64. | 50. | 12.24 | 6.78 |
| mauritania | 151. | 129. | 183. | 164. | 1.64 | 2.04 |
| botswana | 111. | 84. | 127. | 107. | 1.07 | 2.05 |
| senegal | 945. | 966. | 1224. | 1068. | 2.18 | 0.84 |
| ivory coast | 606. | 436. | 1060. | 805. | 4.77 | 5.24 |
| somalia | 306. | 275. | 368. | 320. | 1.54 | 1.25 |
| Nigeria | 6759. | 5361. | 10621. | 8074. | 3.84 | 3.47 |
| ghana | 683. | 516. | 815. | 671. | 1.48 | 2.21 |
| cameroon | 736. | 591. | 1078. | 878. | 3.24 | 3.36 |
| Sub-Sahara 2 | 10550. | 8580. | 15957. | 12473. | 3.51 | 3.17 |
| mozambique | 741. | 651. | 852. | 740. | 1.17 | 1.07 |
| gambia | 78. | 63. | 102. | 83. | 2.29 | 2.40 |
| benin | 302. | 206. | 447. | 293. | 3.33 | 2.98 |
| togo | 269. | 176. | 344. | 269. | 2.08 | 3.56 |
| liberia | 144. | 119. | 253. | 218. | 4.82 | 5.16 |
| sierra leone | 375. | 293. | 464. | 385. | 1.80 | 2.30 |
| madagascar | 1271. | 922. | 1768. | 1273. | 2.79 | 2.72 |
| comoros | 21. | 18. | 30. | 24. | 3.04 | 2.34 |
| guinea | 409. | 318. | 471. | 407. | 1.19 | 2.09 |
| zaire | 810. | 712. | 1250. | 1088. | 3.68 | 3.60 |
| guin bissau | 65. | 54. | 83. | 75. | 2.06 | 2.70 |
| upper volta | 1085. | 849. | 1244. | 1090. | 1.15 | 2.11 |
| cent afr emp | 99. | 85. | 105. | 85. | 0.49 | -0.00 |
| niger | 1122. | 755. | 1678. | 985. | 3.41 | 2.25 |
| chad | 710. | 564. | 660. | 514. | -0.61 | -0.78 |
| burundi | 281. | 242. | 344. | 298. | 1.69 | 1.76 |
| mali | 1034. | 806. | 1202. | 1041. | 1.26 | 2.15 |
| swaziland | 91. | 54. | 137. | 83. | 3.53 | 3.60 |
| rwanda | 192. | 157. | 271. | 219. | 2.88 | 2.80 |
| malawi | 1110. | 764. | 1444. | 1137. | 2.22 | 3.37 |
| uganda | 1158. | 848. | 1416. | 1051. | 1.69 | 1.80 |
| namibia | 77. | 76. | 113. | 104. | 3.26 | 2.61 |
| Sub-Sahara 3 | 11443. | 8734. | 14680. | 11463. | 2.10 | 2.29 |
| Sub-Sahara T | 34171. | 27066. | 46398. | 36818. | 2.58 | 2.60 |
| Total | 50562. | 37623. | 72445. | 53233. | 3.04 | 2.93 |

Table A14. All Grains -- Total utilization and food and average annual growth rates (1966-68 to 1978-80)

COMMODITY: Wheat

| country | 66-68 average prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | 78-80 average prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | Average Annual Growth rates 66-68 to 78-80 'prod/cap % | com imp/cp % | aid/cap % | food/cap % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tunisia | 125. | 28. | 29. | 133. | 122. | 83. | 13. | 157. | -0.21 | 9.50 | -6.27 | 1.40 |
| algeria | 94. | 49. | 11. | 110. | 67. | 111. | 1. | 135. | -2.76 | 6.99 | -17.53 | 1.73 |
| morocco | 124. | 20. | 31. | 111. | 93. | 79. | 5. | 129. | -2.37 | 11.98 | -13.63 | 1.27 |
| libya | 33. | 84. | 0. | 97. | 37. | 145. | 0. | 131. | 0.98 | 4.64 | - | 2.58 |
| Egypt | 46. | 57. | 14. | 88. | 46. | 91. | 35. | 116. | -0.11 | 3.93 | 7.52 | 2.33 |
| North Africa | 78. | 46. | 18. | 101. | 66. | 94. | 18. | 127. | -1.42 | 6.08 | 0.16 | 1.89 |
| lesotho | 53. | 19. | 0. | 50. | 31. | 45. | 0. | 67. | -4.46 | 7.23 | - | 2.39 |
| sudan | 6. | 9. | 3. | 16. | 15. | 12. | 4. | 26. | 8.14 | 1.90 | 2.87 | 3.89 |
| zambia | 0. | 13. | 0. | 11. | 1. | 20. | 2. | 21. | 32.08 | 3.54 | 54.04 | 5.47 |
| ethiopia | 25. | 1. | 0. | 21. | 14. | 6. | 3. | 19. | -4.63 | 16.24 | 25.53 | -0.97 |
| zimbabwe | 3. | 18. | 0. | 17. | 25. | 0. | 0. | 18. | 18.59 | -33.62 | - | 0.60 |
| Kenya * | 17. | 2. | 0. | 10. | 12. | 4. | 1. | 14. | -2.68 | 7.86 | 34.15 | 3.09 |
| angola | 5. | 10. | 0. | 12. | 1. | 10. | 1. | 11. | -9.43 | 0.53 | - | -0.29 |
| tanzania | 3. | 3. | 0. | 5. | 4. | 0. | 3. | 7. | 2.12 | - | - | 2.33 |
| Sub-Sahara 1 | 13. | 6. | 1. | 15. | 12. | 7. | 2. | 17. | -0.91 | 1.61 | 12.50 | 1.25 |
| mauritius | 0. | 48. | 0. | 47. | 0. | 45. | 14. | 59. | - | -0.53 | - | 1.87 |
| gabon | 0. | 16. | 0. | 16. | 0. | 40. | 0. | 47. | - | 8.00 | - | 9.58 |
| sao tome etc | 0. | 33. | 0. | 28. | 0. | 38. | 0. | 36. | - | 1.21 | - | 2.09 |
| congo | 0. | 17. | 0. | 13. | 0. | 35. | 0. | 35. | - | 6.10 | - | 8.52 |
| reunion | 0. | 24. | 0. | 21. | 0. | 44. | 0. | 33. | - | 5.07 | - | 3.82 |
| cape verde | 0. | 10. | 0. | 11. | 0. | 40. | 0. | 31. | - | 11.91 | - | 9.10 |
| mauritania | 0. | 10. | 0. | 9. | 0. | 20. | 15. | 31. | -3.54 | 5.49 | 54.51 | 11.27 |
| botswana | 1. | 3. | 0. | 3. | 1. | 18. | 6. | 23. | -0.02 | 17.47 | - | 18.28 |
| senegal | 0. | 16. | 0. | 25. | 0. | 17. | 6. | 19. | - | 0.50 | 26.82 | -2.55 |
| ivory coast | 0. | 18. | 0. | 12. | 0. | 22. | 0. | 18. | - | 1.74 | - | 3.21 |
| somalia | 0. | 8. | 0. | 9. | 0. | 4. | 15. | 18. | - | -5.09 | 45.59 | 6.20 |
| Nigeria | 0. | 3. | 0. | 2. | 0. | 15. | 0. | 12. | -2.77 | 15.34 | - | 14.51 |
| ghana | 0. | 4. | 4. | 7. | 0. | 11. | 3. | 11. | - | 8.55 | -1.48 | 3.49 |
| cameroon | 0. | 6. | 0. | 5. | 0. | 12. | 0. | 10. | - | 6.08 | - | 6.09 |
| Sub-Sahara 2 | 0. | 6. | 0. | 6. | 0. | 15. | 1. | 14. | -1.84 | 8.68 | 11.69 | 7.63 |
| mozambique | 1. | 8. | 0. | 7. | 0. | 5. | 8. | 11. | -11.86 | -4.45 | - | 3.33 |
| gambia | 0. | 5. | 0. | 5. | 0. | 7. | 3. | 10. | - | 2.10 | - | 5.26 |
| benin | 0. | 3. | 0. | 3. | 0. | 9. | 1. | 8. | - | 9.51 | - | 9.10 |
| togo | 0. | 4. | 0. | 4. | 0. | 8. | 1. | 8. | - | 6.60 | 26.80 | 6.24 |
| liberia | 0. | 4. | 0. | 4. | 0. | 8. | 1. | 8. | - | 5.07 | 10.39 | 4.78 |
| sierra leone | 0. | 9. | 1. | 9. | 0. | 5. | 2. | 7. | - | -4.75 | 11.45 | -1.63 |
| madagascar | 0. | 4. | 0. | 4. | 0. | 5. | 1. | 6. | - | 2.08 | 24.81 | 3.63 |
| comoros | 0. | 5. | 0. | 5. | 0. | 5. | 0. | 5. | - | 0.51 | - | 0.51 |
| guinea | 0. | 1. | 3. | 5. | 0. | 2. | 4. | 6. | - | 9.76 | 1.59 | 1.26 |
| zaire | 0. | 0. | 3. | 3. | 0. | 5. | 0. | 4. | -0.06 | 33.78 | -17.93 | 3.20 |
| guin bissau | 0. | 4. | 0. | 4. | 0. | 4. | 0. | 4. | - | 0.96 | - | 0.96 |
| upper volta | 0. | 3. | 0. | 3. | 0. | 3. | 2. | 4. | - | -0.33 | - | 3.80 |
| cent afr emp | 0. | 6. | 0. | 5. | 0. | 4. | 1. | 4. | - | -3.70 | - | -1.35 |
| niger | 0. | 1. | 0. | 1. | 0. | 1. | 3. | 4. | 7.88 | 1.50 | - | 9.84 |
| chad | 2. | 2. | 0. | 3. | 1. | 1. | 2. | 4. | -2.89 | -6.35 | - | 1.84 |
| burundi | 3. | 1. | 0. | 3. | 1. | 2. | 1. | 3. | -10.45 | 3.26 | - | 0.12 |
| mali | 0. | 2. | 0. | 2. | 0. | 1. | 2. | 3. | -2.46 | -2.41 | - | 3.60 |
| swaziland | 0. | 0. | 0. | 0. | 2. | 0. | 0. | 2. | - | - | - | - |
| rwanda | 0. | 1. | 0. | 1. | 1. | 0. | 2. | 2. | 18.05 | -33.74 | - | 7.82 |
| malawi | 0. | 3. | 0. | 3. | 0. | 1. | 0. | 1. | -5.32 | -8.17 | 43.71 | -5.87 |
| uganda | 0. | 4. | 0. | 3. | 1. | 0. | 0. | 1. | 13.13 | -46.56 | - | -9.20 |
| namibia | 1. | 0. | 0. | 1. | 1. | 0. | 0. | 1. | -0.33 | - | - | -0.30 |
| Sub-Sahara 3 | 0. | 3. | 1. | 3. | 0. | 3. | 2. | 5. | -1.07 | 1.73 | 5.98 | 2.34 |
| Sub-Sahara T | 4. | 5. | 1. | 8. | 4. | 9. | 2. | 12. | -0.93 | 5.36 | 9.49 | 3.52 |
| Total | 20. | 13. | 4. | 27. | 17. | 26. | 5. | 35. | -1.38 | 5.84 | 1.74 | 2.24 |

Table A15. Per capita wheat production, commercial imports, aid and food and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: Rice | 66-68 average | | | | 78-80 average | | | | Average Annual Growth rates 66-68 to 78-80 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | prod/cap % | com imp/cp % | aid/cap % | food/cap % |
| tunisia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | -4.42 | - | -4.35 |
| algeria | 0. | 0. | 0. | 0. | 0. | 1. | 0. | 1. | -17.29 | 12.09 | - | 4.96 |
| morocco | 1. | 0. | 0. | 1. | 1. | 0. | 0. | 1. | -6.31 | -5.46 | - | -4.74 |
| libya | 0. | 8. | 0. | 7. | 0. | 13. | 0. | 11. | - | 4.08 | - | 3.70 |
| Egypt | 47. | 0. | 0. | 25. | 39. | 0. | 0. | 28. | -1.49 | 8.31 | - | 0.76 |
| North Africa | 23. | 0. | 0. | 13. | 19. | 1. | 0. | 14. | -1.92 | 6.95 | - | 0.49 |
| lesotho | 0. | 0. | 0. | 0. | 0. | 1. | 0. | 1. | - | - | - | - |
| sudan | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 13.71 | -3.46 | - | 0.19 |
| zambia | 0. | 1. | 0. | 1. | 0. | 1. | 0. | 2. | 36.56 | 3.88 | - | 5.94 |
| ethiopia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | -18.22 | - | -18.22 |
| zimbabwe | 0. | 1. | 0. | 1. | 0. | 1. | 0. | 1. | -18.60 | -1.85 | - | -4.90 |
| Kenya * | 1. | 0. | 0. | 1. | 2. | 0. | 0. | 2. | 3.83 | 2.12 | - | 5.60 |
| angola | 3. | 0. | 0. | 3. | 2. | 2. | 0. | 4. | -4.29 | 17.43 | - | 3.34 |
| tanzania | 7. | 1. | 0. | 6. | 9. | 1. | 1. | 9. | 2.36 | -4.48 | - | 2.72 |
| Sub-Sahara 1 | 2. | 0. | 0. | 2. | 2. | 1. | 0. | 2. | 2.03 | 0.45 | - | 2.83 |
| mauritius | 0. | 71. | 0. | 72. | 0. | 72. | 0. | 69. | 9.50 | 0.13 | - | -0.37 |
| gabon | 1. | 3. | 0. | 3. | 1. | 10. | 0. | 11. | 0.44 | 11.78 | - | 10.52 |
| sao tome etc | 0. | 17. | 0. | 17. | 0. | 20. | 0. | 20. | - | 1.66 | - | 1.22 |
| congo | 2. | 1. | 0. | 3. | 2. | 2. | 0. | 4. | 0.39 | 4.52 | - | 2.68 |
| reunion | 0. | 98. | 0. | 85. | 0. | 101. | 0. | 82. | - | 0.29 | - | -0.23 |
| cape verde | 0. | 6. | 0. | 6. | 0. | 16. | 0. | 16. | - | 8.69 | - | 9.23 |
| mauritania | 0. | 9. | 0. | 9. | 2. | 30. | 0. | 30. | 14.72 | 10.05 | - | 10.26 |
| botswana | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 4. | - | - | - | - |
| senegal | 31. | 48. | 0. | 75. | 24. | 47. | 0. | 67. | -2.10 | -0.25 | - | -0.93 |
| ivory coast | 47. | 8. | 2. | 40. | 41. | 22. | 0. | 50. | -1.20 | 8.43 | - | 1.80 |
| somalia | 0. | 6. | 0. | 6. | 1. | 12. | 2. | 16. | - | 5.82 | - | 8.62 |
| Nigeria | 4. | 0. | 0. | 3. | 5. | 5. | 0. | 9. | 2.59 | 58.74 | - | 9.86 |
| ghana | 4. | 3. | 2. | 7. | 4. | 3. | 0. | 5. | -1.68 | -0.51 | - | -2.18 |
| cameroon | 2. | 1. | 0. | 3. | 4. | 4. | 0. | 7. | 5.75 | 11.47 | - | 8.57 |
| Sub-Sahara 2 | 7. | 5. | 0. | 10. | 8. | 10. | 0. | 15. | 0.81 | 6.08 | -10.04 | 3.45 |
| mozambique | 8. | 0. | 0. | 6. | 4. | 6. | 1. | 10. | -4.33 | 73.28 | - | 5.14 |
| gambia | 51. | 20. | 0. | 59. | 27. | 44. | 3. | 65. | -5.23 | 6.78 | - | 0.79 |
| benin | 0. | 2. | 0. | 2. | 2. | 3. | 0. | 5. | 17.43 | 3.15 | - | 6.92 |
| togo | 8. | 1. | 0. | 6. | 5. | 4. | 0. | 8. | -3.10 | 9.77 | - | 2.25 |
| liberia | 80. | 28. | 3. | 90. | 93. | 33. | 0. | 109. | 1.30 | 1.34 | -30.65 | 1.55 |
| sierra leone | 118. | 11. | 0. | 99. | 110. | 7. | 0. | 96. | -0.56 | -4.05 | -22.41 | -0.29 |
| madagascar | 179. | 1. | 0. | 125. | 170. | 17. | 0. | 133. | -0.44 | 32.23 | - | 0.53 |
| comoros | 32. | 33. | 0. | 59. | 27. | 44. | 0. | 59. | -1.33 | 2.42 | - | -0.06 |
| guinea | 61. | 4. | 3. | 54. | 49. | 11. | 4. | 60. | -1.85 | 10.06 | 2.14 | 0.86 |
| zaire | 4. | 0. | 1. | 4. | 5. | 1. | 0. | 5. | 2.34 | 14.42 | -8.40 | 1.77 |
| guin bissau | 63. | 15. | 0. | 64. | 39. | 58. | 0. | 88. | -3.97 | 11.88 | - | 2.73 |
| upper volta | 5. | 1. | 0. | 5. | 3. | 1. | 0. | 4. | -4.74 | 8.08 | - | -1.70 |
| cent afr emp | 3. | 0. | 0. | 2. | 6. | 0. | 0. | 4. | 4.85 | -0.75 | - | 5.91 |
| niger | 6. | 0. | 0. | 4. | 4. | 4. | 0. | 6. | -3.07 | 25.64 | - | 4.32 |
| chad | 7. | 0. | 0. | 5. | 8. | 0. | 0. | 6. | 1.06 | 38.23 | - | 1.16 |
| burundi | 1. | 0. | 0. | 1. | 1. | 0. | 0. | 1. | 8.67 | -0.62 | - | 6.65 |
| mali | 22. | 0. | 0. | 18. | 19. | 5. | 0. | 22. | -0.97 | 60.65 | - | 1.71 |
| swaziland | 10. | 0. | 0. | 0. | 6. | 0. | 0. | 5. | -4.12 | - | - | 23.62 |
| rwanda | 0. | 0. | 0. | 0. | 1. | 1. | 0. | 1. | 20.43 | 8.24 | - | 12.44 |
| malawi | 2. | 0. | 0. | 1. | 6. | 0. | 0. | 4. | 10.27 | -29.52 | - | 9.56 |
| uganda | 0. | 1. | 0. | 1. | 1. | 1. | 0. | 1. | 2.72 | -0.44 | - | 0.79 |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | - | - | - | - |
| Sub-Sahara 3 | 25. | 1. | 0. | 20. | 23. | 5. | 0. | 22. | -0.60 | 9.86 | -1.86 | 0.89 |
| Sub-Sahara T | 12. | 2. | 0. | 11. | 11. | 5. | 0. | 14. | -0.27 | 6.89 | -1.44 | 1.81 |
| Total | 14. | 2. | 0. | 11. | 13. | 4. | 0. | 14. | -0.80 | 6.91 | -1.42 | 1.51 |

