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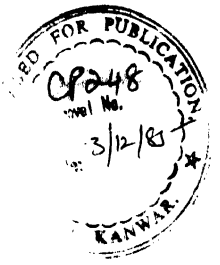
# A REVIEW OF THE ROLE OF AGRICULTURAL RESEARCH, TECHNOLOGY AND POLICY IN THE SEASONALITY OF HOUSEHOLD FOOD SUPPLY AND PRODUCTION IN SUB-SAHARAN AFRICA

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# A REVIEW OF THE ROLE OF AGRICULTURAL RESEARCH, TECHNOLOGY AND POLICY IN THE SEASONALITY OF HOUSEHOLD FOOD SUPPLY AND PRODUCTION IN SUB-SAHARAN AFRICA

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The seasonal patterns of food supply and consumption are directly related to the food production capacities and the overall agricultural development status of a given region. In this paper, various aspects of the consequences of seasonality on food supply and production in sub-Saharan Africa, excluding South Africa, are reviewed. The paper is presented under the following ten main headings: 1) Food production trends and crop yields 2) Food production and population growth 3) Consumption and production 4) Seasonality of foods, price and agricultural productivity 5) Food expenditure, labor, and traditional agriculture 6) Food marketing 7) Food security and self-sufficiency 8) Some traditional solutions to seasonality 9) The Green Revolution and Africa 10) Agricultural research priorities for minimizing seasonality

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## 1. FOOD PRODUCTION AND CROP YIELD TRENDS

The fact that much of sub-Saharan Africa is unable to feed itself and that food production in the region has steadily declined is well documented. In the last two decades the food production per caput in sub-Saharan Africa has decreased by 25% and malnutrition in mostly the rural areas of the region has increased (Brandt, 1984). In much of the region, per caput calorie intake is below minimal nutritional standards (USDA, 1981; Eicher and Baker, 1982; Labonne, 1983). The severity of the calorie intake shortages and malnutiriition in rural areas, particularly the semi-arid ones, is most serious towards the end of the dry season. Sub-Saharan Africa's declining food production is essentially a reflection of, and confounded with its underdevelopment. Sub-Saharan Africa is the poorest part of the world's economy in which over 60% of the 36 low-income countries, with low rates of economic growth and negative rates of growth of agricultural output are found (Eicher and Baker, 1982).

The yields of the major food crops, roots and tubers, cereals and pulses in sub-Saharan Africa are lowest among the developing regions (Fig.1). Cereal yields of Africa are less than half those in Asia and yields for pulses, roots and tubers, are two-thirds of Asian yields (USDA, 1981).

For example, if we examine the yield trends of two of the major cereal crops of Africa, sorghum and maize, there has been little improvement in the last two decades. In sorghum, during these two decades, yields in the USA and Mexico have shown spectacular increases

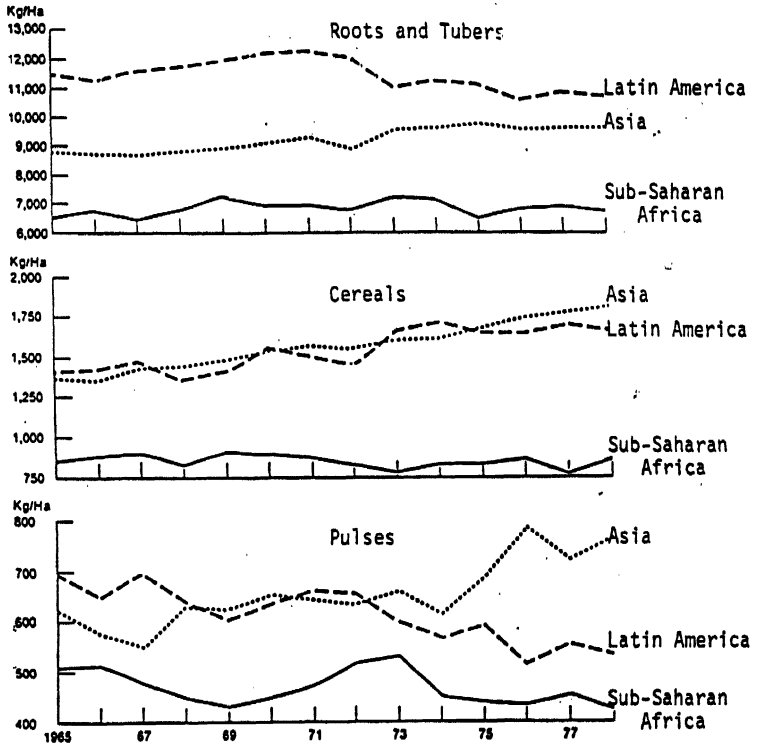


Fig.1. Sub-Saharan Africa, Asia, and Latin America yields for staple crops.

Source: USDA, 1981

whereas those of Africa have remained stagnant (Fig.2). The trend in maize yield improvement in the USA and western Europe has been as spectacular as the sorghum yield improvement in the USA and Mexico. On the other hand, African maize yields continued to stagnate and tended to decrease after the mid-1970's (Fig.3). In both crops, at the beginning of the 1980's, the yield gap between the highest-yielding region, the USA, and the lowest-yielding one, Africa, was in the order of five to eight fold. In addition to soil and climatic factors, the main reason for the tremendous difference in yield between the two regions must be the differences in the level of crop production technology. Until the yield levels of the important African food crops are significantly improved, the problem of seasonal fluctuations in food supply will remain with the small scale African farmer. To solve the problems of seasonal fluctuations in food supply in Africa it is essential to improve crop yields by using improved technology; including improved cultivars, better agronomic and cultural practices, higher inputs, adequate crop protection, better machinery and equipment, and overall improved farm management. It will suffice here to stress that government policy and the overall development strategies and priorities in any African country have a major bearing on national technological progress and agricultural growth.

Per capita food production in sub-Saharan Africa in the 1960's and 70's declined, whereas Asia and Latin America recorded steady improvement (Fig.4).

