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INTERFACES BETWEEN AGRICULTURE, FOOD SCIENCE, AND NUTRITION

PROCEEDINGS OF A NATIONAL WORKSHOP IN SUDAN

10-15 December 1983

Editors

Samir Miladi, Salah Mahgoub, and Paul Neate

The International Center for Agricultural Research in the Dry Areas

P.O. Box 5466, Aleppo, Syria

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We hope this publication will bridge a gap in the knowledge between the disciplines of agriculture, food science, and nutrition, and will prove useful to those concerned with alleviating hunger and malnutrition, and improving the quality of life for the rural poor in Sudan.

Mohamed A. Nour
Director General
ICARDA

PREFACE

These Proceedings comprise the papers presented at the National Workshop on Interfaces between Agriculture, Food Science, and Nutrition, held at the Food Research Centre, Shambat, Sudan, 10-15 December 1983. It constitutes a review of current policies and programs in these fields in Sudan.

The workshop was sponsored jointly by the International Center for Agricultural Research in the Dry Areas (ICARDA), Ford Foundation, and UNICEF, and was the result of a recommendation made at the regional workshop on Interfaces between Agriculture, Food Science and Nutrition in the Middle East, sponsored by ICARDA and the United Nations University (UNU), held at Aleppo, Syria 21-25 February 1982.

The objectives of the national workshop were to:

1. Assess the present state of food production, availability, and consumption and the nutritional status in Sudan, and to consider ways to improve them.

2. Review current policies and programs, including research on these aspects, and to identify areas which need attention.

3. Determine follow-up activities and priorities for multidisciplinary communication and research, and

4. Consider constraints in Sudan which inhibit these activities, and to determine ways to overcome them.

More than 30 participants from Sudan were invited to attend in their personal capacities. They included: senior staff of the Agricultural Research Corporation (including the Food Research Centre), and the Universities of Khartoum and Gezira; senior officials from the Ministries of Agriculture and Irrigation, Health, Trade and Supplies, Interior, and of Education and Guidance. Senior scientists from ICARDA, including two nutrition consultants, Ford Foundation, and UNICEF also participated.

Papers were presented on specific topics related to agriculture, food science, and nutrition in Sudan. Much of the time was dedicated to discussion and to development of concrete recommendations for future policies, programs, and actions.

Holding this workshop was one of the first steps toward increasing awareness of problems common to the fields of agriculture, food science , and nutrition. It provided a critical review of the existing situation in Sudan, and suggested ways to improve it.

It is hoped that the findings of the workshop will have wide application, and will guide the formulation of national food and nutrition policy and the orientation of current activities. We hope it will also strengthen cooperation between field workers, scientists, planners, and decision-makers in the fields of agriculture, food science and nutrition.

Samir Miladi
ICARDA Food Policy and Nutrition
Consultant to the Workshop

SECTION I

An Introduction to the State of Agriculture, Food and Nutrition in the Middle East

Perspectives for increasing food production in the Middle East and North Africa

Mohamed A. Nour and David F. Nygaard

ICARDA, Aleppo, Syria

Many of the chronic problems limiting agricultural production in developing economies throughout the world are also prevalent in the Middle East. But there are also differences -- differences between recent trends of agricultural development in the Middle East and other regions. The common problems are similar to most of us and listing them here would have little value (Schultz 1984). Therefore this paper concentrates on these differences: specifically,the special characteristics and problems of Middle Eastern agriculture are pointed out and the problems associated with these characteristics are described. Thus, new solutions to new problems are required and several strategies are considered.

The development of this paper is based on three assumptions with respect to the current status of agriculture in the region, and these should be stated at the outset. First, there is great potential to increase agricultural productivity and, consequently, agricultural production in all countries in the region. Second, while recognizing that there has been agricultural growth in the region in the past 20 years, the current and expected future demand requires substantially higher rates of growth. Third, there is wide recognition of both of these factors by responsible leaders of the countries in the region and an apparent willingness on their part to take the necessary steps to realize the agricultural potential and meet the urgent requirements for food. Yet little has been done in the face of the pending crisis.

Certainly, ICARDA's research thrust is based on the assumptions in this paper. We feel that the region needs, and is ready to accept, new creative approaches to solving agricultural development problems. Thus, we are undertaking a sincere effort to find solutions and are optimistic that the results of efforts by ICARDA and many other organizations that are active in the region will make a significant contribution towards increasing agricultural production and improving the livelihoods of the rural families. In doing so, we must keep in mind that production of more

food at lower prices will benefit consumers in general, perhaps more than producers.

Several questions need to be addressed. What are these differences? Where is this potential? What are the problems or constraints, and what are the priorities for alleviating them? The subsequent discussion is organized in four sections. First, some of the major trends in the region's agriculture, population, and food trade are reviewed. Examples of the indications of physical production potentials are given in the second section. The third examines the stumbling blocks in the way of realizing these potentials, while the final section focuses on priorities for dealing with these constraints.

Food Production and Trade Perspective[1]

Changes in total and per caput food production in the region are shown in world perspective in Table 1. The 67% increase in total food production in the Middle East over the past two decades may seem spectacular, but it has barley kept pace with an equally spectacular population expansion, resulting in less growth in per capita production than in the developed countries. While population growth may largely cancel the benefits of increased food production, and is the root of other development problems, the focus of this paper remains on production.

Grain production in the Middle East region over the past two decades has grown at an annual rate of 2.5 percent, lagging behind the world (2.7%) and the average of developing countries (3.0 %). The region's slower growth in grain production compared to developing countries, as shown in Table 2, is due to its smaller expansion of grain production area and a slower growth in yields. Particularly in the past decade, the region's improvement in grain yields has lagged far behind that of all developing countries, 1.2 and 2.5 %, respectively.

The situation for meat production in the region, as shown by Table 3, is more favorable, the rate of growth having kept pace with that of other developing countries, at 3.9%, and surpassing that of the developed countries, which averaged 2.6% . This reflects the strong economic incentives for meat production in the Middle East. Meat prices have increased rapidly due to growing demand. Table 3 shows that Tunisia, Syria, Saudi Arabia, and Turkey had growth rates in meat production well in excess of other countries in the region.

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1. We wish to thank Thomas Nordblom who made a major contribution to this section and to Ahmed Mazid who helped assemble the tables and graphs.

Fig. 1 shows that the developed countries exported food greater in net value than food imports over the last decade. In contrast, in the developing countries, the opposite was true. This implies the existence of a comparative advantage for food production in the developed countries relative to the developing countries. The deficit balance of food trade in the developing countries is even more pronounced for the Middle East, where the value of food imports has far exceeded that for food exports.

Fig. 2 allows comparison of five countries in the region with respect to the trends in the nominal values of their food imports and exports. Because the values shown in Figs 1 and 2 are based on nominal prices, the effects of price inflation and quantity increases are lumped together as value increases. Nevertheless, valid comparisons can be drawn.

Syria and Tunisia have similar trends in gradually rising expenditures for food imports and low levels of food exports. In both countries high domestic demand has taken large shares of domestic food production. Saudi Arabia, with its tremendous oil revenue, has shown an astronomical rise in food import expenditures. Food exports from this country are insignificant. Since 1973, Egypt has also greatly increased food imports while showing only slight increases in earnings from food exports. Perhaps a large part of these increasing trends are due to price inflation and not quantity increases.

Turkey is a large net exporter of food and stands in marked contrast to the other countries in the region. With the exception of 1974 and 1975, Turkey has had export revenues far above those spent on imports.

The trends in imports and exports of animals and animal products for five selected countries are shown in Table 4. With the exception of Turkey, a net exporter of these products, most countries in the region have shown tendencies to import more and export less. The case of Syria provides a remarkable example. In the period 1968-1970, 44% of the value of Syria's food exports were animal products. By the 1976-78 period this share had fallen to only 6.5% .

The differences in food production, consumption, and trade between the major classes within countries, illustrate the concept of comparative advantage. There are natural, physical infrastructure, and institutional reasons why comparative advantages exist. The natural aspects of comparative advantage include climate, soil, crop varieties, weeds, pests, and diseases. In addition to those natural aspects, there are the man-made infrastructures such as roads, ports, and grain storage and milling facilities. The presence or absence of these facilities may

profoundly affect production costs and costs of food delivery and processing.

The ways in which the natural and man-made resources are exploited are heavily influenced by existing institutions, i.e., the political and traditional framework of land tenure, agricultural credit, taxation and subsidization, market structure, and trade barriers. It is clear that these institutional aspects affect the costs of farm operations and, therefore, affect farmers' choices of crop and production practices. Given the natural resources available in a country, human institutions are developed to construct and managed them.

A partial picture of the natural and infrastructural contexts of agricultural production in the region is shown by the abundance of cultivated land and its division into irrigated and rainfed areas. Table 5 shows that fully 80% of the cultivated land area in the Arabic-speaking countries supports rainfed agriculture, although this varies from as much as 92% in Morocco and 90% in Syria to as little as 2% in Egypt. However, irrigated agriculture produces over 60% of the food in these countries and one can ill afford to neglect this; any future development plans must fully consider ways to help the region increase agricultural productivity on both rainfed and irrigated areas.

ICARDA's main thrust up to now has been to develop new technology that will give greater advantage to agricultural production in the region. The clearest examples of these are (i) the development of new plant varieties capable of high and stable yields, (ii) the discovery of efficient means to control diseases, pests, and weeds, and (iii) the determination of agronomic practices that are most efficient under local conditions.

"Local conditions" is the key phrase that encompasses all costs and constraints from the farmer's viewpoint: conditions that will change from one location to another. Farmers will adopt new methods, practices, and materials if, from their perspective, it is in their advantage to do so.

Production Potential

There are many research efforts in the region that show dramatically the technical possibilities for potential productivity increases. To give just a few examples, however, one needs only to consider some of ICARDA's findings. This is a young center, just entering its seventh year, and

perhaps the most important achievement to date has been to demonstrate technical feasibility of achieving significantly higher yields under rainfed farming systems.

ICARDA's research activities are divided into four programs, each of which can point to examples where large yield increases have been achieved. The Food Legumes Improvement Program has developed chickpea cultivars that have shown resistance to ascochyta blight. This allows chickpeas to be planted two to three months earlier in Mediterranean climatic environments and thus make better use of limited available moisture. In the 1980/81 season, trails on farmers' fields showed dramatic differences (doubling of yields) between new cultivars planted in November/December and old cultivars planted in March.

In the Cereals Improvement Program, the barley project is currently screening over 6,500 lines and has several hundred barley lines in preliminary and advanced yield trials. In the 1980/81 season, fifteen lines grown at ICARDA experimental stations in Syria and Lebanon in preliminary yield trails yielded 6 t/ha or more. This should be compared to average yields on farmers' fields in a similar rainfall zone in Aleppo Province of only 1.3 t/ha. Not all of this increase is attributable to a variety effect, but it illustrates the gap that exists.

The Farming Systems Program has research plots at five different locations along a rainfall transect in Aleppo Province, and agronomic work on barley has also shown that a large potential to increase yields exists. Table 6 suggests that increases are possible in all the rainfall zones but are highest in the drier zones 2, 3, and 4. It should be noted that the yield achieved in zone 4 is over 250% of that found on farmers' fields. This potential is even more encouraging because these drier zones contain some of the poorest families in rural areas of Syria.

The Pasture and Forage Improvement Program is exploring the possibility for replacing the fallow in the prevalent cereal/fallow rotation with a forage crop. Preliminary results show that forages such as Pisum, Vicia, and Lathyrus spp. have yield potential exceeding 4 t/ha, particularly when phosphorus fertilizer is applied. Because of the economic value of forage, such a change in rotation would more than compensate for a detrimental effect on the subsequent cereal crop. It is interesting to note that four tonnes of conserved forage is enough for six months of winter maintenance feed for 20 sheep.

Of course, these successes only indicate technical feasibility, some of which may not be economically feasible. This is a point that will be

addressed in detail later, but indications are promising for these technical achievements to be economically attractive as well. Economic analysis of the response of barley to phosphorus application have been conducted by the Farming Systems Program. For example, Table 7 shows that the costs of an application of P_2O_5 at 60 kg/ha were compensated for by more than 250% .

In its outreach program, ICARDA has played a catalytic role in helping national research programs increase their capacity to do research and get their research results on to farmers' fields. The best example of this and the one of which we are most proud is the Nile Valley Project with activities here in the Sudan as well as in Egypt. Sudanese scientists with the support of the project have developed and tested a technological package for faba bean production involving earlier sowing, more frequent irrigation, and pest control which gives up to a 100% increase in economic returns.

In spite of findings of this nature, agricultural production in the region has not grown as quickly as it could nor as it should. The next section explores some of the reasons for lagging productivity increases.

Constraints to Agricultural Development

While the previous section drew solely on ICARDA's activities, there are numerous examples from national research programs and international organizations operating in the region that could have been used as well. In any case, the point that emerges should be clear: there are other constraints to increasing agricultural productivity in the region in addition to the technical ones. We need to look at the economic, social, and political institutions and the physical infrastructure to find the stumbling blocks. The major problem appears to be our inability to reproduce the research achievements, such as those mentioned in the last section, on farmers' fields

Again, it is not necessary to restate the long list of constraints to the diffusion of new technology. These lists are readily available in the literature on development (Zandstra et al. 1979; Schultz 1978). Instead, only six issues are discussed, ones especially important to the Middle East. All of these issues will require more research if they are to be solved, and in general, national agricultural research organizations in the developing world have not received the support they require. Since ICARDA is a research organization, we prefer to look at the six constraints within the context of a research environment

Risk and uncertainty: The first of these refers to production variability in the rainfed areas of the region caused by extensive climatic variation. Consider, for example, barley production in dry villages in Aleppo Province. Barley producers in the village were visited by ICARDA scientists on a regular basis for three growing seasons -- 1977/78 to 1979/80. By chance, the three years were very different from each other. The first year, 1977/78 was an average rainfall year (240 mm); the second, 1978/79, was very dry (150 mm); and the third 1979/80, well above average (270 mm). Barley yields varied widely over these years, as can be seen in Figure 3. The difference from year to year and also the differences among farmers in a given year should be noted. The inter-farm difference is particularly striking in the best growing season, 1979/80. Only those barley plots that were harvested are shown in the figure. In the driest year, 27 of the 36 (75 %) plots that were studied were grazed by sheep flocks and not harvested at all. In the average year, about 10 percent of the plots were grazed, while no plots were grazed in the wet year.

Farmers' responses to production instability are well documented (Anderson et al. 1977). Most importantly, they reduce the amounts of costly inputs used in the production process. Furthermore, if they perceive that new techniques increase output instability more than current practices, they will adopt them less quickly or perhaps not at all. Research by ICARDA scientists in Jordan and Tunisia as well as in Syria (Roe and Nygaard 1980; Arabiat et al. 1982) shows that farmers consider production uncertainty to be one of their major problems. Even under irrigated conditions, e.g., faba bean production, yield instability would lead farmers to use fewer inputs than are economically profitable.

Farmers respond to risky production alternatives in several ways. One is to seek stable off-farm income, and this is very widely practiced in the Middle Eastern region. The classic response to uncertainty by producers averse to taking risks is to diversify activities by growing several crops. In zone three in Aleppo province, for example, wheat is the major source of income in a good year, but is less important in an average year when income from lentil by-products plays a larger role.

A more important form of diversification comes from adding animal production to the farming enterprise. This is virtually a universal practice in this region, and our lack of understanding of the interface between cropping and livestock systems is the second constraint that will be addressed.

Livestock-cropping interface: The conventional wisdom is that animals play a stabilizing role in the risky agricultural systems that are

characteristic of the Middle East. They are a source of relatively liquid capital, they complement the inter- and intra-annual variations in cropping income, and they make it possible to extract some productivity out of uncultivated village common lands. Some form of this crop-livestock system is found in all the rainfed areas of the Middle Eastern region. Even in irrigated systems animals play an important role, as is demonstrated by the amount of precious irrigated land allocated to the production of berseem clover in Egypt (Habashy and Fitch 1 81), where roughly half of the farm land is devoted to this crop in the winter months.

An example of a barley-sheep system in the dry zone in Syria nicely illustrates the interdependence of these two components. Currently research conducted by the Farming Systems Program at ICARDA indicates that a farmer makes a series of decisions during the course of the barley-growing season. Each decision is made considering all currently available information, but acknowledging that future events are uncertain. Thus, each decision is made in a way so as to keep as many options as possible open, i.e., delay decisions until more information is available.

For instance, in November, the farmer must decide on, interalia, land allocation, land preparation, planting date, variety, and phosphorus and nitrogen fertilizer use. He is likely to use little or no nitrogen fertilizer at planting, instead waiting until February to decide if there is a sufficient amount of accumulated rainfall to merit a nitrogen application and if so, how much. Some decisions are irreversible but some are not, and become part of a risk-reducing strategy. He may choose a variety that will have a good grain yield in a good season but one that will also have a reasonably good production of dry matter in a dry year. It should be recalled that, instead of harvesting, 75% of the farmers in a previous example mentioned earlier let their animals graze their barley. This grazing decision was due, in part, to a low potential grain yield that year, but also to the high grazing value of the crop.

Animals play other roles in Middle Eastern agriculture as well. They are a source of liquid capital, and in some cultures animal ownership may have social importance. Large numbers of animals in the region (300 million in 1980), huge areas of unimproved grazing land (natural grazing land is estimated to be twice the area of cropped land), and growing regional consumption of meat and animal products attest to the importance of animal production in its own right. This important sector has not received its fair share of research funds to date, and thus ICARDA intends to increase its efforts in animal production in the future.

Moisture use and management: In addition to irregular rainfall, much of the region receives precious little rain, even in a favorable year. We do not understand sufficiently well how best to use the little water that is available. This lack of understanding of this crucial topic is a major constraint to attainment of the region's production potential.

ICARDA research has shown significant increases in water-use efficiency by applying phosphorus and nitrogen fertilizers to barley or by advancing the date of planting chickpea (ICARDA 1981). This is not surprising. On the other hand, as can be seen in Fig. 4, little or no moisture is stored on fallow plots according to farmers' current practices, which goes against conventional wisdom. Thus, perhaps a forage crop could be effectively introduced into this barley/fallow rotation, or perhaps the fallow could be managed more efficiently. There is considerable scope for improving the use of the moisture that is available, and new techniques must be developed.

Irrigated agriculture, which was the foundation stone of early Middle Eastern civilization and is still very important in the ICARDA region, is also plagued by problems. New lands that can brought into agricultural production are becoming more scarce, so increases in total production will need to come from increased productivity per hectare. Increasing the cropping intensity is one way to achieve this if irrigation water is available. Yet there are large differences in how effectively this irrigated land is used. Compare, for example, the cropping intensity difference between Egypt and the Sudan. In Egypt, on average, each hectare of irrigated land has 2.85 crops per year, while irrigated land in Sudan has less than one crop per year (FAO 1975).

To be sure, there are problems associated with irrigated systems and they are falling far short of their potential. In many countries in the region, land quality has deteriorated because of rising water tables, waterlogging of the soil surface, salt and sodium accumulation, etc. However, certainly one of the main problems is management and control of water delivery systems. In research being conducted by the Agricultural Research Corporation in Sudan in collaboration with ICARDA, 95% of the farmers in a survey of faba bean producers reported problems with the water delivery system, and yields were reduced as a result (Salkini et al. 1980). As is the case with rainfed agriculture, it is a question of how to use water more efficiently. The region would benefit substantially from more research in this area.

Equilibrium and adjustment: No part of the developing world is more subject to change than the ICARDA region. Changes, both rapid and radical, are taking place all around us. Very few geographical locations

in the Middle East come to mind where traditional agriculture is not affected by this. New machinery, different prices of both outputs and inputs, infrastructure developments, etc. all affect agricultural production. It is helpful to think of agriculture as tending toward an equilibrium with numerous changes that disrupt the balance. Thus, continuous adjustments are required by the producer. Obviously, the more changes there are, the more complex the adjustment process is.

Consider two examples of these radical changes:

1. In the Syrian steppe, motorized transport has enable Bedouin families to transport water to the sheep rather than vice versa, and consequently the practice of sheep production in the steppe has been dramatically affected. Stocking rates have increased to the point that the steppe is rapidly deteriorating in the process (Bahady 1980).

2. In Turkey, mechanized land preparation that conserved soil moisture and allowed farmers to plant earlier enabled wheat production in the country to double in the space of a few years. Subsequently, energy prices were drastically increased and this has now put new pressure on high energy-using inputs. Thus, Turkish farmers have had to learn new techniques and also adjust to relative price changes within a short period of time.

These changes and the adjustments they require have created an even stronger need for an effective network of agricultural extension services than in the past. What is extension other than teaching farmers new methods, i.e., helping them adjust and move to a new equilibrium? Extension services are, in general, inadequate in the Middle East, yet this is an important project if high adoption rates of new technology are to be achieved.

Labor migration[1]: The prevalence of oil reserves in the Middle East, the distribution of those reserves, and radical changes in oil prices have created a labor migration from agricultural based economies (e.g., Egypt, Sudan, Syria, and Tunisia) to oil producing countries (e.g.,Saudi Arabia, Kuwait, and Libya) in unprecedented numbers. Unfortunately we understand very little about this labor migration in general , have given little attention to the effects it has on agricultural production and technological change, and know even less about how this migration affects food consumption and human nutrition in these countries.

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1. This section was added after discussions with John Gerhart and we wish to acknowledge his contribution. See also comments in The Interface Between Agriculture, Food Science and Human Nutrition. Edit. David F. Nygaard and Peter Pellett, United Nations University, forthcoming.

Nevertheless, until future studies become available we can anticipate some probable effects. Labor migration from rural areas of young males for medium and long term contracts in other countries certainly effects the local agricultural labor market, significantly changes the contribution of women and children to agricultural production, and probably alters the family decision making process about agricultural activities. It may discourage some modern agricultural practices such as time-sensitive decisions on input use, e.g., the timing of weed or pest control. On the other hand it may encourage labor-saving mechanization due to the labor shortage, particularly for tasks traditionally performed by men.

On the consumption side, remittances of laborers who live abroad will affect, sometimes radically, consumption patterns of the family remaining behind. There are examples where diets have improve as a result of these remittances (e.g., more variety in the diet and a better balance in nutrients) but also examples where diets have deteriorated (e.g., mothers substituting commercial infant formulas for breastfeeding). At a minimum, these changes should be studied so the negative effects of them can be minimized.

Finally, there are social forces which are created by such large migration patterns, and these are even more complex to understand but probably more far reaching and more permanent. Such forces can have an impact on both the sending countries and the receiving countries.

Distribution effects of development: An issue that goes hand in hand with the previous section on change is the question of who gains and who loses in the process. The benefits are often not shared equally. A final constraint to improving the lives of rural families in the region is the failure to develop projects that help improve the lot of poor families and reduce income inequalities. This is perhaps the point that brings us closest to the interest of our colleagues in human nutrition and food science.

Many studies of the Green Revolution (Somel, in press) have shown a net gain to regions or countries where the new rice and wheat varieties have been adopted. Ryan (1977) argues that, while new wheats replaced pulses in India, per caput consumption of protein was no worse than before while per caput consumption of calories increased. These, however, are average figures and ignore the distribution effects. Brady (1981) shows that there has been significant social gain for the new rice varieties in East Asia. This is illustrated in Table 8. However, These gains go to the consumer, while the producers lose as a result of producing more. Production gains that keep prices down allow the results of the new

technology to go to consumers, most of whom live in the cities. One result of this is a degradation of the human condition and nutrition in rural areas.

Most technologies are "biased." Mechanized harvesting, for example, generally favors farmers with better land holdings, not the smaller holder with shallow, stony soil. Mechanization in general in the Middle East has replaced male labor, while the tasks done by females, e.g., weeding the fields and winnowing the grain, are still done by hand. Development projects, seeking high benefit/cost ratios, are drawn to favored areas with higher production potential. As pointed out in Table 6, the relative potential for improvement may now be higher in disadvantaged areas, such as the drier marginal lands. Production priorities do not always coincide with objectives that consider human needs and meet human nutritional requirements.

This list of six constraints on improving the situation for agricultural families in our region is by no means comprehensive, but it is hoped that interesting and important issues that are special to the Middle East have been raised. Some suggestions for action on these points follow below.

Summary and Conclusion

Although the Middle East has made recent gains in increasing agricultural production, these are overshadowed by several other changes in the region. Some of these changes are prevalent in all developing countries across the world, but others are especially relevant to the Middle East. Two crucial changes that have caused an increase in the demand for food are the extraordinarily high rates of population growth and rapid increases in income in several countries in the region. This latter factor has manifested itself in an explosive demand for meat and other animal products.

Thus, food consumption for most of the people in the region has not improved in spite of considerable production gains. Fortunately, research at ICARDA and other organizations has shown the existence of large potentials for further increases in agricultural productivity, even in the lower rainfall areas. However, a number of constraints must be alleviated before this potential can be achieved.

Six such constraints, discussed in this paper, are particularly important to this region: They are:

1. Risky and uncertain production.
2. Lack of understanding of the complex interrelated cropping-livestock systems prevalent in the region.
3. Poor use of scarce moisture.
4. Radically changing economic environments that create agricultural problems in decision-making, and poorly developed or non-existent agricultural extension systems.
5. Massive labor migration.
6. The inability to improve the income-distribution effects of introducing new technologies.

All of these constraints call for more research effort on our part. In considering possible solutions for each of these constraints, we can see that the task is not easy, but neither is it impossible.

1. Production is risky because the climate is variable. Solutions require agricultural techniques that are less sensitive to the vagaries of the weather as well as production diversification and other strategies to stabilize incomes.

2. Current livestock research suffers from the same problems that exist in current crop research, i.e., too much of it is done in isolation from other production activities. The strength of the rainfed agriculture in this region lies in the way the various components complement each other, but more research is needed on these interrelationships.

3. Moisture is a scarce resource in the region and using it efficiently requires a better understanding of soil/plant moisture dynamics; also, more work is required on moisture storage and conservation.

4. Due to the dynamic nature of Middle Eastern economies it is likely that agricultural producers will be faced with even greater adjustment problems in the future. Therefore, efforts are needed to seek ways to assist the farmer's decision-making process as he adjusts to new situations and conditions. For example, the effort to develop a methodology of on-farm testing that involves the farmers in the research process promises to be most useful.

5. Labor opportunities that are currently available in the region could be used to the advantage of agricultural development if, for example, wages earned abroad were partially invested in agriculture. However, we need a much better understanding of the magnitude and effect of

this migration before we can capitalize on it.

6. Finally, we must improve the distributional impact of improved technologies. It is possible that efforts to find new technologies that are widely adaptable are destined to benefit those persons who are already relatively well off. Thus, in order to help the poor farm families, it may take much more location-specific efforts. The need to improve agricultural productivity on shallow sloping soil is just one such example.

The impression we wish to impart is that we have much work to do. All of the suggestions made above require funds and scientific effort, perhaps with more and closer collaboration among the many disciplines that are represented. However, the outlook is positive and optimistic, as we have made great strides recently in more clearly identifying the problems. Now, the challenge is to find the solutions.

Table 1. Changes in total and per caput food production and in population.

	1961-1963 TO 1978-1980		Annual rate of increase(%)	
	%total increase	Annual rate	1961-1963 to 1968-1970	1968-1970 to 1978-1980
Food production				
World	54	2.6	2.7	2.4
Developed countries	48	2.3	2.7	2.0
Developing countries	62	2.8	2.7	3.0
Middle East	67	3.0	2.9	3.1
Population				
World	38	1.9	1.7	2.0
Developed countries	16	0.9	0.9	0.9
Developing countries	53	2.5	2.5	2.4
Middle East	58	2.7	2.7	2.7
Per caput food production				
World	12	0.6	0.7	0.6
Developed countries	27	1.4	1.7	1.2
Developing countries	9	0.5	0.2	0.7
Middle East	6	0.3	0.2	0.4

Source: FAO Production Yearbooks, 1963, 1971, 1975, 1980.

Table 2. Growth in grain production (Compound annual growth rate, %).

	Production			Area			Yields		
	1961/62 to 1979/80	1961/62 to 1971/72	1971/72 to 1979/80	1961/62 to 1979/80	1961/62 to 1971/72	1971/72 to 1979/80	1961/62 to 1979/80	1961/62 to 1971/72	1971/72 to 1979/80
World	2.7	3.3	2.4	0.5	0.4	0.7	2.2	2.9	1.7
Developed countries	2.5	3.3	1.8	0.2	-0.2	0.8	2.3	3.5	1.0
Developing countries	3.0	3.3	3.2	0.8	0.9	0.6	2.3	2.3	2.5
Middle East	2.5	2.8	2.7	0.5	0.2	0.9	2.0	2.7	1.2

Source: U.S. Department of Agriculture, World Indices of Agricultural and Food Production (USDA Economic Research Service Statistical Bulletin No. 669, Washington, D.C. July 1981). Cited by: Terry N. Barr, The World Food Situation and Global Grain Prospects. Science, Vol. 214. Dec. 1981, p 1091.

Table 3. Growth in total meat production (t x 1000).

	Average 1969-71	Average 1978-80	% Total increase	% Annual compound to growth rate
World	105,865	138,630	30.9	3.0
Developed countries	70,806	89,281	26.1	2.6
Developing countries	35,059	49,349	40.8	3.9
Middle East	2,375	3,338	40.5	3.9
- Tunisia	55	88	60.0	5.4
- Syria	70	127	81.4	6.8
- Saudi Arabia	51	100	96.1	7.8
- Turkey	422	605	43.4	4.1
- Yemen A. R.	53	67	26.4	2.6
- Morocco	201	231	14.9	1.6
- Egypt	386	429	11.1	1.2

* Source: FAO Production Yearbook, 1980.

Table 4. Export and import value of live animals, meat and meat products, Dairy products and eggs in selected countries, 1968-78.

	Average 1968-70			Average 1972-74			Average 1976-78		
	Import	Export	Difference	Import	Export	Difference	Import	Export	Difference
Value in US $ (000)									
Saudi Arabia	NA	NA	NA	97 654	706	-96 948	427 913	954	-426 959
Syria	10 773	25 286	+14 513	34 118	10 459	-23 659	62 644	3 334	-59 310
Tunisia	8 426	4 325	-4 101	21 834	1 772	-20 062	39 113	3 457	-35 656
Turkey	3 485	15 353	+11 868	6 506	42 772	+36 266	3 146	42 324	+39 178
Egypt	7 645	829	-6 816	23 034	2 253	-20 781	166 638	8 349	-158 289
Percentage of food trade									
Saudi Arabia	NA	NA		26.7	8.7		31.9	6.9	
Syria	15.7	44.0		18.3	23.5		19.9	6.5	
Tunisia	15.6	18.2		19.0	4.9		17.8	6.3	
Turkey	8.3	7.8		4.6	10.4		7.2	5.9	
Egypt	5.3	0.5		5.3	1.3		14.3	3.2	

Source: FAO Trade Yearbooks (1971, 1974, 1979)

Table 5. Present land use in the countries of the near east region (ha x 1000).

Country	Cultivated area including fallow land			
	Total	Rainfed	Irrigated	% rainfed
Algeria	7000	6750	250	96.4
Bahrain	2		2	0.0
Egypt	2650	10	2640	0.03
Iraq	5920	3000	2920	50.7
Jordan	529	490	39	92.6
Kuwait	1		1	0.0
Lebanon	276	196	80	71.0
Libya	2520	2395	125	95.0
Morocco	7040	6590	450	93.6
Mauritania	263	260	3	98.9
Oman	36	4	32	11.1
PDRY	252	162	90	64.3
Qatar	2		2	0.0
Saudi Arabia	897	720	177	80.3
Somalia	960	800	160	83.3
Sudan	7800	6240	1560	80.0
Syria	5470	4960	510	90.7
Tunisia	3500	3360	140	96.0
UAE	20	16	4	80.0
YAR	1200	1100	100	91.7
Subtotal	46338	37053	9285	80.0
Afghanistan	4900	1816	3084	37.1
Cyprus	433	389	44	89.8
Iran	16000	5550	10450	34.7
Pakistan	19200	5700	13500	29.7
Subtotal	40533	13455	27078	33.2
Grand total	86871	50508	36363	58.1

Source: Arar, Abdulla, "The Role of Rainfed Agriculture in the Near East Region". Proceedings of the F.A.O. Regional Seminar on Rainfed Agriculture in the Near East and North Africa. Amman, Jordan, 5-10 May 1979. F.A.O., Rome 1980. P. 13.