Table A16. Per capita rice production, commercial imports, aid and food and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: Coarse Gr. | 66-68 average | | | | 78-80 average | | | | Average Annual Growth rates 66-68 to 78-80 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | prod/cap kg | com imp/cp kg | aid/cap kg | food/cap kg | prod/cap % | com imp/cp % | aid/cap % | food/cap % |
| tunisia | 35. | 3. | 9. | 17. | 45. | 31. | 1. | 10. | 2.03 | 21.50 | -15.95 | -4.74 |
| algeria | 30. | 5. | 0. | 21. | 35. | 24. | 0. | 18. | 1.23 | 14.97 | - | -1.57 |
| morocco | 159. | 2. | 0. | 70. | 125. | 6. | 0. | 72. | -1.97 | 7.60 | - | 0.27 |
| libya | 60. | 18. | 0. | 20. | 41. | 37. | 0. | 13. | -3.23 | 6.03 | - | -3.67 |
| Egypt | 105. | 5. | 0. | 64. | 93. | 13. | 5. | 56. | -0.95 | 7.38 | 48.30 | -1.19 |
| North Africa | 96. | 5. | 1. | 52. | 83. | 16. | 2. | 47. | -1.18 | 10.44 | 9.22 | -0.96 |
| lesotho | 165. | 36. | 0. | 143. | 151. | 60. | 0. | 139. | -0.75 | 4.42 | - | -0.21 |
| sudan | 118. | 0. | 0. | 104. | 151. | 0. | 0. | 128. | 2.10 | 2.78 | - | 1.78 |
| zambia | 250. | 6. | 0. | 164. | 167. | 22. | 0. | 130. | -3.32 | 12.03 | 10.52 | -1.97 |
| ethiopia | 145. | 0. | 0. | 128. | 119. | 1. | 0. | 108. | -1.67 | 23.02 | -21.36 | -1.41 |
| zimbabwe | 287. | 6. | 0. | 147. | 239. | 5. | 0. | 123. | -1.50 | -2.03 | - | -1.44 |
| Kenya * | 215. | 1. | 5. | 144. | 150. | 5. | 0. | 116. | -2.96 | 16.93 | - | -1.82 |
| angola | 87. | 2. | 0. | 57. | 56. | 11. | 0. | 54. | -3.58 | 15.76 | - | -0.37 |
| tanzania | 89. | 1. | 0. | 74. | 75. | 4. | 1. | 67. | -1.34 | 9.58 | 5.93 | -0.83 |
| Sub-Sahara 1 | 151. | 2. | 1. | 115. | 129. | 5. | 0. | 105. | -1.32 | 9.13 | -16.76 | -0.79 |
| mauritius | 1. | 11. | 0. | 10. | 1. | 17. | 0. | 8. | 7.55 | 3.55 | 14.70 | -1.50 |
| gabon | 4. | 5. | 0. | 8. | 16. | 26. | 0. | 28. | 11.82 | 15.05 | - | 10.80 |
| sao tome etc | 6. | 35. | 0. | 39. | 8. | 25. | 0. | 29. | 2.15 | -2.53 | - | -2.36 |
| congo | 4. | 2. | 0. | 6. | 8. | 6. | 0. | 13. | 5.47 | 7.21 | - | 7.19 |
| reunion | 32. | 53. | 0. | 25. | 26. | 92. | 0. | 25. | -1.57 | 4.73 | - | -0.25 |
| cape verde | 32. | 17. | 0. | 76. | 16. | 131. | 0. | 110. | -5.84 | 18.54 | - | 3.16 |
| mauritania | 84. | 26. | 0. | 94. | 18. | 21. | 10. | 42. | -11.93 | -2.04 | 54.96 | -6.46 |
| botswana | 70. | 115. | 0. | 137. | 34. | 103. | 0. | 107. | -5.79 | -0.96 | - | -2.04 |
| senegal | 151. | 2. | 3. | 150. | 127. | 4. | 4. | 108. | -1.48 | 7.47 | 2.66 | -2.69 |
| ivory coast | 57. | 1. | 0. | 41. | 46. | 7. | 0. | 36. | -1.67 | 18.77 | - | -1.25 |
| somalia | 103. | 1. | 0. | 91. | 64. | 3. | 3. | 56. | -3.91 | 11.46 | 44.26 | -3.96 |
| Nigeria | 123. | 1. | 0. | 99. | 114. | 4. | 0. | 87. | -0.62 | 10.45 | - | -1.01 |
| ghana | 66. | 1. | 1. | 49. | 45. | 5. | 2. | 43. | -3.10 | 13.55 | 9.56 | -1.20 |
| cameroon | 105. | 2. | 0. | 84. | 104. | 8. | 0. | 89. | -0.07 | 12.46 | - | 0.44 |
| Sub-Sahara 2 | 107. | 3. | 0. | 89. | 96. | 6. | 1. | 77. | -0.95 | 6.87 | 9.37 | -1.16 |
| mozambique | 86. | 2. | 0. | 73. | 47. | 12. | 0. | 51. | -4.85 | 15.21 | - | -2.86 |
| gambia | 113. | 0. | 0. | 89. | 68. | 15. | 7. | 67. | -4.07 | 40.95 | 34.78 | -2.32 |
| benin | 117. | 1. | 0. | 79. | 115. | 1. | 1. | 72. | -0.15 | -4.39 | - | -0.77 |
| togo | 134. | 1. | 0. | 87. | 109. | 3. | 3. | 86. | -1.71 | 13.67 | 24.14 | -0.03 |
| liberia | 0. | 3. | 0. | 3. | 0. | 5. | 0. | 4. | -52.45 | 4.66 | - | 2.14 |
| sierra leone | 9. | 1. | 0. | 9. | 10. | 3. | 0. | 11. | 0.75 | 7.48 | - | 1.87 |
| madagascar | 23. | 0. | 0. | 17. | 15. | 1. | 0. | 11. | -3.68 | 4.51 | - | -3.45 |
| comoros | 14. | 0. | 0. | 9. | 15. | 0. | 0. | 10. | 1.05 | -3.04 | - | 0.98 |
| guinea | 40. | 1. | 0. | 28. | 25. | 1. | 0. | 18. | -3.74 | -0.36 | 28.94 | -3.63 |
| zaire | 26. | 5. | 0. | 28. | 24. | 10. | 0. | 30. | -0.85 | 5.77 | -0.60 | 0.61 |
| guin bissau | 51. | 1. | 0. | 44. | 32. | 14. | 0. | 40. | -3.86 | 31.03 | | -0.74 |
| upper volta | 205. | 1. | 0. | 160. | 169. | 5. | 2. | 154. | -1.60 | 18.36 | - | -0.32 |
| cent afr emp | 48. | 1. | 0. | 43. | 37. | 2. | 0. | 31. | -2.21 | 2.41 | -23.07 | -2.78 |
| niger | 308. | 1. | 0. | 199. | 315. | 0. | 3. | 181. | 0.19 | -6.65 | - | -0.76 |
| chad | 197. | 0. | 0. | 157. | 136. | 1. | 0. | 107. | -3.03 | 7.48 | - | -3.15 |
| burundi | 77. | 2. | 0. | 68. | 71. | 2. | 0. | 63. | -0.63 | 0.17 | - | -0.56 |
| mali | 191. | 1. | 0. | 148. | 158. | 1. | 0. | 136. | -1.60 | 6.78 | - | -0.72 |
| swaziland | 128. | 95. | 0. | 134. | 155. | 91. | 0. | 147. | 1.60 | -0.40 | - | 0.77 |
| rwanda | 57. | 0. | 0. | 47. | 52. | 2. | 0. | 44. | -0.70 | 15.26 | 4.74 | -0.48 |
| malawi | 282. | 0. | 0. | 181. | 228. | 8. | 0. | 186. | -1.74 | 33.36 | - | 0.24 |
| uganda | 129. | 1. | 0. | 92. | 107. | 1. | 0. | 80. | -1.52 | 2.72 | - | -1.16 |
| namibia | 72. | 37. | 0. | 107. | 63. | 52. | 0. | 105. | -1.11 | 2.94 | - | -0.14 |
| Sub-Sahara 3 | 102. | 3. | 0. | 78. | 85. | 6. | 0. | 70. | -1.49 | 6.65 | 20.31 | -0.82 |
| Sub-Sahara T | 119. | 2. | 0. | 93. | 102. | 6. | 0. | 83. | -1.25 | 7.33 | 1.26 | -0.91 |
| Total | 114. | 3. | 0. | 84. | 98. | 8. | 1. | 76. | -1.23 | 8.47 | 5.12 | -0.91 |

Table A17. Per capita coarse grains production, commercial imports, aid and food and average annual growth rates (1966-68 to 1978-80)

COMMODITY: All grains

| country | 66-68 average prod/cap kg | 66-68 average com imp/cp kg | 66-68 average aid/cap kg | 66-68 average food/cap kg | 78-80 average prod/cap kg | 78-80 average com imp/cp kg | 78-80 average aid/cap kg | 78-80 average food/cap kg | Average Annual Growth rates 66-68 to 78-80 prod/cap % | Growth com imp/cp % | Growth aid/cap % | Growth food/cap % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tunisia | 160. | 31. | 38. | 151. | 166. | 113. | 14. | 167. | 0.34 | 11.40 | -7.80 | 0.86 |
| algeria | 124. | 54. | 11. | 132. | 101. | 136. | 1. | 154. | -1.64 | 7.99 | -17.53 | 1.28 |
| morocco | 285. | 23. | 31. | 182. | 219. | 85. | 5. | 202. | -2.16 | 11.59 | -13.73 | 0.88 |
| libya | 94. | 110. | 0. | 123. | 78. | 194. | 0. | 155. | -1.51 | 4.85 | - | 1.91 |
| Egypt | 198. | 63. | 15. | 178. | 178. | 103. | 40. | 199. | -0.87 | 4.28 | 8.71 | 0.97 |
| North Africa | 197. | 51. | 19. | 166. | 167. | 110. | 21. | 187. | -1.36 | 6.59 | 0.81 | 0.97 |
| lesotho | 218. | 55. | 0. | 193. | 182. | 106. | 0. | 207. | -1.52 | 5.60 | - | 0.59 |
| sudan | 124. | 10. | 3. | 120. | 166. | 12. | 4. | 154. | 2.51 | 1.75 | 2.87 | 2.09 |
| zambia | 250. | 19. | 0. | 176. | 168. | 43. | 2. | 152. | -3.25 | 6.78 | 40.11 | -1.22 |
| ethiopia | 170. | 1. | 0. | 149. | 133. | 7. | 3. | 127. | -2.05 | 16.04 | 17.84 | -1.35 |
| zimbabwe | 290. | 26. | 0. | 165. | 264. | 6. | 0. | 142. | -0.79 | -11.77 | - | -1.23 |
| Kenya * | 232. | 3. | 5. | 155. | 164. | 10. | 1. | 131. | -2.89 | 11.35 | -17.33 | -1.36 |
| angola | 95. | 12. | 0. | 71. | 60. | 23. | 1. | 70. | -3.82 | 5.83 | - | -0.18 |
| tanzania | 98. | 6. | 0. | 85. | 88. | 5. | 5. | 82. | -0.90 | -1.26 | 27.49 | -0.30 |
| Sub-Sahara 1 | 166. | 8. | 1. | 132. | 142. | 12. | 3. | 124. | -1.25 | 3.81 | 5.11 | -0.48 |
| mauritius | 1. | 131. | 0. | 129. | 1. | 135. | 15. | 136. | 7.67 | 0.25 | 52.19 | 0.44 |
| gabon | 5. | 24. | 0. | 27. | 17. | 77. | 0. | 85. | 10.71 | 10.36 | - | 10.07 |
| sao tome etc | 6. | 84. | 0. | 84. | 8. | 84. | 0. | 85. | 2.15 | -0.04 | - | 0.10 |
| congo | 6. | 21. | 0. | 22. | 10. | 43. | 0. | 52. | 4.37 | 6.14 | - | 7.56 |
| reunion | 32. | 175. | 0. | 131. | 26. | 237. | 0. | 140. | -1.57 | 2.58 | - | 0.55 |
| cape verde | 32. | 33. | 0. | 92. | 16. | 186. | 0. | 157. | -5.84 | 15.50 | - | 4.55 |
| mauritania | 84. | 46. | 0. | 112. | 20. | 70. | 25. | 103. | -11.30 | 3.51 | 54.76 | -0.66 |
| botswana | 71. | 118. | 0. | 140. | 35. | 124. | 6. | 134. | -5.71 | 0.46 | - | -0.39 |
| senegal | 182. | 66. | 3. | 250. | 150. | 67. | 10. | 194. | -1.58 | 0.21 | 10.15 | -2.11 |
| ivory coast | 104. | 27. | 2. | 94. | 87. | 51. | 0. | 104. | -1.45 | 5.48 | - | 0.81 |
| somalia | 103. | 15. | 0. | 106. | 65. | 19. | 20. | 90. | -3.73 | 2.07 | 46.96 | -1.30 |
| Nigeria | 127. | 4. | 0. | 104. | 120. | 24. | 0. | 108. | -0.50 | 16.31 | 5.11 | 0.33 |
| ghana | 70. | 8. | 6. | 64. | 49. | 19. | 5. | 59. | -3.01 | 6.91 | -1.01 | -0.61 |
| cameroon | 107. | 9. | 0. | 92. | 108. | 23. | 0. | 106. | 0.08 | 8.54 | - | 1.21 |
| Sub-Sahara 2 | 115. | 13. | 1. | 105. | 104. | 32. | 2. | 106. | -0.83 | 7.43 | 7.74 | 0.14 |
| mozambique | 95. | 10. | 0. | 86. | 52. | 23. | 9. | 73. | -4.88 | 6.84 | - | -1.39 |
| gambia | 164. | 26. | 0. | 154. | 95. | 65. | 13. | 142. | -4.42 | 8.12 | 41.45 | -0.64 |
| benin | 117. | 6. | 0. | 84. | 117. | 13. | 2. | 85. | -0.01 | 5.72 | - | 0.11 |
| togo | 142. | 6. | 0. | 97. | 114. | 15. | 4. | 102. | -1.79 | 8.39 | 24.90 | 0.48 |
| liberia | 80. | 36. | 3. | 98. | 93. | 46. | 1. | 121. | 1.30 | 2.21 | -10.28 | 1.74 |
| sierra leone | 128. | 21. | 1. | 117. | 121. | 14. | 3. | 114. | -0.45 | -3.18 | 8.54 | -0.20 |
| madagascar | 202. | 5. | 0. | 145. | 185. | 22. | 1. | 149. | -0.75 | 13.98 | 24.81 | 0.24 |
| comoros | 46. | 38. | 0. | 73. | 43. | 49. | 0. | 74. | -0.55 | 2.19 | - | 0.12 |
| guinea | 100. | 6. | 6. | 87. | 74. | 15. | 8. | 83. | -2.55 | 8.51 | 2.28 | -0.33 |
| zaire | 31. | 5. | 4. | 35. | 29. | 16. | 1. | 40. | -0.34 | 9.28 | -13.54 | 1.01 |
| guin bissau | 115. | 20. | 0. | 112. | 71. | 77. | 0. | 133. | -3.92 | 12.05 | - | 1.45 |
| upper volta | 210. | 4. | 0. | 167. | 172. | 9. | 4. | 162. | -1.66 | 7.06 | - | -0.27 |
| cent afr emp | 51. | 7. | 0. | 50. | 42. | 5. | 1. | 39. | -1.57 | -2.22 | 8.70 | -2.05 |
| niger | 313. | 2. | 0. | 204. | 319. | 5. | 5. | 191. | 0.14 | 6.72 | - | -0.52 |
| chad | 206. | 2. | 0. | 165. | 145. | 2. | 2. | 116. | -2.85 | -1.29 | - | -2.87 |
| burundi | 80. | 3. | 0. | 72. | 74. | 4. | 1. | 68. | -0.72 | 1.49 | - | -0.43 |
| mali | 214. | 2. | 0. | 168. | 177. | 7. | 2. | 161. | -1.54 | 9.60 | - | -0.36 |
| swaziland | 139. | 95. | 0. | 135. | 164. | 91. | 0. | 154. | 1.41 | -0.40 | - | 1.12 |
| rwanda | 57. | 1. | 0. | 48. | 54. | 2. | 2. | 47. | -0.53 | 5.34 | 19.88 | -0.11 |
| malawi | 284. | 3. | 0. | 185. | 234. | 9. | 0. | 191. | -1.59 | 9.89 | 43.71 | 0.28 |
| uganda | 130. | 5. | 0. | 96. | 109. | 2. | 0. | 82. | -1.43 | -8.69 | - | -1.29 |
| namibia | 72. | 37. | 0. | 108. | 63. | 52. | 0. | 106. | -1.10 | 2.94 | - | -0.14 |
| Sub-Sahara 3 | 127. | 7. | 1. | 101. | 109. | 13. | 2. | 97. | -1.30 | 5.95 | 5.62 | -0.33 |
| Sub-Sahara T | 135. | 9. | 1. | 112. | 117. | 19. | 2. | 109. | -1.15 | 6.30 | 6.01 | -0.22 |
| Total | 148. | 18. | 5. | 123. | 128. | 38. | 6. | 125. | -1.21 | 6.44 | 2.01 | 0.12 |