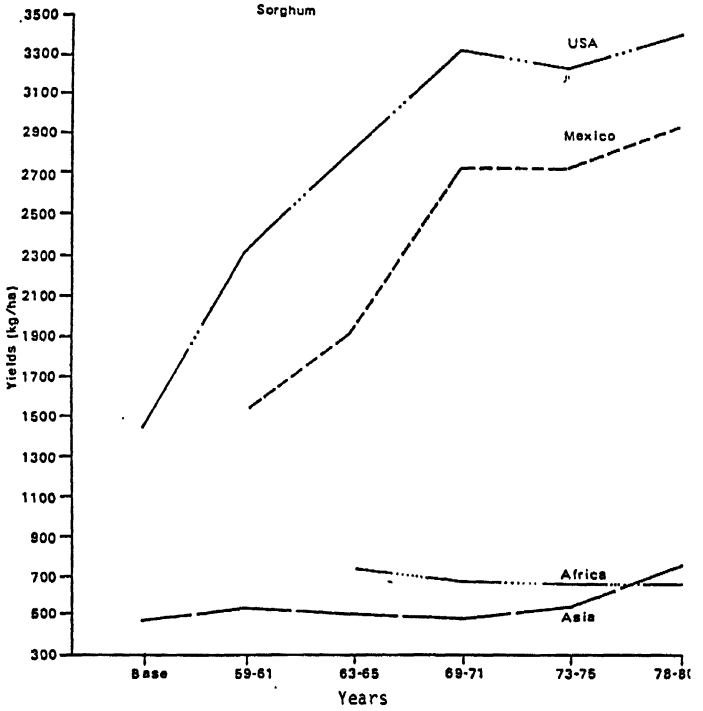


Fig. 2. Progress in sorghum yield improvement, 1948-1980

Source: Leng, 1982

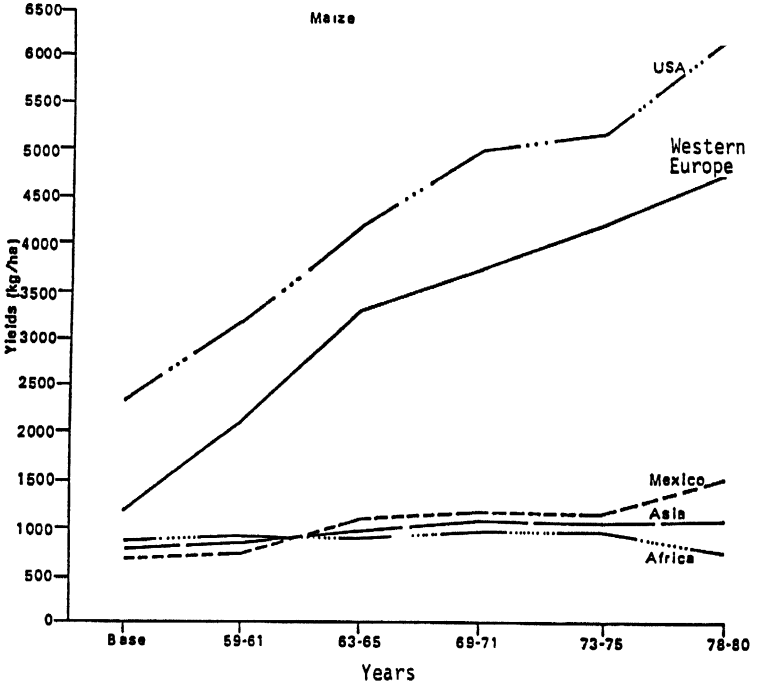


Fig. 3. Progress in maize yield improvement, 1948-1980

Source: Leng, 1982

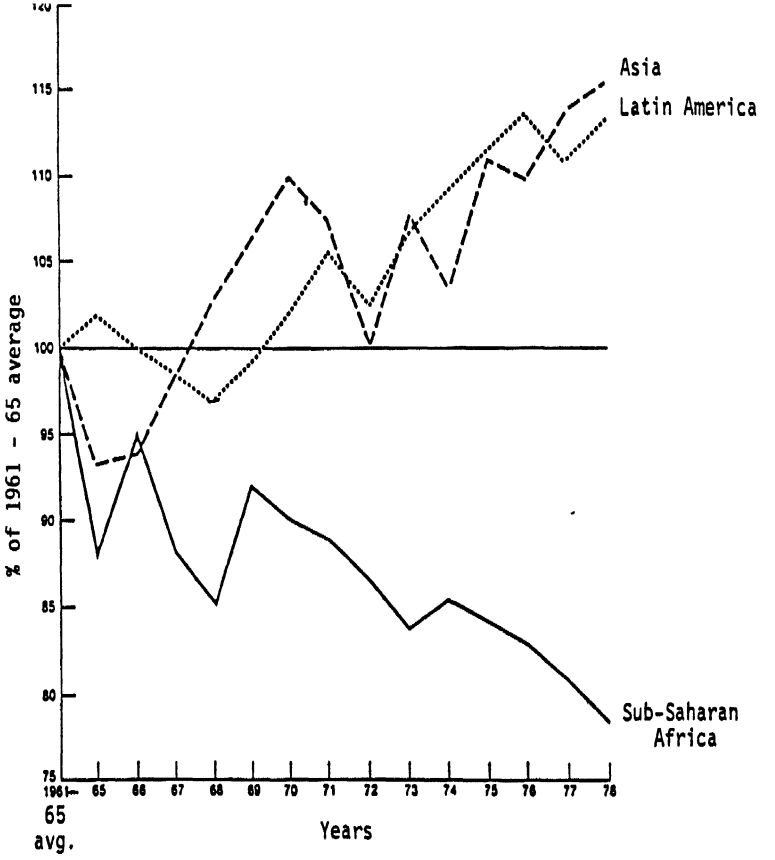


Fig.4. Sub-Saharan Africa index of per capita food production

Source: USDA, 1981

## 2. FOOD PRODUCTION AND POPULATION GROWTH

The growth in population and the massive movements of people to urban centers are exacerbating the precarious food situation of Africa that seems to deteriorate from year to year. Even such countries as Kenya and Zimbabwe that are more successful food producers than other sub-Sahara African countries are likely to experience food shortages in the future mainly because of their high population growth rate. For example, by the year 2000, the population of Kenya is expected to double and remain predominantly rural. The trend in most other African countries is similar.

In much of the sub-Saharan Africa food production has not kept pace with the rapidly increasing population (Calvo, et al, 1973, McCarthy and Mwangi, 1982, Ugonis, 1984). In the decade of the 1970's of all the major regions of the world, Africa had the lowest, 1.8%, rate of change in food production and the highest, 2.9%, rate of change in population increase with per caput production of cereals declining (Figs. 5 and 6). Even within Africa itself, there is a wide fluctuation in cereal production from country to country. In general, those countries realizing the lowest per caput cereal production are the ones that also face the most severe fluctuations of food supply. Households with adequate incomes are not generally affected by problems of seasonal variation in food supply as are those with very low incomes.

In the last 25 years, in a significant proportion of the semi-arid parts of the sub-Saharan Africa, the main issue has not been the seasonal fluctuation in food available to the rural poor, but the near

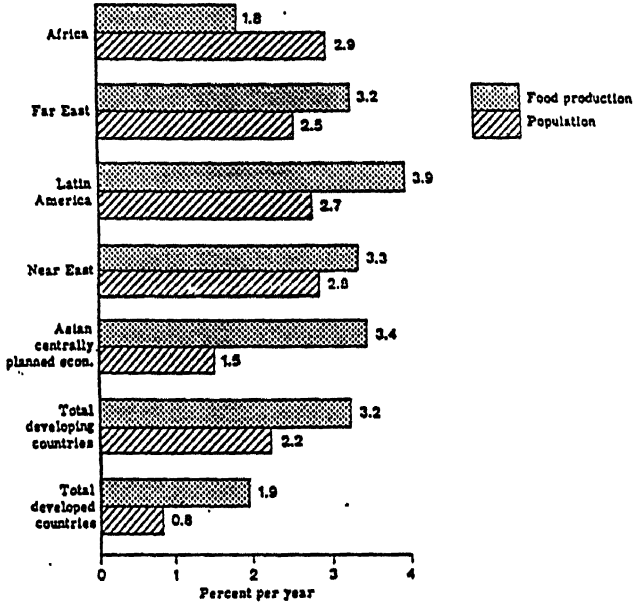


Fig. 5. Annual rates of change of food production and population in developing and developed regions, 1971-80