Table 6. Barley yields in Syria, 1980/81.

Rainfall Zone	Yields on farmers' fields (kg/ha)	Yields on trails at (kg/ha)	Potential increase
1	3 150	4 100	30 %
2	1 211	3 610	198 %
3	1 106	2 400	117 %
4	674	1 710	254 %

Note: Zone 1 - Average rainfall between 350 mm and 600 mm.

Zone 2 - Average rainfall between 250 mm and 350 mm and not less than 250 mm in two thirds of the years.

Zone 3 - Average rainfall over 250 mm and not less than this in half the years surveyed.

Zone 4 - Average rainfall between 200 mm and 250 mm and not less than 200 mm during half the years surveyed.

Source: Nygaard, David, and Alister Allan. A Farming Systems Approach to Agricultural Research. Paper presented at Research Conference on Crop Production in Lebanon. December 1981.

Table 7. Partial budget for phosphate application to barley in zone 3. (Rainfall 292mm in 1980/81 Cropping Season), figures per ha.

	No P_2O_5	60 Kg P_2O_5/ha
Income		
Grain Yield (t/ha)	1.470	2.400
Grain revenue (Sl/ha)	882	1,440
Straw Yield (t/ha)	2.340	5.340
Straw revenue (Sl/ha)	468	1,068
Total revenue (Sl/ha)	1,350	2,508
Expenses		
Fertilizer		
P_2O_5 x Price		130
Labor for application		10
Credit		13
Harvesting		
Labor, equipment, transport, bags, etc.		173
Total change in expense	0	326
Net benefit	1,350	2,182
Benefit/cost ratio		2.55

Notes: a) Cost of P_2O_5 = 2.17 SL/kg
b) Price of Barley grain = 0.70 SL/kg
c) Price of Barley straw = 0.20 SL/kg
d) Labor for broadcasting fertilizer = 10.00 SL/120 kg of TSP
e) Both trails received 60 kg N/ha, at a seed rate of 90 kg/ha with Beecher barley.

Source: Nygaard, David and Alister Allan. A Farming Systems Approach to Agricultural Research. Paper presented at Research Conference on Crop Production in Lebanon. December 1981.

Table 8. Estimates of annual benefits of rice research,(million US $).

Period	Producers Gain	Consumer Gain	Social Gain
1966-71	-345	702	357
1972-75	-290	590	300

Source: Brady, N.C. "Food and Research Needs of the World." Advances in Food Producing Systems for Arid and Semi-Arid Lands. Edited by Manassah and Briskey, Academic Press, 1981.

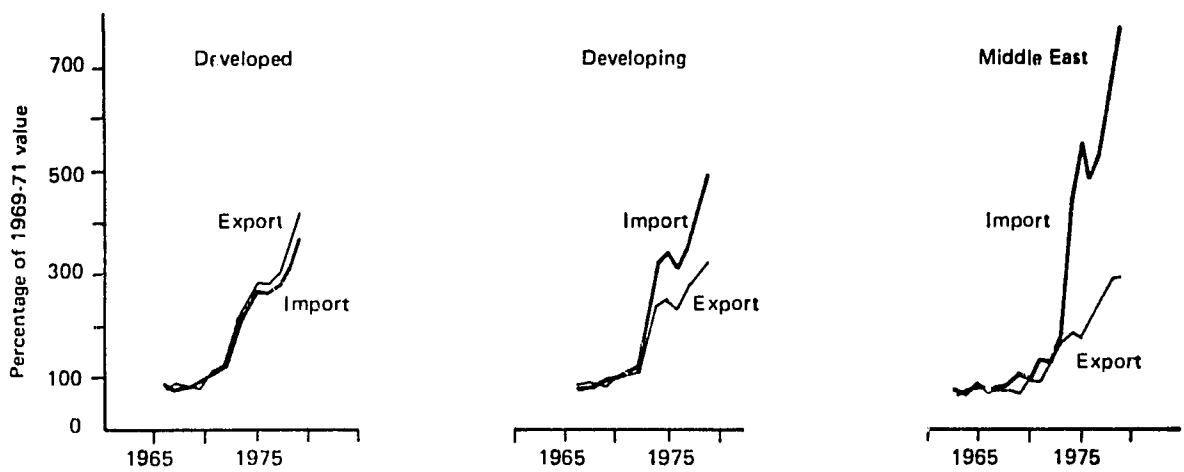

Fig. 1. Food* import and export value indices from 1964 to 1979.

* Excluding fish.
Source: FAO Trade Yearbooks, 1971, 1974, 1979.

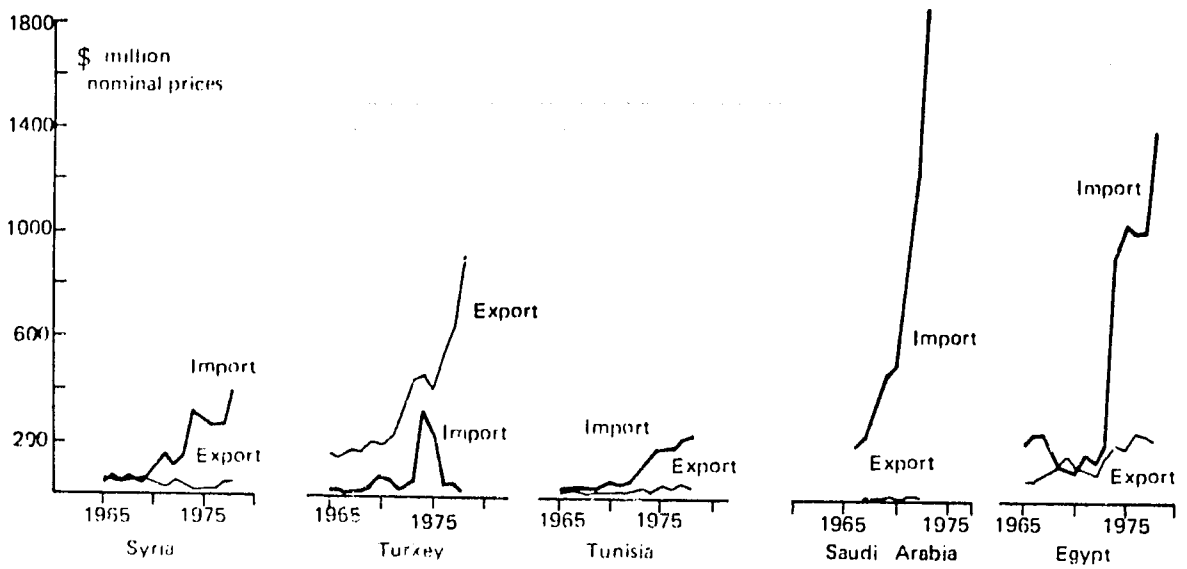

Fig. 2. Food and animal import and export values in selected Middle East countries.

Source: FAO Trade Yearbooks, 1971, 1974, 1979.

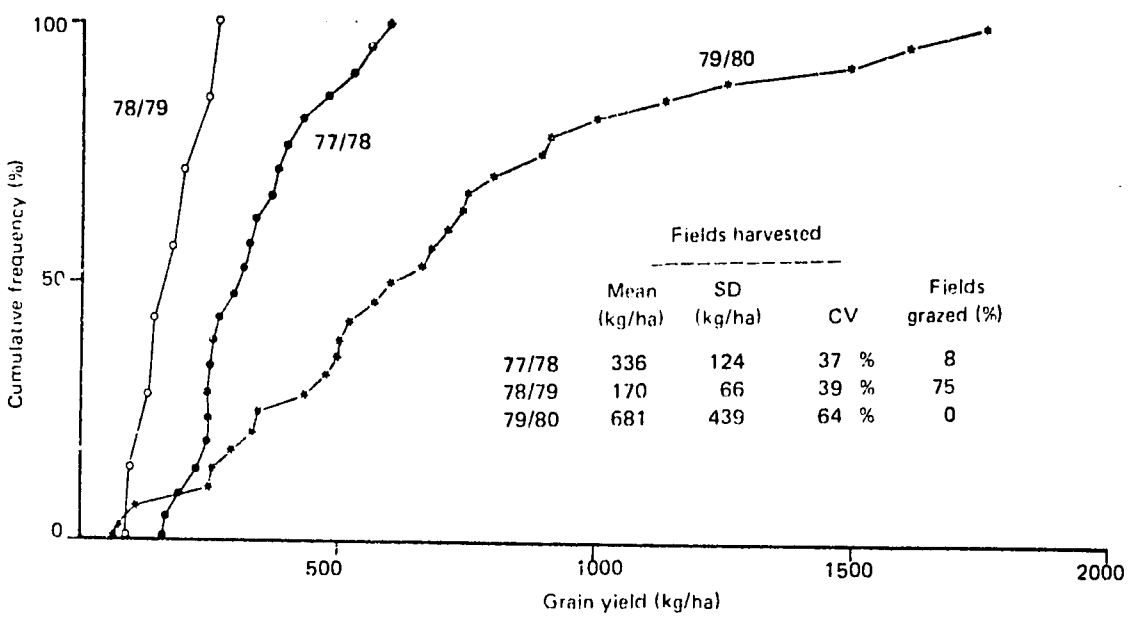

Fig. 3. Barley yield distributions at Hawaz village, Syria.

Source: Farming Systems Program, village study data, ICARDA, Aleppo, Syria.

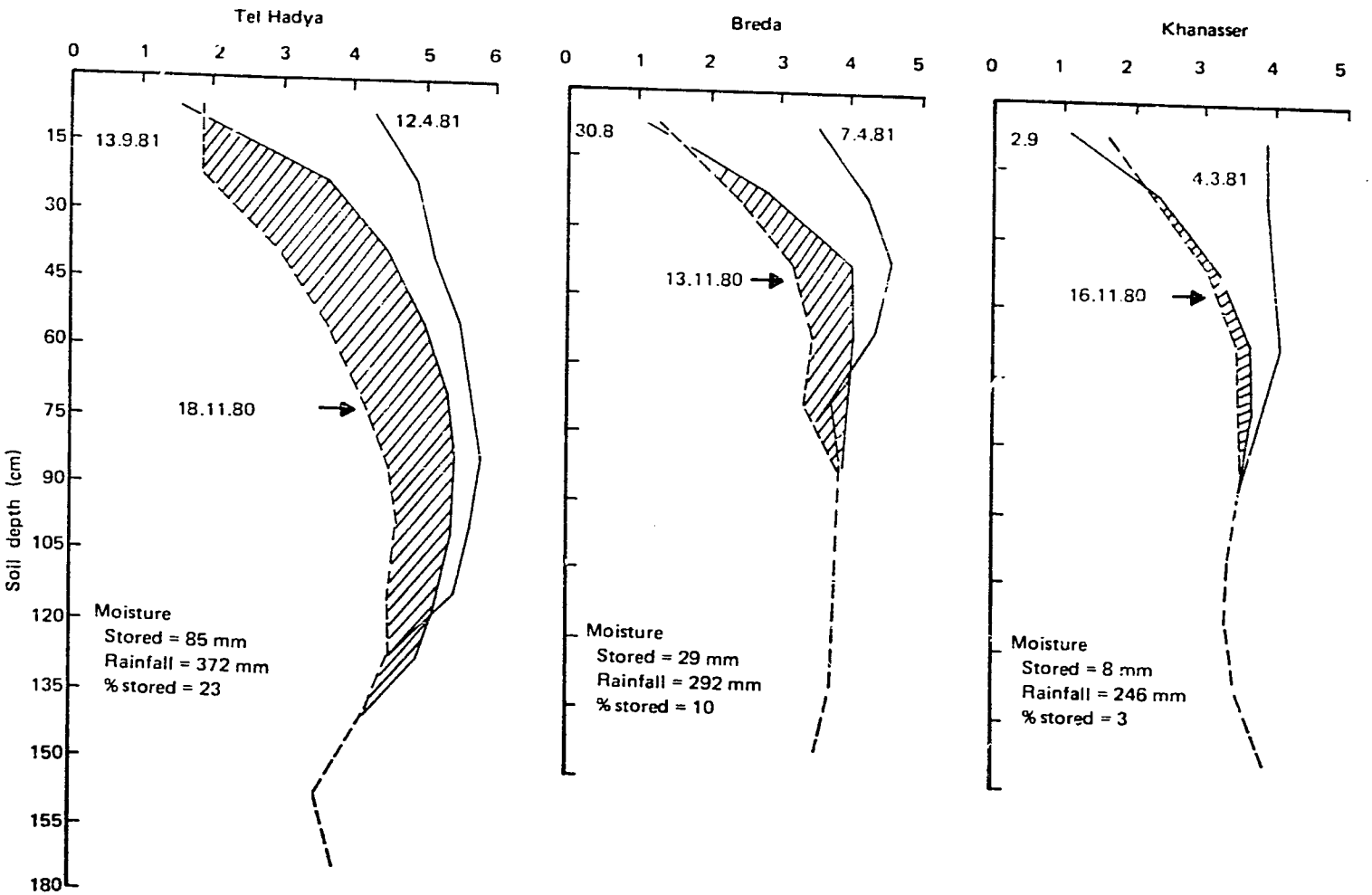

Fig. 4. Moisture loss under fallow during summer months, 1981.

Source: Cooper, P.J.M. Moisture storage under Summer fallow in Syria as affected by winter rainfall and management. Forthcoming.

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The State of Food and Nutrition in the Middle East

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It is now recognized that the food and nutrition situation is the result of interaction between ecological, social, cultural, historical, political and economic factors. Policy decisions and development strategies and their implementation affect this interaction.

Since the beginning of this century, similarly to most of the developing world, Middle East countries have been struggling for their independence, for their political freedom, and for the management of their natural resources. Now that all the countries of the region are independent and to a certain degree they are managing their natural resources, however, the quality of life of the large mass of population is still below expected levels.

Most countries in the Middle East have implemented various policies of agrarian reform; rural development programs coupled with land reclamation and redistribution among the population. The aim of these policies is to attack rural poverty through abolishing land feudalism, to improve income distribution, increase productivity, and establish a new social and economic order. National development plans have always stressed, to a varying degree, the common objective of food self-sufficiency, and improving farmers' income and the living standards of the population.

The region has also witnessed a large increase in oil revenues, particularly since 1973. This provides the oil-producing countries with a unique opportunity to change their economic structure by using oil revenues to fund development.

The changes that have occured in the region have several implications. As a result of social and political instability, capital has been transported to more secure free market countries. Oil wealth in turn, lead to migration of manpower, professional skills, and surplus

labor from certain countries (Sudan, Egypt, Jordan, YAR) to the oil producing countries. The large increase in oil prices has had a negative effect on the economies of countries dependent on agriculture, such as Sudan, Somalia, and Mauritania.

In addition, the new wealth of the region has not always been used for socio-economic development, but was used for military purposes, which increased instability in the region. All of the above aggravated food and nutrition problems.

Middle East Region Definition

In this paper, the term "Middle East" will follow the FAO definition which consists of the Arabic-speaking countries in addition to Afghanistan, Cyprus, Iran, and Pakistan.

Some social and economic indicators on different countries of this region are given in Table 1.

Agriculture in the Middle East

This topic has been well presented in the previous paper; however, certain aspects related to food production need to be stressed. Only 6% of the total land area in the region is under agriculture, the rest is mostly arid or semi-arid land. Some 60% of the total agricultural land is under rainfed and dryland agriculture. The erratic rainfall contributes to the instability of food production. Certain areas of the region, such as Mauritania, Somalia, and Sudan, are sometimes affected by severe droughts. Therefore, rainfall affects food production, food availability, farm income, and, to a certain degree, the national development plans of the countries with agriculturally-based economies.

In certain countries of the region desertification is a problem, e.g. Somalia, where 31% of the land is exposed to this problem. The high price and the nonavailability of oil derivatives, lead to wood being used as a fuel and hence to deforestration.

In the irrigated areas, which constitute a small part of the total agricultural land, inefficient water control, and inadequate water management, combined with inadequate drainage, have led to a progressive loss of cultivated land through the increasing salinity and waterlogging. This in turn reduces food production.

Another characteristic of the region is the small size of land holdings, which limits the possibility of introducing new technology (seed fertilizer mechnization) to increase food production.

In spite of the major role which agriculture plays in the national economy of several countries of the region, its share in the national development plans has been inadequate and a large percentage of the budget was not used.

The region also suffers from the lack and/or inadequacy of agricultural institutions, especially as regard credit. In most cases the small farmer does not benefit from credit since the credit banks do not cover all the agricultural areas, and complicated administrative procedures prevent the small farmer from having access to credit facilities.

The market for main crops such as wheat, cotton, olive oil, maize, rice, and sugar, is mainly government controlled. Prices offered to farmers are lower than the international market, and provide low incentive. Other products, such as fruits and vegetables, are mainly controlled by middle men who exploit the farmers.

Institutions which can play a leading role in increasing agricultural production, such as research and extension services, are inadequate and are not provided with the necessary financial resources, manpower, and logistics. Generally, cash crops are receiving first priority in research and extension and limited attention is paid to food crops.

Some 54% of the population in the region is involved in agriculture. In certain countries, such as Somalia and Sudan, with agricultural economies, the proportion is larger, up to 70%.

During the last decade the percentage of the rural population and the labor force in agriculture have been decreasing due to migration to urban areas or to the oil-producing countries. The professional staff are also migrating. Private investment is being moved from rural to urban areas where the return for investment in housing, hotels, etc. is much higher, and faster. All the above have contributed to a continuous deterioration in terms of the food and nutrition problems in the region. Table 2 represents food production as compared to world data.

Food Situation in the Middle East

Food Production

In general the growth of world food production since the 1960s has been lower than that of population. In spite of the constraints facing food production in the Middle East region, it was reported that during the last decade (the 1970s) the percentage of annual increase in food production was 3.5% (Table 2); a higher rate than in Africa but lower than in the Far East and Latin America. However, this represents only 0.7% per annum increase per caput for 1970-79 (Table 3). This is an alarming situation. Food production data for the individual countries of the region are given in Table 4.

Food Export and Import

In several countries of the region where the economy depends on agriculture, food exports are a major source of foreign exchange. Examples are Cyprus, Lebanon, and Jordan for fruits and vegetables, Tunisia for olive oil and citrus fruit, Somalia for livestock and banana, and Sudan for maize, groundnuts, and sesame. The indices of value of exports during the last decade are shown in Table 5. The annual increase in value in food exported was 13.6%, compared to 15.6% in other developing countries.

Food exports have decreased since 1971, particularly rice, sugar, cattle, groundnut, bananas, eggs, and fish products. This is mainly due to increase in domestic consumption.

One of the main problems of the region is rapidly increasing food demand which cannot be met through local production, thus increasing the region's dependence on food imports. The indices of value of food imports during the seventies increased by more than eleven fold, and to thirteen fold in the case of feed. This represents an annual increase of 26.6% in the case of food, which is considered to be highest in the world.

The Middle East, which has the lowest population, is the largest food importer in terms of value among all the developing regions. In 1969-71 the countries of the region imported $1.3 billion of food. By 1980 imports reached $14.9 billion, a 10-fold increase.

This substantial growth in food imports in the 1970s is not only due to the high rate of population growth, but also to increase in national per caput income and urbanization, which has led to greater expenditure on

consumer goods, especially food. This is true not only in the oil-exporting countries, but also in some other countries, e.g. Egypt, which imported $3 billion of food in 1980.

The annual rate of increase in volume and value of food imports in the Middle East during the last decade was the highest in the world.

Food Availability and Consumption

Figures for food availability are calculated on food production data plus food imports, minus food exports. Allowance is made for food produced for livestock fodder, for losses during storage and transportation, and for seed for planting. Data for the region on food availability are obtained from the food balance sheets. The data available is not recent and there may have been an increase for certain countries, such as Egypt, Jordan, Tunisia, Cyprus, and the oil-exporting countries, and a decrease in other countries, especially Afghanistan, Somalia, Mauritania, and possibly Sudan. Several countries do not produce food balance sheets on a regular basis; even if a food balance sheet is made it is often not accurate due to poor agriculture statistics. The amount of food actually consumed may be lower than that shown on food balance sheets, depending on the degree of losses of food and nutrients in the household, i.e. during storage, preparation, and cooking. Food balance sheets do not indicate differences that may exist in diets of different population groups, socioeconomic classes, ecological zones, and geographic areas within a country, neither do they provide information on seasonal variation in the total food supply, or the distribution of food within the family. Tables 6, 7, and 8 show daily per caput availability of protein and energy from various food groups for the countries of the region.

Despite the limitations of food balance sheet data, it is possible to draw reasonably valid conclusions concerning protein, fat, and food-energy availability. However, since vitamin and mineral content can vary widely due to soil and climatic conditions even whithin a single country, nutrient-availability data are less valid. Certain deficiency syndromes exist, and deficiencies of vitamin A, zinc, iron, and iodine have been observed in various areas. The most common deficiency, however, is that of total food rather than of specific nutrients, and most diets are probably adequate in their protein energy balance.

Large-scale food expenditure surveys have been relatively rare in the region. A recent review of such surveys covered Cyprus, Iran, Iraq, Libya, Pakistan, and Tunisia. These surveys showed the percentage of total expenditure on the various food groups. When considered in conjunction with food balance sheet data these indicate the relative

prices of the various products. A national food-consumption survey was made only in Tunisia by the National Statistics Institute. The results of the survey were used to some extent for regional development planning.

Nutrition Situation in the Middle East

The nutrition situation in the region varies greatly among countries, within population groups in the same country, and among family members. In certain families, adults may be over-weight while preschool children are under-weight. Only Egypt and Tunisia have conducted national nutritional status surveys. Other countries have scatered surveys on a limited number of population groups.

Child Nutrition Status

Infant mortality

Infant mortality varies from country to country in the region. Until now not all countries have exact information on infant mortality, since death of the preschool child is not always reported. Data from the Population Reference Bureau shows that infant mortality in 1981 varied from 18/1000 in Cyprus up to 205/1000 in Afghanistan. Even within a country the infant-mortality rate among the rural population is found to be higher than among the urban population. This is due to limited social services, lack of clean water supply, malnutrition, poor sanitation and mother education, immunization, etc. There is no correlation in the Middle East between average GNP and infant mortality; rates of infant mortality are higher in Saudi Arabia and Oman than in Syria, Lebanon, and Cyprus. Infant mortality is decreasing in several countries, however, e.g. Bahrain, UAE, and Egypt, due to the improvement of the health delivery systems. Almost 60% of infant deaths in most of the countries of the region are due to under-nutrition associated with infection. Mortality in the age range of 1 to 4 years is much lower than infant mortality, but infectious diseases of childhood, such a measles, pertuggis, and pneumonia begin to appear in the second half of the first year or in the second year.

Low birth weight of infants

Poor nutritional status of the mother can contribute to low birth weight infants (below 2.5 kg at birth). Cultural factors, especially age of marriage, repeated pregnancy, and physical labor, common in most rural areas, also contribute to low birth weight. The incidence of low birth weight has a close correlation with socioeconomic status. Countries with low per caput calorie intake per day have a higher incidence of low birth weight infants. WHO estimated that some 2.5 million low birth weight

infants will have been born in the Middle East in 1983. The low survival capacity associated with low birth weight appears primarily due to lower resistance to infection, and, consequently, a greater frequency and severity to infections. As of yet, the problem has not been widely studied in the region.

Protein energy malnutrition

Anthropometric measurements are used as indicators of PEM. Results of surveys carried out in five countries of the Middle East are shown in Table 9. The classification used in Pakistan is slightly different from those used for the other studies. Since weight for age criteria probably overestimate prevalence of malnutrition, height for age and weight for height have been suggested as more significant criteria; 80% of median weight for height and 90% of median height for age have been suggested as useful classification limits for identifying significantly malnourished children. Children below these cut off points may be described as wasted and stunted, respectively. Stunting is a serious problem in Egypt, Oman, and Pakistan. In the nutrition survey in Egypt, it was estimated that stunted linear growth probably affects up to 2 million children in the 6-72-month age range. In a survey in Saudi Arabia, 5% of children surveyed were below 75% of weight for age.

The survey in Jordan showed that the pattern of increase in weight during the first six months of life appeared to be satisfactory and comparable with that reported in countries with higher socioeconomic standards. However, after the age of 6-9 months, the children showed a drop in mean weight. In a small study in Libya, marasmic infants were generally the youngest in a large family. The mother was often illiterate and tended to breastfeed her baby for only a short period and to use supplementary foods early. A community survey in a rural area of Sudan showed that an increase in bottle feeding, lack of supplementary food, and inequitable distribution of food within the family were important causitive factors in the etiology of malnutrition.

Nutritional Deficiencies of Public Health Importance

Iron Deficiency Anaemia

Iron deficiency is by far the most common nutritional disorder, and the most frequent cause of anaemia in most of the countries of the Middle East region. WHO has estimated that 20-25% of children, 20-40% of adult females, and up to 10% of adult males in the region suffer from varying degrees of anaemia. In the vulnerable groups, such as infants and pregnant and lactating women, the proportion with anaemia may reach 70-90%. Anaemia is a public health problem in Oman where 60% of mothers

surveyed had haemoglobin levels less than 12 mg/100 ml, and also in Bahrain. It was also found to be an important problem in preschool children. In Kuwait, children less than two-years old also showed a high incidence. It should be noted that parasitic infestations are of extreme relevance to the problem of anaemia, with blood loss adding to the potential of the existing deficiencies.

Vitamin A Deficiency

Vitamin A deficiency is a serious problem in the Middle East. In Pakistan and Jordan, serum retinol levels were shown to be low or deficient in up to 76% of preschool children. It is estimated that possibly more than 10,000 cases of xerophthalmia occur annually in the region. Vitamin A deficiency is a problem in certain parts of Sudan. The increase of income and changes in the diet have directly affected vitamin A intake in several countries. Until now there are no intervention programs undertaken at the national level in the region; however, in certain countries vitamin A tablets are distributed through MCH centers.

Goitre and Iodine Deficiency

Endemic goitre is prevalent in the region, especially in Afghanistan, Egypt, Iran, Iraq, and Tunisia. Women are more frequently affected than men and it is more common among rural than urban populations. A study in Sudan showed that the incidence of goitre is highest among the rural population who consume sorghum and millet.

Certain countries have taken goitre control measures, especially Tunisia, Algeria, and Lebanon, where iodized salt is distributed. However, no data is available to indicate the effectiveness of this measure or on the availability of iodized salt to the poor segment of the population, since it is sold at a higher price.

Rickets and Vitamin D Deficiency

Rickets is still a significant nutritional problem in the region, which is determined by cultural rather than social or economic factors. Rickets has been reported in several countries of the region, including Egypt, Iran, Libya, and Tunisia. In a survey in Egypt involving 8000 children, 5% showed vitamin D deficiency. In the Gulf countries, the incidence of rickets is decreasing.

Diseases of Affluent Societies

The change in the diet and life style in several of the oil-producing countries and in urban populations has contributed to the appearance of diseases of affluent society, especially heart disease. Increased consumption of sugar and fat and lack of physical exercise, leading to obesity, in association with cigarette smoking and high blood pressure, are major elements which contribute to heart disease and premature death.

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Table 1. Some socioeconomic indicators in the Middle East countries.

Country/Group	Population[a] (millions) 1979	Average[a] annual increase 1970/79 (%)	GNP[a] (billion $)	GNP[a] per caput ($)	Literacy (%)	Infant mortality rate per 1000 (1975)
Group I:Oil producing						
Kuwait	1.27	6.1	18.04	14,890	60	39
United Arab Emirates	0.91	3.4	11.44	14,230		138
Qatar	0.21	3.2	2.84	12,740		138
Saudi Arabia	8.06	3.0	63.06	7,690	15	150
Libya	3.13	4.1	18.66	6,910	45	130
Bahrain	0.34	2.9	1.51	4,100		78
Oman	0.87	3.1	2.16	2,570		142
Group II:Oil/agriculture						
Iraq	12.40	3.2	22.69	1,860	26	104
Algeria	18.79	3.2	22.18	1,260	35	142
Group III:Agriculture						
Tunisia	6.37	3.3	5.70	950	38	125
Syria	8.37	3.3	7.53	930	53	114
Egypt	41.80	2.7	11.48	280	40	90
Cyprus	0.62	1.0	0.91	1,520	76	17
Jordan	2.90	3.3	3.15	1,050	59	97
Pakistan	77.90	3.0	17.78	230	21	142
Yemen Arab Republic	7.30	3.0	2.91	520	13	160
Yemen P.D.R.	1.80	3.2	0.70	390	27	155
Sudan	17.76	2.5	5.57	320	20	141
Mauritania	1.49	2.6	0.41	270	17	187
Somalia	3.89	2.6	0.48	130	50	177

[a] J. Econ. Coop. Islamic Countries Vol. 1, No. 4 and Vol. II, No. 1, 1979-80: except for Cyprus and Egypt which are from IADS 1980.
Cyprus and Egypt data for population and GNP from IADS (1980).
Cyprus data for literacy from Compendium of Social Statistics 1977 (UN 1980).

Table 2. Food production in the Near East Region as compared to Africa and to world data.

	Near East	Africa	Developing nations	Developed nations	World
Food production index[1] 1979	131	115	128	121	124
Annual % increase 1970-1979	3.5	1.6	3.0	2.2	2.5

Source: FAO. The State of Food and Agriculture, 1979. FAO, Rome, 1980.
1. 1969-1971 average = 100.

Table 3. FAO index numbers of food (crops and livestock) production per caput, developing regions and MSAs.

	1975	1976	1977	1978	1979	change 1978 to 1979	Annual rate of change 1961-70	1970-79
	...1969-71 average = 100...					.....%.....		
Developing market economies	101	101	102	103	100	-2.6	0.4	0.3
Africa	94	94	89	90	89	-0.9		-1.3
Far East	102	99	103	104	100	-4.3	0.2	0.4
Latin America	102	104	105	106	105	-0.3	0.7	0.8
Near East	106	109	104	106	103	-2.7	0.5	0.7
Asian centrally-planned economies	108	111	108	113	116	2.7	1.1	1.6
Total-Developing countries	103	104	104	106	105	-0.9	0.6	0.7
MSA in Africa	94	93	91	91	90	-1.1	0.4	-1.2
MSA in Far East	100	96	101	101	95	-6.0	-0.1	-0.1
MSA in Latin America	95	98	98	101	103	2.0	1.0	
MSA in Near East	103	102	95	95	92	-3.0	0.2	-0.5
Total-MSA countries	99	96	99	99	94	-4.8	0.1	-0.3

Source. FAO. The State of Food and Agriculture 1979, FAO. Rome 1980 (4)
MSA - Most Seriously Affected countries.

Table 4. Rates of growth of population and food, agricultural, and cereal production, 1961-65/70 and 1970-76, for individual countries of the Near East and North Africa.