Table A18. Per capita all grains production, commercial imports, aid and food and average annual growth rates (1966-68 to 1978-80)

| COMMODITY: | 66-68 average | | | 78-80 average | | | Average Annual Growth rates 66-68 to 78-80 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Wheat | Rice | Coarse Gr. | Wheat | Rice | Coarse Gr. | Wheat | Rice | Coarse Gr. |
| country | calors/cap cal/day | calors/cap cal/day | calors/cap cal/day | calors/cap cal/day | calors/cap cal/day | calors/cap cal/day | calors/cap % | calors/cap % | calors/cap % |
| tunisia | 1217. | 3. | 166. | 1437. | 2. | 93. | 1.40 | -4.35 | -4.74 |
| algeria | 1009. | 4. | 205. | 1239. | 7. | 170. | 1.73 | 4.96 | -1.57 |
| morocco | 1016. | 9. | 670. | 1182. | 5. | 692. | 1.27 | -4.74 | 0.27 |
| libya | 883. | 72. | 188. | 1199. | 112. | 120. | 2.58 | 3.70 | -3.67 |
| Egypt | 807. | 248. | 615. | 1064. | 272. | 533. | 2.33 | 0.76 | -1.19 |
| North Africa | 924. | 126. | 503. | 1158. | 133. | 448. | 1.89 | 0.49 | -0.96 |
| lesotho | 459. | 0. | 1367. | 609. | 13. | 1333. | 2.39 | - | -0.21 |
| sudan | 149. | 4. | 993. | 236. | 5. | 1227. | 3.89 | 0.19 | 1.78 |
| zambia | 101. | 8. | 1577. | 191. | 16. | 1243. | 5.47 | 5.94 | -1.97 |
| ethiopia | 195. | 1. | 1228. | 173. | 0. | 1035. | -0.97 | -18.22 | -1.41 |
| zimbabwe | 154. | 10. | 1408. | 165. | 5. | 1183. | 0.60 | -4.90 | -1.44 |
| Kenya * | 88. | 9. | 1380. | 127. | 18. | 1108. | 3.09 | 5.60 | -1.82 |
| angola | 107. | 27. | 543. | 104. | 40. | 519. | -0.29 | 3.34 | -0.37 |
| tanzania | 45. | 62. | 707. | 60. | 86. | 640. | 2.33 | 2.72 | -0.83 |
| Sub-Sahara 1 | 137. | 16. | 1103. | 159. | 22. | 1004. | 1.25 | 2.83 | -0.79 |
| mauritius | 432. | 709. | 95. | 539. | 679. | 79. | 1.87 | -0.37 | -1.50 |
| gabon | 144. | 32. | 77. | 431. | 107. | 265. | 9.58 | 10.52 | 10.80 |
| sao tome etc | 259. | 168. | 370. | 331. | 194. | 277. | 2.09 | 1.22 | -2.36 |
| congo | 119. | 28. | 55. | 316. | 39. | 127. | 8.52 | 2.68 | 7.19 |
| reunion | 193. | 834. | 243. | 303. | 811. | 236. | 3.82 | -0.23 | -0.25 |
| cape verde | 100. | 56. | 725. | 284. | 161. | 1053. | 9.10 | 9.23 | 3.16 |
| mauritania | 79. | 92. | 900. | 284. | 297. | 404. | 11.27 | 10.26 | -6.46 |
| botswana | 28. | 0. | 1317. | 214. | 35. | 1028. | 18.28 | - | -2.04 |
| senegal | 232. | 738. | 1436. | 170. | 660. | 1035. | -2.55 | -0.93 | -2.69 |
| ivory coast | 113. | 397. | 397. | 165. | 492. | 341. | 3.21 | 1.80 | -1.25 |
| somalia | 80. | 59. | 870. | 165. | 160. | 536. | 6.20 | 8.62 | -3.96 |
| Nigeria | 22. | 28. | 947. | 110. | 86. | 838. | 14.51 | 9.86 | -1.01 |
| ghana | 68. | 70. | 473. | 103. | 54. | 409. | 3.49 | -2.18 | -1.20 |
| cameroon | 47. | 26. | 810. | 96. | 69. | 854. | 6.09 | 8.57 | 0.44 |
| Sub-Sahara 2 | 53. | 99. | 851. | 129. | 148. | 740. | 7.63 | 3.45 | -1.16 |
| mozambique | 68. | 55. | 699. | 100. | 100. | 493. | 3.33 | 5.14 | -2.86 |
| gambia | 49. | 584. | 853. | 91. | 642. | 644. | 5.26 | 0.79 | -2.32 |
| benin | 26. | 22. | 759. | 75. | 50. | 692. | 9.10 | 6.92 | -0.77 |
| togo | 35. | 62. | 830. | 73. | 81. | 828. | 6.24 | 2.25 | -0.03 |
| liberia | 41. | 892. | 30. | 72. | 1072. | 39. | 4.78 | 1.55 | 2.14 |
| sierra leone | 78. | 977. | 86. | 64. | 944. | 107. | -1.63 | -0.29 | 1.87 |
| madagascar | 33. | 1229. | 162. | 51. | 1310. | 106. | 3.63 | 0.53 | -3.45 |
| comoros | 44. | 582. | 86. | 46. | 578. | 97. | 0.51 | -0.06 | 0.98 |
| guinea | 44. | 531. | 268. | 52. | 589. | 172. | 1.26 | 0.86 | -3.63 |
| zaire | 28. | 42. | 266. | 41. | 52. | 286. | 3.20 | 1.77 | 0.61 |
| guin bissau | 36. | 631. | 425. | 40. | 871. | 388. | 0.96 | 2.73 | -0.74 |
| upper volta | 25. | 46. | 1535. | 38. | 37. | 1477. | 3.80 | -1.70 | -0.32 |
| cent afr emp | 45. | 21. | 416. | 38. | 42. | 296. | -1.35 | 5.91 | -2.78 |
| niger | 11. | 37. | 1904. | 34. | 62. | 1738. | 9.84 | 4.32 | -0.76 |
| chad | 26. | 50. | 1507. | 33. | 57. | 1026. | 1.84 | 1.16 | -3.15 |
| burundi | 30. | 6. | 650. | 30. | 13. | 608. | 0.12 | 6.65 | -0.56 |
| mali | 19. | 178. | 1418. | 30. | 219. | 1300. | 3.60 | 1.71 | -0.72 |
| swaziland | 0. | 4. | 1290. | 18. | 47. | 1413. | - | 23.62 | 0.77 |
| rwanda | 7. | 3. | 448. | 17. | 11. | 423. | 7.82 | 12.44 | -0.48 |
| malawi | 25. | 12. | 1732. | 12. | 36. | 1782. | -5.87 | 9.56 | 0.24 |
| uganda | 25. | 10. | 883. | 8. | 11. | 768. | -9.20 | 0.79 | -1.16 |
| namibia | 6. | 0. | 1026. | 5. | 0. | 1009. | -0.30 | - | -0.14 |
| Sub-Sahara 3 | 32. | 197. | 743. | 42. | 219. | 674. | 2.34 | 0.89 | -0.82 |
| Sub-Sahara T | 71. | 108. | 890. | 108. | 134. | 797. | 3.52 | 1.81 | -0.91 |
| Total | 248. | 112. | 809. | 324. | 134. | 726. | 2.24 | 1.51 | -0.91 |

Table A19. Per capita calorie consumption from wheat, rice and coarse grains and average annual growth rates (1966-68 to 1978-80)

| SHARES: | 66-68 average | | | 78-80 average | | |
|---|---|---|---|---|---|---|
| country | SSR:Wheat % | SSR:Rice % | SSR:C.Grains % | SSR:Wheat % | SSR:Rice % | SSR:C.Grains % |
| tunisia | 74.8 | 0. | 76.5 | 56.2 | 0. | 58.7 |
| algeria | 63.3 | 62.1 | 90.6 | 37.4 | 4.2 | 59.1 |
| morocco | 71.2 | 119.3 | 100.0 | 52.5 | 99.8 | 96.1 |
| libya | 28.2 | 0. | 76.7 | 20.5 | 0. | 51.9 |
| Egypt | 39.4 | 136.3 | 95.2 | 26.7 | 106.6 | 84.1 |
| North Africa | 55.9 | 133.8 | 95.6 | 37.0 | 103.0 | 82.3 |
| lesotho | 77.8 | 0. | 82.1 | 40.5 | 0. | 71.5 |
| sudan | 32.8 | 11.4 | 103.4 | 49.0 | 47.7 | 102.0 |
| zambia | 0.3 | 1.3 | 110.2 | 5.0 | 26.0 | 90.1 |
| ethiopia | 95.8 | 0. | 99.8 | 63.0 | 0. | 99.0 |
| zimbabwe | 15.1 | 39.9 | 117.6 | 102.8 | 6.5 | 118.3 |
| Kenya * | 126.9 | 102.4 | 104.4 | 73.7 | 87.1 | 98.7 |
| angola | 34.6 | 103.4 | 128.5 | 11.6 | 44.0 | 84.1 |
| tanzania | 51.4 | 82.9 | 101.6 | 59.2 | 81.7 | 98.5 |
| Sub-Sahara 1 | 71.5 | 78.8 | 104.8 | 57.1 | 73.4 | 99.8 |
| mauritius | 0. | 0.0 | 4.6 | 0. | 0.1 | 6.9 |
| gabon | 0. | 22.1 | 46.2 | 0. | 7.3 | 37.8 |
| sao tome etc | 0. | 0. | 14.9 | 0. | 0. | 23.5 |
| congo | 0. | 52.3 | 64.4 | 0. | 40.4 | 59.8 |
| reunion | 0. | 0. | 37.3 | 0. | 0. | 22.1 |
| cape verde | 0. | 0. | 65.6 | 0. | 0. | 10.8 |
| mauritania | 1.8 | 3.2 | 75.9 | 0.4 | 5.2 | 37.3 |
| botswana | 22.6 | 0. | 38.3 | 3.1 | 0. | 26.3 |
| senegal | 0. | 38.9 | 97.4 | 0. | 33.7 | 94.5 |
| ivory coast | 0. | 81.9 | 98.4 | 0. | 64.5 | 86.6 |
| somalia | 0. | 0. | 99.5 | 1.8 | 7.3 | 92.1 |
| Nigeria | 12.9 | 99.5 | 99.0 | 2.1 | 51.0 | 96.4 |
| ghana | 0. | 47.3 | 97.5 | 0. | 53.2 | 87.1 |
| cameroon | 0. | 65.9 | 98.3 | 1.1 | 50.4 | 93.1 |
| Sub-Sahara 2 | 4.4 | 59.4 | 97.2 | 1.3 | 45.3 | 93.2 |
| mozambique | 14.2 | 107.7 | 105.6 | 2.1 | 39.5 | 80.2 |
| gambia | 0. | 72.1 | 99.6 | 0. | 36.9 | 75.7 |
| benin | 0. | 13.4 | 99.0 | 0. | 41.7 | 98.0 |
| togo | 0. | 86.3 | 99.3 | 0. | 58.4 | 96.5 |
| liberia | 0. | 72.3 | 2.3 | 0. | 73.9 | 0.0 |
| sierra leone | 0. | 91.3 | 89.8 | 0. | 94.2 | 80.2 |
| madagascar | 0. | 103.4 | 100.3 | 1.1 | 91.0 | 97.9 |
| comoros | 0. | 49.0 | 99.1 | 0. | 38.1 | 99.5 |
| guinea | 0. | 90.6 | 98.2 | 0. | 76.4 | 94.1 |
| zaire | 5.2 | 79.0 | 83.7 | 3.2 | 83.9 | 70.4 |
| guia bissau | 0. | 80.7 | 99.9 | 0. | 39.9 | 69.4 |
| upper volta | 0. | 89.9 | 99.8 | 0. | 65.3 | 96.2 |
| cent afr emp | 0. | 97.8 | 96.9 | 0. | 98.9 | 95.5 |
| niger | 10.5 | 96.0 | 103.9 | 7.6 | 51.5 | 100.4 |
| chad | 53.0 | 99.9 | 99.9 | 31.6 | 92.7 | 99.5 |
| burundi | 67.8 | 72.6 | 97.9 | 19.9 | 88.7 | 97.4 |
| mali | 18.9 | 99.9 | 99.7 | 9.2 | 80.4 | 99.0 |
| swaziland | 0. | 1488.7 | 57.5 | 100.0 | 106.2 | 63.1 |
| rwanda | 12.4 | 19.4 | 99.5 | 32.6 | 41.3 | 96.0 |
| malawi | 5.9 | 109.5 | 106.8 | 6.2 | 118.7 | 96.4 |
| uganda | 8.6 | 37.1 | 101.8 | 99.8 | 43.8 | 99.1 |
| namibia | 100.0 | 0. | 66.4 | 100.0 | 0. | 54.7 |
| Sub-Sahara 3 | 10.6 | 95.2 | 99.7 | 6.7 | 83.0 | 93.5 |
| Sub-Sahara T | 47.4 | 84.0 | 100.8 | 28.0 | 68.8 | 95.7 |
| Total | 54.2 | 96.2 | 99.9 | 34.9 | 76.2 | 93.1 |