Source: FAO, Rome, 1981

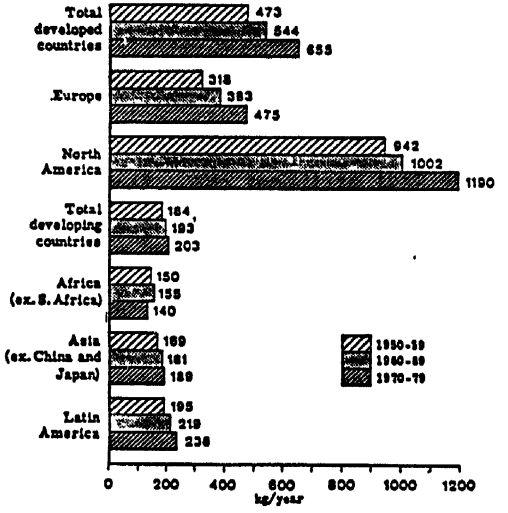


Fig. 6. Per caput production of cereals by region, 1950-59, 1960-69 and 1970-79

Source: FAO, Rome, 1981

total unavailability of any food, leading to disasterous famines and widespread starvation. As a consequence of this situation, millions of Africans have died. Famine has devastated much of Africa from West to East and North to South (Table 1). The most recent famine still has the Sahel, Ethiopia, Sudan and Mozambique in its grips. A recent issue of Newsweek (June 3, 1985) states that, "Across the sub-Saharan drought belt, three quarters of the 10 million people who died, or are likely to die as a result of the on-going famine are children under the age of five and of the tiny, shriveled survivors, all too many will be blighted for life in body or mind". The immediate task for that part of Africa engulfed by the current famine is to find temporary solutions for the problem and in the long run create situations conducive to improving food production in the region. The problem of seasonal fluctuation in food supply can, therefore, be solved only through long-term agricultural development plans.

Table 1. Reported famines in Africa since 1960

| Year | Country |
|---|---|
| 1960 | Morocco; Mauritania |
| 1960-61 | Republic of Congo |
| 1962 | Algeria |
| 1967-70 | Nigeria |
| 1972 | Burundi |
| 1973 | Sudan |
| 1971-74 | Angola, Chad, Mali, Niger, Mozambique, Burkina Faso, Senegal, Benin, Togo, Mauritania. |
| 1973-75 | Ethiopia |
| 1984-85 | Ethiopia, Chad, Sudan, Mali, Mozambique, Niger, Burkina Faso |

Source: For 1960-75 period, Olembo, 1977
For 1984-85, Newsweek, June 3, 1985

The short fall in Africa's agricultural production and the increasing food demand by the growing population have dictated the importation of food grains at increasing prices using very scarce foreign currencies (USDA, 1981). For example, Africa imported in 1984, 12 million tons of wheat without satisfying all its needs (Ugonas, 1984). Until Africa becomes self-sufficient in food production, this import of food grains is likely to continue. This will certainly have adverse effects on the economic growth of the African countries importing food. The pre-occupation of most of these countries has been to avert, without much success, the famine closely associated with the droughts of the early 1970's (Swanberg and Hogan, 1981).

In selected African countries, such as Nigeria, there were phenomenal increases in food imports in the 1970's. In Nigeria's case the reasons for the steep rise in food grain importation were the growth in income, population, and foreign reserves. Neglect of agriculture, and the lower priority and attention given to that sector since the country's oil boom have contributed significantly to Nigeria's increasing food grain import bill. In the case of rice, the Nigerian consumer with his increasing income tended to demand higher quality and better-processed products and these were easily obtained through imports (Adesimi, 1983). Even in Senegal, there is a strong preference for imported rice, and the consumer is willing to pay a premium for imported, high quality rice thus underscoring the difficulty in replacing imported rice by domestic produce (Ross, 1979).

One of the long term strategies to reduce Africa's food import bill and increase local production is to strengthen research and development service on food crops important to Africa. Essentially because of the colonial heritage in most African countries, past and present research

emphases have been, and continue to be on export and industrial crops (Nweke, 1979). If Africa is to be able to feed itself by the turn of the century it must now invest more on agriculture in general, and food crops in particular

## 3. CONSUMPTION AND PRODUCTION

In much of rural Africa the family-run farm is the centre of livelihood and dictates the pattern of household food source and consumption. The use of the market as a food source for rural communities is very restricted. Since consumption of one's own produce is essentially a way of life in most rural areas, this style dictates the production of specific crops preferred by the local inhabitants (UN, ECA, 1974). Throughout Africa one finds social communities established around the culture of a given crop, or group of crops. The major traditional and relatively widespread food crops are maize, sorghum and millets, wheat and barley, plantains and bananas, and roots and tubers. Pulses are found along with these main crops. The use of, and recourse to, the market by local inhabitants is only for food items which are not produced by the family farm (UN, ECA, 1974). If the family farm has excess produce over and above its requirements this is normally sold in the local market. Centres of high population concentration which can not produce sufficient food for their own use must resort to the market. In many regions food demand is increasing far more rapidly than supply, particularly around urban centres (Arouna, 1977; Calvo et al, 1973).

A 1973 survey by the UN Economic Commission for Africa covering the semi-arid belt of sub-Saharan Africa established an average per caput level of private consumption of about $7 per month of which about two-thirds was spent on food items (UN, 1974). The survey further showed that the foods of the region including cereals, root, and tuber crops accounted for about a quarter of the total consumption expenditure of the average West African, and the major part of which was consumption of his own farm production. In the semi-arid parts of Africa, sorghum and millet are the major sources of calories and home production is the primary source of these crops. Estimates of calories consumption by income strata in this region revealed that the lower income households consumed inadequate amounts of food to meet recommended levels of calorie intake (Whelan, 1982; FAO, 1981).

With progresively lower incomes, shortages of food intake per caput become progressively more severe. The proportion of underfed people becomes larger with lowered incomes. According to FAO an 'underfed' person is one whose daily food intake is below 1.2 times the basic metabolic rate. Underfed persons are forced to subsist on quantities of food insufficient to lead a full, healthy, well-developed and active life (Mazumdar, 1980).

Taking the entire African continent, by 1980 the mean daily per caput food supply amounted to 2110 calories as opposed to a requirement of 2336 calories, indicating that on the average, the continent was underfed (Mazumdar, 1980).

Taking into account the increase in population, the decline in production, and the severity of the continent-wide recent and current drought, the per caput food consumption for Africa must have fallen dramatically in the last four or five years. The number of underfed persons in Africa, of course, varies tremendously from region to region, country to country, and even from locality to locality within a country. For those countries where statistics are available, in 1980 the proportion of the underfed was about 10% in the Ivory Coast and Morocco and over 50% in Chad, Mali, and Mauritania. The number of underfed people in both Ethiopia and Zaire were said to exceed 10 million (Mazumdar 1980; Whelan, 1982).

The crop production environment in a given region appears to be the main factor determining the per caput food situation in Africa. Modifying the crop production environment to a more favourable one is certainly difficult. In the long run, increasing per caput income offers the best hope of liberating diets from environmental constraints (Eicher and Zalla, 1970). This would involve tackling Africa's problem of economic underdevelopment in all its aspects.

Environmental factors generally determine the dominance of a given cereal in a given place. Maizé dominates where rainfall and soil are favourable. In poor soils and drought stress situations sorghum and pearl millet are the dominant cereals. In various parts of Africa, the cereals are consumed in various traditional preparations such as tô (West Africa), ugali (Eastern and Southern Africa), bogobe (Botswana), ogi (Nigeria), injera (Ethiopia), kisra (Sudan), couscous (Sahel), bread, fermented and unfermented drinks (ICRISAT, 1982).