Country	Period	Population increase(%)	Production			Production per caput		
			Food	Agricul-tural	Cereals	Food	Agricul-tural	Cereals
Afghanistan	1	2.3	1.3	1.3	0.6	-1.0	-0.9	-1.6
	2	2.6	4.5	4.7	5.7	1.9	2.0	3.0
Algeria	1	3.4	2.6	2.7	5.2	-0.8	-0.6	1.8
	2	3.2	2.5	2.5	4.5	-0.7	-0.7	1.3
Cyprus	1	1.1	7.3	7.1	-2.0	6.1	5.9	-3.1
	2	1.2	-4.5	-4.4	2.0	-5.7	-5.6	0.8
Egypt	1	2.5	3.5	3.3	3.3	1.0	0.7	0.8
	2	2.4	2.1	1.4	1.4	-0.2	-1.0	-1.0
Iraq	1	3.2	2.8	3.9	5.0	0.5	0.7	1.7
	2	3.4	-0.2	-0.5	-3.6	-3.5	-3.8	-6.9
Jordan	1	3.0	-10.4	-9.8	-12.3	-13.4	-12.8	-15.3
	2	3.4	0.4	0.5	-4.8	-3.0	-2.8	-8.2
Libya	1	3.7	0.8	1.1	-2.1	-2.8	-2.5	-5.8
	2	3.1	10.2	9.5	27.8	7.1	6.3	24.7
Mauritania	1	2.0	1.8	1.8	0.1	-0.3	-0.3	-1.9
	2	2.0	-3.9	-3.9	-6.2	-5.8	-5.8	-8.2
Pakistan	1	2.8	6.2	6.0	9.1	3.4	3.1	6.3
	2	3.2	2.9	2.0	3.1	-0.2	-1.1	-0.1
Saudi Arabia	1	2.7	2.5	2.5	1.8	-0.2	-0.2	-0.9
	2	3.0	4.6	4.6	6.5	1.6	1.6	3.5
Somalia	1	2.2	2.8	2.8	0.2	0.5	0.5	-2.0
	2	2.6	-0.6	-0.6	0.3	-3.2	-3.1	-2.3
Sudan	1	2.9	3.9	4.3	4.4	0.9	1.3	1.5
	2	3.1	5.4	4.1	5.4	2.2	1.0	2.2
Syria	1	3.2	-0.6	-0.4	-4.8	-3.7	-3.7	-8.0
	2	3.1	11.4	9.0	20.7	8.3	5.8	17.6
Tunisia	1	2.1	1.3	1.4	-1.0	-0.7	-0.6	-3.0
	2	2.3	6.5	6.4	7.9	4.1	4.0	5.5
Yemen A R	1	2.8	-2.5	-2.5	-1.9	-5.3	-5.3	-4.7
	2	2.9	9.2	9.5	13.0	6.3	6.6	10.1
Yemen PDR	1	2.7	2.5	2.0	2.9	-0.2	-0.6	0.2
	2	3.0	3.8	3.3	1.8	0.8	0.4	-1.1

Note: 1 refers to period 1961-1965/70
2 refers to period 1970-1976.
Source: The Fourth World Food Survey, FAO (1977).

Table 5. Indices of value of imports and exports of agricultural products for Near East and African regions, as compared to developing and developed countries.

	Agricultural products		Food		Feed		Raw materials		Beverages		Fishery products	
	I	%	I	%	I	%	I	%	I	%	I	%
Near East (Developing)												
Exports	214	10.4	303	13.7	63	5.2	164	8.3	210	9.6	249	13.6
Imports	653	29.3	692	30.8	935	32.8	427	21.8	488	20.4	845	32.9
Africa (Developing)												
Exports	264	13.5	263	12.3	130	6.4	179	8.7	318	17.5	290	15.3
Imports	456	22.2	489	23.0	677	25.3	357	19.2	264	16.9	345	19.2
Developing Countries												
Exports	293	15.3	299	15.6	462	23.0	209	9.8	344	17.4	432	20.6
Imports	418	20.7	436	21.5	656	28.1	352	17.4	311	16.3	336	16.8
Developed Countries												
Exports	346	17.5	354	18.0	392	18.3	264	13.2	423	19.8	359	16.8
Imports	308	16.0	318	16.6	354	18.1	220	10.3	378	18.7	365	17.3

Source: FAO, The State of Food and Agriculture, 1979. FAO, Rome, 1980.
I = Index 1969-1971 Average = 100
% = Annual percentage change 1969-1978.

Table 6. Protein (g) and food energy (Kcal) as supplied by various food groups. Per caput per day for some countries of the Near East and North Africa, 1975-1977.

Country	Total		Cereals		Roots/ tubers		Sugar/ honey		Pulses		Nuts and oil seeds		Vegetables		Fruit		Meat and offals		Eggs		Fish/ seafood		Milk		Oils/ fats	
	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P
Saudi Arabia	2308	58.9	1140	30.1	11	0.2	152	-	24	1.6	38	1.6	40	1.9	262	2.7	116	10.1	12	0.9	10	1.4	125	7.3	162	-
Libya	2948	74.9	1193	33.8	41	0.9	457	-	55	3.8	99	3.2	91	4.3	214	2.6	133	12.3	5	0.4	17	2.1	197	9.5	54	0.1
Iraq	2323	61.5	1441	39.5	10	0.1	349	-	53	3.4	10	0.3	62	3.6	67	1.0	79	5.7	11	0.9	5	0.8	59	5.4	155	-
Cyprus	2964	90.0	1235	35.8	74	1.7	200	-	75	5.2	113	3.2	44	2.4	163	2.2	388	21.6	26	2.1	12	1.7	205	12.5	317	0.1
Algeria	2357	63.1	1485	44.7	53	1.1	214	-	47	3.1	6	0.2	20	0.9	93	1.1	42	3.4	5	0.4	5	0.3	128	6.8	246	-
Jordan	2060	56.0	1253	35.5	27	0.6	252	-	51	3.1	23	0.7	29	1.6	46	0.6	76	5.3	20	1.6	6	0.8	54	5.5	192	0.1
Tunisia	2658	72.5	1465	44.1	31	0.7	248	-	72	4.7	39	1.0	73	3.9	76	1.1	94	7.5	10	0.9	10	1.5	96	6.0	421	0.1
Syria	2618	73.3	1356	38.8	28	0.7	245	-	132	7.7	90	3.0	109	6.0	134	2.0	87	5.8	17	1.3	3	0.4	89	7.0	314	0.1
Yemen AR	2260	67.9	1529	43.9	24	0.6	179	-	118	7.6	8	0.2	19	1.2	115	1.0	85	5.9	8	0.6	9	1.3	75	5.1	87	0.1
Yemen PDR	1919	58.0	1160	31.5	1	-	143	-	14	0.4	20	1.3	56	3.7	178	1.8	56	3.7	3	0.3	50	13.0	63	4.2	171	0.1
Sudan	2226	67.0	1245	39.6	45	0.6	185	-	38	2.6	67	2.7	22	1.2	63	0.8	123	10.5	3	0.3	3	0.4	134	7.5	272	-
Egypt	2779	76.1	1851	49.9	37	0.7	236	0.2	102	7.7	22	0.9	84	3.8	91	1.2	61	5.2	6	0.5	8	1.2	41	4.2	229	0.1
Mauritania	1895	68.0	1023	26.0	11	0.2	141	-	99	6.5	17	0.9	1	0.1	38	0.4	113	10.5	4	0.4	42	6.6	321	16.3	80	0.1
Pakistan	2255	62.0	1439	39.2	12	0.2	263	0.5	73	4.1	6	0.5	18	1.0	41	0.5	37	3.4	3	0.2	3	0.4	160	11.5	194	0.1
Somalia	2137	73.9	939	25.1	28	0.2	177	-	9	0.6	65	2.3	9	0.5	51	0.6	275	24.2	2	0.1	2	0.3	432	19.3	141	0.1
All Developing Countries	2260	57.3	1369	31.8	162	1.9	156	-	95	6.0	50	2.7	33	1.9	48	0.6	102	5.8	9	0.7	16	2.5	49	2.9	134	-
All Developed Countries	3395	99.1	1036	29.4	159	3.7	441	-	29	1.9	45	2.2	62	3.3	87	1.1	478	26.8	53	4.2	50	7.1	295	17.5	468	0.2
World	2571	69.8	1278	31.2	161	2.3	234	-	77	4.8	48	2.5	41	2.3	59	0.7	205	11.5	21	1.7	25	2.8	116	6.9	225	0.1

C: Food energy Kcal/caput/day
P: Protein g/caput/day; as provided by the various food groups.
Source: Food Balance Sheets. 1975-1977 Average FAO (1980).
Note: Food Balance Sheet data are not available for the Gulf countries.

Table 7. Estimated average daily availability of selected nutrients and adult requirements for some countries of the Near East and North Africa, 1977.

Country	Food energy Kcal (g)	Protein Total (g)	Protein Animal (g)	Fat (mg)	Calcium (mg)	Iron (kg)	Retinol (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic Acid
Saudi Arabia	2233	63.0	24.9	54.8	560	14.3	834	1.11	1.07	15.1	78
Libya	2985	75.0	25.2	86.9	655	17.3	970	1.48	1.35	17.2	121
Iraq	2155	57.4	13.0	31.6	375	14.8	1137	1.36	0.82	12.3	74
Cyprus	3054	92.8	40.4	105.3	797	21.5	1038	1.97	1.55	19.8	117
Algeria	2372	62.8	11.6	45.1	410	12.5	341	1.30	0.81	11.2	53
Jordan	2107	56.0	13.8	41.4	349	10.8	280	1.15	0.72	9.8	42
Tunisia	2674	73.0	17.5	73.6	437	16.5	1058	1.53	1.05	13.6	128
Syria	2685	77.6	15.4	59.8	575	20.4	944	1.94	1.14	15.3	150
Yemen A.R.	2311	69.4	14.2	38.1	405	19.6	444	1.63	1.04	16.3	35
Yemen P.D.R.	1975	60.7	22.7	38.5	466	15.6	374	1.08	0.81	14.2	32
Sudan	2274	68.3	19.0	63.2	496	19.0	551	1.53	1.13	16.8	44
Egypt	2787	76.5	11.2	50.1	427	19.9	745	1.89	0.95	16.4	112
Mauritania	1963	69.9	34.7	47.3	768	15.0	484	1.03	1.30	12.1	11
Pakistan	2281	62.9	15.8	41.6	544	17.7	648	2.14	1.02	19.5	44
Somalia	2228	75.9	44.2	75.7	905	16.1	856	1.41	1.85	17.6	32
All Developing Countries	2260	57.3	12.0	38.4	348	16.1	609	1.32	0.79	13.7	77
All Developed Countries	3395	99.1	55.7	125.3	843	18.5	1055	1.79	1.79	20.9	130
World	2571	68.8	23.9	62.2	483	16.8	730	1.45	1.06	15.7	92
Requirements											
Adult Male (65 kg) (moderately active)	3000	37	-	-	400- 500	5- 9	750	1.2	1.8	19.8	30
Adult Female (55 kg) (moderately active)	2200	29	-	-	400- 500	14-26	750	0.9	1.3	14.5	30
Pregnancy (Latter half)	+350	38	-	-	1000-1200	-	750	+0.1	+0.2	+2.3	50
Lactation (1st 6 months)	+550	46	-	-	1000-1200	-	1200	+0.2	+0.4	+3.7	50

Source: Nutrient Availability FAO Food Balance Sheets: FAO (1980): Requirements FAO/WHO Nutrition Studies No. 28, Handbook of Human Nutritional Requirements. FAO, Rome, 1974.

Table 8. Per caput dietary supplies in relation to nutritional requirements for countries of Near East region and North Africa.

	Averages				Requirement
	1966-68	1969-71	1972-73	1974-77	Kcal/caput/day
	% of requirements				
Africa	92	94	93	95	2334
Algeria	77	79	89	98	2400
Mauritania	85	83	75	82	2310
Morocco	96	102	108	106	2420
Somalia	95	96	96	92	2310
Tunisia	85	90	107	111	2390
Near East	98	99	102	108	2455
Afghanistan	98	81	82	81	2440
Cyprus	112	120	126	123	2480
Egypt	104	104	103	108	2510
Iran	95	97	110	132	2410
Iraq	87	91	95	96	2410
Jordan	87	93	89	84	2460
Lebanon	100	100	101	101	2480
Libya	93	105	124	126	2360
Saudi Arabia	89	89	93	102	2420
Sudan	84	92	89	96	2350
Syria	95	98	101	105	2480
Yemen A.R.	86	81	87	90	2420
Yemen P.D.R.	93	89	85	79	2410
Asia	88	94	93	93	2216
Pakistan	89	95	95	98	2310

Source: The State of Food and Agriculture, 1979. FAO, Rome, 1980

Table 9. Anthopometric indicators of nutritional status of children aged 1-5 years for some Near East region countries.

	Percentages of children											
	Weight for Age(%)				Height for Age (%)				Weight for Height (%)			
Country	<60	60-75	75-90	>90	<85	85-90	90-95	>95	<80	80-85	>85	Number of children
Kuwait	0	2	33	65	<1	3	22	58	1	3	96	1611
Bahrain	2	16	50	32	2	12	28	58	4	12	84	300
Oman	6	20	37	37	9	15	25	51	22	17	61	428
Egypt	1	8	39	53	5	17	40	39	<1	2	98	8016
Pakistan	34		66		30		70		8	46*	46*	1202

Sources of data: Kuwait : Mostafa; Oman : Amin; Pakistan: Anderson; Bahrain : Amin; Egypt : AID

SECTION II

The Present Agricultural and Food Situation in Sudan

Agricultural Production in Relation to Agricultural Policies and Strategies in Sudan

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Introduction

Agriculture is the dominant sector of the Sudanese economy. It contributes approximately 40% of the country's gross domestic product (GDP), while 95% of exports are agricultural commodities. Moreover, about 80% of the population generate their livelihood, directly or indirectly, from agriculture; 70% of the total active labor force is engaged in agriculture. Almost 25% of the loans and credit facilities extended by the banking system go to the sector. Thus, agricultural production has a direct bearing on the national economy as a whole.

This paper attempts to review various development plans: their objectives, targets, achievements, and shortcomings, and to make recommendations for the future.

Production Targets in the Development Plans

The 10-year plan (1960/61-1970/71) was the first attempt at comprehensive development planning in Sudan. The plan aimed to expand food production to achieve selfsufficiency. Other objectives were the production of import-substitution commodities to save foreign exchange, the production of raw materials for indigenous industries, and expansion of agricultural exports to increase the country's foreign exchange earnings.

GDP was planned to increase by 5% annually, with an annual growth rate of 4% in the agricultural sector and 21% in total investments.

The plan concentrated on irrigated agriculture and ignored the rainfed sector; this created regional development imbalances, since the irrigated schemes are mainly concentrated in the Central Region. By 1964 the plan was abandoned.

The 5-year plan (1970/71-1974/75) had the ambitious objectives of increasing GDP by 7.6% annually and a growth rate of 9.9% in the agricultural sector which received 38% of the total public sector investments. Again, the traditional sector (80% of population) did not find due consideration. A major feature of the plan was to produce import-substitution commodities like sugar, wheat, rice, and tea.

High fuel prices adversely affected the plan by increasing prices and costs of production.

This was followed by a 6-year plan (1977/78-1982/83) which aimed to increase the production of the irrigated sector, modernize traditional agriculture, and to integrate crop and livestock production. The agricultural sector was allocated 32% of public sector investment.

Under this plan, existing irrigation schemes were to be rehabilitated, through provision of machinery and implements and improvement of irrigation systems, transport, communication, storage, and marketing, and rainfed agriculture was to be increasingly mechanized.

The Three-year Investment Program (1982/83-1984/85) allocated LS 526 million (28% of total allocation) to the agricultural sector. The program aimed to complete and rehabilitate existing irrigated schemes, to fully utilize existing schemes' capacities, and to increase exports, and animal production. The rainfed sector received greater attention. The TYIP suffered from shortages of machinery, chemicals, seeds, and labor. Poor husbandry and financial problems also contributed to program targets not being fully met.

Cropped Areas

The total cropped area increased from 7.9 million feddans in 1965/66 to 17.0 million feddans in 1979, or by 7.7% per annum (Table 1).

The area under cereals increased from 4.8 million feddans to 11.2 million feddans over the same period (9% / year). Wheat area increased by 10.9% / year, while sorghum and millet increased by 6 and 5% /year,

respectively.

Oil seed area increased by 6.3% /year, from 1.9 million feddans in 1965/66 to 5.6 million feddans in 1982/83.

Legume cultivation increased from 16,800 feddans in 1965/66 to 43,200 feddans in 1979 (7% /year).

These changes in cropped area reflect national agricultural policies, supply and demand for the crops, and prices.

Most groundnuts (more than 50%) and sesame are grown under traditional systems where production is influenced by the Government policy of setting a floor price to these commodities prior to harvest. Areas under these crops are also to some extent affected by prices received by farmers in the previous season.

Fluctuations in legume areas reflect fluctuations in their prices. Moreover, as these legumes (e.g. broad beans) are mainly grown in the Northern Region where they have to compete with other crops like wheat and vegetables, the relationship between the prices of these crops and broad bean prices also influences the area cropped.

Animal Production

Livestock increased from 44 to 52 milion head between 1974 and 1979 (4% /year). Individual estimates for the rate of increase were: cattle 4.7% ; sheep, 5%; 23% goats, and 5% camels. Per caput share of livestock was 2.6 head in 1975, 2.8 head in 1979; the highest in the Arab World.

Crop Production Development

Production of all agricultural crops, except cotton and sesame, increased from 1970/71 to 1980/81 (Table 2). Cereals production increased from 2.1 million t in 1970/71 to 2.8 million t in 1980/81 (2.7% /year). Within the cereals rice had the highest increase of 3.6% /year, millet the lowest 1.1% /year.

Oil seeds production increased from 636,000 t in 1970/71 to 928,000 t in 1980/81 (3.8% /year). Groundnuts registered an increase of 7.6% /year and sesame an increase of 3.2% /year.

Most of the increase in crop reduction was due to increases in rainfed areas, while cropped irrigated areas declined. The fluctuations in sesame production were due to decreases in area planted and yields. Comparing actual production with the targets of the 6-year development plan, the execution rate is low. Exceptions are chicken meat and groundnuts for which targeted growth rates were met.

Table 3 depicts yields of various crops. Yields are low, and yields fell between 1970/71 and 1980/81; sorghum, wheat, and groundnuts by 1% /year and cotton by 7.5% /year.

Support of Agricultural Development

The Government of Sudan provides support for:

1. Agricultural research: through the Agricultural Research Centre and the Universities.

2. Agricultural extension: disseminates the findings of the research bodies to the farming community.

3. Veterinary services: including disease research and control, vaccine production, and meat inspection for the local market and export.

4. Credit: two credit systems operate in Sudan.

Under the informal sheil system, local merchants extend cash loans against the harvested crop. The disadvantages of the system are the high cost to the farmer and the possibility of a heavy debt burden in case of crop failure.

The second system is the agricultural and commercial banks. Three types of credit are available: short-term (up to 15 months), medium (5 years), and long-term (5-10 years). Interest rate is 14% per annum (1983).

Normally, the Agricultural Bank of Sudan (ABS) requires collateral of 30% of the loan value. ABS services include credit, storage and marketing facilities, and provision of machinery, fertilizer, and other inputs.

Agricultural Pricing and Marketing Policies

Agricultural production and consumption are closely linked to the level of prices and pricing policies as well as the marketing system and institutions.

The Government in Sudan plays a major role in directing and determining the prices, as the Government is a major partner in most of the big production corporations of Sudan.

The Government:

- provides the infrastructural facilities necessary for agricultural production, e.g. construction of dam reservoirs, canals, roads, and other civil works.
- provides agricultural inputs by direct purchase or against foreign loans and grants.
- supervises and controls directly marketing of major agricultural commodities, i.e., cotton, or indirectly through its marketing corporations for commodities like groundnuts and sesame.
- formulates policies that affect cost of production and hence commodity prices.

In agricultural commodity markets, Government can influences prices by:

- curtailing export of certain commodities, e.g., sorghum or livestock exports could be stopped temporarily to influence prices and production.
- determining quotas of certain commodities to some industries and predetermining the prices of these quotas, e.g., textiles, oil seeds.
- setting the exchange rate, which influence revenues to producers, particularly in determining exchange rates for imported production inputs.
- direct commodity subsidies, e.g., bread, where the Government subsidized imported wheat, while local producers shared in paying this subsidy through determining the price of the locally produced wheat.
- declaring commodity prices prior to harvest for some commodities, e.g., wheat and cotton. This is mainly as an incentive to the cotton producer to improve cotton quality by taking care of picking and to

encourage the wheat producer to deliver crop to the mills.

- determining minimum prices for some commodities e.g., groundnuts, gum arabic, and sesame. These are meant to stabilize prices, where Government intervenes to buy (through its corporations) when prices fall below the floor price.

Taxation

Agricultural production is taxed both directly and indirectly.

Direct taxation includes Usher (Define), Gibana (Define), and crop transport licensing fees. These have less effect than indirect taxes.

Indirect taxes include:

- import tax on agricultural inputs. These increase production costs and reduce producer income.

- exchange rate. When the exchange rate puts the Sudanese Pound higher than its real value, imports become cheaper and depress prices of local produce.

- pricing policies. Subsidized prices of imports depress prices of local produce, leading to the producers effectively subsidizing the consumers, e.g., wheat.

Food Consumption and the Individual Consumption Level

Table 4 shows food consumption and production in Sudan for several years. The increase in food consumption shown in the table is attributed mainly to population growth and the level of income. In the period 1970-1979 the population increased by 3% annually, while the trend shifted to a higher rate of 3.7% per year for period 1975-1979. In the same period national income annual growth rate (at 1975/76 fixed prices) was 3.1%. As a result per caput income decreased from SL 110 to SL 103. Moreover, rural: urban population ratio decreased from 79.8% in 1970 to 77.5% in 1979. This internal population movement to towns and cities affects food consumption patterns as cost of living is higher in urban areas and possibilities of employment are better. Moreover, Table 4 shows effect of income in increasing the level of consumption of some foods above population growth rate, e.g., oils, starches, eggs, vegetables, white meats and fruits. All these foods are locally produced with the exception of sugar, of which small quantities are still imported.

Consumption of legumes, red meats, and milk products increased at a lower rates than that of population growth. This indicates shortage in local production to meet the required level of consumption. Depression in production of these commodities could be due to drought, pricing policies, and bad pastures and grazing.

The above factors of increase in rate of population growth, internal population migration and income all affected the individual share of the various food commodities and consequently the qualitive and quantitive level of nutrition. Table 4 also shows individual share of various foods in kg/year for the period 1970-72 to 1977-79. The table also shows the nutritional content of these foods in calories, protein, and fats per day. The largest consumption increases were in oils and fats, potatoes, eggs, vegetables, sugar, and white meats. Increases in cereals, milk, and fruits consumption were very small. Per caput consumption of legumes and red meats declined.

Per caput energy consumption increased from 2132 calories/day in 1970-72 to 2450 calories/day for 1977-79, with an increase in plant sources from 88.9% to 90.4%. Per caput protein consumption increased from 57.639/day in the first period to 60.45 g/day with reduction in the contribution of animal to total protein from 26.11 to 24.88%.

Self-sufficiency

Sudan is one of the few Arab countries depending on its own agricultural production to meet its local demand. Table 5 shows Sudan's self-sufficiency for the different commodities. The rate of self-sufficiency in cereals increased from 92.78% in 1970-72 to 98.4% in 1977-79.

It is evident that the most important commodities in the group are wheat - the major deficit component (173,000 t) - and sorghum, the main surplus commodity (134,000 t). Self-sufficiency in legumes, vegetables, fruits, and fish also increased. For sugar, in spite of the increase in self-sufficiency from 34 to 44%, deficits increased from 153,000 to 197,000 t for the period 1970 to 1979.

Sudan is self-sufficient in root crops, white meats, and eggs, and produces surpluses of red meat and vegetables.

Conclusions

It is well known that increasing agricultural production and improving related pricing and marketing policies are major strategies to resolve nutrition problems. Nevertheless, the deliberate use of public policy to influence the shape of agricultural production, processing, and distribution of food in the country has generally been implicit. Agricultural production can be adapted to put more emphasis on nutritional needs, particularly the needs of vulnerable target groups. In some cases subsidies can serve to support the nutrition program, but subsidies in Sudan don't directly go to the small producer. For instance, floor prices of groundnuts and sesame can go to the middle-man who normally buys from the producer and sells into the market.

Agricultural production policies must, therefore, be reviewed to determine what effect agricultural policies have on nutrition in general and on the nutrition of vulnerable groups in particular.

Projects to increase food production should also have nutrition objectives. Research and extension should be directed towards improving cropping patterns to meet seasonal nutritional needs.

Government intervention in the market to reduce seasonal, annual, and regional food price variabilities is required. Intervention may be by buying large quantities of foods during times of abundance and selling during shortage, or by constructing warehouses and facilitating food processing.

Table 1. Areas cropped for period 1965/66-1982/83 ('000 feddans).

Crop	1965/66	1975	1979	1982/83
Cereals	4867.2	9518.4	11200.8	13092
Wheat	139.2	645.6	583.2	674.4
Sorghum	3225.6	5968.8	7262.4	9177.6
Millet	1459.2	2548.8	3105.6	2822.4
Maize	40.8	208.8	164.4	316.8
Rice	2.4	19.2	19.2	100.8
Other		127.2	76.8	
Legumes	16.8	163.2	43.2	856.8
Oil Seeds	1898.4	4190.4	4454.4	5644.8
Sesame	955.2	2236.8	2073.6	2721.6
Groundnuts	943.2	1915.2	2347.2	2923.2
Other		38.4	33.6	
Fruits		69.6	120.0	
Vegetables		93.6	28.8	
Cotton	1058.4	1120.8	1044.0	1502.4
Sugar cane	19.2	40.8	62.4	254.1
Fodder crops		31.2		
Other		160.8		24
Total cropped area	7860	15592.8	17143.2	21592.8

Source: 1) Ministry of Economic Planning, Economic Survey, 1979/80.
2) Ministry of Agriculture & Irrigation, Agricultural Statistics.

Table 2. Agricultural production ('000t), 1970/71 - 1980/81.

Commodity	Actual production 1970/71	1980/81
Cotton	731	287
Sorghum	1535	2068
Wheat	163	218
Millet	439	492
Rice	7	10
Sesame	297	221
Groundnuts	339	707
Sugar Cane	860	1953
Red Meats		401
Chicken Meat	10	21
Milk		2620
Fish	22.2	28.33
Eggs	17	28.67

Source: 1) Ministry of Agriculture and Irrigation, Agricultural Statistics

2) Ministry of Economic Planning, Economic Survey 1967/77 - 1981/82

Table 3. Crop yield (kg/feddan),1970/71 - 1980/81.

Crop	1970/71	1980/81
Sorghum	312	295
Millet	251	188
Wheat	555	495
Maize	330	308
Rice	496	347
Sesame	159	109
Groundnuts	367	329
Broad beans	687	672
Cotton	602	296
Sugar cane	34,458	

Table 4. Food availability (kg/year) and nutritional content per capita/day (1970-79)

Commodity	per caput (kg/year)		%	1970-72			1977-79		
	1970-72	1977-79	Increase	Calories	Protein	Oils	Calories	Protein	Oils
Total cereals	150.05	157.35	0.68	1292	38.62	11.4	1365	40.82	12.02
Wheat	22.13	22.57	0.28	186	6.21	0.8	189	6.32	0.81
Maize	1.93	2.24	2.23						
Rice	0.96	0.79	2.75						
Sorghum + millet	125.04	131.02	0.67						
Root crops	10.16	15.7	5.79	17	0.4	0.2	25	0.6	0.04
Sugars	16.61	20.22	2.85	176			214		
Legumes	2.17	1.94	1.59	20	1.39	0.12	18	1.24	0.11
Oils	14.2	22.88	7.05	317	0.47	35.12	510	0.75	56.87
Vegetables	31.35	38.88	3.12	16	1.0	0.14	19	1.23	0.18
Fruits	20.07	21.77	1.17	58	0.7	0.19	63	0.77	0.2
Total meats	21.68	20.41	0.86	84	6.45	6.0	79	6.09	5.64
Red meat	20.94	19.54	0.98	81	6.21	5.83	76	5.8	5.44
White meat	0.74	0.87	2.34	3	0.24	0.17	3	0.29	0.2
Milk	81.75	82.71	0.17	146	7.84	7.84	147	7.93	7.93
Eggs	1.21	1.66	4.62	3	0.26	0.24	7	0.5	0.1
Fish	1.59	1.60	0.44	3	0.5	0.1	3	0.52	0.1

Source : AOAD, Khartoum 1981

Table 5. Self-sufficiency and food gap ('000t) in Sudan, 1970-1979.

Commodity	% self-sufficiency		Food gap	
	1970-72	1977-79	1970-72	1977-79
Cereals total	92.78	98.54	164.9	43.24
Wheat	39.43	60.27	205.87	173.13
Maize	100.0	100.0		
Rice	34.1	73.9	9.7	4.0
Sorghum (t)	202.67	205.43	50.67	133.89
Sugar	34.46		152.9	197.4
Legumes	91.8	43.58	2.71	2.36
Oils	151.66	93.51	102.97	73.98
Vegetables	99.83	118.69	0.87	0.31
Fruits	98.18	99.96	6.04	1.06
Meat total	101.06	99.76	3.23	4.48
Red meat	101.1	101.27	3.23	4.48
White meat	100.0	101.33		33.0
Milk	98.84	100.0	20	
Eggs	100.0	97.9		33.0
Fish	99.46	100	0.12	0.07

Source : AOAD, Khartoum 1981.

Food Export and Food Import in the Sudan

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Sudan has excellent potential for large scale production of several food crops and a vast animal wealth. Products that can successfully be grown in Sudan range from temperate-climate products like wheat and various pulses to sub-tropical and tropical products like sorghum, maize, millet, coffee, tea, sugar, citruses, and rice. Citrus fruits (oranges, grapefruit, and limes), mango, and pineapple are grown successfully; in horticultural products the list is long comprising such items as potatoes, tomatoes, onion, and beans.

Despite our natural wealth, Sudan is, in effect, a net importer of foods. This paper reviews individual food items on both import and export lists with a view to highlighting aspects relating to products, quality, and availability.

Major Food Exports from Sudan

Groundnuts

Groundnuts are our traditional leading oil crop, in terms of volume of production and its contribution to GNP and foreign exchange earnings. Up to the mid-seventies domestic consumption was very low. The bulk of exports consisted of crushing grades (oil stock FAQ) with small scale production and exportation of hand-picked selected (HPS) edible products. Within the last ten years or so, however, groundnuts were introduced as a rotation crop in the irrigated areas of central Sudan. This resulted in a large surplus for the local crushing industry, which underwent considerable expansion including, in some cases, solvent extraction. During the same period the edible-lines industry also introduced fairly modern processing facilities. Thus, during the last five years or so exports of this commodity have been exclusively of edible lines (HPS).

Although the targeted production should have reached one million t (in shell) more than five years ago, total production has never exceeded 0.5 million t due to progressively decreasing productivity and losses due

to inferior quality. Aflatoxin contamination is the major quality-reducing factor. Due to increasing incidence of aflatoxin in groundnuts from the rain belt, total exports in 1979 and 1980 were only 37,000 and 20,000 t respectively, compared to 97,000, 94,000 and 89,000 t in 1978, 1981 and 1982, respectively.

Vegetable Oils

Grouadnut oil and sesame seed oil are the sole exports, groundnut oil constituting over 90% of the total. Sesame oil is mainly exported to Middle Eastern countries, and groundnut oil to western Europe, mainly France. Both oils are exported as filtered crude; acidity (FFA), moisture, and impurities are the main contracted quality characteristics. During 1978-82 the lowest export volume was 12,000 t in 1979, while the highest figure of 40,000 t was realized in 1978 and 1980. In 1981 and 1982 the average was 22,000 t.

Oilcake/Meal

Three types are produced in Sudan: cotton-seed, groundnut, and sesame-seed. There was hardly any export of cotton-seed cake or meal over the last five years. During the same period exports of groundnut and sesame seed averaged 100,000 t/year. Recently, demand for and availability of groundnut cake/meal has been declining due to aflatoxin contamination problems, while restrictive measures in importing countries are increasing.

All the modern cleaning plants are in port Sudan, hence cake produced elsewhere tends to have higher impurity levels due to pressing poorly-cleaned material.

Sesame-seed

Sesame-seed is grown almost exclusively under rainfed cultivation both on the light soils of western Sudan and on the heavy clay-type soils of central and eastern Sudan. Three types are produced: red and mixed varieties, with an oil content normally of over 50%, which are used mostly as a source of edible oils, and the white variety, which has several uses in food. A maximum of 2% impurities is the legal requirement for all grades, while for the white variety a new trend is to export a super white grade which is cleaned to a maximum of 0.5% impurities or less. Sudan is a leading world exporter of high quality sesame-seed.