Table A20. Selfsufficiency levels for wheat, rice and coarse grains (1966-68 and 1978-80)

| COMMODITY: country | 66-68 Wheat food/cap kg | 66-68 average ratios of Import wheat Consumpt. wht. % | Com.Imp. wheat Consump. wheat % | Aid wheat Consump. wheat % | 78-80 Wheat food/cap kg | 78-80 average ratios of Import wheat Consumpt. wht. % | Com.Imp. wheat Consump. wheat % | Aid wheat Consump. wheat % |
|---|---|---|---|---|---|---|---|---|
| tunisia | 133. | 35.8 | 17.4 | 18.4 | 157. | 49.7 | 42.7 | 6.9 |
| algeria | 110. | 43.1 | 35.5 | 7.6 | 135. | 68.0 | 67.3 | 0.7 |
| orocco | 111. | 36.7 | 14.3 | 22.4 | 129. | 52.8 | 49.4 | 3.4 |
| libya | 97. | 73.7 | 73.7 | 0. | 131. | 88.2 | 88.2 | 0. |
| Egypt | 88. | 72.0 | 57.8 | 14.2 | 116. | 91.5 | 66.2 | 25.3 |
| North Africa | 101. | 53.1 | 38.3 | 14.9 | 127. | 73.4 | 61.3 | 12.1 |
| lesotho | 50. | 31.1 | 31.1 | 0. | 67. | 60.9 | 60.9 | 0. |
| sudan | 16. | 69.3 | 54.0 | 15.3 | 26. | 53.9 | 40.7 | 13.2 |
| zambia | 11. | 108.7 | 108.6 | 0.1 | 21. | 93.2 | 84.9 | 8.4 |
| ethiopia | 21. | 4.4 | 3.7 | 0.7 | 19. | 38.9 | 26.6 | 12.3 |
| zimbabwe | 17. | 88.8 | 88.8 | 0. | 18. | 0.6 | 0.6 | 0. |
| Kenya * | 10. | 12.5 | 12.4 | 0.1 | 14. | 26.0 | 22.9 | 3.2 |
| angola | 12. | 72.5 | 72.5 | 0. | 11. | 88.1 | 80.1 | 8.1 |
| tanzania | 5. | 50.8 | 50.8 | 0. | 7. | 37.8 | 0. | 37.8 |
| Sub-Sahara 1 | 15. | 34.6 | 31.5 | 3.1 | 17. | 44.4 | 33.3 | 11.1 |
| mauritius | 47. | 102.2 | 102.2 | 0. | 59. | 100.8 | 77.1 | 23.8 |
| gabon | 16. | 102.0 | 102.0 | 0. | 47. | 81.5 | 81.5 | 0. |
| sao tome etc | 28. | 116.1 | 116.1 | 0. | 36. | 104.5 | 104.5 | 0. |
| congo | 13. | 131.6 | 131.6 | 0. | 35. | 99.7 | 99.7 | 0. |
| reunion | 21. | 103.8 | 103.8 | 0. | 33. | 105.3 | 105.3 | 0. |
| cape verde | 11. | 94.4 | 94.4 | 0. | 31. | 113.4 | 113.4 | 0. |
| mauritania | 9. | 121.7 | 120.8 | 0.9 | 31. | 103.3 | 58.8 | 44.5 |
| botswana | 3. | 80.7 | 80.7 | 0. | 23. | 104.3 | 77.4 | 26.9 |
| senegal | 25. | 65.0 | 63.6 | 1.4 | 19. | 123.7 | 91.2 | 32.5 |
| ivory coast | 12. | 137.3 | 137.3 | 0. | 18. | 111.8 | 111.8 | 0. |
| somalia | 9. | 92.9 | 91.1 | 1.8 | 18. | 94.4 | 21.8 | 72.6 |
| Nigeria | 2. | 90.3 | 90.3 | 0. | 12. | 113.4 | 113.4 | 0.1 |
| ghana | 7. | 102.0 | 54.6 | 47.4 | 11. | 106.1 | 83.4 | 22.7 |
| cameroon | 5. | 106.7 | 106.7 | 0. | 10. | 104.2 | 100.3 | 3.9 |
| Sub-Sahara 2 | 6. | 96.7 | 90.7 | 6.0 | 14. | 110.2 | 101.0 | 9.3 |
| mozambique | 7. | 91.8 | 91.8 | 0. | 11. | 99.9 | 36.2 | 63.6 |
| gambia | 5. | 101.9 | 101.9 | 0. | 10. | 102.4 | 69.3 | 33.1 |
| benin | 3. | 102.0 | 102.0 | 0. | 8. | 104.4 | 97.5 | 6.9 |
| togo | 4. | 102.3 | 100.6 | 1.8 | 8. | 101.7 | 88.5 | 13.2 |
| liberia | 4. | 101.7 | 96.8 | 4.9 | 8. | 103.7 | 95.0 | 8.7 |
| sierra leone | 9. | 104.8 | 97.1 | 7.6 | 7. | 98.3 | 64.7 | 33.6 |
| madagascar | 4. | 101.1 | 99.3 | 1.8 | 6. | 99.9 | 82.8 | 17.1 |
| comoros | 5. | 100.0 | 100.0 | 0. | 5. | 100.0 | 100.0 | 0. |
| guinea | 5. | 81.5 | 16.0 | 65.4 | 6. | 101.9 | 38.8 | 63.1 |
| zaire | 3. | 96.9 | 4.8 | 92.1 | 4. | 104.8 | 99.3 | 5.5 |
| guin bissau | 4. | 100.0 | 100.0 | 0. | 4. | 100.0 | 100.0 | 0. |
| upper volta | 3. | 102.0 | 102.0 | 0. | 4. | 101.9 | 55.1 | 46.8 |
| cent afr emp | 5. | 113.2 | 113.2 | 0. | 4. | 103.4 | 87.5 | 15.8 |
| niger | 1. | 90.8 | 90.8 | 0. | 4. | 100.0 | 34.7 | 65.3 |
| chad | 3. | 47.7 | 47.7 | 0. | 4. | 69.2 | 17.9 | 51.3 |
| burundi | 3. | 33.3 | 33.3 | 0. | 3. | 80.9 | 52.4 | 28.4 |
| mali | 2. | 82.6 | 82.6 | 0. | 3. | 92.6 | 41.1 | 51.5 |
| swaziland | 0. | 0. | 0. | 0. | 2. | 0. | 0. | 0. |
| rwanda | 1. | 91.3 | 91.3 | 0. | 2. | 70.8 | 0.2 | 70.5 |
| malawi | 3. | 96.1 | 96.0 | 0.2 | 1. | 99.7 | 70.7 | 29.0 |
| uganda | 3. | 125.5 | 125.5 | 0. | 1. | 0.2 | 0.2 | 0. |
| namibia | 1. | 0. | 0. | 0. | 1. | 0. | 0. | 0. |
| Sub-Sahara 3 | 3. | 94.1 | 71.4 | 22.7 | 5. | 96.7 | 63.5 | 33.2 |
| Sub-Sahara T | 8. | 58.5 | 51.8 | 6.7 | 12. | 77.8 | 64.4 | 13.3 |
| Total | 27. | 54.3 | 41.2 | 13.1 | 35. | 74.5 | 62.1 | 12.4 |

Table A21. Per capita wheat consumption and share of wheat total imports, commercial imports and aid in wheat consumption (1966-68 and 1978-80)

| SHARES: | 66-68 All Grains | 66-68 average ratios of | | | | 78-80 All Grains | 78-80 average ratios of | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| country | food/cap kg | Consump. wheat Consump. grain % | Imports grain Consumpt. grn. % | Com.imp. grain Consump. grain % | Aid grain Consump. grain % | food/cap kg | Consump. wheat Consump. grain % | Imports grain Consumpt. grn. % | Com.imp. grain Consump. grain % | Aid grain Consump. grain % |
| tunisia | 151. | 75.4 | 33.0 | 14.7 | 18.3 | 167. | 72.2 | 47.8 | 42.3 | 5.5 |
| algeria | 132. | 80.8 | 37.5 | 31.4 | 6.1 | 154. | 76.6 | 63.5 | 63.0 | 0.5 |
| morocco | 182. | 52.2 | 20.3 | 8.4 | 11.9 | 202. | 55.1 | 31.2 | 29.3 | 1.9 |
| libya | 123. | 57.7 | 55.7 | 55.7 | 0. | 155. | 65.5 | 77.7 | 77.7 | 0. |
| Egypt | 178. | 43.1 | 33.4 | 27.2 | 6.2 | 199. | 50.0 | 52.3 | 37.7 | 14.5 |
| North Africa | 166. | 53.6 | 31.1 | 22.8 | 8.3 | 187. | 57.8 | 49.5 | 41.6 | 7.9 |
| lesotho | 193. | 27.4 | 24.4 | 24.4 | 0. | 207. | 31.1 | 44.9 | 44.9 | 0. |
| sudan | 120. | 13.4 | 9.7 | 7.7 | 2.1 | 154. | 17.0 | 9.5 | 7.2 | 2.3 |
| zambia | 176. | 5.7 | 9.2 | 9.1 | 0.0 | 152. | 12.7 | 24.3 | 23.2 | 1.1 |
| ethiopia | 149. | 15.2 | 0.9 | 0.7 | 0.2 | 127. | 15.5 | 7.0 | 5.0 | 1.9 |
| zimbabwe | 165. | 8.8 | 10.8 | 10.8 | 0. | 142. | 11.0 | 2.8 | 2.8 | 0. |
| Kenya * | 155. | 6.9 | 4.3 | 1.4 | 2.9 | 131. | 10.9 | 6.5 | 6.2 | 0.3 |
| angola | 71. | 15.8 | 14.1 | 14.1 | 0. | 70. | 16.0 | 30.5 | 29.2 | 1.3 |
| tanzania | 85. | 6.5 | 6.6 | 6.4 | 0.3 | 82. | 8.7 | 10.9 | 5.7 | 5.1 |
| Sub-Sahara 1 | 132. | 11.6 | 6.0 | 5.1 | 0.9 | 124. | 14.0 | 10.3 | 8.5 | 1.8 |
| mauritius | 129. | 36.1 | 99.9 | 99.8 | 0.1 | 136. | 40.2 | 101.7 | 91.8 | 9.9 |
| gabon | 27. | 56.5 | 85.2 | 85.2 | 0. | 85. | 48.8 | 76.2 | 76.2 | 0. |
| sao tome etc | 84. | 32.7 | 97.3 | 97.3 | 0. | 85. | 41.7 | 96.3 | 96.3 | 0. |
| congo | 22. | 59.7 | 96.3 | 96.3 | 0. | 52. | 66.8 | 81.8 | 81.8 | 0. |
| reunion | 131. | 11.6 | 87.0 | 87.0 | 0. | 140. | 16.8 | 95.6 | 95.6 | 0. |
| cape verde | 92. | 11.0 | 33.2 | 33.2 | 0. | 157. | 19.5 | 103.2 | 103.2 | 0. |
| mauritania | 112. | 7.1 | 37.8 | 37.7 | 0.1 | 103. | 30.6 | 86.2 | 63.2 | 22.9 |
| botswana | 140. | 2.1 | 77.8 | 77.8 | 0. | 134. | 15.4 | 86.0 | 81.9 | 4.1 |
| senegal | 250. | 9.8 | 26.5 | 25.3 | 1.2 | 194. | 9.3 | 38.3 | 33.4 | 4.9 |
| ivory coast | 94. | 11.9 | 27.0 | 25.1 | 2.0 | 104. | 16.1 | 42.5 | 42.5 | 0. |
| somalia | 106. | 7.8 | 13.3 | 13.1 | 0.2 | 90. | 19.5 | 37.7 | 18.5 | 19.2 |
| Nigeria | 104. | 2.6 | 3.4 | 3.4 | 0.0 | 108. | 11.0 | 20.4 | 20.4 | 0.0 |
| ghana | 64. | 11.1 | 20.9 | 12.3 | 8.6 | 59. | 19.9 | 36.0 | 28.0 | 7.9 |
| cameroon | 92. | 5.1 | 8.2 | 8.2 | 0. | 106. | 9.4 | 19.0 | 18.6 | 0.4 |
| Sub-Sahara 2 | 105. | 5.4 | 12.3 | 11.6 | 0.7 | 106. | 12.9 | 28.4 | 26.7 | 1.8 |
| mozambique | 86. | 9.3 | 10.9 | 10.9 | 0. | 73. | 16.3 | 39.5 | 28.2 | 11.3 |
| gambia | 154. | 3.1 | 14.8 | 14.7 | 0.1 | 142. | 6.2 | 48.7 | 40.3 | 8.3 |
| benin | 84. | 2.8 | 6.4 | 6.4 | 0. | 85. | 8.8 | 14.5 | 12.5 | 2.1 |
| togo | 97. | 3.5 | 5.5 | 5.2 | 0.3 | 102. | 8.4 | 17.4 | 13.5 | 3.9 |
| liberia | 98. | 4.4 | 37.6 | 34.9 | 2.7 | 121. | 6.6 | 37.3 | 36.7 | 0.6 |
| sierra leone | 117. | 6.6 | 16.0 | 15.3 | 0.7 | 114. | 5.7 | 12.6 | 10.7 | 1.9 |
| madagascar | 145. | 2.1 | 2.8 | 2.7 | 0.0 | 149. | 3.2 | 13.5 | 12.9 | 0.5 |
| comoros | 73. | 5.8 | 46.1 | 46.1 | 0. | 74. | 6.0 | 58.9 | 58.9 | 0. |
| guinea | 87. | 4.9 | 11.8 | 5.8 | 6.0 | 83. | 6.6 | 24.8 | 16.3 | 8.5 |
| zaire | 35. | 8.1 | 24.1 | 13.9 | 10.2 | 40. | 11.3 | 37.2 | 35.6 | 1.6 |
| guia bissau | 112. | 3.1 | 15.5 | 15.5 | 0. | 133. | 3.0 | 53.5 | 53.5 | 0. |
| upper volta | 167. | 1.5 | 2.2 | 2.2 | 0. | 162. | 2.8 | 7.6 | 5.2 | 2.4 |
| cent afr emp | 50. | 9.1 | 13.2 | 12.8 | 0.5 | 39. | 9.5 | 13.9 | 12.3 | 1.5 |
| niger | 204. | 0.5 | 1.0 | 1.0 | 0. | 191. | 1.7 | 4.6 | 2.3 | 2.3 |
| chad | 165. | 1.8 | 1.0 | 1.0 | 0. | 116. | 3.0 | 3.0 | 1.2 | 1.9 |
| burundi | 72. | 4.7 | 3.9 | 3.9 | 0. | 68. | 4.7 | 6.6 | 5.0 | 1.6 |
| mali | 168. | 1.1 | 1.2 | 1.2 | 0. | 161. | 1.8 | 5.1 | 3.9 | 1.1 |
| swaziland | 135. | 0. | 49.0 | 49.0 | 0. | 154. | 1.1 | 42.2 | 42.2 | 0. |
| rwanda | 48. | 1.6 | 3.1 | 2.6 | 0.5 | 47. | 4.3 | 8.9 | 4.8 | 4.1 |
| malawi | 185. | 1.3 | 1.4 | 1.4 | 0.0 | 191. | 0.6 | 4.5 | 4.4 | 0.2 |
| uganda | 96. | 2.5 | 4.4 | 4.3 | 0.1 | 82. | 1.2 | 1.8 | 1.8 | 0. |
| namibia | 108. | 0.7 | 31.4 | 31.4 | 0. | 106. | 0.7 | 45.8 | 45.8 | 0. |
| Sub-Sahara 3 | 101. | 3.2 | 6.9 | 5.8 | 1.1 | 97. | 4.6 | 14.4 | 12.2 | 2.2 |
| Sub-Sahara T | 112. | 7.0 | 8.2 | 7.3 | 0.9 | 109. | 10.7 | 17.6 | 15.7 | 1.9 |
| Total | 123. | 21.8 | 15.5 | 12.2 | 3.3 | 125. | 27.5 | 29.0 | 24.9 | 4.1 |