In Nigeria, for example, the most important cereals are sorghum, millet, maize and rice. The per capita consumption of these cereals in the various states of Nigeria is given in Table 2. Demand was predicted to exceed supply by 2.3 million tonnes for sorghum and 1.2 million tonnes for millet in Nigeria by 1985 (Davies, 1985). In the case of wheat, since Nigeria's own production is low, the country's demand for the crop was expected to exceed 2.0 million tonnes by 1985 (Davies, 1985). The popularity of bread, particularly among the urban population, is contributing to the increasing demand for wheat in Nigeria. In 1981, of the major wheat-consuming countries of West Africa, Nigeria alone accounted for more than 50% of the wheat imported by the region (CIMMYT, 1983).

Table 2. Consumption in kg. per capita per week of cereals in various States of Nigeria

| State | Sorghum | Millet | Maize | Rice | Wheat |
|---|---|---|---|---|---|
| Kaduna | 1.93 | 1.46 | 0.08 | 0.01 | 0.005 |
| Bauchi, Borno and Gongola | 1.60 | 1.78 | 0.70 | 0.01 | n |
| Niger and Sokoto | 1.74 | 0.79 | 0.96 | 0.05 | n |
| Kano | 1.78 | 1.91 | n | 0.01 | n |
| Benue and Plateau | 0.80 | 0.67 | n | 0.005 | n |
| Kwara | 1.17 | 0.03 | n | 0.27 | n |
| Oyo, Ondo and Ogun | 0.01 | 0.01 | 0.15 | 0.05 | n |
| Imo and Arambra | n | n | 0.25 | 0.12 | n |
| Bendel | 0.005 | 0.005 | 0.28 | 0.15 | n |
| Rivers | n | 0.02 | 0.06 | 0.09 | n |
| Cross River | n | n | 0.15 | 0.12 | n |
| Lagos | n | n | 0.04 | 0.06 | n |
| Total | 9.035 | 6.675 | 2.67 | 0.945 | 0.005 |

Source: Davies, 1985

n = negligible

## 4. SEASONALITY OF FOODS, PRICE AND AGRICULTURAL PRODUCTIVITY

Seasonal fluctuations in food supply in the typical rural African household are well known. Home-grown foods are normally available in plenty immediately after, and for a few months following harvest. On the other hand, food supplies are at their lowest level towards the end of the dry season and in the months preceding harvest. Seasonal fluctuations in food supply can be minimized by improved storage practices that are dependant on the suitability of the product in question for long term storage (Plate, 1967.). The single most important factor determining how much grain is available for storage in a given area is rainfall. Seasons of good rainfall normally result in bumper harvests and plenty to store, but if the rains fail there may be no harvest at all. Food price fluctuations also have seasonal pattern.

During the 1970's the relative price of food in practically all African countries rose steadily and this trend magnified seasonal food price fluctuations (Ghai and Smith, 1983). Low income households are the most vulnerable target group, suffering from the consequences of food supply, and price fluctuations.

Households that produce substantially more than they consume, and are able to store, or sell their excess produce normally have the capacity to cope with seasonal fluctuations without serious food shortage in a bad season. The long-term solution to the seasonal fluctuations of food supply on a national, regional or Africa-wide basis lies in increasing agricultural productivity and improving food storage conditions.

The main aim in advancing agricultural productivity should therefore be to obtain the best possible mix of activities and products to suit the needs of each country or a region in a country and its people. In this total approach of raising agricultural productivity, rural people in Africa have a crucial role to play as producers, consumers, and labor force. Bunting (1984) lists seven groups of factors offering opportunities or constraints for agricultural and rural progress:

a) Volume of effective demand for rural products

b) Output delivery system

c) The resources which producers command

d) Production methods

e) Knowledge systems

f) The policies and practices of governments

g) International relationships

For West Africa, Okwuosa (1973) emphasized that production presented a greater constraint to agricultural development than effective demand. He stressed that agricultural development policy in West Africa should be directed to removing the factors that impede increase in production. Getting farmers to adopt improved technologies is one of the most important factors limiting progress in agricultural production. Okwuosa (1973) further noted, in addition to increasing the production of the important crops in a region, there is the need to link agricultural development with industrial development for the utilization of the agricultural raw materials for the development or expansion of agro-based industries.

The needs and emphases of the various sub-Saharan African countries vary relative to the seven groups of factors enumerated by Bunting (1984). The priorities and resource endowments of different countries also vary; therefore, forcing each country to tackle its own high priority problems relative to its human and material resources. However, as a long-term objective, each country must handle each of these seven factors in the context of its own position. It is only when each country's agricultural and rural development issues are tackled comprehensively that a lasting solution to the problem of seasonal fluctuation in food supply in each country can be realized.

The storability of a given product has a major influence on whether it is seasonal or not. Among the cereals, for example, maize and sorghum are damaged by insects under the traditional farmers' storage conditions and therefore are more subject to seasonality problems than the small-seeded millets such as tef (Eragrostis tef) and finger millet (Eleusine coracana) which have very few storage problems. Problems of seasonal maize storage are most serious in humid and hot regions of tropical Africa (Jones, 1972). Cassava roots begin to rot within 48 hours after removal from the ground and the crop must be processed at once if it is to be kept for any period of time. However, this does not affect year-round food supplies because the live roots can be stored in the ground for months without any cost (Jones, 1972).

In tropical Africa where temperature fluctuations are of little consequence in determining crop seasons, availability of water for crop production either as natural rainfall or irrigation is perhaps the single

most important factor influencing seasonal food production. As the rainfall and irrigation situations improv the farmer's choice of strategy to minimize the seasonality problem widens. Where rainfall and irrigation practices permit, it is possible to increase cropping intensity and practice combinations of various cropping systems, such as sole, mixed, inter-, relay, double, and ratoon cropping. With improved water supply, as the cropping intensity increases and higher crop yields are obtained per unit of time and land the problem of seasonal fluctuations in food supply will decrease.

The homogeneous ecological belts and monomodal rainfall pattern stretching in an east-west direction across West Africa, make seasonality a major problem. On the other hand, in eastern Africa, mainly because of the tremendous diversity in altitudes, regional variations in temperatures and rainfall, and the bimodal rainfall pattern in some areas, the period of harvest is extended and thus problems of food seasonality are less.

The problem of food supply seasonality resulting in the usual seasonal feast and famine situation in subsistence economies can not be isoloated from the overall problem of under-development, and in particular from low agricultural productivity. The problem of seasonality is most serious in cereal-growing parts of sub-Saharan African. Even within cereal-growing areas, those parts facing adverse weather conditions, particularly low rainfall, are most severely exposed to seasonal fluctuations in food supply.

Again, the problem of food supply seasonality in sub-Saharan Africa should be viewed in the light of the region's prevailing poverty, malnutrition and low agricultural productivity. People in those parts of Africa that are not poverty-stricken do not have to worry much about the problems of food supply seasonality because they can afford to purchase food at any time during the year.

As emphasized by Eicher and Baker (1982) and Eicher (1982), unless the problem of African rural poverty is handled in a long-term and comprehensive manner related to what they have called the fundamentals of agricultural development i.e. structural reforms; training African scientists, strengthening national research, extension and training institutions, and placing high priorities on agricultural development, Africa's problems of food production, and in the context of this paper, seasonality of food supply, cannot be solved.