Sorghum

Sorghum is the major cereal grain produced in Sudan. It is the only crop in which production is completely mechanized. Although it is a traditional staple and national food-reserve crop, recent trends in consumer habits have resulted in an increasing surplus for export. Exports for the past four years have averaged about 280,000 t/year, the main customer being Saudi Arabia where the product is used in animal and bird feeds. Customers in western Europe include West Germany, Holland, and Belgium, where the product is used for industry.

Horticultural Products

This is an emerging line of exports that has not yet assumed a clearly identified pattern. However, the planned export-oriented medium- and large-scale farms in central Sudan should lead to increasing exports of fresh products to western Europe. So far Sudan exports mainly to Saudi Arabia, and occasionally to the Gulf States. Limes, citrus fruits, mangoes, okra, and egg plant are the major export items. Exports for the last five years averaged some 2000 t.

Meat and Livestock

The bulk of our exports in this category is in live animals (sheep, cattle, goats, and camels). The main customers are Saudi Arabia, Egypt, and other African and Arab countries. It is well known that the official trade statistics for live animal exports are well below actual figures. The official figure for the past five years is an average of about 500,000 head/year.

Miscellaneous

Sudan exports about 500 t of dried products, such as onions, each year to western Europe. There is also an irregular export trade in white beans mainly to Egypt and Iraq ranging from a few hundred to a few thousand tonnes a year. A special export product is Karkadi (Hobiscus Sabdarifa), which is used to make a soft drink (Sudan tea) in western Europe. It also finds a limited industrial use as a food colorant and additive and in cosmetics and medicines. The average yearly export for the last five years is 3000 tonnes.

Food Imports

Wheat

Consumption of wheat in Sudan has increased much faster than expected since the 1970s. Consequently, the Government has not been able to achieve self-sufficiency from the irrigated schemes such as Gezira. In addition, the schemes failed to realize projected production quotas, due both to declining productivity and reluctance on the part of farmers to hand their crop to the authorities as is deemed by the agreement between the two parties. According to the statistics of the Ministry of Supply, wheat deliveries by farmers to all the local flour mills started at 150,000 and 160,000 t in the years 1977 and 1978, progressively declined to 20,000 t in 1981, and then levelled off at 60,000 t in 1983.

Imports of wheat and flour in 1976/77 were about 200,000 t, while in 1982/83 they reached 600,000 tonnes. Very little attention to quality of imported wheat is paid by the Sudanese authorities, resulting in consistent complaints from millers and bakers and reflected in persistent shortages of bread. Imports of wheat constitute one of the main constraints on the national economy and balance of payment deficits. A fast remedy has been foreseen in the introduction of 20-30% of sorghum flour in bread making, but so far no progress has been in this direction. A better solution is to increase wheat production, but this may require some basic changes in policy, and call for major shifts in production zones.

Rice

Results from experiments on rice production are promising. Imports in 1981, 1982, and 1983 averaged 70,000 t, mainly from China, India, and Egypt.

Lentils

Lentils are a popular and fairly important food item, constituting at least one basic meal per day in diets at schools, military barracks, hospitals, etc. They are imported mainly from Greece, Turkey, and Syria, by Government corporations and private sector companies. Imports for the years 1981, 1982, and 1983 averaged about 200,000 tonnes. To the author's knowledge, there is little control of quality for imports, although in most contracts there is bound to be a quality clause. Generally speaking however, quality seems fairly satisfactory and there are few complaints.

Beans

Vicia faba (foul masri) constitutes a regular part of the diet in practically every household, rural and urban. It is grown as an irrigated winter crop in northern Sudan. Although the crop has received increasing attention from researchers for several years, little of the research findings have been applied. In 1981, 1982, and 1983, Sudan imported an average of 50,000 t/year, from mainly Egypt, Syria, and Turkey as well as from China. The most frequent quality complaints concern physical properties, mainly excessively hard and wrinkled seed tests (skin). There have also been reports recently of storage problems due to pest infestations.

Dried Milk

Imports of milk powder increased from about 4000 t in 1980 to more than 10,000 t in 1982. Imports came from several western European countries and from Australia.

There is hardly any quality control on imports and it is not uncommon to find batches either with expired dates, or bearing no reference at all to dates of manufacture and expiry. There is an abundance of milk powder on the world market and competition between manufacturers and sellers is high. Price alone has become a major selling factor, which may lead to malpractices. The situation seems to warrant at least some consumer-protection oriented control efforts on the part of the Government.

Sugar

According to the national plans for agriculture, Sudan should now have been a net exporter of sugar. Imports, however, are still rising, from an average of under 200,000 t in 1977/78 to an average of just over 300,000 t/year in 1979-1983.

The sugar industry was controlled by public-sector corporations. Recently, however, there has been some restructuring of the industry whereby existing sugar factories operate as private-sector companies. It remains to be seen if the new policy will bring about higher productivity and lower production costs.

Tea

Production of tea in south Sudan started successfully more than 30 years ago. However, political instability in the region has prevented commercial production. There is currently a project sponsored by the European Economic Community which is so far rated as successful.

Traditionally, tea imports were handled by individuals and private sector companies, but for several years now one company has had a monopoly. The operation is well organized, in terms of product availability, quality, and price controls, in contrast to several other commodities.

Coffee

Very little coffee is produced in Sudan, most being imported. Imports in 1981-83 averaged about 2,000 t/year, the main sources of which were East African countries, Mexico, and Brazil.

Baby Foods, Biscuits, and Canned Foods

During the past few years, Sudan has been flooded with imported biscuits, fruits, jams, soft drinks, canned fish products, etc. Because imports were effected through barter trade or against earnings of Sudanese expatriates and because of a very high traffic in smuggled goods it is almost impossible to quote reliable statistics. These imports were rarely from countries of origin nor necessarily through identified importers or registered agents. Consequently, inferior quality or expired-date products were common. The scant quality control observed was almost exclusively in the form of investigations by health authorities following specific complaints.

Recently, the Ministry of Commerce has imposed a total ban on the system of barter and nil-value imports and on several of these products. It is hoped that these measures will boost demand for locally manufactured products, thereby encouraging new investments in this sector as well as rehabilitation of existing food factories.

Conclusions

Food imports have made a significant contribution to the recent balance of payment deficit and to a marked shift towards wasteful consumer habits. There is a great need to strictly adhere to recent national policy for the rehabilitation of agricultural and industrial sectors, and for boosting our traditional and nontraditional exports.

Present State of the Food Industry in Sudan

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The food processing industry plays an important role in food availability as most agricultural products require some processing to become edible or storable food. Storage of foodstuffs from times of excess for later use is one of man's greatest achievements.

A government census in 1983 estimated the population of Sudan to be 22 million, with a growth rate of 2.8% annum. Thus high rate of growth imposes increasing demands on food production.

Sudan has great agricultural potential, and the food industry could play a major role in exploiting this. However, Sudan, as a developing country, faces several problems which hinder the development of the food industry.

This paper represents a review of the present status of food industry and the major problems facing it.

Oil Seeds

Processing of oil-seeds for edible oil production is the oldest and most developed food industry in the country. Due to the different oil-seed crops grown (cotton, sesame, groundnut, and castor) the industry is spread throughout the country. Production of vegetable oils exceeds the local demand, and the surplus is exported. Today there are 124 plants with a total capacity of 1.5 million tonnes of edible oil per annum. These plants can be categorized into four groups, according to their capacity.

Group	Designated plant capacity (t/annum)	No of plants
1	1,000 - 10,000	86
2	11,000 - 30,000	25
3	21,000 - 50,000	6
4	51,000 -150,000	5

The actual output of the plants differ as not all of them are working at full capacity; about 55 plants are working at 10 to 40% of designated capacity, while the rest are working at 50-100% capacity.

Table 1 shows area, production, consumption, surplus , and percent self-sufficiency of oil-seeds in the country. This industry is the most successful one in the county.

Sugar

The sugar industry started in Sudan in 1962 with the establishment of the El Geneid sugar factory. By 1981 there were five sugar factories, four of which are owned by the public sector and the fifth is a joint private/public sector venture.

Table 2 shows dates of establishment and total plant capacity. The total plant capacity of 685,000 t/year is more than the total local demand of 450,000 t/year. However, production is far below both the planned and the designated plant capacities (Table 3). The gap has to be filled by import of sugar. The amount of sugar imported varies from one year to another depending on the quantity produced locally and availability of foreign currency (Table 4).

Cereals

Sorghum and wheat are the most important cereal crops in Sudan.

During the period 1971-82 wheat consumption increased from 284,700 to 629,400 t/year. Over the same period, production only increase from 124,000 to 164,000 t, the deficit being imported. Wheat flour consumption in urban areas increased from 15.4 to 24.3 kg/caput/annum.

Sorghum production exceeds local demand, the surplus (241,300 t in 1980/81) being exported. Production in 1980/81 was 700,000 t (Table 5).

Mills

Tea mills, with plant capacities of 70-400 t/day, have been established in Sudan since 1961. Total plant capacity is now 1720 t/day, but actual output is only 1320 t/day, as mills suffer from lack of raw materials and spare parts, and from power cuts.

Bakeries

Most bakeries in Sudan produce baladi-type bread. Most are small concerns, with output capacity of 0.5-3 t/day. Hygiene conditions are generally poor, and bread produced is of inferior quality. Some modern bakeries are being introduced in the cities.

Flour extraction from local wheat is high (80%), which gives a grey color and poor texture to the bread.

Biscuits

Biscuits are manufactured from imported flour with 72% extraction rate. Most of the factories have poor hygiene conditions. Production is usually limited by availability of raw materials.

Recommendations

To overcome the shortage of wheat and flour, the following points should be considered:

1. Efforts should be directed towards increasing the local production of wheat in terms of quantity and quality.

2. Pilot plant studies carried out at the Food Research Centre showed that 10-40% substitution of wheat flour by sorghum flour in bread-making is possible, depending on the quality of wheat flour. In the case of biscuits, 50-75% substitution is possible, and 100% in the case of snack foods was achieved.

   In addition to the reduction in wheat flour requirements, this approach will ease the raw materials problems both for bakeries and biscuit factories. At the moment, two mills are producing decoricated sorghum which can meet the demand for production of composite flour.

3. Promotion of industrial-scale production of Kisra. The Grain Technology department of the Food Research Centre has done pioneering

work. This project could have great impact of sorghum and wheat consumption. Extra funding for this project is needed.

Fruits and Vegetables

Three fruit and vegetable processing factories were established in the 1960s by the government; two canning factories (Karina, northern Sudan, and Wau, in the south), and an onion dehydration factory at Kassala (eastern Sudan). The location of the factories was a political decision, rather than based on feasibility studies.

None of these factories is a successful enterprise till now. In 1972, two canning factories were established by the private sector, but both are now out of production. In 1979 another two canning factories were established, one in Khartoum (Saeed Food Factory) and the other in Kassala (Kassala Canning Company). Only these two factories are operating satisfactorily.

Table 6 shows the products and actual and designated capacities of the factories. If these capacities are fully utilized, the country will be exporting a large amount of canned and dehydrated products. However, due to the many problems facing this industry, the country is still importing some fruit and vegetable products. The quantity of processed fruit and vegetable products imported increased from 4570 t in 1978 to 11,463 t in 1982 with a value exceeding 8.7 million LS.

Cold Stores

There are about 29 cold stores in Khartoum Province, and very few in other parts of the country. Of these, five have a capacity of 216 to 1400 t. Four are engaged mainly in the storage of potatoes and the fifth for citrus. The others have a capacity of 10 t or less and are mainly engaged in banana ripening.

Storage of meat, dairy products, poultry, and fish products is little practised.

Packaging

The three major packaging factories are located in Khartoum North. These are the Blue Nile Company, with a capacity of 5000 t/year, Salamabi (5000 t), and Sudanese Packing Company (7000 t).

These factories are operating well below capacity, i.e. the production of the Blue Nile Company for 1982/83 was only 2.5 tons. Lack of electricity and raw materials are the main reasons.

Major Problems Facing the Food Industry

In Sudan, being an agricultural country, one would expect the food industries to be more advanced. Unfortunately, this is not the case. Many factors contribute to the failure and inefficiency of this industry. These are:

1. Lack of raw materials: These plants are facing a serious shortage of raw materials. At Karima Canning Factory the major raw material is tomatoes, which must be imported in the form of tomato concentrate. The same situation is found in all canning factories producing tomato paste, including those of the private sector.

2. Energy and power: Intermittent electricity cuts and continuous voltage and frequency fluctuations have caused serious damage to equipment, necessitating costly repairs.

3. Credit and finance: The evaluations of the Sudanese Pound relative to the US dollar between 1978 and 1983 have constantly increased the cost of production as well as the cost of new factories.

   The ever-rising cost of raw materials, fuel, and labor caused cash flow problems in the industry.

   Most of the factories are old and therefore need spare parts or refurbishing or both. Lack of foreign currency is a major handicap.

4. Labor shortages: These have been a serious problem for the industry, due to the emigration of skilled workers and technicians to the oil-producing countries, and the movement of others to higher-paying jobs within the country.

5. Transportation (of both raw materials and end products) difficulties.

6. Poor management: Employment should be based on capability rather than any other criteria. Furthermore, the managers do not have full authority within their duties, i.e. budget and administration.

7. Protection of local industry: There is no defined policy regarding the importation of food products, even those produced locally. Local products should be protected by a ban on imports as a further

incentive for the industry to expand.

8. Food standards regulations: Applying the Sudanese Food Standards Specifications will improve the quality of local produce.

9. Export incentives: The Government should encourage the food industry to export some of its products, i.e. fruitjuice and squashes to neighboring countries.

It was decided recently to run most of the food factories as private enterprises, owned by the Ministry of Finance and the commercial banks. It is hoped that this will overcome red-tape and bureaucracy.

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Table 1. Prospects for the cil-seed industry in Sudan, 1975-2000.

Year	Area (hax1000)	Production (000 t) Seed	Production (000 t) Cils	Consumption (t x 1000)	Demand (t x 1000)	Surplus	% Self-sufficiency
1975	1746	2521	365	104.060	230.770	134.23	158.17
1985	2552.16	2322	556.95	147.58	340.34	216.34	163.65
2000	4164.	4060	974.4	245.0	543.1	431.3	179.4

Source: Arab Organization for Agricultural Development.
The future of food economics in Arab World (1975-2000).
Vol.4, Statistical figures Khartoum, December 1979 P.110.

Table 2. Sugar plant capacities in Sudan.

Factory	Date of establishment	Designed capacity (t)	Attached farm's area (feddan)
Geneid	1962/63	60,000	37,000
New Halfa	1965/66	75,000	41,888
Sennar	1976	110,000	31,000
Assalaya	1980	110,000	28,100
Kenana	1981	330,000	80,920
Total		685,000	219,908

Table 3. Sugar production (t) during 1979/80 and 1981/82 seasons.

Factory	1979/80	1980/81	1981/82	Planed production 1982/83
Geneid	29,600	29,600	16,000	40,272
New Halfa	43,053	36,145	40,000	62,000
Sennar	30,523	26,115	25,000	50,000
Assalaya	7,560	8,565		
Kenana	22,000	10,700	162,000	200,00
Total	132,736	206,825	243,000	352,682

Table 4. Amount and value of sugar imported during 1978/1982.

Year	Imported sugar	
	Quantity	Value (LS x 1000)
1978	197,750	18,930
1979	155,608	20,479
1980	301,234	117,591
1981	191,390	75,779
1982	172,600	65,987

Source: Foreign Trade Statistical Digest No.4 **Vol.15** **Bank** of Sudan.

Table 5. Dura production and export, 1976/77-1980/81.

Year	Area (000 feddan)	Production (000 t)	Export (000 t)
1976/77	2788	674	133
1977/78	3036	812	47
1978/79	3310	1011	172
1979/80	2680	566	286.2
1980/81	3020	700	241.3

Source: First National Economical Conference, Khartoum, Dec. 1982.

Table 6. Fruit and vegetable factories in Sudan.

	Plant capacity			
	Tomato paste (t)	Fruit juice (t)	Jams (t)	Vegetables (t)
Canning factories				
Karema	1569	300	300	1800
Wau	643	300	300	1000
Sudanese Tomato Paste and Canning Factory	2507	500	300	-
Saeed Food Factory	2000	4500	2000	1500
Kassala Canning Co.	206	800	225	-
Elzayat Canning Factory	-	100	200	-
Elnasir Canning Co.	-	-	780	-
Total	6925	7080	3325	4300

Dehydration factories	Designed plant capacity
Kassala Dehydration Factory	900 t dried white onions
Babanosa Milk Factory	1000 t dried milk

Problems of Post-Harvest Losses in Food Crops in Sudan

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In spite of adequate food production on a world scale, hunger and malnutrition still exist. This is the result of unequal distribution of food among nations, within nations, within communities, and even within families. Loss and deterioration of available food resources further add to the problems.

In September 1975 the growing international awareness of the need to reduce food losses culminated in a resolution at the Seventh Special Session of the United Nations General Assembly stating that "the further reduction of post-harvest food losses in developing countries should be undertaken as a matter of priority with a view to reaching at least 50% reduction by 1985" (Harris and Kindbland 1979).

Of the agricultural commodities, grains (cereals, legumes, oil seeds) contribute the bulk of the world's calories and protein. Fruits and vegetahles constitute a major part of the diet. Large post-harvest losses are reported for all these commodities. Fig.1 shows some of the sources of these losses.

Reduction of post-harvest grain losses, especially those caused by insects, microorganisms, rodents, and birds will increase available food supplies, particularly in less-developed countries where losses are largest and the need for food is greatest.

An FAO sub-committee reported that "there is no agreed methodology of post-harvest loss assessment. There can be no agreed single figure for the percentage of post-harvest losses on a global scale or even on a national basis".

Table 1 gives some indication of storage losses occurring in African countries. Repeated handling increases losses. Hall (1970) estimated total losses at about 30%.

Grain Losses in Sudan

In Sudan, some 2-3 million tonnes of grain are used for human consumption. All the grain, except for part of the wheat, is produced locally.

At present, Sudan is an importer of wheat and exporter of sorghum. Wheat imports may be reduced and sorghum exports increased by increasing production, providing production, storage and handling, transport, and marketing systems are improved and developed.

Grain loss occurs at all stages, from sowing to consumption. Harvest and post-harvest losses are sometimes combined into a single loss, as some elements are common to both. The losses prior to harvest are the concern of the agricultural management, while the post-harvest losses are our concern.

The extent of grain losses in Sudan is not known, but FAO and local reports suggest approximately 30% losses. Any quantitative analysis of the losses would be difficult and time consuming due to the lack of pertinent statistics and data.

Progress in reducing post-harvest losses requires identification and elimination of the causes and problems associated with it.

The main causes of grain loss in Sudan are poor handling, transport, and storage facilities and practices. Grain is lost through spillage, chemical deterioration, and infestation with microorganisms and pests.

Losses ca be in the form of:

1. Quantitative (weight) loss
2. Qualitative loss (chemical and physical changes)
3. Reduction in nutritional value
4. Seed loss
5. Loss of reputation (may be reflected in the international market)

Measures to Reduce Grain Losses

Grain Handling and Storage Facilities

In Sudan grain is often bagged and transported by truck or train to stores (warehouses or pits). Pits are bulk stores, but grain is transported in

bags. These handling and storage facilities need to be improved.

Traditional storage methods have some economic disadvantages. First, the wastage is extremely high. Bagged sorghum can not be easily and economically treated against pest infestation. On the farm, spillage from bags broken in handling cannot be avoided. Bagged grain is exposed to rodents, birds, and temperature and humidity variation, which results in considerable losses.

In addition, bags are expensive. More man-power is needed for bagged grain than for bulk handling. Apart from economic advantages, bulk handling and storage enables better control of infestation and quality. Thus bulk farm-storage is recommended.

It is also necessary to have silos, elevators, and proper warehouses at several points in the country. They should be located at the country transport terminals and at export and import terminals. They should be equipped with all necessary personnel and equipment, such as fumigation facilities.

Fumigation

Grain should be fumigated before, and if necessary during, storage. Grain can be fumigated in bulk or in bags; however, treating bulk grain is considered to be more effective. The design of grain storage should be in such a way as to facilitate fumigation.

Moisture and Temperature

Moisture and heat can cause considerable damage to stored grain by inducing germination, growth of fungi, fermentation, and insect infestation. The upper limit of temperature suitable for fungal growth is about 60°C and 42°C for insect breeding. In the tropics it is very difficult to control temperature or relative humidity in the ambient air. Therefore, the greatest emphasis should be placed on the moisture content of the grain at the time of storage. In elevators and silos it may be necessary to move the grain through conveyers from time to time to reduce temperature and moisture. Exhaust and blowing fans are another solution in warehouses. Moisture and temperature detectors should be installed in bins and warehouses.

Insects and Mites

Of various insects in Sudan, beetles, moths, cockroaches, ants, and termites, in that order, causes most grain damage and loss. Under high temperature and moisture conditions they multiply rapidly. To reduce losses due to insects, the grain should be cleaned prior to storage and kept at lower temperature and a minimum moisture content.

Rodents and Birds

Rodents and birds can cause a lot of damage to and loss of grain in the field and in storage. The most effective control is to prevent their access to the grain. The cleanliness of the warehouse, storage area, and surroundings is very important. Sometimes the use of poisons may be necessary to control these pests.

Transport

The only significant port is Port Sudan which lies 700 km from Khartoum and 700-1500 km from the major grain production areas. The existing transportation system depends on trucks and railways. The transportation system needs to be improved. It is recommended that hopper cars should replace box trucks. Railway transport should also be in bulk.

Remarks and Recommendations

At a recent seminar held in Sudan and organized by FAO, the following remarks and recommendations were made:

Remarks

1. There is a need for the full-time commitment of qualified staff, and the provision of facilities and recurrent funds for the establishment of a permanent Storage Investigation, Training, and Advisory Unit.

2. The largest losses in grain storage at all levels in the Sudan are caused by insect-pest infestation. It was also recognized that some storage problems may arise from pre-storage operations (harvesting, threshing, and drying) and these operations should also be considered by the Unit.

3. There is an essential requirement for:

   - the evaluation of storage methods and product losses at all levels of the farming and trading sectors, and

- the collection of data concerning the through-put and quantities stored at all primary collection and marketing centers.

These evaluations will subsequently identify priority areas for future attention.

4. There is an immediate need to train appropriate Sudanese personnel, at all levels, both locally and abroad, specifically in the following disciplines:

   - the biology of stored products pests and their control;

   - storage management;

   - produce inspection procedures;

   - the design, maintenance and repair of storage structures.

5. Further investigatory work is required upon:

   - storage pits, metal bins, and sacks. Sack storage needs special attention because of its predominant use within the trading and marketing sectors;

   - the susceptibility to storage insect pests of different varieties of cereal grains grown in the Sudan with particular reference to sorghum and maize;

   - the behavior and control of Bruchidae infesting pulses, with particular reference to those attacking Vicia faba;

   - the testing or modification of internationally known pest-control and store-management techniques, applied under local conditions; and

   - the use and value of traditional pest-control methods utilized by farmers.

6. Consideration should be given to the application of internal quarantine procedures in order to inhibit the spread of stored-product pests with particular reference to Trogoderma granarium.

7. Finally, there is an immediate need for greater support in the storage sector for the Agricultural Extension Services, the Research Services, the Plant Protection Department, and the Agricultural Bank of the Sudan, and for better integration of their activities on a national basis.

Recommendations

1. It is recommended that a Storage Investigation, Training, and Advisory Unit should be established with the following objectives:

Short-term

- To collect information on present storage systems and the causes and extent of losses in those systems.

- To collect and apply existing national and international knowledge on how to reduce storage losses.

- To conduct or stimulate investigations to obtain information needed to solve current problems.

- To train people responsible, directly or indirectly, for applying loss reduction measures.

- To support and encourage the Plant Protection Department and the Agricultural Bank of the Sudan in their practical programs of pest control and store management.

Longer term

- To develop sub-stations of the Unit in order to meet the needs of different regions of the country.

- To conduct long-term investigations as required to provide for the future needs of the storage system in the Sudan.

- To evaluate new storage structures and techniques which may be introduced in the Sudan.

- To develop a long-term training program to serve the needs of Government agencies, Cooperatives, and the private sector, of the grain storage system in the Sudan.

- To provide advice to institutions and Government on matters relating to the design operation of storage systems, produce inspection, grading, and quality control.

- To provide technical guidance on the development of legislation to improve the standard of storage and the quality of food supplied to the consumer or for export.

2. It is recommended that a committee representing all concerned institutions should be set up to guide the establishment and development of the Storage Investigation, Training, and Advisory Unit.

Fruits and Vegetables

Fruit and Vegetable Production

Fruit and vegetable production in Sudan ranks second to that of food grains. However, production is increasing due to high demand both internally and externally. The total production was 598,383 t in 1982. AOAD (1975) showed that Sudan is leading the Arab countries in the increase in consumption of fresh products. Exports have been limited in recent years to mangoes and limes to a few Arab countries(due to some internal export problems). Reports have shown that the value of exported produce has increased from 1 million Sudanese pounds in 1977 to about 10 million in 1981 (Nawas 1983), and the potential is there for production of more fruits and vegetables for the European and Arab markets as well as for the local market.

In addition to their economic importance, fresh fruits and vegetables are nutritionally important as sources of vitamins, minerals, basic carbohydrates, and proteins. A daily supply of fresh fruits and vegetables is important for maintenance of good health.

Fresh fruits and vegetables are highly seasonal in production and highly perishable in storage. The production areas are distributed throughout the country, far from the main markets, and this necessitates the transport of these sensitive crops over long distances. Losses are increased by the bad transport and road system, and adverse climatic conditions of high temperature and low relative humidity, to which the crops are exposed during transport and marketing.

Post-Harvest Losses

Due to the natural characteristics of fresh fruits and vegetables and because of certain physiological processes they deteriorate with time, after being harvested. The rate of deterioration and loss in quality and quantity is affected by the type of crop, its handling, and the conditions to which it is subjected after harvest.

Fruits and vegetables tend to deteriorate rapidly under poor handling and storage. Estimates in Sudan put post-harvest losses at 30-50%, (Tables 2a and 2b). These losses occur at all stages of handling; Table 3

shows estimates of losses at different stages.

Efforts need to be directed towards reduction and control of these losses.

Types of Post-Harvest Losses

Knowledge of the types of and factors affecting losses is essential for their control. Post-harvest losses can be classified into three main types; (1) mechanical, (2) physiological, and (3) pathological. These may exist separately or interact (Booth and Coursey 1972).

Mechanical damage

Physical damage to the plant tissue may occur during harvesting, transportation, storage, or marketing. In addition to causing direct loss, mechanical damage always renders produce liable to other types of damage (physiological and pathological).

Mechanical damage is the direct or indirect cause of most post-harvest of fresh produce in Sudan.

Physiological damage

Natural physiological changes and processes take place during the life of fresh produce. Under certain conditions, if these changes and processes are not controlled, they will lead to the rapid deterioration and loss of these products.

The most important of these physiological stages and processes are maturity and ripening, transpiration and respiration.

Maturity. Knowledge of the maturity stage is essential in determining the right time for harvesting; a lot of problems and losses arise due to harvesting at the incorrect stage of maturity.

Transpiration (moisture loss). This causes shrivelling, shrinkage, and deterioration of harvested crops. Transpiration is affected by several factors such as temperature, relative humidity, and air movement. If it is not controlled it will result in total loss of the crop.

Respiration. As with transpiration, the rate of respiration is mainly affected by temperature. An increase in the rate of respiration results in rapid reduction in quality, and a general decrease in the shelf life.

Other physiological phenomena such as sprouting and rooting, and physiological disorders such as chilling injury and rind injuries also add to the extent of post-harvest losses.

Pathological damage

One of the most important causes of losses in fresh fruits and vegetables is due to the attack by pathogens (fungi, bacterial, and viruses). The pathological damage may be direct but is encouraged by mechanical injury and poor storage conditions. Storage at low temperature and chemical treatments are the best methods of control and both are lacking in Sudan. Habish and Dirar (1973) reported that if the traditional methods of harvesting and handling of perishable produce are not improved, pathological damage will continue to increase.

Factors Affecting Post-Harvest Losses of Fresh Produce

The main factors affecting these losses are the climate, handling and storage practices, and the lack quality control.

Climatic Factors

High temperature and low relative humidity encourage losses and rapid deterioration of produce.

Transpiration rates are very high under our conditions and are a main cause of the rapid deterioration of our crops. However, it could be controlled by storage at low temperature and high relative humidity, as well as by other simpler practices of wrapping or washing (Table 4). The rate of respiration, ripening and softness, and pathological damage are all increased by the prevailing climatic conditions, but could be largely controlled under proper storage conditions.

Handling and Storage Practices

The poor handling and storage practices employed in Sudan result in all types of post-harvest damage. The following factors affect losses:

Harvesting at the incorrect maturity stage

Harvesting before or after the right maturity stage results in losses in both quality and quantity. Incorrect timing of harvest may be due to ignorance of the right stage or unavailability of transportation, as well as lack of standards. Experiments with banana showed that farmers loose about 20-30% of weight of their produce by harvesting 7-10 days earlier than the correct stage (Salih 1980). Some crops when harvested immature never ripen properly, while harvesting at later stages of maturity result in high losses due to softness of fruits. Harvesting fruits of mixed stages of maturity also results in increased losses as well as lower prices.

Harvesting method

Use of the incorrect harvesting method also results in increased losses. Abdalla (1980) and Yagi et al. (1980) found that losses in citrus fruits and mango could be reduced greatly just by improving harvesting method.

Harvesting time

Harvesting during the day and exposure of the crops to the sun increases losses.

Containers

Incorrect containers used for harvesting, transport, and storage result in increase of mechanical, as well as other types of damage. El Shafie (1980) and Yagi (1980) found a reduction of losses in tomatoes and mangoes by the use of the proper container and packaging material (Tables 5a and 5b).

Transport

Salih (1980) found that neck damage in banana could be reduced from 60% to 5% just with the use of boxes to transport bananas instead of bulk loading, and the damage could be reduced to less than 2% by lining the boxes with polyethylene sheet.

Storage

Some improper storage practices like traditional storage of onions in huts and storage of potatoes in pits lead to high losses. Improvement in these practices could reduce losses.

Lack of storage facilities

Proper storage facilities for fruits and vegetables, although essential, are lacking in Sudan. Cold storage is only available for potatoes in Khartoum Province and although the available capacity is well below that required, the benefits of reduction of losses, extending the season of availability, and reduction of prices are obvious.

All other cold stores are used for bananas and citrus fruit, but none of them is working properly and they are adding to post-harvest losses.

Lack of quality control measures

One of the factors encouraging post-harvest losses in fresh produce is the lack of laws and standards regulating handling and marketing of these products.

Furthermore, lack of proper roads and transport adds to the above mentioned factors.

Suggestions and Recommendations

- Efforts should be made on extension and education to inform both producers and consumers about the extent of losses and means for reducing these losses as well as better utilization of the produce.
- Assistance should be given to the farmers and producers to improve handling of their produce; i.e. in obtaining the proper harvesting tools, containers, transport, and marketing of their produce.
- Standards for fresh fruits and vegetables should be established and quality control should be enforced.
- Encouragement of and assistance in establishment of cold stores.
- In introduction and breeding of early and late maturing cultivars to reduce seasonality and to extend the season of availability.
- Planning of distribution of production in the different producing regions.
- Introduction of and breeding for new cultivars, selection should consider keeping-quality as well as other parameters.

- Promotion of export and processing of excess produce.

- Post-harvest research should be aided and directed more towards reduction of losses under traditional conditions.

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Table 1. Weight losses during storage in a number of countries.