Table A22. Per capita grain consumption and share of grain total imports, commercial imports and aid in grain consumption (1966-68 and 1978-80)

| SHARES: country | 66-68 All Grains aid/cap kg | 66-68 average ratios of: Aid wheat / Aid grain % | Aid rice / Aid grain % | Aid crs.grain / Aid grain % | 78-80 All Grains aid/cap kg | 78-80 average ratios of: Aid wheat / Aid grain % | Aid rice / Aid grain % | Aid crs.grain / Aid grain % |
|---|---|---|---|---|---|---|---|---|
| tunisia | 38. | 75.6 | 0. | 24.4 | 14. | 91.8 | 0.0 | 8.2 |
| algeria | 11. | 100.0 | 0. | 0. | 1. | 100.0 | 0. | 0. |
| morocco | 31. | 98.6 | 0. | 1.4 | 5. | 100.0 | 0.0 | 0. |
| libya | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Egypt | 15. | 99.7 | 0. | 0.3 | 40. | 87.3 | 0. | 12.7 |
| North Africa | 19. | 95.6 | 0. | 4.4 | 21. | 88.3 | 0.0 | 11.6 |
| lesotho | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| sudan | 3. | 100.0 | 0. | 0. | 4. | 100.0 | 0. | 0. |
| zambia | 0. | 30.8 | 0. | 69.2 | 2. | 96.0 | 0. | 4.0 |
| ethiopia | 0. | 46.5 | 0. | 53.5 | 3. | 99.6 | 0. | 0.4 |
| zimbabwe | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Kenya * | 5. | 0.3 | 0. | 99.7 | 1. | 100.0 | 0. | 0. |
| angola | 0. | 0. | 0. | 0. | 1. | 100.0 | 0. | 0. |
| tanzania | 0. | 0. | 0. | 100.0 | 5. | 64.2 | 25.1 | 10.7 |
| Sub-Sahara 1 | 1. | 39.5 | 0. | 60.5 | 3. | 88.6 | 7.8 | 3.6 |
| mauritius | 0. | 0. | 0. | 100.0 | 15. | 96.7 | 0. | 3.3 |
| gabon | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| sao tome etc | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| congo | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| reunion | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| cape verde | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| mauritania | 0. | 60.7 | 0. | 39.3 | 25. | 59.4 | 0.6 | 40.0 |
| botswana | 0. | 0. | 0. | 0. | 6. | 100.0 | 0. | 0. |
| senegal | 3. | 11.3 | 0. | 88.7 | 10. | 61.6 | 0.6 | 37.8 |
| ivory coast | 2. | 0. | 100.0 | 0. | 0. | 0. | 0. | 0. |
| somalia | 0. | 83.0 | 0. | 17.0 | 20. | 73.9 | 12.5 | 13.6 |
| Nigeria | 0. | 0. | 0. | 100.0 | 0. | 100.0 | 0. | 0. |
| ghana | 6. | 61.2 | 26.3 | 12.5 | 5. | 57.3 | 0. | 42.7 |
| cameroon | 0. | 0. | 0. | 0. | 0. | 100.0 | 0. | 0. |
| Sub-Sahara 2 | 1. | 44.1 | 31.8 | 24.1 | 2. | 67.2 | 3.8 | 29.1 |
| mozambique | 0. | 0. | 0. | 0. | 9. | 92.4 | 6.4 | 1.2 |
| gambia | 0. | 0. | 0. | 100.0 | 13. | 24.5 | 19.3 | 56.2 |
| benin | 0. | 0. | 0. | 0. | 2. | 29.6 | 0. | 70.4 |
| togo | 0. | 22.6 | 0. | 77.4 | 4. | 28.4 | 0.8 | 70.8 |
| liberia | 3. | 7.9 | 92.1 | 0. | 1. | 95.8 | 4.2 | 0. |
| sierra leone | 1. | 72.6 | 27.4 | 0. | 3. | 99.5 | 0.5 | 0. |
| madagascar | 0. | 100.0 | 0. | 0. | 1. | 100.0 | 0. | 0. |
| comoros | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| guinea | 6. | 54.1 | 45.6 | 0.3 | 8. | 49.4 | 45.6 | 5.0 |
| zaire | 4. | 73.2 | 24.6 | 2.2 | 1. | 39.1 | 49.1 | 11.8 |
| guin bissau | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| upper volta | 0. | 0. | 0. | 0. | 4. | 54.0 | 1.0 | 45.0 |
| cent afr emp | 0. | 0. | 0. | 100.0 | 1. | 98.5 | 0. | 1.5 |
| niger | 0. | 0. | 0. | 0. | 5. | 48.0 | 0. | 52.0 |
| chad | 0. | 0. | 0. | 0. | 2. | 83.3 | 12.8 | 4.0 |
| burundi | 0. | 0. | 0. | 0. | 1. | 83.4 | 0. | 16.6 |
| mali | 0. | 0. | 0. | 0. | 2. | 81.2 | 2.6 | 16.2 |
| swaziland | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| rwanda | 0. | 0. | 0. | 100.0 | 2. | 74.0 | 6.2 | 19.8 |
| malawi | 0. | 100.0 | 0. | 0. | 0. | 100.0 | 0. | 0. |
| uganda | 0. | 0. | 0. | 100.0 | 0. | 0. | 0. | 0. |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Sub-Sahara 3 | 1. | 65.9 | 30.1 | 4.0 | 2. | 68.5 | 12.6 | 18.9 |
| Sub-Sahara T | 1. | 51.0 | 19.7 | 29.3 | 2. | 74.6 | 8.3 | 17.1 |
| Total | 5. | 87.1 | 3.8 | 9.1 | 6. | 84.2 | 2.5 | 13.3 |

Table A23. Per capita grain aid and share of wheat, rice and coarse grains (1966-68 and 1978-80)

COMMODITY:

| country | 66-68 average ratios of: Com wheat imp / Total exports % | 66-68: Com rice imp / Total exports % | 66-68: Com c.grn imp / Total exports % | 78-80 average ratios of: Com wheat imp / Total exports % | 78-80: Com rice imp / Total exports % | 78-80: Com c.grn imp / Total exports % |
|---|---|---|---|---|---|---|
| tunisia | 6.5 | 0.3 | 0.7 | 5.9 | 0.0 | 1.8 |
| algeria | 6.2 | 0.1 | 0.8 | 5.0 | 0.1 | 0.8 |
| morocco | 4.6 | 0.0 | 0.6 | 13.0 | 0.0 | 1.0 |
| libya | 0.9 | 0.2 | 0.2 | 0.8 | 0.2 | 0.2 |
| Egypt | 21.0 | 0.0 | 1.8 | 32.4 | 0.0 | 3.4 |
| North Africa | 6.5 | 0.1 | 0.7 | 6.2 | 0.1 | 0.8 |
| lesotho | 23.9 | 0. | 44.5 | 24.9 | 1.7 | 29.8 |
| sudan | 4.7 | 0.5 | 0.1 | 7.3 | 0.3 | 0.1 |
| zambia | 0.6 | 0.1 | 0.3 | 1.7 | 0.3 | 3.0 |
| ethiopia | 1.7 | 0.6 | 0.2 | 7.1 | 0.1 | 1.6 |
| zimbabwe | 1.9 | 0.2 | 0.9 | 0.0 | 0.1 | 0.5 |
| Kenya * | 0.8 | 0.3 | 0.3 | 1.4 | 0.2 | 1.3 |
| angola | 1.8 | 0.2 | 0.8 | 1.1 | 0.6 | 0.9 |
| tanzania | 1.6 | 1.4 | 1.1 | 0. | 1.1 | 1.7 |
| Sub-Sahara 1 | 1.6 | 0.3 | 0.6 | 2.1 | 0.4 | 1.3 |
| mauritius | 4.9 | 13.7 | 2.1 | 3.7 | 7.3 | 1.2 |
| gabon | 0.9 | 0.3 | 1.4 | 0.5 | 0.3 | 0.5 |
| sao tome etc | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 |
| congo | 3.4 | 0.7 | 1.5 | 9.5 | 1.3 | 2.6 |
| reunion | 4.9 | 17.0 | 6.0 | 10.4 | 16.7 | 11.4 |
| cape verde | 32.4 | 26.6 | 40.6 | 87.6 | 90.0 | 303.7 |
| mauritania | 1.7 | 2.4 | 3.1 | 4.2 | 7.8 | 4.0 |
| botswana | 1.2 | 0. | 71.2 | 1.3 | 0.3 | 5.1 |
| senegal | 3.8 | 19.6 | 0.3 | 3.7 | 12.9 | 0.7 |
| ivory coast | 2.2 | 1.8 | 0.3 | 1.4 | 2.5 | 0.6 |
| somalia | 6.9 | 9.9 | 1.0 | 3.8 | 18.4 | 1.4 |
| Nigeria | 2.0 | 0.0 | 0.9 | 1.9 | 2.6 | 1.2 |
| ghana | 1.4 | 1.9 | 0.5 | 2.2 | 1.4 | 1.1 |
| cameroon | 2.4 | 0.8 | 2.0 | 2.1 | 1.1 | 1.9 |
| Sub-Sahara 2 | 2.1 | 2.9 | 1.4 | 1.9 | 2.7 | 1.3 |
| mozambique | 3.5 | 0.0 | 1.7 | 4.0 | 11.8 | 8.8 |
| gambia | 2.8 | 7.5 | 1.0 | 3.2 | 11.2 | 4.5 |
| benin | 5.6 | 6.8 | 1.9 | 13.8 | 6.9 | 5.2 |
| togo | 2.6 | 1.2 | 0.9 | 2.5 | 1.9 | 1.0 |
| liberia | 0.2 | 4.0 | 0.2 | 0.5 | 4.9 | 0.3 |
| sierra leone | 3.7 | 5.3 | 1.1 | 3.7 | 8.0 | 1.2 |
| madagascar | 1.7 | 0.7 | 0.2 | 1.8 | 15.4 | 0.3 |
| comoros | 3.3 | 35.9 | 1.4 | 4.5 | 47.9 | 0.9 |
| guinea | 0.6 | 4.1 | 1.0 | 0.8 | 8.5 | 0.4 |
| zaire | 0.1 | 0.1 | 1.9 | 2.5 | 0.3 | 4.6 |
| guin bissau | 9.9 | 42.6 | 7.2 | 4.8 | 93.7 | 16.5 |
| upper volta | 9.6 | 2.6 | 1.5 | 7.4 | 5.6 | 8.9 |
| cent afr emp | 3.3 | 0.1 | 1.1 | 3.3 | 0.1 | 1.8 |
| niger | 2.4 | 0.4 | 1.0 | 0.9 | 4.3 | 0.2 |
| chad | 5.6 | 0.0 | 1.1 | 0.9 | 0.6 | 0.7 |
| burundi | 5.1 | 0.9 | 5.7 | 5.3 | 1.2 | 6.5 |
| mali | 7.2 | 0.1 | 1.7 | 1.4 | 8.8 | 3.4 |
| swaziland | 0. | 0. | 6.8 | 0. | 0. | 3.4 |
| rwanda | 2.0 | 1.4 | 1.3 | 0.0 | 1.5 | 3.4 |
| malawi | 1.7 | 0.2 | 0.2 | 0.5 | 0.0 | 3.8 |
| uganda | 1.4 | 0.8 | 0.2 | 0.0 | 1.0 | 0.5 |
| namibia | 0. | 0. | 0. | 0. | 0. | 0. |
| Sub-Sahara 3 | 1.5 | 1.5 | 1.5 | 1.6 | 4.5 | 2.6 |
| Sub-Sahara T | 1.8 | 1.6 | 1.2 | 1.9 | 2.6 | 1.5 |
| Total | 3.5 | 1.1 | 1.0 | 3.8 | 1.5 | 1.2 |

Table A24. Share of value of commercial wheat, rice and coarse grain imports in total merchandise exports

# ANNEX B

Economic Rationality and Rainfed Potential for Wheat Production

in Algeria, Morocco, Tunisia, Ethiopia, Kenya, Tanzania and Angola:

Wheat Supply and Cost Curves

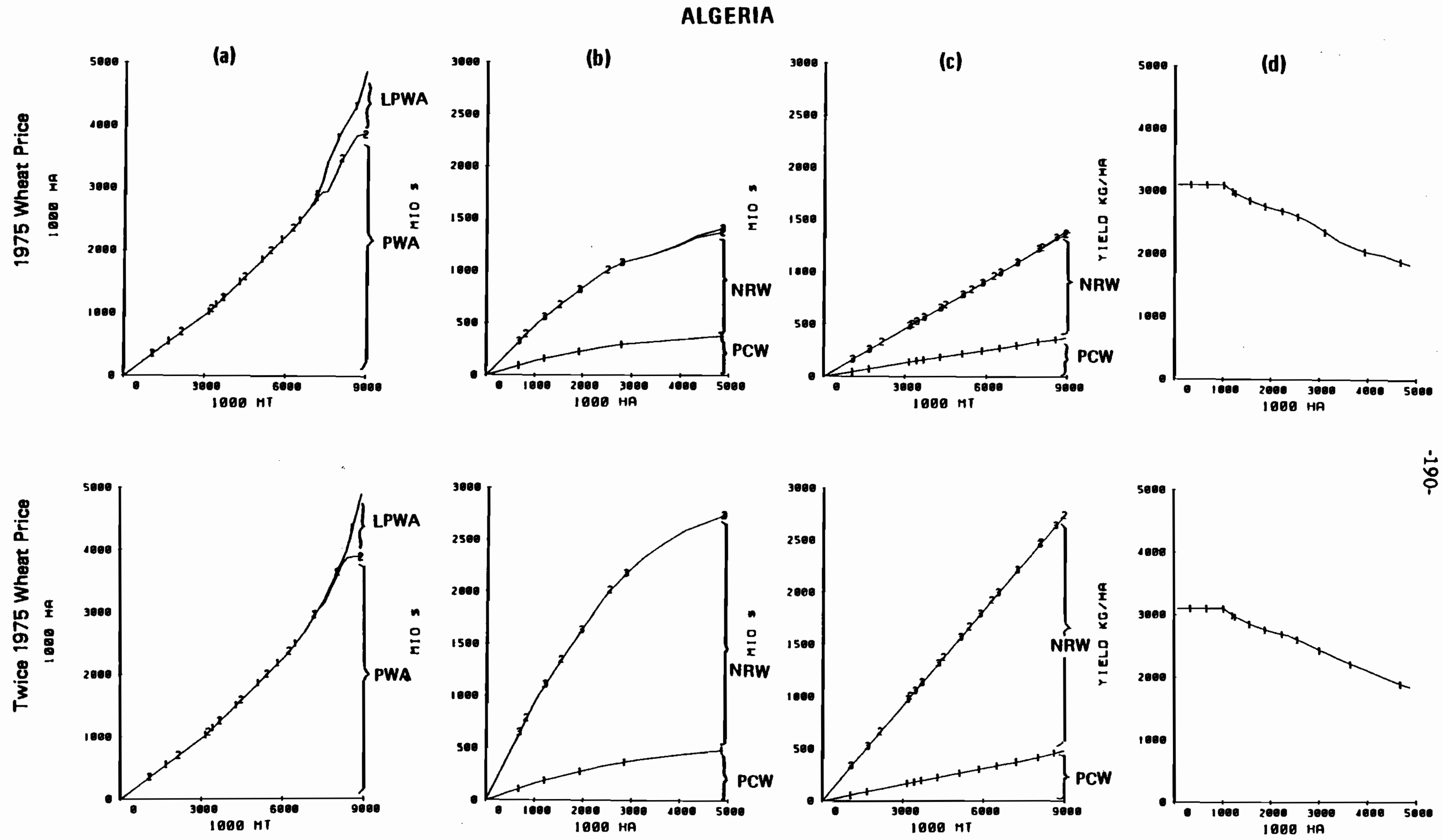



Fig.B1 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Algeria

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

## MOROCCO

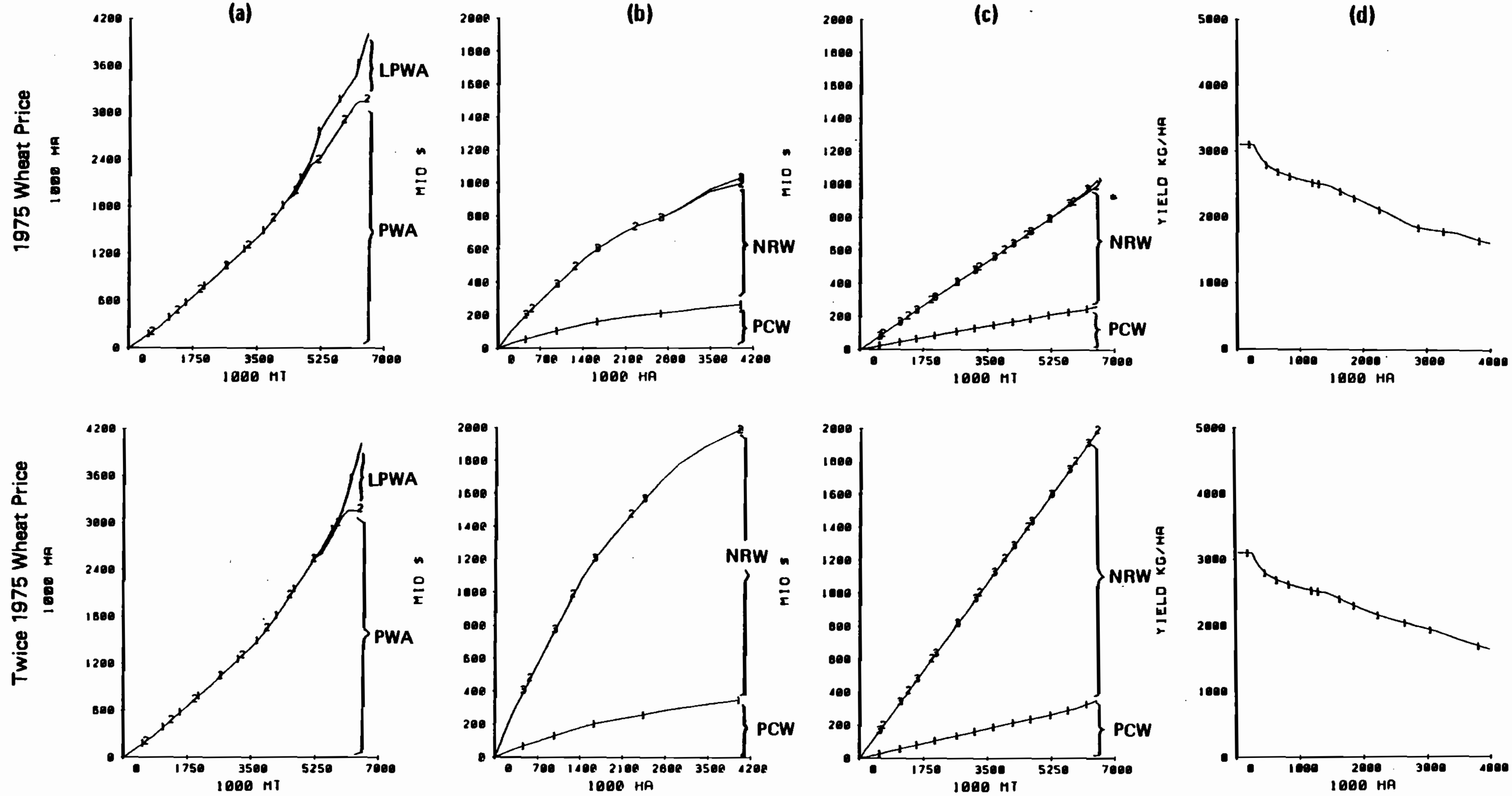



Fig.B2 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Morocco

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

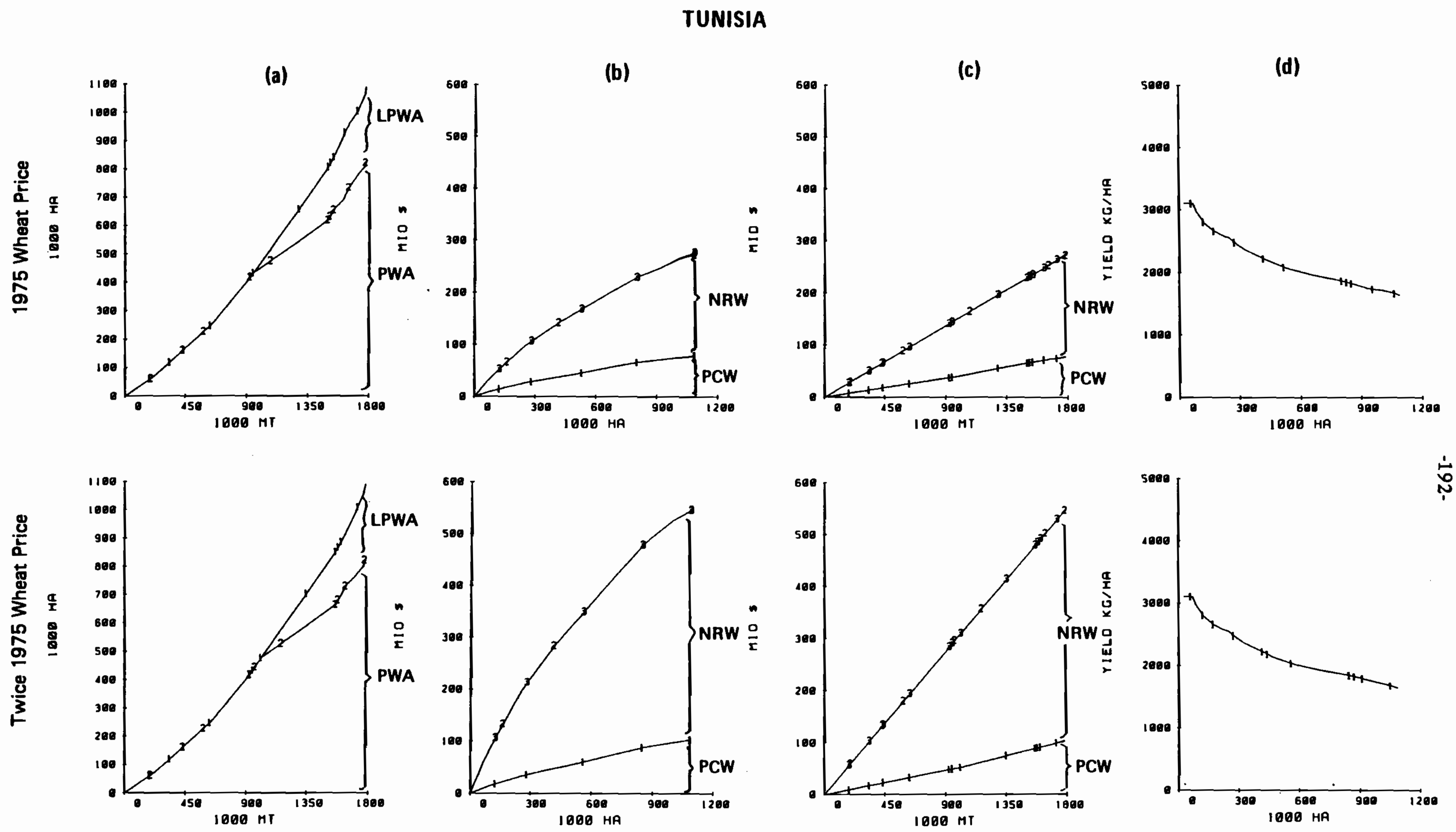



Fig.B3 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Tunisia

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

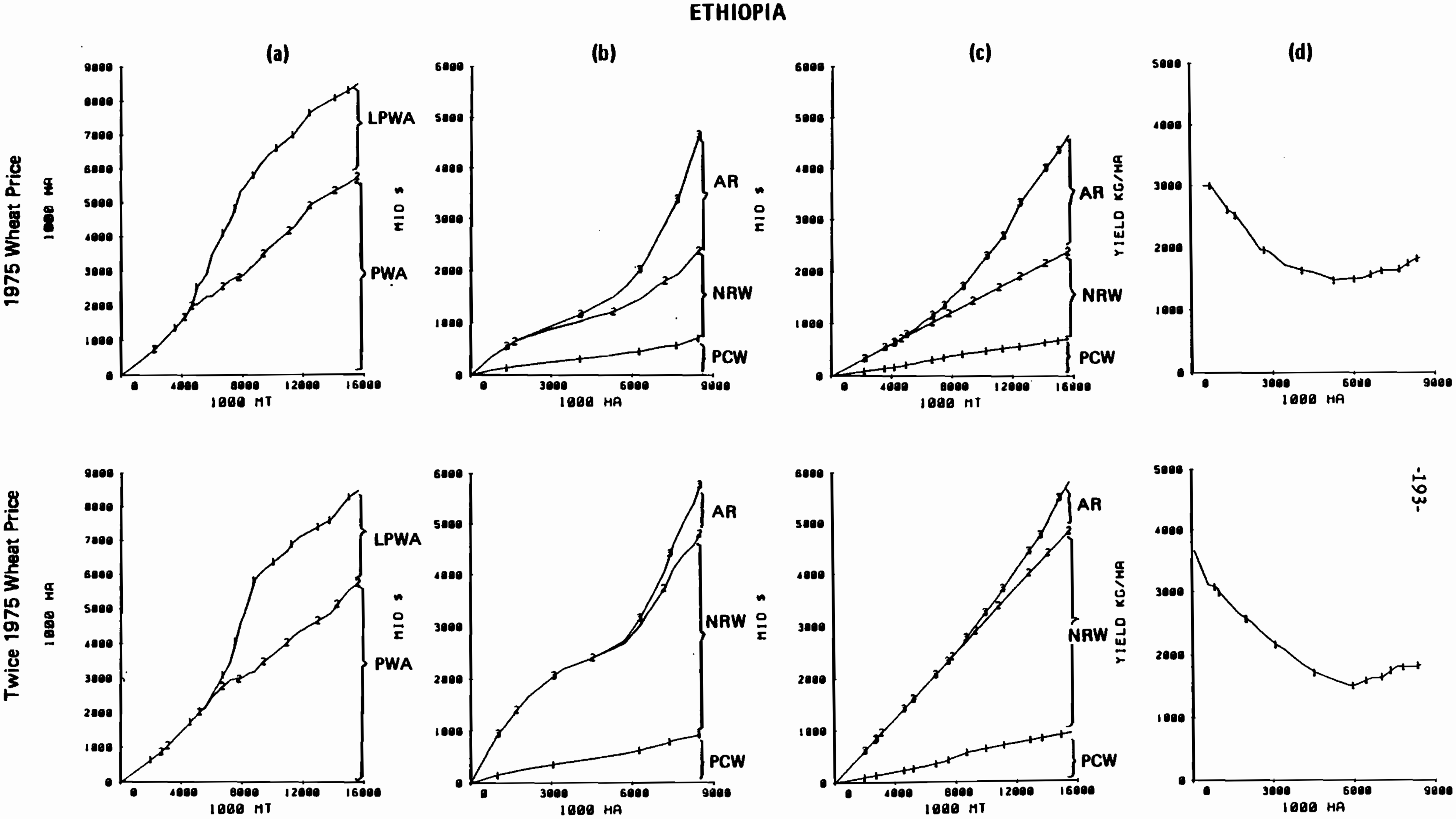



Fig.B4 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Ethiopia

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

# TANZANIA

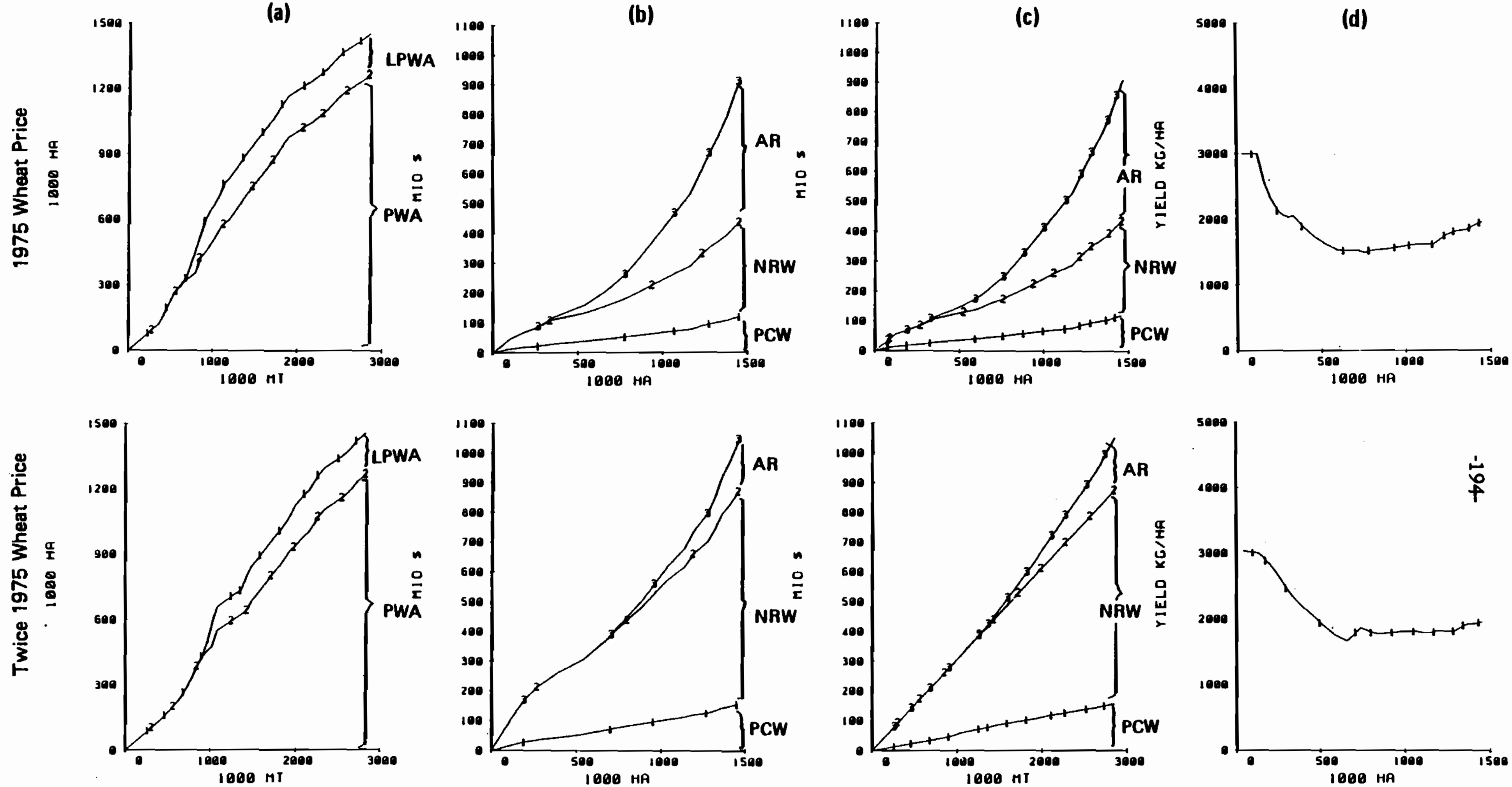



Fig.B5 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Tanzania

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

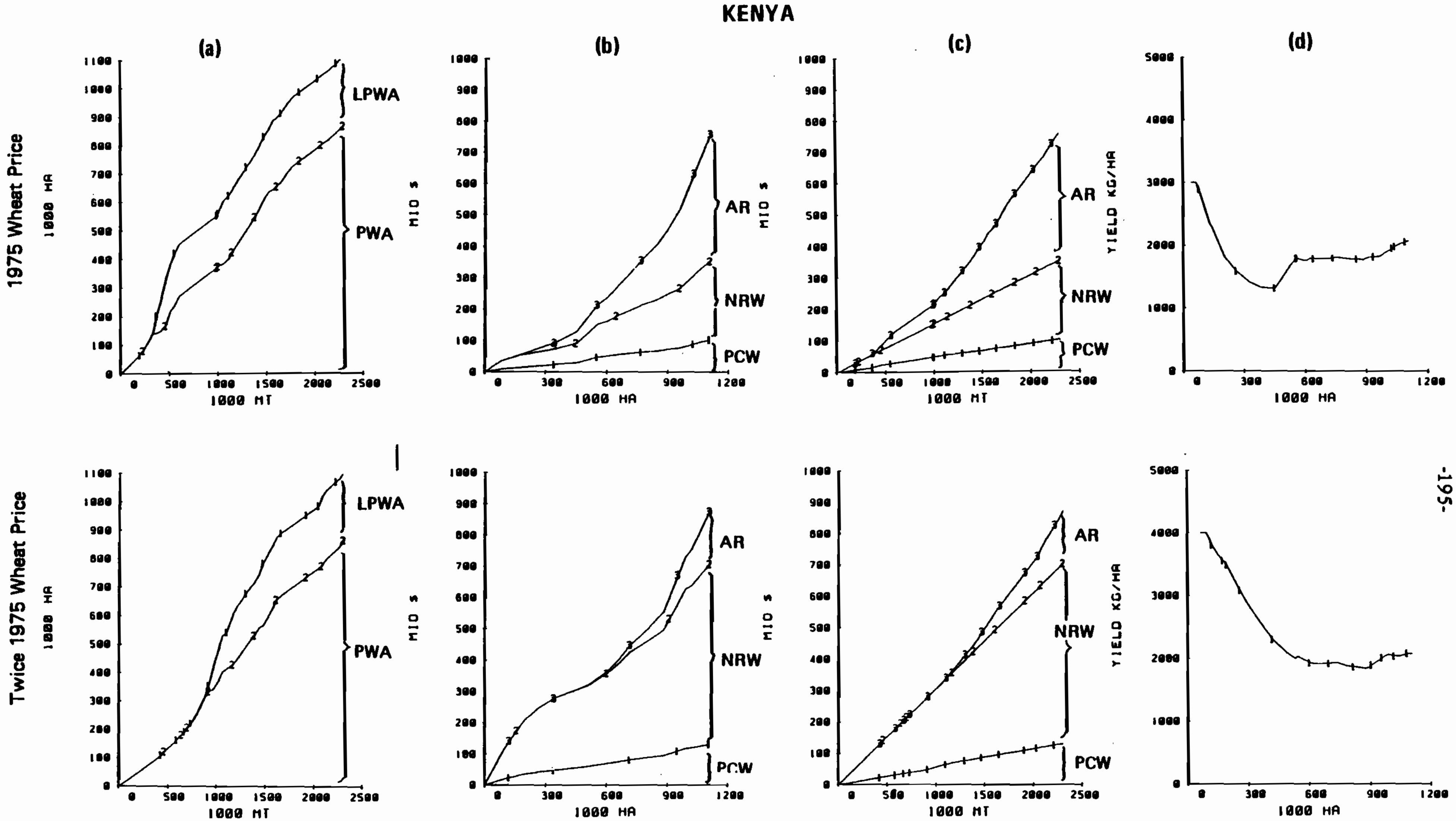



Fig.B6 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Kenya

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

# ANGOLA

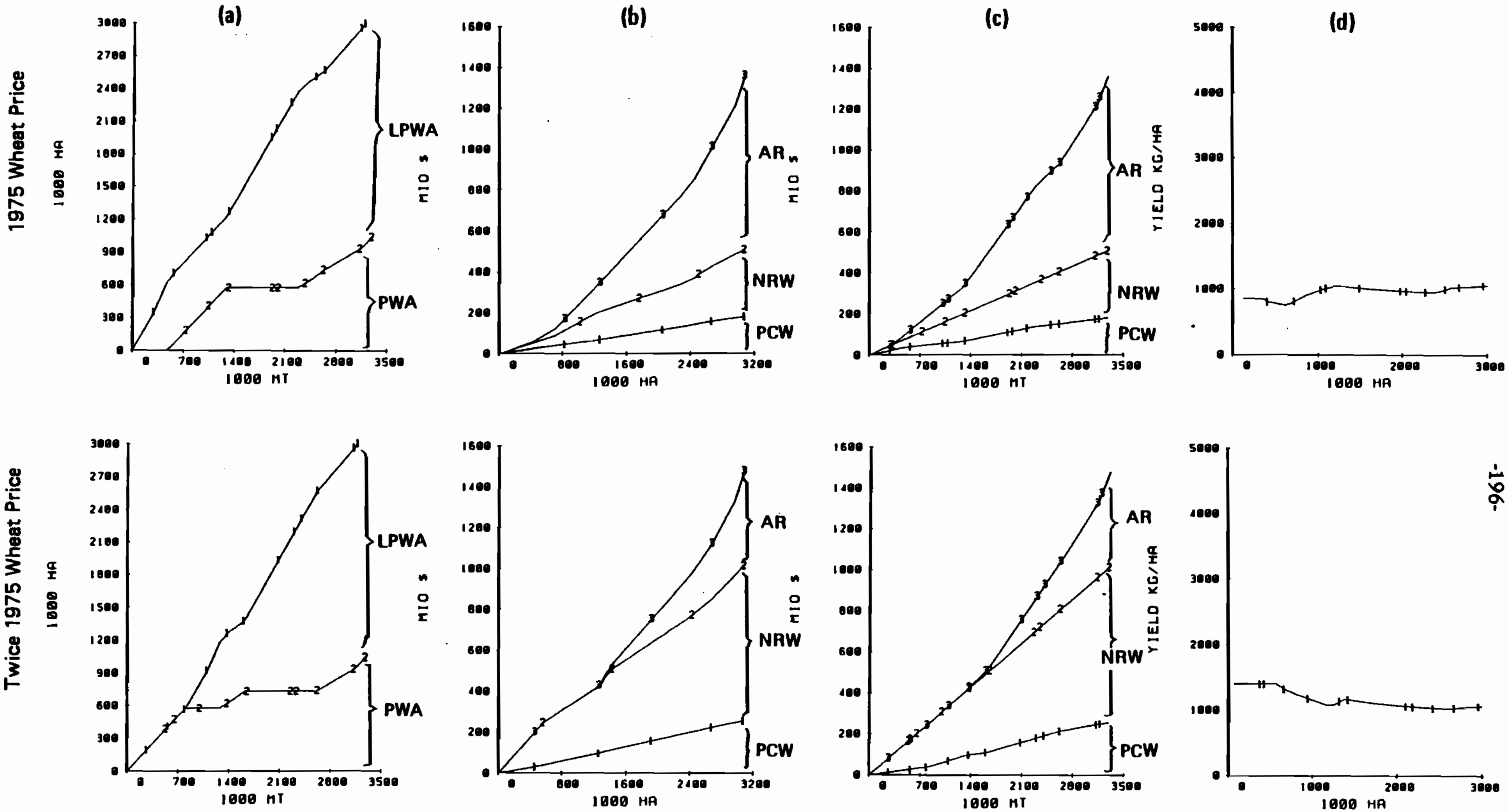



Fig.B7 Wheat acreage, yield, revenue and production costs and total revenue from production of optimal crop-mix: Intermediate level of inputs for the production of wheat and competitive crops on the basis of maximizing net revenue: Results for Angola

AR: Additional revenue ie. difference of revenue produced from wheat and competitive crops and revenue produced from mono cropping of wheat on all land areas where wheat can be grown.

NRW: Net revenue from wheat production.

PCW: Production costs of wheat.

LPWA: Low productivity wheat area.

PWA: Very high to moderate productivity wheat area.

# ANNEX C

## 1. The Food and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA)

The Food and Agriculture Program (FAP) of IIASA has been engaged in the development of a set of linkable national models for agricultural policy analysis since 1976 with the help of a network of collaborating institutions around the world. The purpose of the FAP is to study the effect on the domestic food situation in given countries of alternative policy measures as taken by their own governments, by the governments of other countries and by international organizations which operate under specified international agreements.

### 1.1. FAP's Approach to Policy Analyses

The emphasis has been on policy analysis. For realistic policy analysis one must consider policy instruments and actions which can be identified with specific decision makers. Thus government is an important actor in our system. Moreover, policies have to be effective when various economic agents adjust their behavior in response to policies. Thus we have to distinguish various economic agents and describe accurately their behavioral responses. This approach is followed both at the national level as well as at the international level. At the national level, the actors comprise various types of farmers and non-farmers and the national government. At the international level the national governments constitute the various actors.

This basic approach permits a wide range of government policies. These include domestic price policies, quantity rationing, trade restrictions, strategic reserve policies, normative consumption and income policies, plan target realization and self-sufficiency policies as well as free market policies. The relative importance of these policies are determined by specifying an hierarchical order among these policies. For example, prices can be allowed to adjust to supply and demand, or may be set at desired levels and stocks may be allowed to adjust. Thus, depending on the particular set of policies and the hierarchy of policy adjustment that is prescribed one can characterize equally well market economies, socialist economies and mixed economies. This is so because the only constraints imposed are the accounting rules and all economies have to respect these accounting identities.

To get the full implications of the accounting identities which are similar in nature to the laws of conservation (you can't get more from the system than you put in), one needs to cover the whole system and not leave any unaccounted sources or sinks which can mask feedbacks and secondary, but not negligible, effects. Thus at the national levels we consider the whole economy and include along with agriculture, also the non-agriculture sector. Similarly, at the international level we include the whole world by including a set of aggregated models for the countries not represented individually in our system.

In summary we would characterize the FAP system of linked models as one that provides a quantitative tool for exploring alternative policy strategies applicable to various kinds of economies, planned as well as market economies, and which is realistic in the sense that it takes into account the behavioral responses of the various actors in the economy. For exploring policies for growth of agriculture, one needs to quantify the supply responses of farmers to various policy instruments. For exploring distribution policies one needs to characterize consumer behavior under the influence of government policies. For exploring the interactions of growth and equity one needs to specify the income generation and distribution process as well as recognize the limitations of government policies and constraints on their consistency. The typical national model of FAP does this. However, the methodological approaches do differ from model to model. The approaches used for each of these elements can be briefly characterized as follows:

*Supply Responses* : Four alternative approaches are used in various models:

- Econometric estimations of acreage response and yield functions. In these relative profitabilities and critical inputs and factors are included as explanatory variables. This is the approach followed in the models of India, Kenya, USA and one version of the Canadian model.
- A non-linear programming model to allocate land, factors and inputs to different crops based on estimated production function is used in the models of our basic linked system.
- A linear programming approach which integrates economic and institutional aspects with agronomic considerations is used in models of Thailand and Bangladesh.
- A hierarchy of linear programs are used in our models of centrally planned economies (Hungary and Poland) to describe and coordinate the behavior of planned and various agricultural subsectors.

*Income Generation* : In some of the models of developing countries different classes are identified based on the distribution of assets such as land, draught animals, equipment, etc., and the product is distributed across these classes as income entitlements as shares of labor, land, capital, etc. In some others, production itself is identified by different size classes. In the developed country models, as impact of income distribution is not significant on food consumption, only two classes are distinguished, namely agriculture and non-agriculture.

*Demand Behavior*: The demand behavior is described through estimated linear expenditure systems. For developing countries, different expenditure classes are distinguished and a separate demand system is estimated for each class from time series of household expenditure surveys.

*Government Policy* : Government policy is described by a hierarchical set of adjustment rules for policy targets such as domestic price targets, trade quotas, stock targets and bounds, tax rate bounds, etc.

### 1.2. A Typical National Policy Model of the FAP

The basic elements of the model system of the FAP are the national policy models. A national model has to reflect the specific problems of interest to that particular nation. Thus the national models differ in their structure and in their descriptions of government policies. The model system of the FAP permits linking of such diverse models but requires that the models meet a few conditions. They have to have a common sector classification at the international trade level, nine agricultural and one non-agricultural sector, and some fairly reasonable additional technical requirements. For example, net exports have to be independent of absolute level of world prices and continuous functions of them. Even though the national models differ from each other, the broad structure is common to most models. Food supply and demand may be distinguished by various income groups. A typical model is shown in Figure 1.

Past prices and government policies affect production decisions. The domestic production in the n sectors of the economy - $y_1, y_2, \ldots, y_n$ - accrues to each of the sectoral groups – represented by superscript j. Thus for group j, its

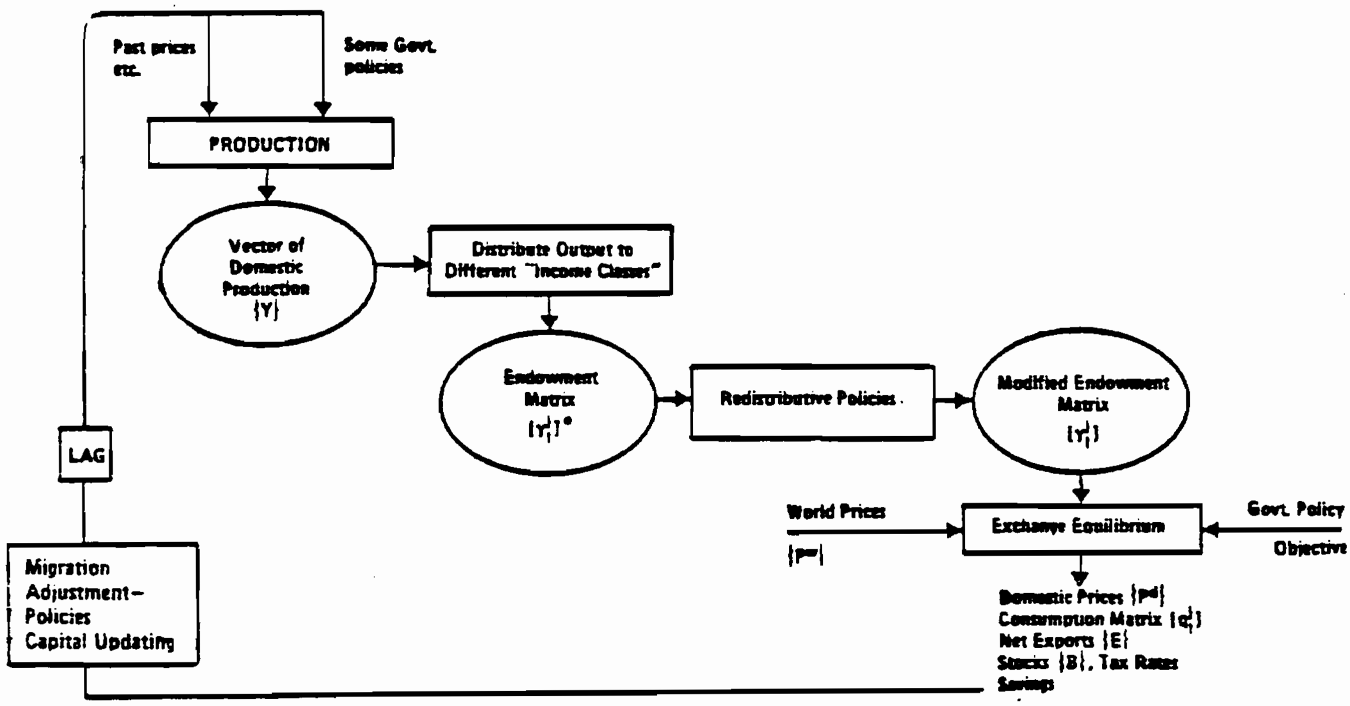



Figure 1. A typical national model.

share of the national product is given by the vector $y_1^j, y_2^j, y_3^j, \ldots, y_n^j$. The income this share amounts to is determined by the price that these products command. For example, if farmers who have grown two million tons of wheat and one million tons of rice, they would have an income of twice the price of a million tons of wheat plus the price of a million tons of rice, minus the cost of producing wheat and rice. The matrix $y_i^j$ thus describes the initial entitlements of the different products for the various groups. Government policies may redistribute these entitlements to $y_i^j$.

Given these entitlements and world prices, the $j = 1, \ldots, J$ groups trade among themselves under the influence of government policies, which include national market policies, (price, buffer stock, trade) public finance policies, (balance of payments, public demand, direct tax) and international market and finance policies, (agreements on price, buffer stock, trade, financing). The resulting exchange equilibrium determines the domestic prices, net exports, tax rates, and the consumption patterns of different income groups whose demand behavior are characterized by a linear expenditure system, and which clear the markets and meet the balance of trade constraint.

### 1.3. The International Linkage

The net exports of all the countries are thus calculated for a given set of world prices, and market clearance is checked for each commodity. The world prices are revised and the new domestic equilibria giving new net exports are calculated once again for all countries. This process is repeated until the world markets are cleared in all commodities. It may be noted that at each stage of the iteration the domestic markets are in equilibrium. The procedure is shown schematically in Figure 2. It may be noted that any international agency – such as buffer stock agency – can be represented as a country, and the effectiveness of its policies can be evaluated within a framework in which country policies react to the policies of the agency.

Since we go through these steps period by period, we have a dynamic simulation that we use for a 5 to 15 year period to predict the consequences of various policies, not only for individual countries, but also for the entire system.

The approach of the FAP model system described briefly above is certainly ambitious, but if certain major policy issues are to be adequately explored, we believe that such a level of complexity is inescapable.