## 5. FOOD EXPENDITURE, LABOR AND TRADITIONAL AGRICULTURE

Although the vast majority of the rural population of sub-Saharan Africa are dependent on their own production of the food they consume, there is also a significant minority of rural people and urban dwellers who survive on purchased food. In an urban area, one Nigerian study has shown that the proportion of household income spent on food was negatively correlated to household income. People in the highest income group earned 23 times as much as those in the lowest, but spent only 4 times as much on food. In the rural households, 83% of their earnings was spent on food (Etukudo, 1978). This pattern of expenditure on food appears to be

generally true in the rest of Africa. Household size and income are the most significant determinants of food consumption (Adesimi, 1978; Adesimi and Ladipo, 1979). As Adesimi and Ladipo (1979) found out in western Nigeria, as the household size increases and the food budget becomes tighter, there appears to be more and more tendency to purchase unprocessed foods for home processing and consumption.

The shortage of the labor force at critical times of agricultural operation adds to the continent-wide food shortage. For example, a nationwide rural household survey in Sierra Leone strongly confirmed that the peak labor demands act as effective constraints on farm output (Byerlee et al, 1977). In this Sierra Leone survey, although labor was widely identified as a constraint, labor productivity under traditional agricultural technologies was also very low. In terms of agricultural operations, it is, for example, well known that early planting generally contributes to higher yields but many farmers throughout Africa fail to plant early mainly because of a shortage of labor at peak planting times. In Nigeria, Davies (1985) reported that the shortage and high cost of labor at peak periods of the crop season has become an important constraint to crop production and the problem is exacerbated by the very limited use of labor-saving tools and equipment. With growing urbanization in Nigeria, in recent years there has been a trend for young people to drift from rural areas into urban centers leading to a shortage of much-needed agricultural labor at critical times. In the case of weeding, although weeds are recognized as a major constraint to higher yields, Nigerian farmers, for example, find it difficult to obtain labor for weeding (Davies 1985). In general, African farmers do recognize the importance of

optimum timing for such critical operations as planting, thinning, weeding, spraying, and harvesting; but these operations may often be delayed because of a shortage of labor resulting in lower yields for the farmer. In many places even if labor is available, the seasonally high price of labor can not be paid by the average small African farmer.

Reflecting on the low productivity of sub-Sahara Africa's agriculture, Franke (1983) and Labonne (1983) emphasize that the poor performance of agriculture is mainly due to the fact that African development models work in favor of urbanization, and rural exodus, and do not pay sufficient attention to creating conditions that favor an increase in agricultural productivity. In terms of an agricultural labor force, they underscore that a smaller number of older farmers are expected to provide for a rapidly increasing total population. For young people in Africa, if there is opportunity, it is increasingly becoming more fashionable, and is considered modern and civilized to move into urban centers. One of the ways to improve agricultural productivity is to minimize the drudgery of African farming and improve labor efficiency by improving farm tools and equipment. Unless new labor-substituting techniques become available through a major research effort in Africa, it will continue to be difficult to realize a more productive agriculture in tropical Africa (Morgan, 1977)

In their attempts to increase food production, countries have tried different strategies. Whether large-scale private farms, or state-owned large farms, or individual-owned traditional small farms are appropriate varies from country to country. A review of the comparative performance of large-scale versus the traditional small-scale farms in

various African countries has been made by Eicher and Baker (1982). Small-scale farms are by far the major suppliers of foods in much of Africa. Seasonality of foods is, therefore, most influenced by the seasonal performances of the small farms in a given country. In West Africa in particular, traditional small-scale agriculture dominates almost all countries of the region, and this is the sector of the economy that engages the majority of the West African population. Government-supported programs have tended to favor large farms, and as a result of governments' focusing chiefly on large-scale schemes, traditional agriculture has been essentially ignored and is in a weak position to meet present and future food needs of the west African region (Vermeer, 1983).

In Nigeria, attempts to deal with the food problem of the country through direct government investment in large-scale, highly capital-intensive projects, rather than by providing support services and infrastructural facilities to traditional small-scale farmers have not solved the country's food problems (Essang, 1978). Coupled with the low priority, and the lack of overall government support given to small-scale traditional agriculture, the food pricing policies have been set to resolve social and political pressures, especially in urban areas. This has meant that high incentive prices did not reach the producers and this has also contributed to reduced agricultural production. Vermeer (1983) and Essang (1978) have concluded that traditional agriculture appears destined to continue to bear the primary responsibility for feeding the west African population. This conclusion also appears valid for the rest of the sub-Saharan Africa.

## 6 FOOD MARKETING

Seasonal abundance and scarcity of a given food commodity normally varies from region to region within a given country. Often food stuffs have to be transported from regions of surplus to deficit. The bulk and perishability of vegetable and root crops, relative to their unit value, do not allow them to be transported over great distances without the use of expensive cooling, handling, packaging and transportation facilities. Cereals and pulses on the other hand can easily be transported to deficit areas to alleviate problems of seasonal shortages. In such situations, appropriate government policies on marketing and pricing of agricultural products have a major influence on food supply seasonality in a given region of a country. Appropriate marketing and pricing incentives can encourage farmers to increase the production of those food commodities that bring them the highest net return. In Kenya, for example, maize wholesalers and large-scale farmers gain little advantage in holding seasonal stocks because they are essentially restricted to trading through legal channels and at government-regulated prices. Where traders are not restricted by government regulations, they are in positions to profit from seasonal and speculative storage. In most of Africa, the largest amount of grains are stored and sold by small-scale farmers. Farmers that can afford to store their produce do so knowing that prices will usually increase as the post-harvest season progresses (Jones, 1972). Seasonality and grain price are generally directly related where prices are highest just before harvest and lowest just after harvest.

The bulk of the agricultural products consumed in rural African households are available unprocessed. Food items for home consumption are mostly obtained raw and processed at home by women (IDRC, 1973). Processing enhances a product's acceptability as food by the local population. Often processing jobs such as dehulling and grinding grain using local equipment are tedious and time consuming. Improved food-processing equipment can eliminate the drudgery in home food processing and also improve the market acceptability of crops.

## 7. FOOD SECURITY AND SELF-SUFFICIENCY

Food security and self-sufficiency have been of major concern to the African countries throughout the last two decades (FAO, 1981). In addition to the efforts of individual coutries for national food security, regional undertakings have been initiated. The most significant of these regional undertakings have been the Lagos Plan of Action of the Organization of African Unity (LPA/OAU) covering the entire continent, CILSS (Interstate Permanent Committee for Drought Control in the Sahel) focusing on relief and developmental needs of the Sahel countries of west Africa, and SADCC (Southern African Development Co-ordination Conference) covering the nine southern Africa countries geographically close to South Africa.

The LPA/OAU (OAU, 1981) emphasizes the collective and individual commitment of OAU countries to the achievement of self-sufficiency in food production and supply, and under food security, among other things

the LPA/OAU stresses that a) most member states should aim, as a first step, at setting up national strategic food reserves of the order of 10% of the country's total food production, b) urgent steps should be taken by every member state to adopt a coherent national food security policy c) member states should examine the feasibility of setting up an African Food Relief Support with a view to assisting member countries in times of food emergency. The current food emergency needs of such worst drought-affected countries as Ethiopia, Sudan, Chad, and Mali and the subsequent mass African famines and deaths are painful reminders that the actions implied in the LPA/OAU are still elusive.