Country	Commodity	Losses (%)	Losses mt	Level of storage	Period of storage	Cause	Source
Ghana	Legumes	9.3	0.006	FTC	12	I	Hayward, I.A.W. 1964. personal communication to FAO Plant Production and Protection Division
Upper Volta	Legumes	50-100		FTC	12	I	Hayward, I.A.W 1964.
Nigeria	Legumes	10		T	6	I	Hayward, I.A.W. 1964.
	Wheat	34		F	24	I	Ahmadu Bello University. Institute for Agricultural Research, 1963.
Somalia	Grain	20-50		FTC	12	RI	Bethke S., 1963. FAO report.
South Africa	Legumes	50		FTC	12	1	Hayward, I.A.W. 1964.
Tanzania	Legumes	50		FTC	12	1	Hayward, I.A.W. 1964.
Malaysia	Rice	17		C	8-9	A	Wright, F.N. 1963.
India	Rice		11.0	FTC	12		Central Food Technological Research Institute, 1965.
	Food grains	20.0		FTC	12		Johnston, I. 1966. Personal communication.
	Food grains	5.0		F	12		Wolpert, V. 1967.
	Grains	4.0	2.8	C	3-4		Pingale, S.V. 1964.
	Wheat	8.3	0.2	C	12		Pingale, S.V. 1964.
	Food grains	9.3		FTC	12		

F-Farmer: T-trader storage: C-Central storage depots: R-Rodent: I-Insects : A- all causes.

Table 2a. Percentage wastage in major fruits and vegetables in Sudan.

	Banana	Citrus	Mango	Onion	Potatoes	Tomatoes
% wastage	55%	40%	30-40%	50%	50%	37-62%
Reference	Salih (1980)	Habish and Dirar (1973)	Habish and Dirar (1973)	Musa el al. (1973)	Musa (1973)	El Shafie (1980)

Table 2b. Retailer losses for some vegetables in Sudan.

	Egg plant	Squash	Okra	S.Pepper	Cucumber	Tomato
% market. loss	50%	50%	50%	50%	50%	50%
Storage period (days)	1.2-4	08-3.5	1.3-2.3	0.7-2.8	1.6-3.7	1.2-5.6

Source: Musa and Thompson (1976).

Table 3. Post-harvest at different stages of fresh produce handling.

	Harvest	Handling & prep.	Transport	Marketing	Household
% loss	4-12%	5-15%	2-8%	3-10%	1-5%

Source: Arab Organization for Agricultural Development (1981).
Supply and demand of agricultural products in selected Arab Countries.

Table 4. Percentage moisture losses of some crops under Sudanese conditions and the effect of some treatments and cold storage on losses.

	Days in storage	% moisture loss Ambient cond.	% moisture loss with treatment	% moisture loss under cold storage	Reference
Grapefruit	15	20.8	10.9 Waxing	0.45 7.2°C, 96% RH	Yagi and Salih 1976.
Limes	16	23.0	1.03 Polythene	7.3 13 C, 98% RH	Thompson *et al* 1974.
Mandrins	30	50.0	5.0 Polythene	6.0 13°C, 90% RH	Yagi 1980.
Mango	18	43.4	12.5 Sawdust	7.75 20°C, 85% RH	Yagi 1980.
Mallow	2	34.7	0.45 Polythene	10.4 4°C 90% RH	Abdalla and Musa 1974.
Onions	120	28.0	16.9 modified store (forced air)		Musa and Abdalla 1983.
Potatoes	90	48.2		3.8 4°C, 90% RH	Musa 1973.
Parslane	5	34.7	0.45 Polythene	10.4 4°C 90% RH	Musa and Abdalla 1974.
Sweet pepper	4	6.8		3.6 5°C, 90% RH	El Shafie and Musa 1983.

Table 5a. The effect of harvest and storage container on quality of tomatoes (pink stage).

Type of container	% damage after transport	% damage after 2 days storage at ambient temp.
Guffa	32.6	56.8
Tin	16.0	50.4
Carton box	11.5	32.1
Plastic box	22.7	35.0
Wooden box	6.9	13.8

Reference: El Shafie (1980).

Table 5b. The effect of packaging material and temperature on weight loss of mango fruits (after 18 days storage).

Packaging material	Ambient cond. 32°C 46% RH	20°C 85 % RH
Control	43.39	7.75
Saw dust	32.12	4.84
Straw	25.33	6.11
Green banana leaves	16.85	3.35
Saw dust + Na OH	12.51	1.82

Reference: Yagi 1980

Food Availability and Trends in Food Consumption in Sudan

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Freedom from hunger is man's first fundamental right, and hunger and malnutrition will impede the progress of any nation in every sphere. The absolute numbers of either undernourished or malnourished people is increasing despite the fact that per caput food production is at present rising. Increased food production by itself will not solve the problem of hunger and malnutrition, these are bound up with poverty, and with economic and social development in general.

Recently much attention has focused on agricultural and food production at both international and regional levels. Different international organizations, particularly the Food and Agriculture Organization (FAO), have devoted much of their effort to defining and proposing solutions to the world food problems. This has taken many forms as shown in some of the FAO publications (e.g. FAO 1977; FAO 1979; FAO 1980; FAO 1982; FAO 1983). Many programs have been proposed to increase and improve food production, to better distribute food commodities and to improve consumption trends (e.g. the Food Security Programs). These problems have also been studied at the regional level. Among the Arab countries, Sudan has been put as one of the hopes to help solve the food problems.

This presentation aims to review and assess the present food production, supply and availability, and the food consumption patterns and trends in the Sudan, and considers ways to improve them.

Food Production and Availability

Agricultural (crop and livestock) and fishery production are the main sources of food. Food supplies in a given region are the sum of domestic production and imported foods. Since domestic agricultural production is the main source of food supply in most developing countries, including Sudan, changes in the level of domestic agricultural output have significant effects upon the level of total available food supplies.

Factors affecting food availability include the amount of cultivated land, soil fertility, climate, irrigation, agricultural methods, cropping patterns, cooperative practices, food processing and storage methods, location and means of distribution, incentives for more production, and social roles and income levels.

In discussing food availability, various aspects should be considered. These include total supplies, consumer prices, income, stocks and food security, food aid, investment in agriculture, and problems and strategies for increasing food production.

Food Availability

Sudan, the biggest country in Africa, occupies an area of 2.5 million km^2. Of this vast area, 200 million feddans (80 million hectares) could be cultivated. At present only 20 million feddans (ca. 10%) is utilized. The 1983 census showed that the population of Sudan is about 20 million people.

Different environmental conditions effect the action and interaction of soil, climate, topography, water resources, vegetation and other biotic factors. Vast supplies of water are available either from precipitation or from the Nile and its tributaries or similar sources (e.g. Gash and Tokar).

Sudan suffers from some of the many problems of food production, supply, and availability that other developing countries face. Still we think that Sudan is in a better position due to the potential it possesses for agricultural and food production. It has been described as the "bread basket" of the Arab world. This belief lead many Arab and international organizations and several countries to make long term investments in agricultural and food production in the Sudan. About 100 projects have been identified, with an estimated total investment of 5 billion US dollars. The Arab Authority of Agricultural Investment and Development (AAAID) was established with an initial capital of 500 million US dollars to put the programs into action (FAO Agric. series No. 9, 1979).

Food Crop Production

(Shown in Tables 1 and 2)

Cereal crops

Cereals provide the starchy base of all diets in Sudan, though in parts of southern Sudan root crops are of considerable importance. The important cereal crops in the Sudan are: dura (sorghum), dukhn (Bullrush millet), telebun (Finger millet) and wheat. Rice and maize are also grown on a small scale. Production figures and important data for the main food grains for a number of seasons are shown in Tables 2-4.

The total food-grain area has increased from 2.94 million hectares in 1971 to 4.2 million hectares in 1981. Production has increased from 2 million tonnes in 1971 to 3 million tonnes in 1981.

a) Dura: Dura is by far the most important food crop in Sudan, occupying about 2.94 million hectares in 1981 (about 35% of the total cropped area), with an average annual production of 2 million tonnes (1981). It is the staple food of the vast majority of the population. Both area and yield fluctuate, depending mainly upon the amount and distribution of rainfall. Dura is also exported; the amount exported has increased from 98,000 tonnes in 1975 to 250,000 tonnes in 1981 (FAO, Country report, Jan 1982).

The immense fluctuation of production, coupled with lack of good storage facilities and a poor transport system results in occasional famines, particularly in remote parts of the country. This situation can be remedied by improvement of storage facilities, by construction of silos, and the encouragement of local methods of storage.

Production reached a record of 2.4 million tonnes in 1978/79 due mainly to acreage increases (from 1.9 million hectares to over 2.94 million hectares). Projections (Table 3) indicate that both area and production will increase, by 1985, to 3.15 million hectares and 2.4 million tonnes.

b) Wheat: The area under wheat nearly doubled during the 1970s reaching a record of over 0.294 million hectares in 1975-76 (Table 2). This increase was in response to the government policy to diversifying agricultural products and the objective of achieving self-sufficiency in wheat. The latter objective appears unattainable in the medium term due to agroecological constraints for growing this crop in Sudan.

About 85% of the country's wheat is produced in the Gezira scheme. Wheat supplies depend on both domestic production and imports. While production has fluctuated during the last few years, imports have grown steadily, reaching a record of 0.49 million tonnes in 1980/81. Projections (Table 4) point to a decrease in wheat imports (down to 0.17 million tonnes) and to an increase in domestic production (up to 0.44 million tonnes) by 1985.

c) Dukhn: This is the staple cereal of the rural population of Western Sudan. The area under dukhn changed little in the period 1973-1982. The small variations shown in Table 2 are mainly due to the variation in rainfall. Area and production reached record values in 1978/79 (1.26 million hectares and 0.55 million tonnes). In 1980/81 only 0.49 million tonnes were produced. Projections suggest a slight increase in both area and production.

d) Telebun: This is the main staple food in the south-western area of Sudan, and is grown in small areas.

e) Rice: A total of about 10,500 ha of rice is grown in the southern region and the Gezira scheme. Production is of the order of 10-12,000 tonnes per annum. Projections point to an increase in area to 14,300 ha in 1985, and a total production of 19,000 tonnes.

f) Maize: This crop is grown in small patches in several parts of the country but it is not a staple cereal in any area. The maize acreage reached a record value of 88,200 ha in 1975/76 but declined and is now about 59,000 ha. Total production was 44,000 tonnes in 1980/81 (Table 2). Area and production are forecast to increase to 70,000 ha and 52,000 tonnes, respectively, by 1985.

Starchy root crops:

In general root crops are grown only in the South where climate and soil suit them. The most important of these are cassava, yams, and sweet potatoes. Total production is shown in Table 1. Production declined from 0.39 million tonnes in the 1960s to 0.31 million tonnes in 1981.

Pulses:

The most common pulses are broad beans (*Vicia faba*) and haricot beans (*Phaseolus vulgaris*), which are produced almost exclusively north of Khartoum. Other pulses produced locally include chickpea, pigeonpea,

cowpea, lima bean, green graw bean, and bambara earthnut. The total pulse production was estimated to be 83,000 tonnes in 1981 (Table 1).

Oil crops:

The most important oilseed crops in Sudan are sesame and groundnuts. THe areas under both crops reached record values in 1977/78 (1.1 million hectares for groundnuts and 1.0 million hectares for sesame). Production was also at record values (1 million tonnes for groundnut and 0.25 million tonnes for sesame). Figures for 1980/81 show a drop in both area and production for the two crops.

Apart from these crops, cotton seeds constitute an important source of vegetable oil for cooking. New oil seeds which are still being experimented on include: karkali seeds, melon seeds, and pumpkin seeds.

Sugar crops:

Sugar cane is the only crop used in Sudan for sugar extraction. Total sugar production increased from 113,000 tonnes in 1972/73 to 208,000 tonnes in 1980/81. This is only 48% self-sufficiency.

Vegetables and Fruits:

Due to the diversity of the environment, a wide range of vegetables and fruits are grown in Sudan. The problems facing horticultural expansion are the marked seasonality of production, lack of good seed, poor transport, storage, and processing facilities, and pests and diseases. Statistical data regarding areas, and total production are at present fragmentary.

Animal Food Production

Foods of animal origin in Sudan are produced by the nomadic pastural population who move every year several hundred miles in search of grass and water. This mode of life does not permit education and other social services to be extended to the nomads. In addition they lack the skill, training, and know-how to make high quality animal products that meet the consumer's demand. Nomadic herds are also low producers when compared to similar animals kept under extension system.

Table 1 shows the number of livestock in Sudan for a number of years, and the total amounts of meat and milk produced. The number of cattle

increased from over 8 million in 1965 to about 19 million in 1981. Sheep and goats followed the same trend and the numbers in 1981 stood at 18 million for sheep and 12.8 million for goats. Camels are also reared, with estimated numbers of about 4 million. Pigs are only kept on private farms of non-muslims and numbered about 8,000 in 1981.

Total meat production increased from 307,000 tonnes in 1970 to 427,000 tonnes in 1981. Milk production also increased, to a total of 1.5 million tonnes in 1981.

Fisheries in Sudan

A number of problems prevent full exploitation of fisheries in Sudan, including:

- Scattered projects that attempt to cover the whole water system,
- Inefficient utilization of resources, and
- Marketing problems.

Fresh-water fish is the main fishery product in the Sudan (Table 1). The production of freshwater fish has nearly remained constant during the last 10 years, ranging between 21,000 and 26,000 tonnes per year.

Effect of Environment on Food Production

Fergusson (1954) divided Sudan into different environmental regions.

1) The desert region: Lies north of latitude 16^{0}N and is practically useless for food production.

2) The semi-desert region: Few grazing animals in addition to quick-maturing crops are found.

3) Irrigated river areas:

   a) the Nile north of Khartoum: conditions suit production of dates, citrus fruits, mangoes, guava, vegetables, dura, wheat, and pulse crops.

   b) the desert deltas: includes Tokar and Gash deltas where dura and dukhn are the main food crops.

c) other riverian areas: includes 'gerfs' along the Atbara river, the Blue Nile and other seasonal water sourses. Vegetable, fruits, maize, and water melons are produced.

4) Irrigated clays: includes the Gezira scheme and many schemes on the Blue and White Niles. Food crops grown include dura, wheat, vegetables, and some tropical pulses.

5) The "Qoz" sands of western Sudan: conditions suit quick-maturing, drought-resistant crops (e.g. dukhn, water-melon, sesame, groundnuts and karkadi). Dura and some vegetables are also grown.

6) The Central Clay Plains: the northern part of these plains suit dura production which is practically the only crop grown. In the southern part, dura and sesame are extensively grown, while maize, groundnuts, and vegetables are grown on a limited scale.

7) The flood plain: occupies large parts of southern Sudan. Dura is grown extensively. Conditions also suit rice, and efforts to increase the area under rice are being made. Maize, dukhn, groundnuts, sesame and cowpeas are grown to a limited extent. Livestock production is a major interest in this region.

8) The Ironstone region (south-western Sudan): conditions are unfavorable for livestock production. Main food crops are dura, dukhn, maize and telebun. Others include sesame, groundnuts, sweet potatoes, cassava, and yam. Perennial trees (e.g. citrus, mangoes, and pawpaws) are also grown.

9) The green belt: occupies the extreme south-western corner of Equatoria Province. Conditions suit the production of a large variety of food crops including:

a) Cereals: mainly telebun but dura and maize are also grown.

b) Root crops: mainly cassava; yams and potatoes are also grown.

c) Vegetables: a variety of these are grown in small patches. In addition, tropical fruits, oil palms, coffee, tobacco, tea, sugar cane, and citrus are also found.

10) The Mountain regions: includes Jebel Marra and the Immatongs. In Jebel Marra, dura, dukhn and various fruits and vegetables are also grown. In addition some temperate fruits (e.g. grapes, strawberries, and apples) are being tried at higher altitudes. In the Immatongs, conditions suit tea and coffee production, in addition to some temperate and sub-temperate crops.

Strategies for Improving Food Availability

Although food production in Sudan seems to be more stable than in most neighboring countries of the Near East, and is also more self-sufficient in foods, the percentage of the undernourished is relatively high (30% in 1974 - FAO, 1979). To remedy this problems food security measures have to be taken. The objective of food security, as defined in the International Undertaking on World Food Security is, "to secure the availability at all times of adequate supplies of these food-stuffs, primarily cereals, so as to avoid acute food shortages in the event of widespread crop failure or natural disasters, to sustain a steady expansion of production and reduce fluctuations in production and prices."

In Sudan, food availability could be increased by both horizontal and vertical expansion of food crops. Efforts to expand the area under food crops by irrigation could be directed towards more efficient use of the water available. In most areas where rainfall is adequate for crop growth, the possibilities for expansion are promising e.g. in the central clay plains.

Vertical expansion could be achieved by the adoption of modern crop production techniques. These include better husbandry practices, such as the use of high quality seeds, crop rotations, optimum populations, weed control, fertilizers, pest and disease control, and mechanization, and by giving incentives to the producers. The aim should be to improve the nutritive value of crops as well as their quantity.

Food production and efficient distribution must go together. At present Sudan lacks efficient transport, food processing, and storage facilities. Extension and improvement of the existing transport systems coupled with facilities for processing and storage of food surpluses are vital for improving the food situation in the Sudan. In addition, efficient marketing of food crops is of vital importance. Since marketing costs tend to constitute a major proportion of food prices, efforts should be made to reduce these costs. This is particularly important given that urban population is rapidly increasing. Reducing marketing costs would also provide incentives to the farmer to increase his output.

For animal food production the future may be stratification of livestock production into intensive fattening of calves and lambs produced under extensive ranching systems.

The Food Security Programme for Arab Countries, in 1980, identified some projects for food grain development in Sudan (Table 5). Many Arab

and Islamic organizations are working to increase food availability in Sudan to satisfy the needs of both Sudan and neighboring countries. The most striking example is the ongoing program of the Arab Authority of Agricultural Investment and Development which includes five projects, covering:

a) Glucose and starch industries
b) Improvement of the edible oil industry
c) Dairy products
d) Poultry production, and
e) Fruits and vegetables.

Modern technology in food production should be adopted. At present, the public sector of the food processing industry is not very promising. All the food processing factories of the Food Industries Corporation seem to be declining. The failure of these factories might be attributed to improper planning and administration. Private sector food factories seem to be more promising. Food processing in Sudan, therefore, needs to be revised to make better use of available technology for increasing food availability.

Food Consumption Pattern and Trends

Surveys need to be conducted to determine food consumption patterns. Together with nutritional status assessment they are essential for defining the food and nutrition situation in the country, and can be used in evolving a national development policy.

FAO has collected data on food consumption patterns in various parts of the world (FAO Food and Nutrition Papers Nos. 1, 10, 16 and 27). Information and data collected are presented in tables of standarized layout and take into account information for rural and urban sectors of the population, when available. Household food consumption is given on a per caput basis or per houshold. Statements aboot coverage, sampling techniques, evaluation of precision, etc. are also given with the tables.

Food consumption pattern data for Sudan are lacking; very few systematic studies concerning food consumption have been conducted. Local food consumption surveys carried out from 1933 to 1971 were reviewed by A/Rahman and El Amin (1973). Each of the surveys was carried out in specific areas of the country. Information on food consumption surveys at the national level is thus limited, and only one survey has been mentioned in FAO reviews of food consumption surveys (the household sample survey in Sudan).

The basic food pattern in Sudan varies throughout the country, due to regional differences in food stuffs produced, climatic conditions and food habits prevalent.

A few general remarks may be made on consumption patterns and trends in Sudan. Some of these lack statistical data and depend on observation.

Youngblood et al. (1973) found that there has been rapid increase in urban per caput consumption of bread in the last 15 years in Sudan, together with growth in wheat imports. The apparent total consumption of wheat flour has increased 7.5% annually (228,000 tonnes - 469,000 tonnes) while per capita consumption increased at an annual rate of 4.7%. This difference of 2.8% is mainly attributed to the population growth. The reasons for the increase in wheat flour consumption are:

1. Urbanization - this involves the influx of refugees from neighboring countries and from rural parts of Sudan.

2. Increased income.

3. Female labor force participation. This affects the amount of bread consumed, as working women find it easier to purchase manufactured bread, as well as eating bread at work.

The study also showed that higher income households consume twice the quantity of bread per caput than do the lowest income households in urban Khartoum and substantially more than rural households. The study found that since 1972 significant changes in the consumption of wheat and in the source of wheat supply have occurred. Increase in domestic wheat production has not kept pace with increases in consumption. The resulting gap has been filled by increasing concessional and commercial imports of wheat grain and wheat flour. From 1972 to 1978, domestic wheat production rose from 124,000 t to 317,000 t and then declined to 164,000 t in 1982. During this period wheat imports almost tripled from 176,000 t to 465,000 t.

Table 6 shows that total consumption of sorghum, millet and wheat flour slightly increased from 1976 to 1981. Maize flour consumption did not increase during the same period, while consumption of milled rice decreased from 12,000 t to 10,000 t. The per caput cereal flour consumption did not change significantly. Thus the increase in total consumption can be attributed to the increase in population, particularly in the rural areas.

Table 1 shows the calorie contribution of the major foodstuffs in Sudan, and the trend of change up to 1975. It shows that dependence on sorghum and millet as a source of calories has decreased from 47% to 44% while consumption of oils and fats, wheat, sugar, and honey has increased.

With regard to pulses, consumption of broad beans (ful masri) is increasing, particularly in urban areas, where it generally constitutes a main dish at both breakfast and dinner.

Foods of animal origin are widely consumed in Sudan. Sudanese generally consume large amounts of mutton and beef, and lesser quantities of meat from goats, camels, game animals, poultry, and fish. However, consumption of mutton and beef varies from place to place and between income groups. Generally, high income groups in cities and large towns eat more meat than low income groups, villagers, and nomadic people.

Milk is also consumed by most Sudanese, especially infants. The source of milk, include fresh bottled milk from established dairies and milk is sold door-to-door in cities or larger towns. Milk powder is also imported. The main milk animals in Sudan are sheep, cows, and goats. Many Sudanese families keep a few milking animals to supply the familiy with milk.

Household Expenditure on Food and Drink

Food consumption trends are very much related to the expenditure on food and drink. The Department of Statistics of the Ministry of Finance and Economic Planning carries out surveys on the household income expenditure on various items, including food and drink. The latest survey conducted during the period 1978-80 (Department of Statistics, 1982). It was intended to cover the whole country but, due to some difficulties, it was limited to Khartoum Province.

In that survey it was found that food and drink constitute the most important items in the houshold budget, accounting for 54% of average household expenditure. There were variations, however, between the different income groups in the proportion of their expanditure going to food and drink; for the three lowest income groups, 60% of the household budget goes to food and drink, whereas for the highest income group food and drink accounts for about 40% of the household budget.

Table 7 shows the expenditure on food and drink items for five income groups as percentages of total expenditure on food and drink.

In each income group, meat accounts for over 20% of household expenditure on food and drink; vegetables and cereal products both account for more than 10%, while dairy products, and sugar and sweets both account for about 9%. In each income group these five items account for 69% of average household budget on food and drink.

Table 8 presents the same data on a per caput basis. Per caput expenditure on certain food items increases sharply in the higher income groups; notable examples are eggs, fish, cigarettes and tobacco, and alcoholic and non-alcoholic drinks, and to a lesser extent fruit, meat, and dairy products. The increases in per caput expenditure on certain other food items are more modest; these include cereal products, vegetables, oils and fats, sugar and sweets and miscellaneous foods. Expenditure on the remaining items, i.e cereals, starchy roots, pulses, tea and coffee, and groundnuts and seeds, is fairly constant across all income groups.

Conclusions

Self-sufficiency in food production, and even surpluses for export is possible in Sudan, if the natural resources are properly utilized. To increase food availability, other aspects, including efficient distribution and transport, proper storage and processing, and food price control, have also to be considered.

Consumption trends are very much affected by food availability in different areas of the country, by food habits and taboos, nutrition education and level of income. Per caput consumption index, at the national level, might not be a very useful indicator for consumption trends in a country like Sudan with such large variations.

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Table 1. General basic data on agriculture , food, and food products in Sudan, 1961-65 to 1981.

Description	Unit	1961-65	1970	1975	1978	1979	1980	1981
Land use	1000 HA							
Total		237,600	237,600	237,600	237,600	237,600		
Arable + perm. crops		11,000	11,700	12,160	12,400	12,400		
Irrigated		952	1,250	1,500	1,650	1,700		
Forests and Woodland		59,305	54,160	50,480	49,560	49,250		
Production	1000 MT							
Total cereals		1,613	2,139	2,794	2,896	3,187	2,933	3,001
Root crops		394	300	312	283	306	302	306
Total pulses		100	74	74	82	83	83	83
Oil crops		834	1,116	1,480	1,473	1,376	1,241	1,211
Total meat		253	307	368	391	399	418	427
Milk total		1,058	1,210	1,300	1,445	1,481	1,505	1,525
Livestock (No.)	1000							
Cattle		8,111	12,300	14,720	15,905	17,300	18,354	18,791
Sheep		8,255	11,358	13,774	17,358	17,200	17,800	18,125
Coats		6,579	8,804	10,921	12,088	12,200	12,570	12,825
Pigs		5	7	7	8	8	8	8
Fishery products	1000 MT							
Fresh water & diadrom		18	21	22	24	26	24	
Marine fish		1	1	1	1	2	1	
Selffish								
Aquatic plants		1	1					

Table 1. Cont.

Description	Unit	1961-65	1970	1975	1978	1979	1980	1981
Indices of production	1969-71 = 100							
Food		184	100	119	127	129	130	134
Agriculture		79	100	115	120	113	112	112
Per caput food prod.		98	100	105	103	102	100	100
Per caput agric. prod.		93	100	101	97	89	86	85
Food supply/caput per day								
Calories	Number	1869	2107	2129				
Proteins	grams	61.7	64.7	64.0				
Fats	grams	48.6	57.4	61.4				
Calories as %of requirement	Percent	79.5	89.7	90.6				
Major foods consumed								
(Share of total cal.)	Percent							
Millet and Sorghum		47.7	45.3	44.4				
Oil and fat		8.0	11.1	12.6				
Wheat		5.1	9.0	8.9				
Sugar and Honey		6.4	8.3	8.4				
Milk prod. excl.butter		7.9	6.6	6.4				
Indices of food products trade	1969-71 = 100							
Value of export		96	82	266	263	205	359	
Volume of export		118	82	115	92	69	105	
Unit value of export		82	100	244	251	277	280	
Value of import		79	103	396	271	366	963	
Volume of import		79	107	78	127	135	196	
Unit value of import		104	100	466	214	280	474	

Source: FAO Country Tables (1982)

Table 2. Area (hax1000) and production (tx1000) data for main food crops in Sudan, 1973-82.

	Sorghum		Dunkn		Wheat		Maize		Rice		Groundnuts		Sesame	
Year	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
1973/74	5208	1625	2641	268	419	235	133	37	15	6	1724	543	2167	240
1974/75	5864	1744	2646	444	598	246	197	45	15	7	1717	875	2199	282
1975/76	6197	2026	2512	403	714	264	210	53	17	7	2066	931	2291	238
1976/77	6287	1800	2773	473	639	294	149	42	23	11	1894	740	2288	253
1977/78	6662	2017	2948	488	592	317	139	42	28	13	2629	1012	2349	245
1978/79	7202	2373	3078	550	577	167	145	45	20	10	2330	810	2061	215
1979/80	6349	1669	2320	309	475	233	147	45	30	8	2352	852	1989	209
1980/81	6956	2068	2598	491	437	218	144	44	25	12	2129	707	2011	221
1981/82 (Proj.)	9389	3356	2618	573	370	182	-	-	-	-	2376	1110	1671	371

Area: '000 fed. Production: '000 t.

Source: Division of Statistics, Ministry of Agriculture, Khartoum

Table 3. Supply and utilization of sorghum in Sudan

Item	80/81 Actual	81/82	82/83	83/84	84/85
Area (fed.x1000)	6837	6800	6850	7150	7500
Production	2223	2125	2232	2361	2475
Carry over stocks(tx1000)	250	200	200	200	200
Total supply (tx1000)	2473	2325	2432	2561	2675
Exports (tx1000)	250	250	300	350	350
Domestic utilization (tx1000)					
Total	2023	2075	2132	2211	2325
Feed	30	30	22	33	35
Seed	58	58	59	59	60
Waste	140	141	143	144	145
Gross food (tx1000)	1795	1846	1908	1975	2085
Population (million)	19.2	19.7	20.3	20.9	21.4
Kgs/caput	93.5	93.7	94.0	94.5	95.0
Extraction rate %	90	90	90	90	90
Net food (tx1000)	1615	1661	1717	1777	1876
Kg/caput	84.1	84.3	84.5	85.0	85.6
Cereals % of total	74.0	74.0	74.5	75.0	75.0

Source: FAO, Jan. 1982, Country Report.

Table 4. Supply and utilization of wheat in Sudan,1980-85.

Item	80/81 Actual	81/82 Proj.	82/83 Proj.	83/84 Proj.	84/85 Proj.
Area (fed.x1000)	436	485	530	586	586
Production(tx1000)	218	242	291	380	435
Imports (tx1000)	310	297	273	208	173
Total supply (tx1000)	528	539	564	588	608
Domestic utilization(tx1000)					
Seed	30	33	36	39	39
Waste	24	26	29	31	34
Gross food (tx1000)	474	480	499	518	535
Population (million)	19.2	19.7	20.3	20.9	21.4
Kg/caput	24.3	24.4	24.6	24.8	25.0
Extraction rate %	85	85	85	85	85
Net food (tx1000)	371	408	424	440	454
Kg/caput	20.6	20.7	20.9	21.1	21.2

Source: FAO, Jan. 1982, Country Report

Table 5. Identified projects for foodgrain development in Sudan.

Project	Capital investment US $ million	Incremental Production as a result of the project in year 2000 (tx1000)
(1) Wheat development in Gezira	163.6	298.2
(2) Modernization of traditional sector	860.0	950.0
(3) Modernization of mechanized sector	250.0	625.7
(4) Expansion of mechanized farms in Western Sudan	1770.0	816.0
(5) Rice development in Abu Kasaba	134.6	156.0
(6) Additional grain storage capacity	34.2	22.5
(7) Grain seed propagation	9.5	
(8) Strengthenning agric. res.	6.3	
Total	3228.2	2868.4

Source: Food Security for Arab Countries, Khartoum, 1980

Table 6. Cereals consumption trends in Sudan, 1976-81.

Cereals	Total consumption (tx1000)		Per caput consumption (kg/year)	
	1976/77	1980/81	1976/77	1980/81
Sorghum flour	1377	1615	81.2	84.1
Millet flour	342	411	20.9	21.4
Wheat flour	338	371	20.5	20.6
Maize flour	37	37	2.3	1.9
Milled rice	12	10	0.7	0.5

Source: Bureau of Statistics & Economic Review of Sudan, 1980.

Table 7. Proportion (%) of household expenditure on food and drink on various items for different income groups (khartoum Urban), 1978-80.

	Income groups (LS/ann)					All households (%)
	500 (%)	500 - (%)	1000 - (%)	2000 - (%)	3000+ (%)	
Cereals	7.7	7.9	6.1	4.8	4.8	6.1
Cereals products	12.6	11.6	11.9	11.8	10.8	11.7
Starches & roots	2.9	2.5	2.1	1.6	1.4	2.0
Pulses	2.7	3.0	3.6	3.2	2.2	3.1
Vegetables	15.8	15.3	14.8	12.4	12.4	14.2
Fruit	2.2	2.9	3.4	4.2	4.8	3.6
Meat	22.6	22.9	23.7	24.3	25.6	23.9
Fish	0.1	0.4	0.5	0.7	0.6	0.6
Dairy products	8.1	9.3	9.8	9.7	10.3	9.7
Eggs	0.0	0.2	0.4	0.8	1.0	0.5
Oils & fats	5.5	5.8	6.0	5.7	4.5	5.7
Sugar & sweets	10.2	10.2	8.7	10.4	9.4	9.4
Miscell. foods	1.7	1.6	1.6	1.4	1.4	1.6
Tea, coffee, etc.	7.1	4.1	3.9	3.4	3.6	3.9
Non-alcoh. drinks	0.0	0.3	0.4	0.6	0.6	0.4
Cigarettes &tobacco	0.5	1.5	2.4	4.2	5.7	2.9
Alcoholic drink	0.2	0.3	0.5	0.6	0.6	0.5
Groundnuts & seeds	0.1	0.2	0.2	0.2	0.1	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Household Income & Expenditure Survey 1978-80, Khartoum Province.

Table 8. Annual per caput expenditure (LS) on items of food and drink for different household income groups, Sudan, 1979/80.