This process yields international prices as influenced by government policies. The outcome of this process are examined by governments who may change their policies for the next period.

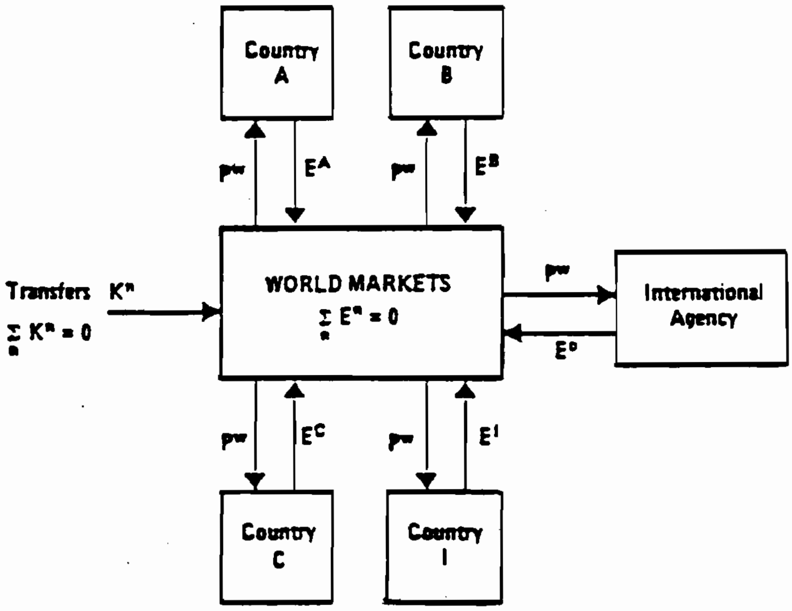



Figure 2. International linkage.

**The Countries and Sectors in the BLS**

The present version of the BLS consists of thirty-four models linked together. Of these twenty-one models, 18 refer to individual countries, two refer to the EC and the CMEA, and 14 to the rest of the world. Table 1 shows the status of the models.

Each model has ten sectors at the international level in which it trades with other countries. The sectors and the units of measurement are shown in Table 2.

Though international trade takes place at the 10-sector levels, individual national models can have a different sectoral detail and, in fact, many detailed models do have greater sectoral detail.

Table 1

Table 1. Models in the BLS

| | Country | Type of Model |
|---|---|---|
| | Egypt | * |
| @ | Kenya | x |
| | Nigeria | * |
| | China | + |
| | India | O |
| @ | Indonesia | * |
| | Pakistan | * |
| @ | Thailand | x |
| | Turkey | * |
| | Argentina | * |
| @ | Brazil | * |
| | Mexico | * |
| | Australia | * |
| @ | Japan | * |
| | New Zealand | |
| @ | Canada | * |
| @ | USA | O |
| | Austria | * |
| @ | EC | * |
| | CMEA | ++ |
| | REST of the World | # |

| Legend | |
|---|---|
| * | Models with the standard common structure |
| x | Models with structure similar to the standard structure |
| O | Detailed models with country-specific structures |
| +,++ | Models with special structures |
| @ | Detailed models under development |
| # | Models based on FAO study AT2000 (Scenario B) |

**Note:**

(i) In addition to the above, the following detailed models are under development: USSR, CSSR, Bulgaria

(ii) Detailed models of the following countries are available but not yet linked for technical reasons: Sweden, Finland, Thailand, Bangladesh, Hungary, Poland

Table 2

| | |
|---|---|
| Wheat | (1000 mt) |
| Rice | (1000 mt) |
| Coarse Grains | (1000 mt) |
| Bovine & Ovine Meats | (1000 mt of Carcass Weight) |
| Dairy Products | (1000 mt of Fresh Milk Equivalent) |
| Other Animal Products | (1000 mt of Protein Equivalents) |
| Protein Feeds | (1000 mt of Protein Equivalents) |
| Other Food | (Millions of 1970 US $) |
| Nonfood Agriculture | (Millions of 1970 US $) |
| Nonagriculture | (Millions of 1970 US $) |

**2. The Analytical Framework Needed**

For a satisfactory analysis of the various issues related to the question of agricultural policies one needs a framework that accounts for a number of important interrelationships and feedbacks: Obviously it is necessary to evaluate the transformation possibilities in production amongst different agricultural commodities due to changes in relative prices, the impact on farm incomes, as well as the substitutions that consumers make. Such substitutions are important as agricultural production is carried out with limited factor availability of land, labor and capital as well as of inputs such as fertilizers and water. Thus, when relative prices of products change, allocations of scarce resources should be expected to change. Similarly, consumers also allocate their limited incomes to different goods and these can be expected to change when relative prices change.

The need to account for the effects of price changes on farmers incomes, and consequently their consumption also, is particularly important for countries where agricultural incomes contribute a large proportion of national incomes as is the case for most developing countries.

Since traded quantities are the differences between domestic supply and demands, they are usually much smaller than domestic supply or demand. Changes in demand due to changes in income, assuming domestic supply is fixed, gets fully reflected in traded quantities. Thus, even small income effects, therefore, can lead to large changes in traded quantities.

And, of course, it is well known that the impact of changes in own prices of net export can be of either sign. The analytical implication of this is that the interaction between prices, supply, income and demand and trade have to be all considered. In order to fully account for these interactions, it is useful to consider a closed system where there are no unaccounted supply sources or demand sinks which can mask some feedbacks. In other words, a general equilibrium framework is indicated which incorporates the relevant government policy instruments and the behavioral responses of various economic agents producers and consumers the changes in such policies is needed.

One could argue that if the net export functions from the rest of the world are known for a country one can do policy analysis using only the national model. For a number of policies such stand alone analysis based on a national model may be adequate. However, net export functions are not easily available. Moreover, shifts in such functions consequent to the responses of other governments to major policy changes by one government would be difficult to account for in analysis with a single country model. Thus what we need is a system of general equilibrium type national policy models linked together through trade and transfers.

The Basic Linked System (BLS) of national policy analysis models of FAP is such a system and we believe that it is particularly suited to analyze issues of agricultural trade and self-sufficiency.

## 3. The Basic Linked System

This section describes in a nontechnical way the structure of the national models which are currently linked into the BLS.

The individual models of the BLS and the linked system together are of the general equilibrium type in that not only physical flows but also financial flows are balanced. The country models must therefore cover the whole economy. In other words, both the agricultural sector and the nonagricultural sector have to be modeled. The policy alternatives to be investigated with the model system affect not only agriculture but also the nonagricultural sector either directly or indirectly through changes occurring in agriculture. Changes in the nonagricultural sector, in turn, have an effect on agriculture. It is therefore necessary to include the nonagricultural sector in the model in such detail as to realistically reflect these interdependencies.

The linkage approach allows the consideration of different income classes. Wherever a significant variation in the preference system of the various income classes is apparent, the population should be classified appropriately to account for these differences.

From the computational point of view it is necessary that all country models adhere to the same commodity classification for the purpose of international trade. It is further assumed that all countries trade at the same time and only once a year, and that trading is achieved instantaneously.

The conditions placed on the demand system of a national model are as follows: Demand must be homogeneous of degree zero and continuous in both prices and income, and a monotonically increasing function of income. There is nonsatiation, i.e. when the price of any commodity drops to zero, weighted total demand exceeds a specified satiation level. One item of demand is considered to be free disposal. This is used as a slack variable if supply exceeds all types of disappearance.

The linkage approach requires that supply be homogeneous of degree zero in domestic prices which, in turn, must be homothetic in world market prices.

It is assumed that supply is given at the time the exchange of commodities takes place; i.e., current demand in all countries must be equal to supply determined in all countries in the previous year, leading to a recursively dynamic system. Although for a few commodities this might not always reflect reality, this assumption is valid for many agricultural products, since their production period is one year. In the nonagricultural sector the production periods may deviate even more from these annual sequences. However, this assumption has the advantage of reducing the computational burden and of allowing great flexibility in the method chosen to model the supply side. Indeed, the supply modules which have emerged cover a wide spectrum of possible techniques. For example, linear programming models, nonlinear programming models with statistically estimated parameters, and conventional, econometrically based supply functions are used.

In order to reduce the dimensionality of the exogenous variables in a linked run, the price-setting process in a country needs to be endogenized. In most models the policy module contains a set of price transmission equations. These equations describe the domestic raw material consumer price (at the wholesale level) of a commodity in relation to the nonagricultural price. The determining variables are the price ratio at the world market of the same commodities, current and one-year lagged, and that at the domestic level one year lagged. In addition, the average of the last two-years' self-sufficiency ratios is also used as an explanatory variable. The reduced form nature of these equations reveals that we did not aim at explaining the structure behind this process of setting domestic price levels. By relating the domestic price among others to the world market price we were able to include the impacts of all trade instruments on the domestic price as a tariff equivalent.

Most of the national models were built by members of FAP using a common structure. Only the models for China, the CMEA countries, India and the USA differ in their structures.

### 3.1. National Models with Common Structure

We begin with describing the BLS models with a common structure. These models are based to a large extent on data published by FAO. The time series used cover the period of 1961 to 1976. By far the largest share of the parameters were econometrically estimated. Other information used to specify the value of a parameter includes national accounts, technical publications and estimates obtained elsewhere.

The *supply module* consists of several subcomponents which we describe in the order in which the information flows through the whole module.

Given last year's results, the *input structure* for agriculture is determined first. The following inputs are dealt with explicitly: cultivatable area, fertilizer, capital, labor and feed use.

An attempt was made to estimate *land* input into agriculture (measured as total area of crops harvested) with several economic variables as determining factors. However, the t-values showed no significance. The only variable used was therefore time. This trend function has the property of reaching assymtotically a ceiling or a floor value.

*Labor* input into agriculture is measured by the number of people employed in this sector. A more precise measure for agricultural manpower could not be used due to lack of data. Hence, such important characteristics as skills and total working hours over a year and during peak seasons could not be taken into consideration.

The ratio of current to previous year's agricultural labor force is determined in the labor function by the per capita income parity between agriculture and nonagriculture, where we approximate income by gross domestic product.

As with the labor force, we had to assume that *capital* is a homogeneous input factor, since lack of data did not allow us to differentiate between various capital goods. Capital stock is determined in the model in two stages. Gross investment is first decided upon and is then converted into capital stock.

Agricultural gross investment is described as a share of total gross investment using a functional relationship which includes the ratio of agricultural to nonagricultural price indices and the ratio of output of the two sectors as determining variables. Both explanatory variables are lagged by one year. Investment in agriculture increases relatively to that in nonagriculture if the terms of trade between the two sectors change favorably for agriculture. The ratio of output of the two sectors in the previous year is taken as a proxy of the ratio of planned output in the two sectors. According to this specification, agricultural gross investment is higher relative to that of nonagriculture the larger the ratio is.

Total gross investment is estimated as a function of total gross domestic product at current prices, trade deficit, and the change in gross domestic product last year and the year before.

For *fertilizer* inputs we assumed that nitrogen, potash, and phosphorus are applied in fixed proportions; hence it suffices to consider nitrogen as a variable. However, the unit value of nitrogen consists not only of the nitrogen price but also of the value of potash and of phosphorus applied together with a unit of nitrogen. Fertilizer input is a function of the unit cost of fertilizer and previous year's crop production. The latter is considered to be a proxy for planned crop production in the current year.

When calculating the input of *feed* concentrates we assume that their supply is completely elastic. With this assumption it is possible to determine feed mix per animal unit independently of the level of animal husbandry.

The functional form employed to determine the feed requirement per animal unit is derived from a feed cost minimization model which finds the minimum cost feed ration as a function of output per animal, (expected) feed prices and a time variable approximating changes in the feed efficiency.

After the levels of these inputs are arrived at they have to be *allocated* (except feed) *to the various commodities*. For this purpose, a nonlinear programming model with a nonlinear criterion function and linear and nonlinear inequality constraints is used. This approach seems very suitable for the task of modeling a multiple input-multiple output system of an industry which is characterized by joint production. In modeling for policy analyses over a time span of 15 to 20 years such an approach has the advantage that both economical and technical relations are included in the mapping.

We postulate that farmers maximize expected net revenue, which is defined here as expected gross revenue minus expected feed cost and expected cost for yield-increasing inputs (excluding fertilizer). The farmer is assumed to have nonstochastic behavior; in other words, he reaches a decision which does not deviate from the optimal one.

The allocation model contains yield functions for crops. Product-specific acreages and numbers of animals are determined by mechanization functions which describe either one of them in terms of labor and capital employed to cultivate or husband a certain amount of acreage or animals respectively. Crop-specific yields are a function of the amount of fertilizer being allocated to that crop and a technical progress term. Similarly, the allocation of labor and capital to the various commodities determines the acreage or number of animals of that particular product. The constraints include land, labor, capital and fertilizer. In addition, there are flexibility constraints for capital. The capital stock employed in the production process of any commodity has to reach a certain fraction of that of last year. The argument for applying these constraints is that the ease with which capital can be moved between the production processes of different crops from year to year would otherwise be unrealistically high.

Given the type and parameters of the yield and mechanization functions used in the allocation model, the outcome of this model is determined by the input structure, the relative prices and the cost of the yield-increasing inputs (other than fertilizer).

There is a smooth surface for the substitution processes between capital and labor employed in the production process of any commodity. Similarly, the transformation surface is smooth, allowing a gradual shift of the inputs used in the production process of one commodity to be employed in that of another commodity. Of course, the curvature of these surfaces may change with a change in the input intensity.

We would like to point out that the specification of the allocation model allows for annual decisions without explicitly considering the dynamics involved in those production processes which cover periods greater than one year (e.g. beef and dairy production). However, implicitly these characteristics are taken care of in the parameters of the corresponding production function and in the lag structure of the respective price expectation model.

The ***nonagricultural*** sector is aggregated to one commodity. This sector is represented by a Cobb-Douglas production function. Labor employed in this sector is the residual of total labor force and that employed in agriculture. In the same way, the investment in the nonagricultural sector is determined.

The ***demand*** for goods is modeled using a Linear Expenditure System (LES). We tried to estimate the coefficients of the linear expenditure system but obtained unrealistic results. Therefore, we followed a more pragmatic approach.

We estimated for each commodity and total calorie intake nonlinear Engel curves on a per capita basis. The functional forms chosen imply that expenditure elasticities are either constant or decline with increasing expenditure.

The calculation of the marginal budget shares and the committed demand quantities is done annually in the following way. Given expected income the expected per capita consumption for each commodity and for total calorie intake is determined by the corresponding Engel curve. These demand values are then adjusted to guarantee consistency with respect to total expected expenditure and expected income, and with respect to total calorie intake and to ensure that the Engel aggregation condition is fulfilled. From this procedure average expenditures are obtained for each commodity which are used together with the adjusted income elasticities to determine the coefficients of the marginal budget shares and of the committed demand values.

**4. Reference Scenario**

The primary role of the Reference Run is to serve as a "neutral" point of departure, so to speak, from which policy scenarios take off as variants, with the impact of the policy seen in the deviation of that policy run from the reference run. The reference run is the result of extensive validation.

The Reference Scenario attempts to describe the world under existing policy conditions, but it should not be interpreted as a prediction or a forecast. In the tuning process efforts were made to arrive at model outputs which were within the bounds of credibility. Such expectations by their nature have to be based on informed, though subjective, judgement and therefore only in cases of extreme results were model improvements carried out.

Both for the Reference Run and for the other runs a number of important variables remain exogenous, though for a large and complex systems model such as the FAP we can claim that the exogenous variables represent a small share of total variables handled in the model. The more important of these are discussed in summary form below:

- *Population* and its growth is taken from the latest UN and ILO sources medium projections, but for some individual countries, e.g. India, these have been adjusted by the latest local information/projections. Similarly, the participation rate in the total labor force is defined exogenously, but the allocation of the labor force between agriculture and the rest of the economy is endogenized.
- *Land* available for cultivation is exogenous and its value is taken predominantly from FAO sources and from specific local estimates. This also included the development of land over time.
- *Rates of total investment* as share of the GDP are estimated from the historical period and after a period of adjustment in the early 80s they are kept constant. Some exceptions exist to this, e.g. India, where investment rate changes over time are exogenously specified.

It may be worthwhile to re-emphasize that the BLS and by implication the Reference Scenario are not designed as forecast or forecasting tools, but only as a powerful analytical system to explore and understand the impact of alternative policy packages in a logically consistent and complete, though aggregative model of individual economies and the global trading system.