As a consequence of the Africa-wide drought of the early 1970's, several initiatives for Africa's food self-sufficiency and ecological balance are underway. The most important and well-organized is that of the Sahelian countries. CILSS and the Club du Sahel collaborate closely in the funding, planning, and execution of research and development projects for the eight Sahelian countries. The tasks of CILSS/Club du Sahel are listed as; co-ordination of drought control activities, mobilization of resources for national and regional drought control projects, ensuring basic food self-sufficiency, and enhancing economic and social development (Club du Sahel, 1982a). Programming has been carried out for the period up to the year 2000 with ambitious food production targets based on 80% rain-fed agriculture. Particular points stressed in the CILSS/Club du Sahel program were improving drought resistance of rain-fed crops, cereals storage, mass rural

development and food self-sufficiency and ecological equilibrium (Club du Sahel, 1982a). For Mali in particular, a Food Strategy was drawn up with the objective of solving one specific problem - that of food self-sufficiency (Club du Sahel, 1982b). The overall and priority objective was to ensure food security for Mali, then to achieve food self-sufficiency and higher levels of nutrition, i.e. an adequate and well-balanced diet for the entire population (Club du Sahel, 1982b). That was the program as planned in the mid-1970's. The tasks for CILSS/Club du Sahel are just as relevant today as they were envisaged a decade ago. The continent-wide drought has recurred, and has now much of sub-Saharan African in its grip. Unless massive inputs are mobilized, and more concerted efforts put into African agricultural development, food self-sufficiency, and reducing seasonal or annual fluctuations of food supply for Africa will remain elusive for years to come. As Eicher (1983) emphasizes, Africa's food problems in the long run can not be solved by strategies based on slogans such as "food self-sufficiency" alone. Serious efforts and commitments by African governments and the international donor community are badly needed to strike a suitable balance between food production, food imports, and cash crop production in order to achieve growth and equity (Eicher, 1983).

A regional undertaking established in 1977 to improve and stabilize food production in semi-arid parts of Africa, is the Semi-Arid Food Grains Research and Development (SAFGRAD) project implemented by the Scientific, Technical and Research Commission of the OAU. The major activities of SAFGRAD, in co-operation with the International Research

Centers, are to improve and stabilize the production of sorghum, maize, millet, cowpea, and groundnut in the semi-arid farming systems of sub-Saharan Africa. The co-ordination of a regional research network, and strenghthening national programs in the crops of SAFGRAD's concern are additional project activities (SAFGRAD, 1984).

In addition to the on-going continental, regional, or national projects on food production and self-sufficiency, new ones are likely to be formulated and implemented. Notwithstanding all these commendable efforts, as Eicher and Baker (1982) underscore there are no five-to ten-year solutions to Africa's problems of poverty, malnutrition, and lagging food production. They call for a 20 - 30 years time-horizon to concentrate on the fundamentals of agricultural development: structural reforms, training African scientists, strengthening research and extension systems, and improving policy analysis. With this approach to agricultural development and more massive national investments in the agricultural sector, African food production in the long-run should show growth on a sustained basis and thereby contribute to reliable African food security; that in turn should minimize the problems of seasonality in food supply.

## 8. SOME TRADITIONAL SOLUTIONS TO SEASONALITY

African farmers in different regions have traditionally formulated and followed different strategies for minimizing the problems of seasonal fluctuations in food supply. Among the most widely used strategies are the use of root crops, intercropping, and traditional storage.

(a) Root Crops: -

The three most important root crops in Africa are cassava (Manihot esculenta), yams (Dioscorea spp), and sweet potato (Ipomoea batatas). Cassava is by far the most important of these crops both in terms of its total production and distribution in Africa where the four leading producers (Zaire, Nigeria, Tanzania, and Mozambique) account for about a quarter of the total global production. Nigeria alone accounts for about three-quarters of the world production of yams whereas the countries of the "yam zone" (Nigeria, Benin, Togo, Ghana, and Ivory Coast) produce together more than 90% of the global production. Although the sweet potato is found throughout much of Africa the major producers are Rwanda and Burundi (Coursey, 1984).

These three root crops are major staples of millions of Africans. They are in general adapted to the diverse environments and farming systems encountered in the continent. Cassava and sweet potato, in particular, are adapted to a wide range of environments.

Root crops have production constraints including physical and biological ones. Several African national programs and IITA have been engaged in a wide range of research activities to alleviate these constraints. High yielding cultivars resistant to diseases and insects have been developed. The most promising IITA cassava cultivars with good performance in a wide range of environments within Nigeria are TMS 30572 and TMS 30555 (Hahn, 1982). For sweet potato, Hahn (1982) also listed a wide range of disease and insect resistant cultivars with high yields. Terry et al, (1984) gives a comprehensive coverage of the root crops research, production, and utilization in Africa.

(b) Intercropping: -

Intercropping or mixed cropping is traditional and very widely practiced throughout Africa, particularly on small farms. Among its advantages are higher total crop yields, under the conditions of the small-scale African farmer; greater efficiency of labor use, greater efficiency in the utilization of soil and water resources, less dependence on a single crop, greater insurance against unforeseen risks, fewer problems of diseases and pests, the provision of diversified food over extended periods, and fewer problems in the seasonal fluctuation in food supply to the family. Combinations of these and/or other similar advantages account for the traditional and persistent usage of intercropping practices by small-scale African farmers. Experimental data confirming many of these advantages of intercropping have been reported (ICRISAT, 1974; Monyo et al., 1976; AAASA, 1977; Keswani and Ndunguru, 1982).

Although intercropping is widely practised by African farmers, it has not received research attention commensurate with its importance. Further research is needed to confirm or deny the claimed advantages of this cropping system, more breeding efforts are needed to develop cultivars specifically suited for various intercropping systems, and further research is needed to determine the most efficient agronomic and crop protection practices for the various cropping systems. Progress in these research efforts are expected to contribute to reducing the problems of seasonality of food supply.

In parts of Africa where severe seasonal fluctuations in food supply are of major concern, often the most important physical limiting factor is the shortage of water for crop production. In such situations the range of cropping systems available to the farmer are also very restricted. The focal point of research and agricultural development in such cases must be proper soil and water conservation and management including mulching, microcatchments, run-off recycling, crop life-saving irrigation, silvi-pastoral management and fodder banks. The soil and water conservation and management practice suitable for each ecological zone must be combined with the appropriate cropping system for that area. Under the conditions of the small-scale farmers, the Indian experience in crop life-saving research in drought-prone areas appear applicable to much of the semi-arid parts of Africa (ICAR, 1976 and 1977).

(c) Storage Technologies:-

One of the traditional ways of extending the availability of food to the farm household for an extended period is through appropriate storage. Crops vary in their ability to be stored. Root and tuber crops do not generally have a long storage life after harvest. Compared to small-seeded types, large-seeded cereals and legumes also rapidly succumb to storage insects. Efforts to minimize losses, or to extend the storage life of the product without loss in quality can reduce the seasonal fluctuations in food supply on the farm. Among the areas needing special research and development attention for post-harvest handling and processing of African crops are breeding for resistance to post-harvest pests, effective drying methods, rodent control, effective and proper use of insecticides, improvement in rural food processing, formulation and utilization of composite flours, and improving storage structures (Gilman, 1983).