Item	Household income group (LS/annum)					
	500	500-	1000 -	2000 -	300 -	Aver.
Cereals	7.1	8.5	8.1	7.3	7.5	8.0
Cereal products	11.6	12.6	15.8	17.9	17.0	15.2
Roots & starches	2.7	2.7	2.8	2.5	2.1	2.7
Pulses	2.4	3.2	4.8	4.8	3.4	4.1
Vegetables	14.6	16.6	19.6	18.8	19.3	18.5
Fruit	2.0	3.1	4.5	6.3	7.5	4.6
Meat	20.8	24.8	31.4	36.8	40.1	31.0
Fish	0.1	0.5	0.7	1.1	1.3	0.7
Dairy products	7.5	10.1	13.1	14.6	16.1	12.6
Eggs	0.0	0.2	0.5	1.3	1.5	0.6
Oils & fats	5.1	6.4	8.0	8.6	7.0	7.4
Sugar & sweets	9.4	10.9	11.6	15.7	14.7	12.3
Miscellaneous	1.6	1.8	2.2	2.2	2.2	2.1
Tea, coffee, etc.	6.6	4.5	5.2	5.2	5.7	5.1
Non-alcohol. drinks	0.0	0.3	0.5	0.8	1.0	0.5
Alcoholic drinks	0.2	0.3	0.6	0.8	1.0	0.6
Cigarettes & tobacco	0.4	1.6	3.2	6.3	8.9	3.8
Groundnuts & seeds	0.1	0.2	0.2	0.2	0.2	0.2
Total	92.2	108.3	132.8	151.2	156.5	130.0

Source: Household Income & Expenditure Survey 1979-80, Khartoum Province.

The Role of Rural Women in Food Production and Preservation

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Sudan, being a large country, has distinct regional differences in climate, soil patterns, and types of crops, animal production and food habits. Most food production and preservation is done by the rural population. Agriculture is the main occupation of 85% of the population of Sudan.

Women in rural areas work in agriculture, animal husbandry, handicrafts, and trade, in addition to looking after children and other family members.

The subject of this paper is the role of rural women in food production and preservation and it will be discussed in relation to their role in traditional and modernized sectors of food production and preservation. Measures for improving the existing situation are also considered.

Role of Women in Food Production

The Traditional Sector

For the purpose of this study, Sudan is divided into two main regions, the northern and southern regions. The northern region includes Western, Central, Eastern, and Northern Sudan. Generally, the role of women in traditional agriculture is similar throughout the region. However there is some variation according to regional and geographical features and food patterns.

Northern region

In Darfur a survey in rural areas indicated that planting, weeding, scaring away birds, and harvesting are all done by women. Occasionally

they are involved in the heavier labor of cutting down forest, and land preparation. The majority of crops are sold by the women, who also process food crops, such as dura, millet, sesame, groundnuts, and vegetables. They feed and water animals year-round, and fetch water firewood.

El Dawi (1980), studying labor migration in western Sudan, found that the absence of men among the Furs "does not interfere in agriculture production, for the husband and wife produce independently of each other and indeed operate as separate units"; thus among the Furs, women are as active as men in agricultural production. It is also reported that in western Sudan women play a significant role in land preparation, sowing, weeding, and harvesting, and women constitute 60% of the work force. El Hag (1980) reported that more than two-thirds of a woman's day in the Kordufan area was devoted to food production, twice the time devoted by men. They plant okra, sorghum, millet, groundnuts, tomatoes, chillies, and roselle (karkadesh). These crops receive most attention as they constitute the main family diet throughout the area. It is obvious that crop production is directed towards the family needs. Women's role in food production reaches its peak during the rainy season; however, during the summer, they are involved in gum collection where gum trees are planted.

In the traditional sector women lack knowledge of improved agricultural techniques, and this is reflected in the low productivity of their lands.

El Hag (1980) reported that 75% of the population in the west raise animals, especially goats, cows, sheep, and chickens, both for family consumption and for marketing. Cunnison (1963) noted that, among nomad women, the Humer women seemed to be "at it most of the day working in and about their tenants while men appear to be lazying.....underneath a pleasant tree." The main activity of nomad women is food production and preservation, including care of animals; milking, grinding grain, and fetching water and firewood. They winnow cereals by traditional methods, and make merisa (beer). Also, any cultivated land is cleaned, and planted, and crops harvested by the women. The demand for improved lifestyle has obliged women to take more than one job, and the women make and sell handcrafts to supplement the family income.

Migration of men and the educated youth to towns is a drain on the rural economy. The seasonal migration from the west to cotton-growing areas leaves the women to do the cultivation of food crops.

A sample survey conducted in 1967/68 in the area covered by Rahad Irrigation Project showed that 46% of males of 18 years and over migrated from their area to Gezira and Managil Schemes, while only 13% of the women in the same age group migrated.

In a study in 1966 in the village of Um Balla lying on the banks of Wadi Azum, 25% of the family heads were found to be away.

Southern region

The role of women is similar throughout the southern region, except in pastoral communities where care of cattle is of greater importance. The people of southern Sudan are mainly dependent on agriculture.

Surveys done around Juba, Malakal, and Wau revealed that women generally work in the field for five hours daily, four to six days each week, and may work seven or eight hours during planting and weeding seasons. They plant seeds and cuttings, hoe, weed, drive away birds, and harvest, transport, thresh, and winnow the crops. In Wau area, women sometimes cut down forests, clear bush and scrub, turn the soil, and furrow and mound the earth.

Women in all three areas studied were found to be responsible for fetching water and firewood. They are, however, not expected to look after the animals, although they make and sell milk products such as butter and ghee. They also help to sell both cash and food crops. Although it is the women who sell animal products and crops, there were indications that it is the men who get the proceeds from the sale, except in the Malakal area. Along big rivers, men usually do the fishing while women clean and dry the fish.

A study by Bloss confirmed these observations. He found that among the Nilotics, the wife processes and cooks the food and prepares the beer. In addition, they do the lighter work of cultivation, help with building and thatching of the hut, look after the grain store, and fetch water and firewood. While the Nuer women are responsible for milking the cattle, Dinka and Shilluk women are not allowed to do this. The small Dinka rounded hay huts are made by women.

Among the Zandes of south-western Sudan, Culwick (1950) found that certain crops, e.g. sweet potatoes and yams, are regarded as women's crops, and the men play no part in their cultivation. Tasks such as weeding and harvesting groundnuts are only done by women. Generally, men

do the heavier jobs of cleaning the land, while women do the bulk of the weeding and harvesting; other tasks may be shared. Each woman has her own field, from which the produce is her own; the beer she makes from her grain belongs to her and is sold by her. In large households, and sometimes in small ones, there are also plots belonging to the husband which his wives help him cultivate, but the produce of which is separately stored as his.

Food processing and preparation is hard work. The grain has to be threshed and winnowed, cleaned, and then ground. Grinding is done by hand. This is time consuming and hard work; it is estimated that women spend 2-5 hours daily preparing food, 30-60 minutes carrying water, 20 minutes fetching firewood, and 2 hours preparing flour and groundnuts.

Modernized Sector

In the irrigated schemes of northern Sudan, especially the Gezira, Managel, Rahad, Suki, and the Blue and White Nile schemes, there is a considerable difference in the pattern of women's activities. In these modernized agricultural areas tenants are conservative and are opposed to women's direct participation in food production. A study carried out in Kosti showed that only 3% of women were involved in agriculture, while at El Dueim the figure was 7% (Hassan 1981). A survey conducted in the Gezira Managel area revealed that only 10% of women were economically productive compared to 49% of men. However, in the peak seasons for labor the contribution of resident women was substantially greater. On the other hand immigrant women play a larger role in cotton picking (Hassan 1981). Of the economically productive females, 72% were engaged in food production, 9% in handicrafts, and 6% in animal husbandry.

Thus in the irrigated schemes of northern Sudan, women play a lesser role in food production than men. Nevertheless, their role in animal husbandry, child-care, and in the household is important.

In the mechanized schemes of Jibel Marra area, women do more work in food production and preservation than men. Women in agricultural areas near towns often take other jobs to supplement their income. In addition to their food production activities, they fetch water and firewood. Men play a greater role in marketing of agricultural products.

In the big mechanized schemes human labor is replaced by machines, and the number of people depending on agriculture is drastically reduced. Hassan (1981) stated that the increase in modern inputs leads to substitution of manual work by machine. Thus, with such a large

proportion of the population of Sudan being dependent upon agriculture for their living, effort should be put into improving and developing traditional methods of agriculture.

Rural or Traditional Food Technologies

Traditional food technologies have evolved over a long period and are adapted to the specific geographical, cultural, and social characteristics of given areas.

The influx of western-type foods, particularly bread and milk products, constitutes a threat to the continued existence of traditional foods, and is likely to erode the cultural identity of the people. The food pattern of Sudan is now changing rapidly and we believe that we now have to reconsider the application of new technologies to our food system and reevaluate traditional food technologies, which have been largely ignored.

Women in Sudan, especially in rural areas, produce food from local tree, crop, and animal resources at a cost in line with rural purchasing power. They under-take food processing in a flexible way between other domestic tasks, according to the supply of inputs and consumer demand. This flexibility makes them more efficient than large-scale industry. However, the enormous economic and nutritional contribution made by rural women food processors is invisible in Sudan, since we know little of the socioeconomics of this small industry.

Methods of Food Preservation

Food preservation reduces food scarcities, increases overall food supply, and prevents food losses due to contamination.

Most of the traditional processing methods used in Sudan have remained unchanged for centuries and are becoming inadequate and unable to cope with modern needs. These technologies are usually simple, low cost, and highly dependent on natural and environmental conditions.

A wide range of food products are produced by rural women in Sudan; the most popular products are outlined below.

Cereal products

Cereals provide the basis of the Sudanese diet and this is reflected in the variety of traditional products prepared. Sorghum (dura) is the principle cereal eaten, while millet (dukhn) is the staple cereal of the rural population in western Sudan.

Cereal grains are traditionally stored in locally constructed silos for about one year without appreciable losses.

Traditionally, flour is usually prepared by hand; methods include the pestle and mortar, and the saddle stone.

Kisra (unleavend bread): Kisra is a fermented sorghum bread, made from whole sorghum flour. It is the staple food almost throughout the country. However, in towns, consumption of wheat bread is now higher than that of kisra.

Traditionally, the fermented dough is thinned by adding water to the consistency of a batter. This is then spread as a very thin layer on a hot iron plate. Baked kisra is then removed and stacked one on top of the other before serving with a vegetable and/or meat stew.

Nasha (thin porridge): Nasha is made from fermented sorghum dough. The dough is mixed with water to a thin consistency. Then it is cooked, and sugar and milk added (to improve the taste) before serving. Usually it is served to sick people, young children, and lactating mothers.

Aseda (stiff porridge): Aseda is a popular food in Sudan, particularly in the south and west. It is made from a fermented dough, which is cooked in boiling water until a thick porridge is produced. Aseda is also made from maize and millet flours, especially in the south.

Merisa: This is a beer brewed locally from sorghum flour. Sorghum grain is used for brewing throughout Sudan, but particularly in the south.

Merisa is served as an alcoholic drink, unclarified and containing yeast, grain, etc., which makes it an important food, contributing nutritionaly to the people's diet.

Hilu-mur (sweet and stringent): Hilu-mur is a nonalcoholic beverage served during Ramadan (fasting month). A mixture containing sorghum flour (wholemeal), malted sorghum flour, spices, and water is fermented and the baked into thin flakes. To prepare the drink, the flakes are crumbled and soaked in water before straining. Sugar is added to taste, and it is served cool.

Abrey Abyed: Abrey is a beverage made white sorghum flour. The dough is left to ferment in an earthenware container for about five days. The fermented batter, with spices, is baked into very thin white flakes, which are crumbled into cold water and sugar added before serving.

Pulse crops products

Pulse crops are an important source of dietary protein in Sudan, and are mainly produced in North Sudan. The most popular are faba beans (ful masri), haricot beans (fasoulia), pigeonpeas (ads sudani), and chickpea (hummous).

Traditionally these crops are sun-dried to increase their shelf-life.

Tamea: This is a popular traditional food, made from ful masri, or hummous. Soaked grains are washed, minced into a fine paste using a manually operated meat mincer, and onions, garlic, parsley, and spices mixed in. The paste is rolled into small balls and deep-fried in very hot vegetable oil. Tamea is served as a breakfast or supper dish.

Oil seeds products

Fats in most Sudaneese diets are all of vegetable origin. The most important oil-seed crops are sesame, groundnuts, and cottonseed.

Tahina: Tahina is made from sesame seeds. Cleaned seeds are roasted, then ground to a fine slurry. Tahina is used as a dressing for salads.

Peanut past (ful sudani): Dehulled nuts are roasted and then deskinned. The deskinned nuts are pounded into paste and normally packed in small polyethylene bags prior to being sold on the local markets.

Aflatoxin contamination (due to poor post-harvest technology) of groundnut meal has been found in Sudan. Efforts are being made to ensure

that groundnuts entering the world market are aflatoxin free.

With traditional groundnut products, it is almost impossible to monitor aflatoxin levels and the producer (including rural women) may be unaware of the health implications of incorrectly cured or stored groundnuts. Therefore, any development of this traditional sector should include developing techniques to ensure adequate drying and storage of groundnuts.

Dairy products

In towns, fresh milk is available in limited quantities either pasteurized and packaged from dairies or from street vendors poured directly into the customer's own container.

Milk is used to make many traditional products such as butter, fat, cheese, and fermented milk.

Gebna (white cheese): Full-cream milk is heated on a wood fire, and a starter (Rennet) and salt are added and mixed. The gebna is cooled while covered with a muslin cloth. The separated whey is boiled, cooled, and put together with gebna moulds in tins, (ratio 1:4). The tins are sealed and stored.

Roob (fermented milk): Skimmed milk is used for making roob. After heating and cooling it, the starter is added and the mixture is left to ferment at ambient temperature before serving.

The roob is used with cucumber, tomatoes, and spices in making salads, for cooked dishes, and as a drink.

Meat and fish products

Meats available in Sudan include beef, mutton, lamb, camel, poultry, goat, and fish. Lamb is prefered and is traditionally served at social and religious festivals. In Sudan, fish is of lesser importance than meat in the diet. Most fish is eaten fresh.

Sharmout: This is dried meat, usually beef. Fat is removed from the meat, which is then washed and cut into strips about 30 cm long and 2.5 cm wide. These strips may be salted, and are hung on hooks for several days to dry.

The dried sharmout is then stored in tins.

It is used in making mulah sharmout, one of Sudan's national dishes. Traditionally, this is a mixture of dried meat, dried okra (both pounded), onions, spices, and water, and is usually served with kisra and aseda.

Sharmout is not generally on sale and is prepared in the home from surplus meat.

Fasiekh: Fasiekh (cured fish), a product common to the northern provinces, is prepared from poor quality fish. Fresh fish is split, gutted, and salt added. It is then sealed in earthenware jars, or more commonly tin cans, and left for about 15 days to cure.

Fasiekh is usually cooked with onions, tomato paste, and spices before serving.

Dried and salted fish: These are more usually eaten in the south of Sudan or by migrant labor forces in the north. Very little smoked fish is consumed in Sudan.

Fruits and vegetable products

The climate in many parts of Sudan is favorable for production of sun-dried fruits and vegetables, because, for most of the year, temperature is high (30-40°C) and humidity is low, with long hours of sunshine.

For sun-drying, the fruit or vegetable is washed, cut into strips or slices, and spread on the ground or mats. The fruit or vegetable is then left to dry in the sun for at least two days. This process is carried out both at home and on a larger sacle.

A wide range of sun-dried vegetables are available in the local market such as okra, tomato slices (salsa), onions, jew's mallow (molochea), limes, and dates. Dried whole limes are not consumed locally but are exported to the Gulf countries, where they are used as flavoring.

Spices and herbs

The principal spices preserved by sun-drying are whole chillies, corriander, cardmom, and cumin. These are available, ground, in the local market, and are also exported.

Karkadeh (Hibiscus sabdariffa): This is a herb of considerable importance in the internal and external trade of Sudan. Sudan is the principal producer of karkadeh, which is exported to western Europe (especially West Germany).

Normally, the raw calyces are cleaned, spread on the ground or mats, and sun-dried.

The infusion of sun-dried calyces is served with ice as a cold drink. Alternatively, a tea can be made from a hot infusion of the herb which has a traditional use as a medicine for coughs and colds.

Problems and Prospects for Improvement

Imported modern food technologies are energy consuming, and waste excessive amounts of materials and create pollution problems. They also create the following problems in Sudan:

- Heavy dependence on imported food and foodstuffs.

- Under utilization of indigenous food materials.

- Incorrect nutrition concepts. This has influenced the national food policy and led to unnecessary expenditure on expensive western-style foods. It also encourages the abandonment of traditional food technologies, and indiscriminately promotes the use of new technologies.

- Rural-urban migration of males searching for work has not only an economical implication but also affects the social structure of rural people.

Traditional technologies are of low productivity and are both time consuming and labor-intensive. Sun-dried products, for example, are often contaminated by dust, insects, and animals. The long drying time and atmospheric conditions also favor deterioration by microorganisms and enzyme activity. Cereals and pulse grain are liable be infested with insects and rodents due to the lack of proper storage conditions.

The methods employed in the production of these traditional foods are old, not standarized, time consuming, and unable to cope with modern needs. Although they are usually simple and cheap, they depend mostly on natural environmental conditions.

There have been conscious and encouraging efforts to improve indigenous technology, principally in the area of food science and technology. The Food Research Centre spearheaded research and development on improvement of traditional technologies. Its successes to date include:

1. Improvement of flour color and fineness by introduction of a decortication process for sorghum grain.

2. Development of several acceptable sorghum breads and pastries. The technology of sun-drying and product quality of most Sudanese fruits and vegetables have been considerably improved. Also, some new products have been introduced (dried mince meat, dried mulah, and dried soups).

3. Development of a forced-convection solar-drier as an alternative to large-scale mechanized dryers.

4. Formulation of a standard peanut-butter recipe.

In spite of these efforts, there is still a lot to be done to promote traditional foods and beverages. There is an urgent need to upgrade the preparation, quality, presentation, and shelf-life of traditional foods to compete on equal footing with imported foods.

Research Needs and Areas of Future Research

The scope of the traditional food sector and its product coverage needs to be defined. Generally, research and development can be conducted either to up-grade the local technologies or to design and fabricate a commercial plant, as was demonstrated in Japan.

The main research aims are to:

- evaluate the importance of traditional foods in respect to the cultural and socioeconomic environment.

- optimize processing conditions in order to attain the maximum nutrient retention, shelf-life, and hygene of the traditional food.

- elucidate changes in chemical composition, microbial growth, and their effect on the quality.

- assess technology development (technically and economically).

Benefits of Technological Improvement to Rural Women and to the Community

As indicated, rural women are overworked, whether they provide unpaid labor or work for a wage. Hence, improvement of traditional methods of processing will:

- save time and effort for rural women,

- stimulate the production of local food crops,

- increase self-reliance and encourage import substitution,

- provide palatable and convenient foods which improve the quality of life in the rural areas, and

- provide employment for income generation, which, coupled with the above benefits, will slow rural-urban migration.

The Role of Supporting Educational Institutes

Home Science Department, Faculty of Education, University of Khartoum

The activities of this department in the field of traditional technology include:

1. Planning base line surveys to study the life patterns and identify needs and problems of rural women.

2. Training of rural staff in food production, preparation, methods of processing and preservation, and nutrition.

3. Arrangement of human and natural resources. The role of the home economist in understanding and solving the local educational and nutritional problems is emphasized.

4. Child care and development programs in relation to food intake, growth, and health care.

5. Help in the integration of nutritional aspects and family planning.

6. Encouragement of rural women to explore and adopt new methods for improving food habits and the nutritional status of the community.

7. Adaptation of educational programs and syllabi of Home Science towards the solution of rural problems. Students should be trained to play leadership roles in solving those problems.

School Gardening and Nutrition Education Department, Ministry of Education.

The main activities of the Department include:

1. Periodical home visits to get acquainted with the rural population.

2. Training programs in nutrition, food preservation, and health care.

3. Promotion of income generating activities including cottage industry, handicrafts, and poultry raising.

Recommendations

1. Modernization of traditional agriculture through improving agricultural services, i.e., supply of seed, fertilizers, insect and disease control programs, and machinery to increase land productivity.

2. Establishment of modern agricultural schemes and cooperatives in rural areas.

3. Research to evaluate women's activities regarding production of both food and cash crops, and fuel supply, marketing, and transportation, and women's participation in planning and decision making at the village level.

4. Development of modern rural technology, cottage industry, kindergardens, and nurseries to help reduce the heavy workload of rural women.

5. Encouragement of applied nutritition programs and establishment of voluntary groups to teach basic nutrition principles and improving the traditional methods of food preservation and storage.

6. Training programs in the fields of nutrition and health to help rural families to improve the quality of life.

7. There is an urgent need for a central government policy to encourage the improvement and establishment of rural food industries. In this respect we also recommend the creation of a national specialized body

in the field of rural food industries.

8. Extension and dissemination of knowledge and experience gained by the Food Research Centre.

9. A clear decision on the technologies that have to be imported and those that need to be developed is urgently needed.

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SECTION III

Review of Nutritional Problems and Activities in the Sudan

Nutrition Problems in Sudan with Particular Reference to Vulnerable Groups

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Nutrition plays a critical role in human development, especially in the early period of life. It is used in many developing countries as an indicator of development.

Malnutrition is a multifactorial process; thus its correction and prevention can only brought about by multidisciplinary approaches that involve cooperation between those working on agriculture, health, education, social welfare, food technology, transport, legislation, and others.

In view of their complex nature, nutrition programs should be planned as integral components of the national socioeconomic development plan, utilizing approaches that suit the particular local conditions, available resources, and facilities.

Sudan is the largest country in Africa (one million square miles) with a population of about 22 millions. It has a range of climatic conditions, from equatorial to desert-type climate. The population consists of different ethnic groups with characteristic cultures and habits. The staple diets differ from region to region, i.e. in the central part of the country sorghum and wheat are the staple diets, while in the south it is cassava, finger millet, and corn, and in the west it is bulrush millet and sorghum. Legumes are grown mainly in the northern part of the country (annual production 1.628 million t). Rice (annual production 7000 t) and maize (45,000 t) are produced on a small scale. Groundnuts (annual production 0.7 million t) and sesame (0.2 million t) are produced and used for local oil consumption, while the cake is mainly exported (FAO Yearbook 1980).

Sudan is one of the richest countries in Africa in terms of livestock. According to FAO yearbook (1980) there were 18,354,000 cattle, 17,809,000 sheep, 12,570,000 goats, 2,500,000 camels, and 27,000,000 chickens. The per caput protein and caloric availability was:

	Vegetable products	Animal products (excluding fish)
Cal/caput/day	2056	283
Protein (g)	50	18.2
Fat (g)	47.1	18.9

Due to low population density (7.7 people/km^2) the per caput food availability seems to be quite comfortable; however, per caput food might be quite misleading, since with inequitable distribution of food, poorer people are always badly affected. Other factors contributing to inequitable distribution are a poor transportation system, lack of storage facilities in places where food shortage is a problem in certain seasons, i.e. west and south western parts of the country, and lack of developed food technology.

Actual food consumption data from representative parts of the country is not currently available, but preliminary results of studies carried out in Khartoum, Darfur, Cezira, and the sourthern region (Nutrition Division; Osman et al. 1977; Osman and El Amin 1977; Osman and Wisley 'in press'; Osman and Abdul Fatah 1981; Ogilvy 1981) show that actual protein and energy intake is quite satisfactory, while some deficiency was noted in some micronutrient intakes (Vitamin A, riboflavin, iodine).

From these dietary surveys, and from health service records, it is clear that adult Sudanese have satisfactory nutritional status, but that the prevalence of malnutrition among vulnerable groups, i.e. young children, pregnant and lactating mothers, is quite high.

Protein Energy Malnutrition Among Children

PEM is one of the major public health problems among preschool children in Sudan, affecting 40-60% of them (Abdel Rahman and Osman, unpublished data; Smith 1954; Yousef 1967; Sukkar el al. 1979; Osman el al. in press').

As previously stated, dietary surveys showed that a large proporation of the households surveyed have adequate protein and calory sources to meet their daily requirements if the right amount is consumed, and that

all of the rural populations rear domestic animals, e.g. goats, sheep, cows, chickens. In spite of these findings, 50-60% of preschool and school children are suffering from PEM.

A survey in Khartoum province among 4948 preschool children who attend MCH Centers for immunization, showed that a large percentage were of low weight for age (Table 1, Fig. 1).

A simulataneous survey was run among 747, 2-7-year old children who attend 22 kindergartens in Khartoum province. These children belong to the middle and high income strata of the population. This survey revealed that 39.8% of the female children were suffering from first degree malnutrition, while 7.7% suffered from 2nd degree malnutrition. Some 32.9% of the male children suffered from first degree, while 25.4% suffered from 2nd degree malnutrition (Figs 2 and 3). It was thought that this high prevalence of PEM among this group of children might be due to the use of a western norm and low readings against this curve could be attributed to ethnic differences.

To verify this, data on children from Dar El Hanan Kindergarten, which is attended by children from high income families, were plotted separately (Fig. 4). Their growth pattern follows the 50th per centile of the Boston standard, and compares favorably with it. This fact indicates that, at least up to preschool age, the Boston standard could be used as a reference norm. Thus, these findings support the earlier statement, that there is a high prevalence (40-60%) of malnutrition among preschool children. This is characteristic of the findings of all the small-scale surveys carried out in different parts of the country (Osman and Wisley 'in press';Sukkar el al. 1971;Sukkar el al 1979; Taha 1977). This survey also showed that the growth (weight) of these children up to 6 months of age is comparable to the Boston standard, while after that it drops dramatically (Fig. 1).

Breast milk is the best diet for the child up to six months of age. It supplies almost all the essential nutrients in a balanced form and is clean and always available if the mother takes care of herself and continues to breast feed the child. After six months of age the mother's milk will not be enough to meet the daily recommended dietary allowance of the child. The child is growing fast and his need for protein is five times that of an adult when expressed per kg of body weight. Thus, any factor that affects protein and energy intake will be reflected in the child's growth.

As has been discussed earlier, most of the households surveyed own domestic animals, and consequently, milk and eggs are available. Thus PEM is not caused by food shortage but mainly by the ignorance of mothers about infant feeding, by food taboos, and poor sanitary conditions. Gastroenteritis, communicable diseases, and parasitic infestations are among the most important contributory factors that lead to the high prevalence of PEM.

Most of the mothers interviewed start supplementary feeding after 6 months of age and those of them who offer any supplementary foods do so under unhygienic conditions. One of the major health problems of children examied at the health centers is gastroenteritis. Once the child develops diarrhea or vomiting the mother will switch him to strachy foods, i.e., mashed potatoes, custard pudding (pure flavored corn strach), rice water, lemon and sugar. The mothers call these light meals (almost protein free) and believe that these are good for the child during gastroenteritis attacks. It was shown that most of the children suffering from PEM in the central irrigated area of Gezira are infested with parasites (e.g., Giardia, hookworms). Malaria and schistosomiasis are highly prevalent among these children.

Episodes of infection, even when mild, have an adverse impact on nutritional status through reduced nutrient intake, due to anorexia, withdrawal of solid foods, less intestinal absorption, metabolic losses in urine, and internal diversion of nutrients as part of immune response (Sah and Scrimshaw 1983). Taboos and infant feeding habits also play a major role in PEM prevalence in certain parts of the country. Some mothers do not feed children eggs, believing that it would retard the child's speech.

Most mothers abruptly stop breast-feeding their children if they discover that they are pregnant. They believe that their milk will disable the child and he will not be able to walk. Among the Dinka, Neur, and Shilluk tribes of southern Sudan, children are beast-fed on demand until the age of 2-3 years, and are given cows milk from 9 months, and sorghum porridge from one year (Ogilvy 1981).

In Kordofan the women do the daily farm work while men stay at home. Children who are left at home are not given any supplementary foods during the first year of life so as not to deficate on the father.

Thus it is concluded from these studies that the major causes of high prevalence of PEM among children are ignorance about child feeding, taboos, food habits, infection, and parasitic infestation.

Dietary Practices and Aversion during Pregnancy and Lactation

Osman (1982) investigated dietary practices and aversion during pregnancy and lactation in Khartoum Province.

Three hundred and eight pregnant women who attended MCH centers in three towns (Khartoum, Khartoum North, and Omdurman), and 108 mothers who had just delivered were interviewed. The women were selected randomly. The information was gathered from responses to a questionnaire which covered demographic data, educational standard, locality, and the husband's monthly income. Also they were asked about the number of pregnancies, abortions, stillbirths, and living children.

Specific questions were asked about dietary beliefs, taboos, and practices during craving periods, and food aversion during pregnancy. Questions related to change in food habits during postpartum and lactation and the reasons for these changes. Also, the origin of these beliefs and information was asked. A 24-hour dietary recall was carried out and the daily intake of only protein and calories was calculated using food composition tables (Splatt 1962).

Of the mothers interviewed, 25% were aged 15-19 years, 48.8% 20-24 years, 19.5% 25-29 years, 9.9% 30-34 years, and 6.6% 35-40 years.

The women lived in suburban areas and illiteracy among them was high (45.8%); 67.5% of the husbands were laborers with a low monthly income ranging between 30 and 70 LS (Sudanese Pound: 1= 2 US Dollars).

Daily dietary intake: the dietary survey that the mean daily protein intake among the pregnant women was 40 g, while calorie intake was 1800. These values are lower than FAO/WHO recommended daily intakes (protein, 60 g, calories, 2550).

During postpartum the mean daily protein intake was 70 g and calorie intake ranged between 2700 and 3000. The interview revealed that women in the neighborhood and relatives had given highly nutritious meals (consisting of chicken, milk, dates, madida, pigeons, barbecued lamb meat) to mothers during the postpartum period. Those who did not take food to mothers gave money, irrespective of the mother's income level or social rank. They gave this money "for milk" (meaning that she purchased food that would produce more milk). This is a tradition practiced almost all over the country.

Food Craving and Aversions During Pregnancy

Ninety-three percent of the women interviewed craved for one food item or another. Of these, 20% believed that food cravings in pregnency, if not fulfilled, would be directly imprinted on the child. Birth marks and congenital malformation are attributed to food cravings; 71.7% craved for hot, spicy foods; 36.1% for starchy, low animal-protein diets; 32.4% craved for dairy items; 13.6% craved for clay and non-food items; and 13.9% craved for vegetables and fruits.

Of the women interviewed, 57.4% expressed food aversion for meat, fish, and poultry; 13.2% for sour and salty foods; 9.9% believed that strong, spicy foods would affect the child. The reasons cited for food aversions were that these caused heartburn, colic, nausea, vomiting, and diarrhea. Some mentioned that some of these foods had an unpleasant smell.

Diet During Postpartum Period

Dietary practices during the postpartum period are based on beliefs that some foods cause stomach trouble and colic, especially during the first few days after delivery. These include bread and kisra (national pancake prepared from fermented sorghum flour). Consequently, these are avoided.

Other beliefs are that some foods are warm and will "soothe the stomach and will keep on the flow of dirt" and will compensate for loss during delivery. These items include warm pigeon and chicken soup. Also it was found that 79.3% of the women interviewed took hot, strong, black coffee with no sugar immediatly after delivery; 32.1% believed that it would keep up the flow of "unclean" blood and that it would clean the uterus; 47.2% of those who took hot coffee stated that it was a habit and they did not know the reason for taking it.

Of those interviewed, 92.6% believed that food should be changed during the postpartum period (confinement) to compensate for loss during delivery and for the production of more milk. This period lasts for 40 days in which the mother should not do any household work and a special diet consisting of high-protein, high-energy food is given to her. This consists of chicken, pigeon, lamb meat, nasha (a thin porridge made of fenugreek, milk, ghee, sugar, and sometimes "gardiga" ($CaCHO_3$ dug from the soil). Another sort of nasha is offered which consists of decorticated sorghum flour plus sugar. Some of the women interviewed consumed dates Madida (dates plus ghee). Sometimes Hargal (herb with a very strong smell) is boiled, sugar added, and served as a drink. They believe that it would expel gasses and "soothe the stomach."

It was a common belief among those intervewed that a woman should come out of the postpartum period fatter. It is a social prestige for her mother or the close relative who was nursing her, meaning that she had been well looked after.

Diet During Lactation

Those who believed that diet should be changed during lactation (44.4%) said that they shared the usual family diet plus extra rations of fenugreek nasha, milk, and tahina (sweet from sesame plus sugar). Some said that after they shared the family diet they prepared mause (pap from kisra plus sugar) and drink it. All these are high-protein, high-calorie food items. Interviewees believed stated that consumption of these food items would increase the volume of milk produced.

The women interviewed that these beliefs came from their mothers (58.3%), friends and others (20.3%), personal experience (13.8%), and from midwives (7.6%).

Discussion

The normal physiological processes of the body are altered during pregnancy and lactation, and additional demands are imposed on the mother during this period. It is well established that the state of maternal nutrition influences the nutrition and, consequently, the growth and development of the child. Severe reduction of protein and calorie intake will lead to a lower than average weight and length of the newborn child.

The results of this study showed that sound information on importance of well-balanced diets during pregnancy was lacking, as 64.8% of those interviewed said that no special attention had been given to their diet during pregnancy. This situation is aggravated by craving and food aversion during the early stage of pregnancy, and by vomiting during the first trimester. The first trimester is the most important period of pregnancy as far as miscarriages and congential malformations are concerned (Smithal el al. 1977). Dietary pattern and protein intake in pregnancy was studied in Central America and Panama by Arroyave (1975). He found that the rates of nonessential to essential amino acids were higher in plasma of mothers and newborn children in families of low socioeconomic status than in those of high socioeconomic status. Also, he found that the level of retinol was lower in the mother's blood and in the cord blood of the former group than the latter. This shows that the newborn infants of malnourished mothers reflect in some respect the biochemical abnormalities of the mothers, and that the nutritional status of the mother affects the fetus' growth and, consequently, the birth

weight. Also it was shown that human fetal malnutrition may be associated with a decreased number of brain cells (Winick and Rosso 1969).

Animals are widely used to investigate the effect of nutrient deficiencies since experiments with humans are out of the question. The offspring of rats deprived of protein during pregnancy show diminished hyperplasia in all tissues examined. Furthermore, the impaired rates of cellular growth persist even when good nutrition is instituted at birth by fostering the pups on to well-nourished mothers (Naismith and Morgan 1976). The effects of malnutrition in utero in animals are therfore absolute and permanent. The influence of early malnutrition on the growth and development of the brain has attracted much attention recently. It was shown that malnutrition affected the celluar development of the brain (Winick 1970) and it was suggested that a critical period of brain growth may exist during which malnutrition, even for a short period, may produce irreversible retardation.

Naismith and Morgan (1976), in rat experiments, showed that protein supplementation in the early stages of pregnancy for a short period and then restriction to a lower level similar to a control group significantly increased the birth weight of fetuses by 44%. Also, a significant increase in brain size and DNA content was found, although no difference was found between the mean weight of the mothers fed the low protein diet and those that received the supplement.

Riopelle et al. (1975) fed different levels of proteins to pregnant monkeys. They found that those on restricted protein did well and delivered without any complications and that the non-pregnant monkeys, maintained on a similar restricted diet, suffered more than the pregnant ones. They did not study the effect on the offsprings. This effect was attributed to increased metabolic efficiency during pregnancy. ALso, Montgomery and Picus (1955) reported that a woman made metabolically inefficient by surgical loss of much of the small intestine gained weight and felt good when she was pregnant and delivered a healthy normal baby but she returned to a poor state of health after delivery, indicating increased metabolic efficiency during pregnancy.

However, fetal malnutrition might arise even though specific nutrient deficiencies in the mother are not detected. Harper et al. (1970) showed that imbalances among nutritients in experimental animals adversely affected post-natal growth, and Moghissi et al. (1975) and Bessman (1972) showed that amino acid imbalances during pregnancy were related to fetal growth and mental development. It was noticed that mothers of small babies gained less weight during mid-pregnancy and had a lower protein and calorie intake than mothers of average-size babies. Also, their plasma

levels of alanine, tyrosine, and lysine were higher than those of mothers of large babies, who showed a reduction in the levels of glutamic acid, proline, alanine, cysteine, valine, phenylalanine, lysine, and histidine. Metcoff (1980) concluded that birth weight is more related to nutrient pattern at mid-pregnancy than to excesses or deficiencies of specific nutrients. These studies demonstrate that if a pregnant animal is exposed to nutritional deficiency, she might look healthy but the effect of that deficiency on the offspring might be irreversible changes inbrain growth and development.

The increase in lysine, alanine, and tyrosine in the plasma of mothers of small babies resembles the picture that is found in a marasmic child (Osman 1982). This indicates that a caloric deficiency might be more related to low birth weight. The Guatemalan study of food supplementation for pregnant women indicates that the quantity of supplemental calories consumed is closely related to birth weight, and that energy shortage may be more deleterious to fetal growth than reduced availability of protein (Rosso 1981).

These conclusion may hold true if optimum amounts of protein are consumed. However, in regions where the amount of protein consumed is low and most of it is low biological value (a case which is found in communities of poor countries in Africa, Asia, and Latin America), protein deprivation definitely plays a major role and has a great effect on the development of the fetus. Increased amounts of protein, above that needed for fetal growth, are needed for protein synthesis of the expanded uterus, breasts, blood, and extracellular fluid, as well as for protein synthesis in the fetoplacental compartements (Pitkin et al. 1972). In this study, 25% of the women interviewed were in the age range of 15-19 years. Thus, the increased need for energy and protein during pregnancy imposes further physiological stress on teenagers whose average nutritional requirements are already greater than those of adults.

The nutritional knowledge and dietary practices of lactating women interviewed seemed to be quite satisfactory during postpartum and lactation as compared with those during pregnancy, although food intake might be limited by the low income of these families. Good practice is highprotein, high-caloric diet consumption during post-partum and lactation periods. If taken in the right amounts this will meet the recommended extra protein and calorie daily intake. Fenugreek nasha which is consumed by almost all those interviewed at one time or another during this period, beside its high protein content (28%), contains a lactogenic factor which increases the amount of milk produced (El Ridi and Shahat 1944).

In conclusion, it seems that there is a lack of nutritional knowledge and satisfactory dietary practices during pregnancy among Sudanese women of low socioeconomic status, while dietary knowledge and practices during postpartum and lactation are quite satisfactory. Special emphasis on diet during pregnancy should be incorporated in the health and nutrition education programs carried out at all MCH centers. Nutrition during pregnancy and lactation should be expanded as part of a general nutrition curriculum for health visitors, midwives, and other medical staff.

Consumption of high-energy and high-protein diets during post-partum and lactation periods should be promoted, especially that of Fenugreek nasha.

Deficiency Problems

Anaemia

Iron deficiency anaemia is highly prevalent among pregnant women (Modawi 1963) and children. In a survey (Abdel Rahman and Osman, unpublished data) in the El Kalakla group of villages it was found that about 13% of school children were anaemic. When they were given ferrous sulphate tablets their haemoglobin levels rose to normal.

An estimation of the haemoglobin level of children (0-5 years) attending Omdurman comprehansive child health center (Nutrition Division) showed that all those who are underweight had haemoglobin levels below 9 g/100 ml. Also, reports from different hospitals indicate that the prevalence of anaemia among the population is quite high.

Vitamin A Deficiency

Many of the dietary surveys carried out by the Nutrition Division demonstrate a low consumption of leafy vegetables, fruits, and milk. This suggests low vitamin A intke.

In a survey in Jonglei province (Southern Sudan) it was found that the diet supplied about 7% of vitamin A requirements. This was confirmed by the clinical findings; 25-34% of the children examined had xerosis.

In another clinical survey among children in Khartoum and Gezira provinces carried out by a WHO consultant (Henawi 1978), it was shown that the incidence of vitamin A deficiency is below 1.7%, and it was concluded that vitamin A deficiency is not a public health problem in these densely

populated provinces. No biochemical tests were done in these surveys to reveal subclinical deficiency.

Goitre

Surveys in different parts of the country showed varying degrees of incidence of goitre (Osman and Abdel Fatah 1981; Ghalioungi 1954; Kembal 1973).

All these investigators showed that endemic goitre is highly prevalent (50-85%) in Darfur province (Western Sudan), and attributed this to iodine deficiency. This is understandable due to the mountainous nature of the area.

However, Osman and Abdul Fatah (1981) showed that the incidence of goitre was higher among school children of remote villages than in those of small towns in the same area. The only dietary difference between the remote villages and small towns was in the consumption of millet; in the towns they eat wheat bread and sorghum besides millet, while in remote villages they eat only millet. It was postulated that millet might contain a goitrogenic factor; this was confirmed by animal feeding experiments. A group of rats fed millet developed large goitres; the mean weight of the thyroid gland was five times that of the control group, fed sorghum (Osman 1981). Also, it was found that the thyroxine and triodothyronine pattern is distorted. Both T4 and T3 in the plasma of millet fed rats were higher than in the control. This suggests that the goitrogen in millet is interfering with the conversion of T4 to T3, the latter being the active form of the thyroid hormone (Osman et al. 1983).

Recommendations

1. Nutrition considerations should be integral to national socioeconomic plans.

2. Nutrition education is one of the most important intervention programs, and should be given high priority, in conjuction with all health services, extension services, and nutrition centers ofthe Ministry of Education. The program running now should be evaluated, revised, and integrated in the services' delivery system to ensure its continuity.

3. More research is needed in the area of nutrition intervention programs.

4. More emphasis should be given to scientific planning of these programs, taking into consideration local conditions and available resources in the different regions of the country.

5. The nutrition activities in the different government units should be coordinated and should be complementary rather than competitive.

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Table 1. Weight for age of children from health centers in Khartoum Province.

Age (months)	Number	Weight (kg)	Standard weight "Harvard"	%
2	82	5.2	5.0	104
3	276	7.7	5.7	135
4	262	9.9	6.3	157
5	234	6.6	6.9	95
6	402	7.6	7.4	102
7	380	7.4	8.0	92
8	264	7.5	8.4	89
9	362	7.6	8.9	85
10	262	7.7	9.3	82
11	151	7.8	9.6	81.2
12	739	7.0	9.9	70
13	60	8.5	10.2	83
14	70	9.1	10.4	87
15	89	8.1	10.6	76
16	43	9.5	10.8	87
17	33	9.1	11.0	82
18	381	9.1	11.3	80
19	8	7.6	11.5	66
20	25	9.4	11.7	80
21	9	9.6	11.9	80
22	2	9.3	12.05	77
24	398	10.1	12.4	81
30	86	14.4	13.5	106
36	225	10.3	14.5	71
42	28	13.9	15.5	89
48	70	13.0	16.5	78
60	7	14.4	18.4	78

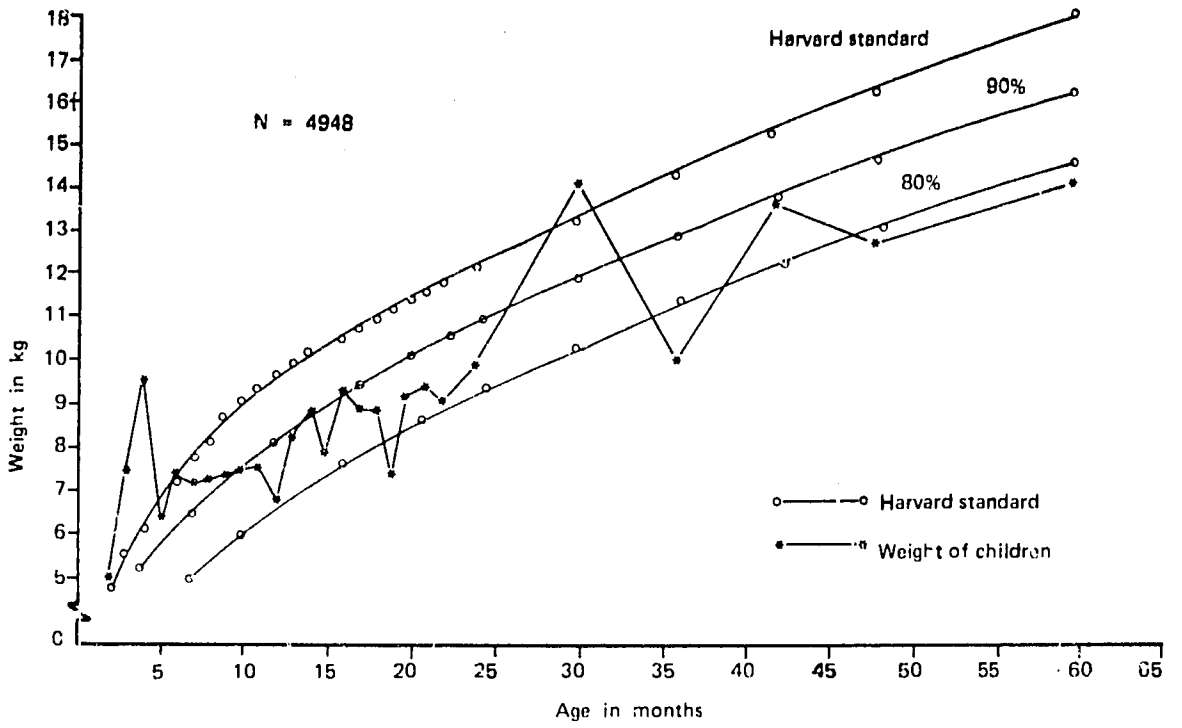

Fig. 1. Weight for age of children from health centers in Khartoum.

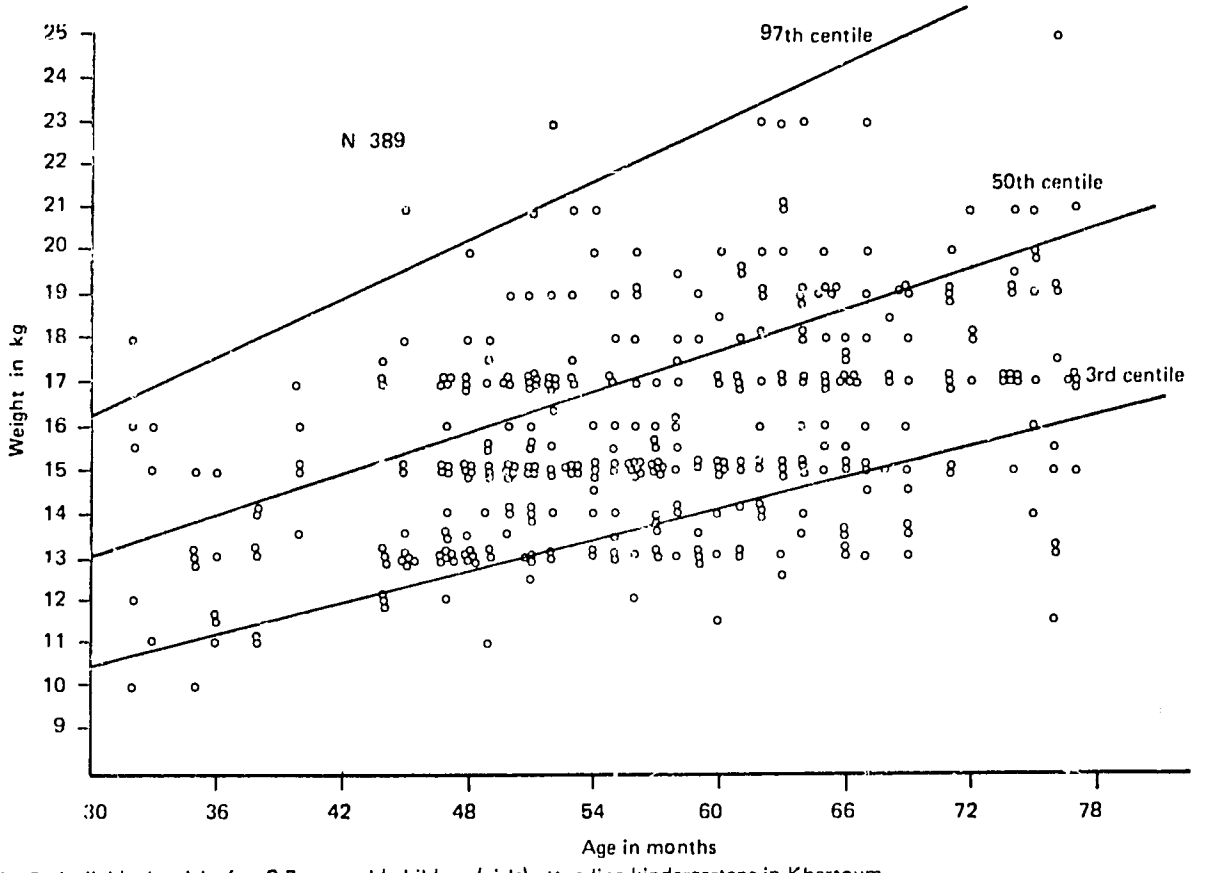

Fig. 2. Individual weight for 2-7 years old children (girls) attending kindergartens in Khartoum.

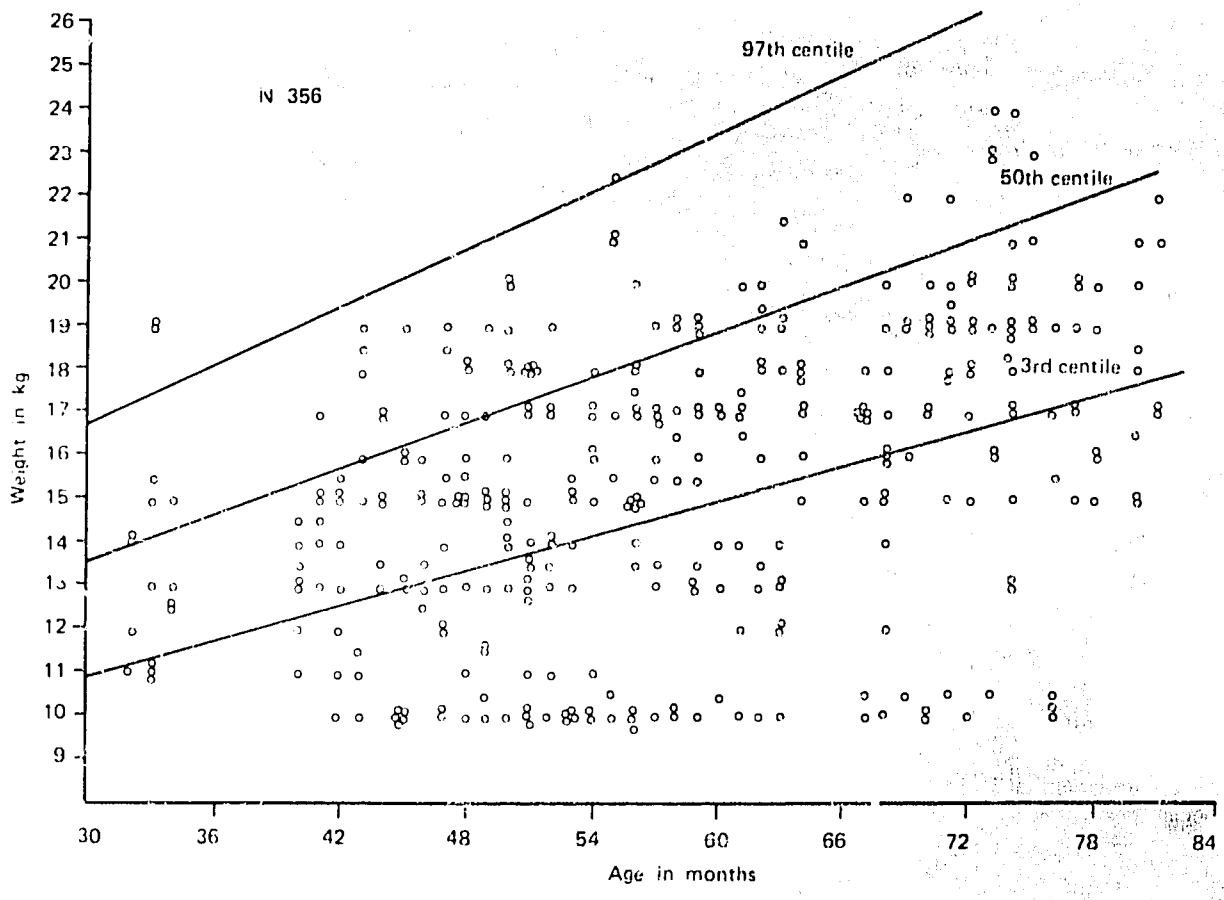

Fig. 3. Weight for age of children (males) attending kindergartens in Khartoum.

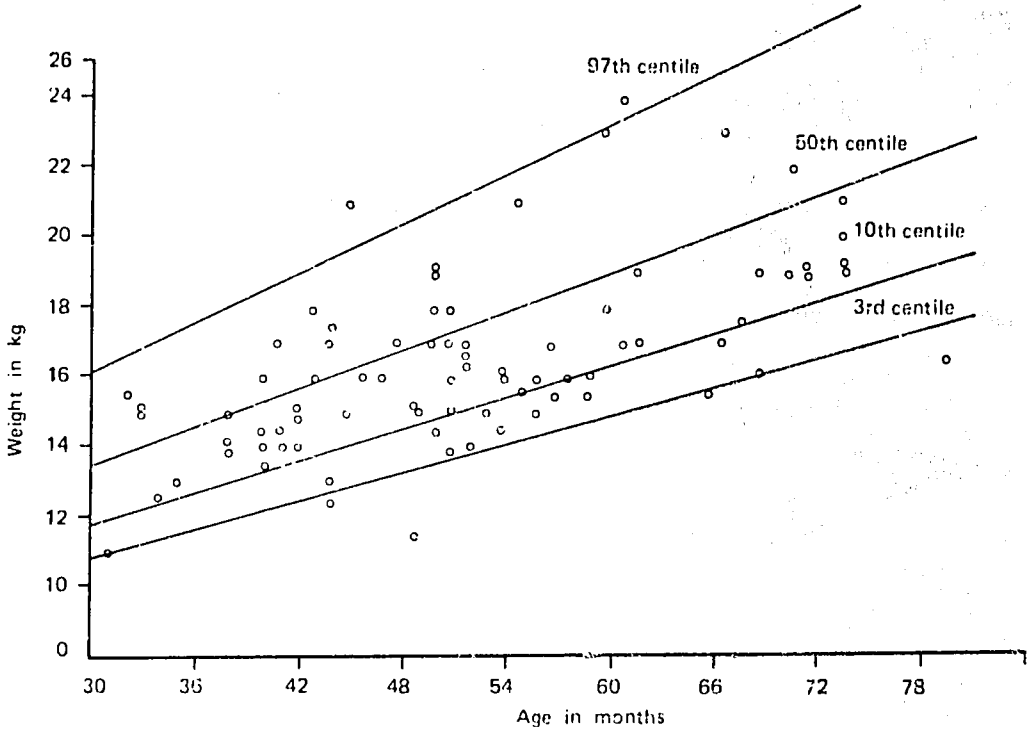

Fig. 4. Individual weight for 2-7 years old children of Dar el Hanan kindergarten.

Review of Nutrition Activities in Sudan

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This paper highlights the activities of the Nutrition Division of the Ministry of Health. Due to lack of coordination and poor exchange of information between the different ministries and institutes involved in nutrition activities in the Sudan, the authors could not cover the whole spectrum of the nutritional activities in the country.

We hope that the establishment of a National Food and Nutrition Council will lead to greater cooperation.

Nutrition Division: Objectives and Strategies

The Nutrition Division aims to provide both preventive and curative nutrition services in conjunction with the primary health care program.

The division plans to establish provincial nutrition units in all provinces to:

- conduct nutritional surveys;
- train health personnel in the field of nutrition;
- cooperate and coordinate with other Ministries and institutes whose activities are related to nutrition;
- work for the establishment of a national Food and Nutrition Council; and
- to increase nutrition awareness among the population.

Dietary Surveys

Khartoum Province

Idd Hussein village (1974): This village is 27 km south of Khartoum, with a population of 9700 people. It was found that only vitamin A consumption is below the recommended daily allowance, while other nutritients were between 108 and 423% sufficient in the diets.

Gezira Province

El Fugara village: The village is a farming community. Energy intake/person per day was found to be 2088 Kcal, while protein intake was 55.8 g/person per day.

Vitamin A intake was only 42% of the recommended daily allowance, while that of B_2 (riboflavin) was 61%.

Darfur Province

Dibbs village (1976): The village is 180 km north west of Nyala Town. Farming is the main occupation; almost all the food consumed is locally produced.

During the dry season, the diet is monotonous, consisting mainly of millet, the staple, and dry foods. After harvest, mainly fresh foods are consumed. The survey was conducted in the dry season; results are shown in Table 1.

Table 1. Daily food intake in Dibbs vilage.

Food groups	Amount (g)	Food energy (Kcal)	Total protein (g)	Calcium (mg)	Iron (mg)	Vit.A (IU)	Thiamine B_1 (mg)	Riboflavin B_2 (mg)	Niacin (mg)	Ascorbic acid (mg)
Cereal	408	1488	37.1	60	8.4		0.81	0.20	4.3	
Strachy root	2	1								
Legumes	3	17	0.7	1					0.5	
Vegetable	88	76	3.4	230	5.5	146	0.03	0.05	0.5	7
Fruit	53	29	0.4	15	0.4	1497	0.07	0.02	0.1	26
Sugar	55	220								
Meat	41	104	13.7	11	1.4		0.01	0.06	0.1	
Fish	1	3	1.0	30	1.0				0.1	
Milk & milk products	52	35	2.3	62	0.1	206	0.05	0.06	0.1	
Oils & fats	46	414								
Average daily intake		2307	58.6	409	16.8	1849	0.97	0.39	7.7	33
Average requirements		1975	57.0	519	13.1	3530	0.91	1.24	12.5	26
Percent of recommended allowance		121	103	79	128	53	1.7	31	64	127

Jonglie Province

Kongor District inhabited by Dinka: The staples are sorghum and maize. The animal foods available are milk and milk products, as well as meat, hunted game, fish, eggs, and chicken.

The intake of nutrients compared with the recommended allowance is shown in Table 2.

Table 2. Nutrient intake as % recommended daily allowance.

	Percentage
Food energy	70
Protein total	131
Calcium	66
Iron	194
Vitamin A	7
Thiamin	226
Riboflavin	37
Niacin	80
Ascorbic acid	10

Vitamin A Deficiency

El Sheikh (1960) reported the first study on occurrence of deficiency of vitamins in Gezira. Typical signs and symptoms of avitaminosis were found in 85% of the cases; the commonest deficiency was avitaminosis A (56%).

In a study of the Red Sea area in 1977, 3.97% of primary school children presented had Bitot spots and 4.18% had night blindness.

A survey was conducted in 1978 in both Khartoum and Gezira province with the help of a WHO consultant (Dr Hinnawi). The city of Khartoum provided the urban sample and 26 villages from the two provinces formed the rural sample. In total, 3740 persons were examined, 1948 boys and 1972 girls. Of these, 13.4% had xerosis of the conjunctiva and 1.9% had both xerosis and Bitot spots. No corneal lesions were detected. Thus, xeropthalmia does not appear to be an important problem in the two provinces. There are indications that hypovitaminosis A is fairly prevalent, but this needs to be confirmed by determinations of serum

vitamin A levels.

A study of the Jongile Development Project showed a high incidence of xerosis alone, and although the diet provides less than 10% of the recommended daily intake of vitamin A, this alone cannot explain the incidence of xerosis.

A survey in 1980 by Drs Abbas and Reddy in the Red Sea and Kassaka areas found dryness of conjunctiva in 32.8% of males and 37.3% of females, while Bitot spots with xerosis were found in 29.1% males and 14.2% of females.

The same study showed that the overall incidence of conjunctival xerosis in children (0-6 years) was 13.6%, while Bitot spot with xerosis was found in 3.5% of males and 1.7% of females, with an average incidence of 2.9%. Therefore, avitaminosis A is a problem of public health importance in the Red Sea and Kassala Provinces.

Massive oral doses (200,000 iu) were given to school children once every six months, since they are the most vulnerable group. Vitamin A capsules were distributed to all health centers, hospitals, and other health units in the area. Another means of reducing the incidence of vitamin A deficiency is though the program of diarrhea control (ORS).

The long-term measure adopted by the Nutrition Division to control vitamin A deficiency is through nutrition education aimed at increasing vitamin A consumption from locally available sources.

Endemic Goitre

This is a common problem throughout Sudan, as shown in Table 3. Prevention, rather than cure, is the best means of control of eudemic goitre.

Table 3. Incidence of endemic goitre in different regions of Sudan.

Reported by	Area	Incidence (%)
Woodman	Azande	3
Smith/Latif	Jebel Marra	20-70
Challoungi	Red Sea	24
	Upper Nile	24.6
	Halfayat El Muluk	35
Kanbal	Darfur	up to 80
	Khartoum	6.3
Munoz	Athara	20
	Red Sea	20

The Nutrition Division conducted a study of endemic goitre in Darfur and found overall incidence to be 57.5%. The incidence among females (66.4%) was higher than among males (53%), as was the incidence of large goitre (Table 4).

Table 4. Incidence and grade of endemic goitre in Darfur.

	Total no. examined	Total affected (%)	Grade I (%)	Grade II (%)	Grade III (%)	Grade IV (%)
Males	11,547	52.9	39.3	11.4	3	0.1
Females	5,923	60.4	38.4	20.1	7	0.9
Total	17,470	57.5	39	14.4	3.7	0.4

Another survey was conducted in Darfur among school children in three areas; Nyala, Tawila, Fasher, and Kas (Table 5).

Table 5. Incidence of endemic goitre among primary school children in three areas of Darfur.

		No.examined	Goitrous	%
Fasher:	boys	160	29	18
	girls	195	49	25
Tawila:	boys	134	47	35
	girls	216	119	55
Kas:	boys	197	92	46
	girls	185	188	75
Idd El Ghanam:	girls	152	45	35
Hyala:	boys	175	18	10
	girls	190	24	13
Total		1604	561	34.6

The highest incidence was in Kas (girls 75%, boys 46%), while the lowest incidence was in Hyala (girls 13%, boys 10%). Some 19% of goitrous children were of Grade I, 11% Grade II, and 4% Grade III; none had Grade IV.

Recently, with the cooperation of the Swedish Government, a survey was conducted in both north and south Darfur, the results of which are still under analysis.

Beside iodine deficiency, which is the main causative factor, a number of contradictory factors have been listed. These are:

- Hardening of water. A sample of water from the Kas areas showed a high content of iron, sodium, and potassium.
- Presence of goitrogenic substances in the staple food (millet), i.e., cyanogenic substances.
- Water pollution.
- Protein-Energy Malnutrition.
- Vitamine A deficiency.
- Brassica family trees.

In an effort to control the disease, the Government has been distributing potassium iodide tablets, iodized oil injections, and iodized tablets to those at risk.

Nutritional Anaemia

Research is needed to determine the prevalence of nutritional anaemia in Sudan. Although it is found throughout the country, it appears that nutritional anaemia is most prevalent in the eastern region, followed by the western and southern regions. No statistical data for anaemia alone is available. However, the number of people suffering from malnutrition, or anaemia, or both more than doubled in the period 1962-66 to 1974. This study showed that the highest incidence was in the Red Sea and Kassala Provinces, followed by Darfur and Bahr El Ghazal Provinces.

Although the problem is still not clear, the Nutrition Division has already adopted means of controlling nutritonal anaemia:

- Nutriton Education.
- Control of PEM.
- Control of endemic diseases.
- Distribution of iron and folic acid tablets to pregnant women.
- Encouragement of agricultural extension workers to educate farmers to grow more fruits and vegetables.

Protein Energy Malnutrition (PEM)

The major causes of malnutrition in the Sudan are:

1. Ignorance about breast feeding and weaning practices.
2. The deterioration of the socioeconomic situation.
3. Absence of proper health and nutrition education.
4. Incorrect food habits and traditions.
5. Infectious and endemic diseases.
6. Ignorance of the nutritional value of different foodstuffs and correct means of preparation and storage.
7. Absence of proper sanitation and environmental hygiene.
8. Absence of family planning.