## 9. THE GREEN REVOLUTION AND AFRICA

The cereal crops that have been significantly affected by the Green Revolution are wheat, rice and maize. Although the Green Revolution has become a reality in a few countries, e.g., Mexico, India, Pakistan, and the Philipines, it has hardly touched sub-Saharan Africa except for isolated advances in maize production in Kenya and Zimbabwe. Even in these countries since the adoption of improved maize technology is restricted to high potential and optimum environments, the national maize yields are only 1.2 tonnes/ha in Kenya and 0.8 tonnes/ha

The success of the Green Revolution is no miracle but has resulted from the judicious use of high yielding cultivars that are resistant to pests and diseases and the use of irrigation, insecticides, herbicides, fertilizers, proper agronomic practices, machinery, proper farm management, sound government policy in credit and price support, appropriate landownership and use policy, trained manpower, sound national research, good state advisory services, and of course motivated and hard-working farmers (Borlaug, 1972; Leisinger, 1984). Much of sub-Saharan Africa is deficient in most of these items. If sub-Saharan Africa's lagging food production problem is to be solved and the region's deteriorating seasonal and yearly fluctuation's in food supply are to be minimized the factors mentioned above, must be singularly and collectively improved in the context of African reality. There are no easy, short-term solutions to the problem. Long-term policies and actions in building up research, training, and agricultural development institutions and programs at the national and regional level are essential. Leisinger (1984), who reviewed the impact of the Green Revolution and the balance of modern technology in the Third World, concluded that countries that adopted the Green Revolution realized significant increases in food production, eliminated seasonal food shortages, reduced food imports, eradicated famine and starvation, increased their rate of employment, and increased farmers' incomes. Although diverging views on the merits and demerits of the Green Revolution have been expressed (Borlaug, 1972; Lele and Mellor, 1972; Hopper, 1975 and 1976; Eicher, 1982; Leisinger, 1984), nevertheless, these are multiple goals to which sub-Saharan African countries must become committed and strive to achieve.

On balance Africa should be better off with, than without the Green Revolution, it is the only realistic long-term way to eliminate Africa's seasonal and yearly fluctuations in food supply and prices.

The impact of a successful technology and the wide-scale adoption of a"package of technology" on food production in an African country can be seen by examining the maize situation in Kenya. Maize is the most important food crop in Kenya both in terms of total production and utilization as food. Kenya has maintained a strong national maize research program for the last 30 years. The result of this program has been the development of maize hybrids suitable for the various ecological zones of the country where hybrid maize has been grown for over 20 years. Gerhart (1975) and Johnson et al (1980) reported on the diffusion of hybrid maize in western Kenya from the mid-1960's to the mid-1970's. In high elevation and optimum rainfall zones of Kenya, the advantages of using hybrid maize seed along with timely planting, proper weeding, optimum plant population, and the use of fertilizers, compared to traditional maize production methods increased yields up to 300% (Gerhart, 1975; Eberhart and Sprague, 1973).

Although hybrid maize in Kenya used to be mainly planted by large-scale farmers in the early 1960's, by the end of the 1960's the small-scale farms hectarage of hybrid maize had already surpassed that of the large-scale farms (Fig.7). By the end of the 1970's large-scale farms occupied only about 5% of the 400,000 ha. of the hybrid maize in Kenya. Similar to the Kenyan trend of the 1960's the contribution of small-scale farms in Zimbabwe to the country's maize production is now on the rise (IDRC, 1985).

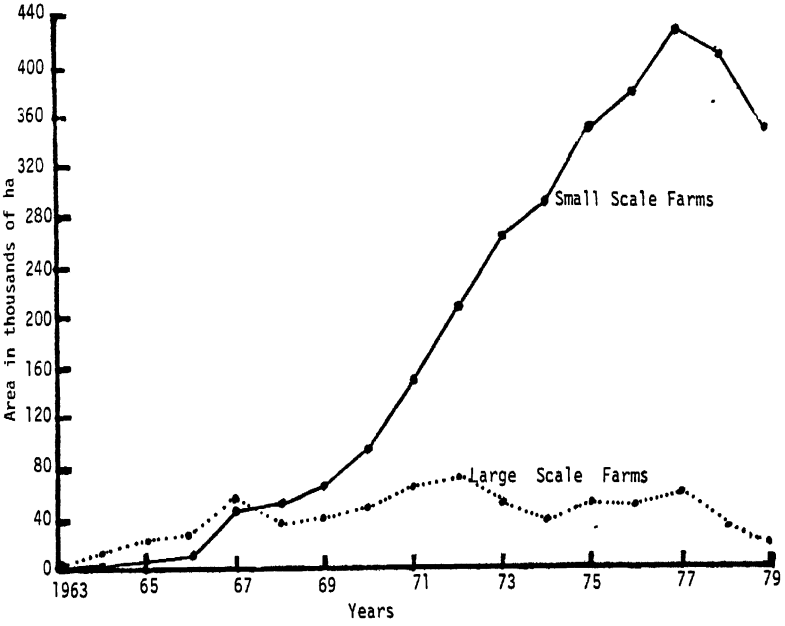


Fig. 7 Area in thousands of ha of hybrid maize grown in Kenya from 1963-1979.

Source: Johnson et al, 1980

The reasons for the success and the widespread adoption of the hybrid maize technology in Kenya have been summarized by Gerhart (1975):

- Optimum maize environment with good soils and reliable rainfall,
- A systematic and local breeding and agronomic research program with close ties to the seed industry and the extension service.
- Ready access of farmers to critical off-farm inputs.
- A good seed industry with an effective seed production and distribution system.
- Effective national extension and training services.
- Effective marketing with guaranteed floor price protecting all maize farmers against wide price fluctuations.
- Improvement of national storage facilities.

Johnson et al, (1980) also evaluated the hybrid maize success story of Kenya and cautioned that too many lessons should not be drawn from the Kenyan experience for the rest of Africa. They emphasize that large-scale commercial farmers, the long-term presence of foreign advisors the aggresive private seed company, and the well-developed transportation infrastructure, that all gave the initial boost to the hybrid maize technology are unique to Kenya.

Kenya is self-sufficient and has minimized the fluctuations in the supply of its staple crop, because of the wide adoption of the hybrid maize and associated technology by both large-and small-scale farmers. Although the Kenyan success might have been influenced by factors unique to Kenya, nevertheless it is a successful African experience that other African

## 10. AGRICULTURAL RESEARCH PRIORITIES FOR MINIMIZING SEASONALITY

As repeatedly emphasized in this paper, the problem of seasonal fluctuations in food supply in a country or region can not be isolated from the overall problem of poverty and low agricultural productivity. Therefore, the areas of research and/or development priority indicated below apply to improving agricultural productivity in general in sub-Saharan Africa. Eight major priority areas are proposed and these are plant breeding, crop choice, crop protection, soil and water management, irrigation, seed industry, agronomy and cropping systems, and processing and storage technology. These areas are mostly well recognized and are already subjects of investigation in various national, regional, and international centers.

(a) Plant Breeding:-

Wherever significant progress has been made in crop production, the core of the progress can often be traced to plant breeding. Africa needs major efforts in plant breeding for all its important food crops. High-yielding cultivars of these crops in the appropriate ecological zones can act as catalysts and carriers of other technologies for improved crop production. The hybrid maize success story of western Kenya is an African example where a successful plant breeding effort has triggered and mobilized a whole range of agricultural development activities and essentially eliminated the problem of seasonality in this staple crop. Eastern Africa countries neighboring Kenya (Tanzania, Uganda, Ethiopia) have also benefited from the plant breeding work done in Kenya by importing and growing Kenyan hybrid maize (Johnson et al, 1980)

This experience suggests that, in addition to national efforts, greater emphasis should be placed on regional plant breeding undertakings for the important African food crops.

(b) Crop Choice :-

It is well known that each crop has specific ecological requirements for its best adaptation and performance. For example, where growing conditions are more favourable in terms of water and soil, maize is often a more preferred crop than sorghum and millets. In more stress environments of soil and water, sorghum and millets are preferable and more reliable crops. As Gerhart (1975) established in his extensive survey of hybrid maize adoption in western Kenya, as the crop loss risk factor due to drought increased in an area, farmers tended to grow more drought-tolerant crops such as sorghum, millet, and cassava. However, in some areas such as the Machakos district of Kenya or the low rainfall sections of the Ethiopian Rift Valley, for different reasons ranging from food preference to bird problems, farmers continue to grow maize, although from experience, farmers realize that the probability of a poor maize harvest is quite high in any one year. In Ethiopia, the largest crop area is taken by tef (Eragrostis tef) although it is the lowest-yielding cereal in the country. In much of the area where tef is grown, several other higher-yielding cereals such as maize, sorghum or wheat could be grown, and grain yields several fold those of tef could be obtained. It is alleged that food preference of the Ethiopian consumer and tradition dictate the continued production of tef in Ethiopia. The proper choice of the most suitable crop for a given agroecological zone should contribute to yield increase and stability, and consequently reduce the problem of seasonality in food supply. Research is needed to identify such crops for each major ecological zone.

(c) Crop Protection:-

Diseases, pests, and weeds account for substantial crop losses in sub-Saharan Africa. A comprehensive coverage of the subject in the tropics is given by Kranz et al (1977) and the aspect of plant breeding for resistance to pests and diseases is well covered by Russell (1978). A wide range of diseases caused by fungi, bacteria, and viruses affect the major African crops. A whole range of soil insects, stem and foliage feeders, head and ear feeders, and storage insects also take their toll of African crops. Migratory pests such as the Quelea could wipe out entire fields in hours or days. The African farmer also loses a lot of his harvest because of weeds. Grass and broadleaved weeds as well as parasitic weeds are widespread. Of the parasitic weeds, Striga is most severe on maize, sorghum, and pearl millet throughout sub-Saharan Africa. Crop protection technology in all its aspects is badly needed in Africa to minimize crop losses and mitigate the problem of seasonal fluctuation in food supply. Expanded efforts in crop protection in Africa are essential to the development and adoption of this technology in Africa.

(d) Soil and Water Management:-

Successful crop production is very dependent on the judicious management of soil and water resources. One of the main agricultural problems in sub-Saharan Africa is improper soil and water resource management. Since crop production in sub-Saharan Africa is mostly dependent on rainfall, it is imperative that steps should be taken to maximize the use of rain water. In semi-arid areas with heavy seasonal rainfall most of the rain water is lost through surface run-off

often resulting in severe soil erosion. Watershed based soil and water management systems are necessary to maintain and improve the long-term productivity of the land. Technologies that restrict surface water and soil loss, water harvesting, contour terraces, contour furrows and ridges, micro-catchment basins to minimize water run-off and improve infiltration, and vegetated waterways, are badly needed throughout semi-arid sub-Saharan Africa. Highest research priority and development strategies in this important area are a must if Africa's stagnating or deteriorating food production position is to improve.

(e) Irrigation:-

The role of irrigation in food production in sub-Saharan Africa is insignificant. Eicher and Baker (1982) give an overview of the potential, experience, and economics of irrigation in sub-Saharan Africa. The main irrigation schemes in the region are those in the river valleys of the Sudan, Ethiopia, Somalia, Mozambique, Zimbabwe, Mali, Senegal, and Nigeria. The severe droughts of the early 1970's as well as that in 1984/85 that devastated much of semi-arid, sub-Saharan Africa have stimulated interest in irrigation in Africa. The potential for irrigated agriculture in terms of the land and water resources in sub-Saharan Africa are enormous. The main problem delaying the expansion of irrigated agriculture is its initial development cost, and its demand for higher technology than is traditionally available in much of Africa. For each area, it is necessary to determine the most suitable irrigation strategy in terms of scale and method. Successful experiences in

irrigated agriculture outside Africa need to be examined carefully in the African context and adopted wherever appropriate. Although rainfed agriculture will continue to be the core of Africa's food production, due attention has to be given to irrigation research and development so that food production in the continent can be increased and made more reliable.

(f) Seed Industry

If farmers are to benefit from advances made in crop improvement research, there must be an effective seed production and distribution system to serve the needs of a country. Improved seed is a basic requirement for improved crop production. The seed is the carrier and promoter of improved inputs and practices. In many situations, the use of improved seed is the cheapest and most effective way of controlling pests and diseases. A strong seed industry has the positive effect of reinforcing and strengthening other sectors of agricultural development, such as, research, extension, and training.

As an African success in this area, the Kenya Seed Company together with a vast network of small shopkeepers have been responsible for the effective production and distribution of hybrid maize to Kenya farmers (Johnson et al, 1980). A successful seed industry needs strong research support; an effective provision for breeder's seed multiplication; a good organization for the production, processing and distribution of commercial seed; a good extension and demonstration network to promote the improved seed; good quality control; and a seed marketing and pricing policy that promotes growth of both the seed industry and the farmer.

House (1985) discusses and provides good guidelines on the role, organization, establishment, and development of such a seed industry. With an effective seed industry, crop production can expand and problems of seasonality in food supply can be minimized.

(g) Agronomy and Cropping Systems:-

Agronomic practices that are optimum for each cropping system in each ecological zone are essential to maximize and stabilize crop yields. Appropriate cultural practices include timely planting, the establishment and maintenance of optimum plant populations, and overall good crop husbandry enable high-yielding cultivars to achieve their genetic potentials. The use of fertilizers along with judicious management of soil fertility help the farmer to realize even higher yields. One of the ways to optimize the use of soil and water resources and therefore maximize yield per unit time and space is to use the most appropriate cropping system. A number of systems including inter-, relay, double, and ratoon cropping are used by farmers under different circumstances. The tillage practice that is most appropriate for each situation, including the use of appropriate farm power and implements, has to be determined and improved. The management of crop residues to improve soil and water use efficiency is critical. All of the above and many more related agronomic and cropping system issues need further and sustained research if the agriculture of sub-Saharan Africa is to improve, and seasonal fluctuations in food supply are to be minimized.

(h) Processing and Storage Technology:-

The importance of appropriate processing and storage technology in minimizing seasonal fluctuations in food supply and prices can not be overemphasized. Apprpriate processing can improve the consumer acceptabilities of agricultural products. For example, dehulling sorghum improves its range of consumer acceptance in composite flours for bread, rice-like boiled products, and several traditional African foods (ICRISAT, 1982). Improved storage structures and technologies are essential to maintain and expect the useful lives of agricultural harvests without loss in quality. Research and development in this broad area is essential to minimize the seasonality problems in food supply.

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