The Size of Problem

According to the National Health Program and the National Health Plan 1977/78 - 1983/84, 50% of children 0-5-years old are suffering from

malnutrition; 40% first degree malutrition, 9% second degree malnutrition, and 1% third degree maluntrition.

Several surveys were conducted in different areas. In Wad Medani, 30% of the children suffered from malnutrition; at Atbara the percentage was 57.7%, while in El Kalakala it was 53.6%.

The percentage distribution of malnutrition found in Kassala was as follows:

1	year	46.7%
1- 2	years	62.9%
3- 6	years	81.6%
6- 9	years	85.2%
9-12	years	62.7%
12-15	years	69.8%

National Nutrition Program for Preschool Children (Nutrition Division - Catholic Relief Services

Under this program, preschool children up to the age of 5 years are weighed regularly and receive food aid - skimmed dried milk, oil, and burgal (cereal), while their mothers receive nutrition education.

The program started in 1976 at the MCH in Khartoum, and in Kassala, Halfa, and Port Sudan. A comprehensive study was conducted in Khartoum in 1979 in order to evaluate the program (Table 6).

Table 6. Degree of malnutrition (Gomez classification), 1976 compared with 1979.

Degree of Malnutrition	% of recommended daily allowance	No. of children 1976	% 1976	No. of children 1979	% 1979
Normal	90 +	1722	35	3856	25
First degree	89-75	2218	45.1	10,870	72
Second degree	74-60	972	19.8	491	3
Third degree	60	4	0.1		
Total		4916		15,321	

Oral Rehydration Salts (ORS)

An agreement was signed between the Ministry of Health and UNICEF, under which UNICEF will provide ORS for a certain period, after which the Sudan Government will produce these salts locally.

The program started in both urban and rural Khartoum. A workshop was conducted for all the health personnel involved in the project in the different areas. ORS packets were distributed and training booklets, pamphlets, and posters were produced.

The use of ORS was evaluated in urban Khartoum by El Mahdi (1982) who found that ORS solutions were used by 83.6% of sick children without objection. Also ORS was accepted by 85% of the mothers. The study found that 65.4% of diarrhea cases came from poor and very poor families.

Hospital Diets

The first dietetic unit was opened at El Bulk Hospital in 1974, and was only responsible for the malnutrition ward. Later, similar nutrition units were established at other hospitals. The units prepare food and give nutrition education to mothers. The patients are followed from admission until discharge through regular weighing.

The first proper dietetic unit was established at Jaj El Safi Hospital in 1982. The unit is wholly responsible for the diets of the

patients from receipt of food stuffs to consumption. Diet sheets are prepared according to the need of the individual case. This unit also serves as a training center of dietetics for students from the Faculty of Education, Ahfad University College, and elsewhere.

Training

The Nutrition Division conducts regular training in nutrition education. Two training courses are held yearly for the nutrition educators who have been appointed at the provincial nutrition units. These courses are financed by UNICEF.

The divison also gives lectures in nutrition at different institutes:

- Omdurman Islamic University.
- Ahfad University College.
- Nursing College.
- School of Health Visitors.
- Occupational Health Training Institute.
- School of Sanitary Overseers.

A pilot project started in Kadugli, south Kordufan Province, for training primary health care personnel and village midwives in the field of nutrition, so that they will be able to conduct nutrition activities at the village level.

Overview of the Nutrition Programs in the Democratic Republic of Sudan

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This paper outlines the various nutritional programs which are operating in Sudan, their history, their strengths and weaknesses, and their relations with each other. Before looking at these programs, however, it is necessary to consider the situation within which they work; thus the paper firstly provides an outline of the principal nutrition problems, and their causes, which the programs are designed to address.

Nutritional Problems in Sudan

The national average of food availability per caput is generally a poor indicator of the nutritional status of the population in a country. This is particularly true in the case of Sudan, since it is the largest country in Africa and includes areas with differing amounts of rainfall, diverse demographic patterns, and limited transport and communication facilities, which leaves some areas chronically or seasonally short of food supplies.

In Sudan most of the staple crops (sorghum, millet, and root crops) are produced in the rainfed traditional agricultural areas and consumed in and around the main centers of production. Thus, they do not enter commercial trading channels. Small farmers in these areas, as is the case of all subsistence areas, have their own food security/marketing system. However, localized and seasonal shortages of staples do occur because of uneven production, and lack of a means for identifying quickly and accuratley a shortage situation or means of correcting a supply situation. Generally speaking, lack of communication and transportation play a major role in the shortages. The fact that an annual surplus of 130,000 tonnes of sorghum has been officially recorded between 1975 and 1980 supports this view. (An annual surplus is supposed to match with the quantity exported according to the current government policy on exportation of sorghum).

In areas below the Sahelian Belt, stretching east from northern Darfure to the Red Sea Province, there is a chronic shortage of food, as desertification has caused major problems to agriculture and animal

production. The pastoral back-ground of many rural people and bad management of grazing land and animal husbandry, coupled with heavy reliance on trees and shrubs as the energy source, have aggravated the situation. Many people in these areas depend for their livelihood on collecting and selling firewood, on small-scale animal husbandry, and hiring themselves out in neighboring large agricultural schemes or in urban areas as manual laborers.

Poverty is a major factor influencing household expenditure on food, and hence human nutrition. A study carried out in 1982, entitled "Towards the Alleviation of Rural Poverty in the Sudan" states that the general concensus was reached by experts in Sudan that the poverty for a family of six of LS 1000 in urban areas and LS 500 in rural areas. The Department of Social Welfare estimated accordingly that 45% of the population (i.e. 1.38 million families, or 8.28 million people) are below the poverty line. There is no way of verifying the estimate until the result of a 1978-80 household budget survey is published. However, the results of this survey in the Khartoum Province support the estimate: 43% of urban, and 36% of rural households had annual incomes less than the poverty line. The 1982 Minihousehold Budget Survey in Khartoum revealed that the lowest income group, with an average income of LS 1280 for a household of six members, which lies well above the poverty line, were consuming only 66% of the internationally recommended calorie requirements.*

A study carried out by Sigma One Corporation in 1982 focussed on another factor which may have a heavy impact on food consumption patterns of the population. This is the government's intervention in the pricing of food commodities, known as the wheat pricing policy or "cheap bread policy". According to the report of the study, in Khartoum, bread accounted for 5.5% of total household expenditure in 1978/79 and in 1982 it rose to almost 8%, which is attributed to the declining real price of bread, making bread a relatively attractive staple vis-a-vis other food commodities. For the same reason, wheat consumption in Sudan grew on average by more than 12% per year during the 10-year period 1971/72 -1981/82. It concludes, however, that the "cheap bread policy" had favored the higher income households and had been ineffective as either a nutritional or income distribution policy.

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* Percentage of Calories by Commodity Group and Estimates of Calorie Adequecy for Expenditure Stratum (1982 Minihousehold Budget Survey).

Wide-spread infectious diseases, particularly diarrheal diseases, measles, malaria, and respiratory infections, often have very serious impact on human nutrition, especially among young children. On average , each child under five-years old suffers two episodes of diarrhea per year, and child mortality rate due to diarrhea is estimated to be 25/1000 per annum. Past studies in Sudan revealed that it is not only the impact of infections and resultant poor use of nutrients, but also the decreased quantity and frequency of food intake during the attacks of infection that aggravate the poor nutritional status of children, which is attributed to the lack of knowledge among parents on proper feeding practices.

Major Nutritional Problems and Causes

Major nutritional problems in Sudan can be summarized into two broad groups: Protein Energy Malnutrition (PEM) and nutritional deficiency diseases, mainly nutritional anaemia, avitaminosis A or vitamin A deficiency, and endemic goitre. I will not discuss further the nutritional deficiency diseases except to say that these deficiencies are considered to be the major public health problems in several areas of the country. The most wide-spread nutritional problem is Protein Energy Malnutrition (PEM). More than 50%, or 2 million, children under five years of age are suffering from some degree of PEM, and among low income families the figure is undoubtedly higher than 60%.

From studies conducted in the past it can be concluded that malnutrition in Sudan can be due to four causes: (a) poverty, (b) inadequate food availability, (c) infectious diseases, and (d) knowledge, attitudes, and practices relating to food consumption and health.

Programs and Activities Relating to Food and Nutrition

Early Developments

Several different types of program have been carried out in Sudan for the explicit purpose of alleviating malnutrition through addressing the above-mentioned causes. Nutrition education, direct feeding programs for preschool children and pregnant women, and integrated health and nutrition programs are examples.

A number of organizations have been involved directly or indirectly in the field of food and nutrition in Sudan since 1965. Before 1965, there had been no activity explicitly planned to improve the food and nutrition situation in Sudan. Under the Freedom from Hunger Campaign

initiated by FAO in 1965, the Sudan Government began a School Gardening and Nutrition Education Project with the technical assistance of an FAO Nutritionist and Horticulturalist. The objective was to start school gardens in different parts of the country and to introduce nutrition education to school children. In 1966, WHO assisted the Ministry of Health in implementing a project entitled the Applied Nutrition Progamme. WHO provided technical assistance through a nutrition advisor and UNICEF provided equipment and supplies. FAO appointed a non-medical nutritionist for this project. These two internationally-assisted projects worked on almost parallel lines, each trying to develop nutrition education programs in their own area with little coordination; this situation unfortunately still prevails.

In 1965 the Food Research Centre in Shambat was established with the objective of promoting improved food production, processing storage, and marketing in Sudan. Recently, it has produced sorghum/wheat composite-flour bread, biscuits, and snack foods. This has been considered timely as the Government's wheat pricing policies, or "cheap bread policy", had been seriously questioned because of the trend in increasing bread consumption in urban areas, which has resulted in a heavy burden on the foreign exchange reserve, and in providing disincentives to the producers of sorghum, the main substitute for wheat. The composite bread may be at least a partial solution to ever-increasing wheat bread consumption in urban areas, and may reduce the heavy reliance on imported wheat, although extensive market research should be undertaken.

In 1971 the Ministry of Health took the initiative of constituting a Technical Advisory Committee for Applied Nutrition (TACAN) with representatives from the various departments of the Ministries of Health, Agriculture, the Faculties of Medicine and Agriculture, University of Khartoum, and other voluntary organizations, with the objective of coordinating nutrition activities. unfortunately the committee met only once and made no tangible impact on any aspect of the nutrition programs in the country.

In 1972, as a second attempt for coordination of activities, a national food and nutrition seminar was organized by the Nutrition Division of the Ministry of Health. One of the main recommendations of the seminar was the establishment of a national food and nutrition council with objectives to formulate food and nutrition policies, to help coordinate research, and to train staff from internal and external agencies interested in food and nutrition activities. This also did not succeed.

The reason for failure can be summarized as follows:

i) Both attempts were not well prepared to discuss a coordinated approach on a concrete basis.
ii) Due to an inadequate database, the members of the committee were not aware of the severity of malnutrition in the country.
iii) Food and nutrition have not been a priority area in the national development plan; in other words there has not been any political committment for solving the problem of malnutrition.

Apart from the initiative taken by the Health Ministry, the Ministry of Agriculture has also shown an interest in establishing a food and nutrition unit within the Ministry. However, the establishment of a focal point in the Government to coordinate and formulate policies and strategies in relation to food and nutrition still remains to be seen.

Primary Health Care Program/Applied Nutrition Program

In 1978 the Government of Sudan adopted the recommendation of the WHO/UNICEF conference in Alma Ata on primary health care and initiated the National Primary Health Care Program with assistance from WHO and UNICEF. The main objective is to provide primary health care service to the rural and nomadic populations through a cadre of Primary Health Care Workers, who are selected from the communities which they are to serve. Nutrition is a component of the program. The objectives of the program include promotion of breastfeeding, appropriate weaning practices and feeding during illness, spacing of pregnancies, and prevention of immunizable diseases through the Expanded Program of Immunization. The thrust of the program is in a) its **appropriateness**: recruiting and training locally available manpower and making a minimum of essential drugs available to the community, b) its **accessibility**: located in the community, c) its **availability**: covering a large population with low costs, ans d) its **acceptability**: services to be provided by a person selected from the community who is familiar with the area, customs, and behavior of the population.

The Nutrition Division of the Ministry of Health was established under the Applied Nutrition Program in 1966 as previously mentioned. The division underwent three major stages of development. Until the middle 1970s, it conducted research and studies, held training courses for health personnel, and provided nutrition education in Khartoum urban area. These activities were carried out independently by the staff of division. In the late 1970s it decided to establish Provincial Health Nutrition Units (PHNUs) throughout the country, and by 1982 the units had been established in eight provinces. The last stage overlaps with the development of the Primary Health Care Program (PHCP). The National Health Program (1977/78-1983/84) set out the strategy that the PHCP is the structure through which problems of malnutrition would be tackled. The role of the

Provincial Health Nutrition Units then became less clear, as the PHCP has its own cadre of health staff responsible for the program's implementation. The role of the PHNUs has now evolved to assisting the PHCP in implementing the nutrition component.

To date, 8600 Primary Health Care Workers (community health workers and village midwives) have been trained and are working in 4000 rural and nomadic communities, comprising some 4 million people.

Almost total lack of effective supervision is one of the major drawbacks to the program. However, it is expected that the plans to involve the district government and local communities in the program planning and management, including supervision, will provide an alternative means for effective supervision of the primary health care workers.

The primary health care strategy aims to provide basic health care services to the entire rural and nomadic population by the year 2000. According to a UN forecas , by the year 2000 the non-urban, or rural and nomadic population will reach 19.4 million. As the realistic size of the population to be covered by one primary health care unit is 1000, 19,400 units will be needed. Salary costs for the units alone in the year 2000 is estimated to be well over 1.5 million Sudanese Pounds by 1983 prices. Of course, it would cost much more to provide health services through hospitals and health centres by medical professionals. However, recurrent expenditure required to maintain the program includes much heavier expenditure on drugs, logistical support, including transport and fuel, refresher courses, and so forth. Of these, drugs alone will cost approximately 23 million Sudanese Pounds per annum in the year 2000. This implies ,however, that an annual recurrent expenditure per caput will be only 1.2 Sudanese Pounds per annum in 1983 prices. (Recurrent expediture for support services to the PHC unit is excluded from this calculation).

This needs to be considered with the fact that the primary health care program is one of the many programs carried out by the Ministry of Health funded by the development budget of the country on one hand, and that primary health workers are just one of the cadres of the available health manpower, and are receiving the lowest salary. The Primary Health Care Program can be, nevertheless, one of the major channels to effectively improve the nutritional status of the population.

School Gardening and Nutrition Education Program

The School Gardening and Nutrition Education Program has continued to develop and, as of 1982, 24 provincial and district centers, and 156 village subcenters have been established. The objective of the program is to improve the feeding practices of children as well as food habits of mothers through nutrition education and promotion of income-generating activities, particularly among low income families.

The main activity of the program is training rural women. The training is for three months and takes place in the villages. It covers a wide spectrum of subjects, ranging from home economics, improvement of local recipes, child and maternal nutrition and health, to income-generating activities for women, kitchen gardening, food preservation, animal husbandry, and skills in communication.

The strength of the program has been its widely-based infrastructure, sound management, and the involvement of school teachers who are well respected in the Sudanese community in nutrition education.

Its weaknesses are the vagueness of its objectives and lack of a monitoring and evaluation system, which make the measurement of outcome or impact almost impossible. In this case, achievement can only be measured by the extent of its infrastructure or the number of trainees. The program also faces difficulty, like any other sector in Sudan, in retaining trained manpower, due to the high turnover rate and emigration to the Gulf states.

Nevertheless, the program has the potential to be an effective channel for nutrition education because of its efficient management and because the majority of the staff are female, which is an advantage in reaching children and women in rural communities. FAO has a plan to continue its assistance to the program and UNFPA initiated its support for population education.

The objective and activities of the program, however, need to be reviewed, and its involvement in new activities needs to be carefully considered in light of its capacity to monitor and follow up. It has already started to face the problem of securing sufficient recurrent budget. Furthermore, the expansion is now heavily reliant upon the budget of the regional government, so it also has to take over the extra work of convincing the regional government to support the program.

Food Aid and Feeding Program

The World Food Program has been operating in Sudan since 1963, and, as of 1983, the total value of assistance amounts to $163 million. The WFP food supplies are provided to (1) workers engaged in various developmental projects as partial payment of their wages, (2) new farmers during initial stages of settlement, and (3) for free distribution in case of emergencies and also for institutional, including school feeding, programs.

UNICEF and Catholic Relief Services initiated their preschool feeding program in 1976 through urban Maternal and Child Health Clinics. Dried skim milk donated by the EEC and the USA was distributed to children under five-years old and to pregnant women. UNICEF withdrew from preschool feeding program in 1980 when it was taken over by the World Food Programme. Catholic Relief Services also withdrew, in 1982, due to management difficulties.

Preschool and school feeding programs have encountered serious problems in reaching the rural areas of the country. As food has to be transported to various parts of the country, it demands considerable manpower and logistical support in distribution, monitoring supplies, providing nutrition education to the beneficiaries, and preventing leakages (food rations could be sold or exchanged with other items in the market).

It may be warranted to provide food for work as partial payment of wages or for rehabilitating the malnourished segment of the population. However, food distribution, particularly the supplementary feeding program, may divert the attention and efforts of the staff involved in the developmental activities, and beneficiaries as well, from the objectives of the development. In the case of the School Feeding Program, feeding is considered to be an incentive for school attendance and an essential means to support boarding schools. If the objective of the activities is to raise school attendance, smaller schools, training of Khalwa teachers to head those schools, or conversion of Khalwas to small schools, and more involvement of communities in primary education through raising awareness of the benefit of primary education (appropriate for the local inhabitants) should also be implemented in parallel. I have seen in Sudan one case of a supplementary feeding program which had been very well managed; however, mothers who came to receive the food ration quickly ran away on receipt of rations or did not come when food did not arrive. There was no time for staff to provide nutrition education to mothers, which was the purpose of the program.

I believe that food assistance cannot solve problems of this nature unless it is planned carefully. The so-called "fill-the-gap" approach needs to be replaced by efforts to make the step towards basic solution of the problem. Supplementary feeding programs based on imported food stuff only provide a shallow and temporary solution to the problem of malnutrition, leaving the main causes of the problem untackled.

Recent Trend

Food Security

In 1981 an FAO mission visited Sudan in response to the request for assistance from the government of the Sudan under the Food Security Assistance Scheme. The main policy recommendations and action plans were to ensure the availability at all times of adequate supplies of foodstuffs, primarily cereals, so as to avoid acute food shortages in the event of widespread crop failure or national disasters, and to maintain a steady expansion of production and prices. The mission recommended in its report that a focal point, at a sufficiently high level, be created in the Ministry of Agriculture and Natural Resources for the coordination of activities of all those involved in the food supply management system. It also recommended that one of the existing Under Secretaries be charged with responsibility for "Food".

In 1983 the Nutrition Division of the Ministry of Health reactivated its efforts to create a body to coordinate food and nutrition activities and to develop related policies. The results still remain to be seen.

There is a definite need for the establishment of an administrative unit for food and nutrition planning and policy formulation. It is likely that a political decision may place the issue on the right track.

Diarrheal Diseases Control

One of the major killers of infants and children in Sudan is diarrheal diseases. An interrelationship between malnutrion and infections, particularly acute diarrheal diseases, has been clearly establshed in recent years. The control of diarrheal disease has made a major breakthrough with the development of a simple solution of sugar and salt in order rehyrate, and even treat, acute cases of diarrhea. The emerging national control program for diarrheal disease is expected to play a pivotal role in the prevention of malnutrition among infants and young children in Sudan.

Teaching of Nutrition in Schools

Teaching of nutrition is part of the Home Economics curriculum in the primary, intermediate, and secondary education for girls, and also of the rural education curriculum for boys. However, with the application of the new educational "ladder" in 1970, school teachers began to neglect the teaching of home economics and rural education, as they are not examinable studies.

In 1977 the Minister of Education formed a technical committee to plan and draw up a new Home Economics syllabus with the objective of enhacing understanding of familly health and nutrition, as well as rural development, through formal education. The recommendations of the committee still remain to be implemented. However, it is encouraging to note the recent efforts of the Integrated Rural Education Centers and the Ministry of Education to establish productive schools, whereby efforts are being made to teach school children food and nutrition by actually establishing school gardens and poultry farms.

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Nutrition Within Primary Health Care

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What is Primary Health ?

The Declaration of Alma Ata (WHO 1978) states that "Health, which is a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right, and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector." It also states that the existing gross inequality in the health status of the people, particularly between developed and developing countries, as well as within countries, is politically, socially, and economically unacceptable.

In another clause it states that "the people have the right and duty to participate individually and collectively in the planning and implementation of their health care."

These statements contrast sharply with the assumption made in the first United Nations Development decade, when it was thought that, as economic growth is attained, eventually the services would be extended to cover more and more people. As a result of this approach, health resources were allocated to sophisticated medical institutions in urban areas. In spite of the heavy investments, these centers were unable to extend the essential services much beyond their immediate vicinity and this ultimately led to widespread disenchantment with that type of health service, which inevitably provided a highly specialized, sophisticated service to a very narrow privileged sector of the society.

The Alma Ata Declaration goes further to emphasize the responsibility of governments for the health of their people and defines primary care as "essential health care based on practical, scientifically sound, and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation, and at a cost that the community and the country can afford to maintain at every stage of their development in the spirit of self reliance and self determination. It forms an integral part of the country's health system, of which it is the central function and main focus, and of overall social and economic development of the community.

It is the first level of contact of individuals, the family, and community with the national health system bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process."

In this modern concept of the health services it is very clear that it is the recipent who has more to say about his health needs and the way they can be met rather than the provider of the service. Thus, the responsibilities are put squarely on the community using its own resources, supported and guided by the government.

An important feature of this approach is the use of minimally-trained lay people resident in, and chosen by the community. These people, usually called primary health workers, deliver simple medical services for a limited number of diseases which constitute the bulk of the health problems of the community. In addition, these workers are the pioneers of social change who introduce simple measures that can contribute significantly towards improving the quality of life in the community.

This approach has been criticized as offering a second rate service to the population - a criticism which is not valid, as the objective of this approach is to extend health services to areas beyond the reach of a centralized system, by screening much larger sectors of the population and identifying the groups that need further care in the central facility. It should thus be looked at as a complementary mechanism and not competitive one.

Moreover, the primary health workers, being local people, are usually in a much better position to understand community problems, and are therefore more responsive to its needs. Also, as they 'speak the language' of the local population they can communicate with them much better than could an outsider.

This concept of health care should be considered as part and parcel of total social and economic development, and not as an alternative.

Primary Health Care in Sudan (PHCP)

In Sudan there are a few health workers who fit the foregoing definition of primary health care workers. The village midwife is but one striking example that has been in successful operation since 1917 - possibly one of the oldest such schemes in the world. It was with this background that the Ministry of Health in 1975 officially committed itself to a five year

National Health Programme, of which the Primary Health Care Programme (PHCP) is a major component.

Objective

The objective of the PHCP in Sudan is to set up a network of Primary Health Care Units (PHCU) throughout the country in such a way as to achieve complete coverage of rural population by 1984.

Each PHCU is expected to serve a population of 4000 residing within a radius of 10 miles of the center. Each five PHCUs are supervized by a dispensary and from a primary health care complex serving 20,000 people (Fig. 1). The complex is supervized by, and reports to a district or rural hospital or health center and these in turn report to province or regional hospitals.

Strategy

a) Primary Health Care Units (PHCU)

i) Staffing: each PHCU shall be staffed by one primary health care worker (PHCW).

ii) Functions:

1) Curative health care; treatment of common diseases; performance of simple procedures; giving oral rehydration salts.

2) Preventive health care: antenatal clinics; identify protein calorie malnutrition immunization; notification of epidemics; active case detection of TB.

3) Refer all other medical or surgical problems to the nearest higher health institution.

4) Promotive: Advise the community on water and food hygiene and refuse disposal; participation in village development, communal activities, and school health.

iii) Supervision: The PHCW is visited once every 2 months by a medical assistant for technical supervision and drug supply.

b) Dispensary

i) Staffing: One medical assistant, one nurse, and a cleaner.

ii) Functions:

1) All functions of PHCU and referral activities to rural or district hospitals.

2) Technical supervision of the PHCW and administrative supervision of the health personnel in the area.

3) Supervision of village midwives.

4) Organization of immunization programs.

5) Consultation with village development committees.

iii) Supervision

Every six months the dispensary is visited by a medical inspector. The visit combines technical supervision with drug supply and immunization activities.

Specific priority problems to be addressed by PHC

a) Malaria.

b) Lack of health information and poor hygiene habits.

c) Communicable diseases preventable by immunization.

d) Protein energy malnutrition.

e) Gastroenteritis.

f) Tuberculosis.

g) Sleeping sickness.

h) Kala azar.

The Importance of Childhood Malnutrition

The PHCP gives a high priority to child health problems in general and to nutritional problems in particular. There is accumulating evidence that PEM is one of the most serious threats to child health in its own right,

and that it underlies, or aggravates the effects of, most of the other serious child health problems.

Several surveys conducted over the last twenty years in different parts of Sudan have indicated a very high prevalence of child malnutrition. The National Health Program estimates the prevalence of PEM in children under five years old at about 50% using the 50th centile of the Boston study as standard. This is further broken down as follows:

- 50% of children had normal weight for age, attaining 90% or more of the Boston standard.
- 40% were between 75-89% of Boston Standard, equivalent to first degree malnutrition.
- 9% were between 60-74% Boston Standard, equivalent to second degree malnutrition.
- 1% were below 60% of Boston standard, equivalent to third degree malnutrition.

At the first National Food and Nutrition Seminar it was reported that about one third of all admissions to the pediatric wards at Medani Hospital were due to PEM.

In a study of the pattern of emergency admissions in Khartoum, Omer and Karrar (1977) reported a prevalence of PEM of 67.7% of all children admitted for whom weights and ages were recorded. This very high prevalence, compared to data from community surveys conducted in Khartoum area, may be due to the effect of malnutrition on the health of children, i.e. children with malnutrition are more prone to succumb to intercurrent infections than well-nourished children.

These data, together with clinical experience, indicate the magnitude of the nutritional problem in children. PEM, together with gastroentritis, with which it interracts, constitute the major threat to child life and health. Such is the importance of this issue that we can confidently say that any health-related program that ignores these problems can never have any positive effect on the health of children in developing countries.

What can the PHCW do ?

The planners have laid out the PHCP in such a manner as to bring the country as close as possible to "health for all by the year 2000" with affordable facilities. The PHCW is the backbone of the program. Given that childhood malnutrition is one of the top priority areas to be addressed by the PHCP, we shall examine how can the PHCW tackle this issue.

Nutrition activities of the PHCW

To be able to tackle the problem of childhood malnutrition the PHCW must:

a. know his community and its needs,

b. be able to measure the growth and nutrition of children,

c. realize the importance of breast feeding,

d. identify suitable diets for young children,

e. recognize the importance of maternal nutrition in relation to child malnutrition,

f. be able to identify and manage common nutrition problems,

g. be familiar with the negative effect of diarrhea and infection on the nutritional status of the child, and

h. be able to motivate the community in controlling the nutritional problems.

The details of each of these activities is beyond the scope of this paper; however, a brief outline of the activities that can be done by the PHCW is given.

Knowing the community and its needs: To achieve this the PHCW must collect information on nutritional problems by conducting appropriate surveys and identifying the at-risk groups and individuals these groups or individuals are the target population for the health care activities.

The PHCW must identify the people in the community who have influence and who can help to implement the necessary action. At the same time the PHCW must draw up a plan action for combating the problem.

During this phase, the PHCW refers cases of serious illness to the nearest health institution for treatment. As well as saving the life of such an individual, the community will realize that the PHCW is the one to whom they should go with health problems.

Monitoring growth and nutrition: Weight is one of the best indicators of nutritional status, and a reliable indicator of growth and health. It is simple to determine, needing very simple and inexpensive equipment. It is cheap, reliable, valid, non-invasive and safe. However, for it to be used in the clinical or epidemiological sense, the age of the child must be ascertained as accurately as possible. Thus, it is imperative that the PHCW must be experienced not only weighing children but also in methods of ascertaining their ages.

The weight chart that shows the expected age/weight relationship for growing children is a very useful simple means through which the PHCW can identify problems. It can also be used as a record of important health events relating to the child, e.g., vaccination and drug prophylaxis. Another important use of the chart is its use as an educational tool to explain to the mother how well her child is doing. All these features make it necessary for the PHCW to familiarize himself with the growth chart and its various uses.

Breastfeeding: Recently there has been international awareness of the value and importance of breastfeeding. Recent studies have shown that it is not only the water, calorie, and protein content of the milk that matter, but that there are so many other facets to breastfeeding that it is not feasible to make an equally good substitute to it. Breastfeeding is even more valuable in our communities - it is vital to the health, well being, and the very survival of the child in his early months of life.

The PHCW must determine the practice of, and attitudes towards breastfeeding in the community. He should encourage, reassure, and help mothers with breastfeeding and solve their problems. In a few cases breastfeeding may be difficult or impossible. In such situations the PHCW is expected to be able to advise on the alternatives, stressing the availability of methods other than the bottle for feeding children in such situation.

Weaning foods: It is perhaps universal experience in developing countries where breastfeeding is well established that we see an excellent growth pattern in the first six months only to see it falter in the next few months and plunge into severe malnutrition by the middle of the second year. This is almost certainly the result of delayed introduction of

adequate mixed feeding.

The PHCW must determine the attitude and practice of mothers in feeding their babies in the last two thirds of the first year. He should also know about types of food, their availability and prices, and should be able to advise on preparation of a simple, inexpensive mix that can be prepared by the mother and which can easily be fed to the child during the early months. The actual preparation of the mix and feeding it to the children during certain clinic activities is much more valuable than simple or lecture lectures demonstrations.

Maternal nutrition: The nutrition of the mother, especially during pregnancy and lactation, is an important determinant of the health of the child. Maternal nutrition during pregnancy is an important determinant of birth weight, which is itself an important determinant of mortality and morbidity. Good maternal nutrition is also likely to be associated with successful breastfeeding. Thus, maternal nutrition should be of primary concern to the PHCW and he should avail himself of every opportunity to discuss with mothers their own feeding, to encourage them in good health practices, and dissipate fears about harmful taboos.

Major malnutrition problems: Ideally, the PHCW should aim to prevent severe PEM by identifying groups at risk and monitoring all children very closely. He should recognize early signs of poor weight gain as a serious sign of PEM. Nevertheless, cases of severe PEM will still occur. Therefore, it is important for him to be able to diagnose and identify the causes and clinical features of severe PEM. He should be capable of treatment at the home level, and should also recognize when the child should be referred to other health institutions. This also applies to other deficiency problems like anaemia, goitre, and vitamin A or D deficiencies.

Negative effect of diarrhea and infection: Diarrhea and acute infections are very common in Sudan. Both have a negative effect on the nutrition of children, and once the child becomes malnourished he is more prone to diarrhea and infectious diseases, thus establishing a vicious circle.

The PHCW should recognize these effects and should be able to explain to the mothers the danger of dehydration and apply simple methods for its control. The mothers must be encouraged to feed their children during diarrhea attacks. He should refer seriously ill children for further treatment.

PHCW should be able to advise mothers about the value of available vaccination, and encourage them to vaccinate their children.

Nutrition and the community: Here the role of PHCW is to emphasize to the community that the nutrition problem is not an individual's problem: it is a community problem and the community's resources should be used to combat this common enemy. This can be achieved by:

a. developing a good relationship with the community,

b. identifying people who are likely to help in improving nutrition of others,

c. identifying children who are at risk,

d. motivating the people to be interested in improving their nutrition, and

e. organizing an effective nutrition education program.

The tasks and functions expected of a PHCW are many, but the basic feature of all of them is their simplicity, their reliance on available resources, and their communal nature. If these measures could be effected on a nationwide basis they could lead to a gradual elimination of the most serious threat to our children's lives. Perhaps this is the quickest way of ensuring that Protein Energy Malnutrition will become history rather than an every day problem.

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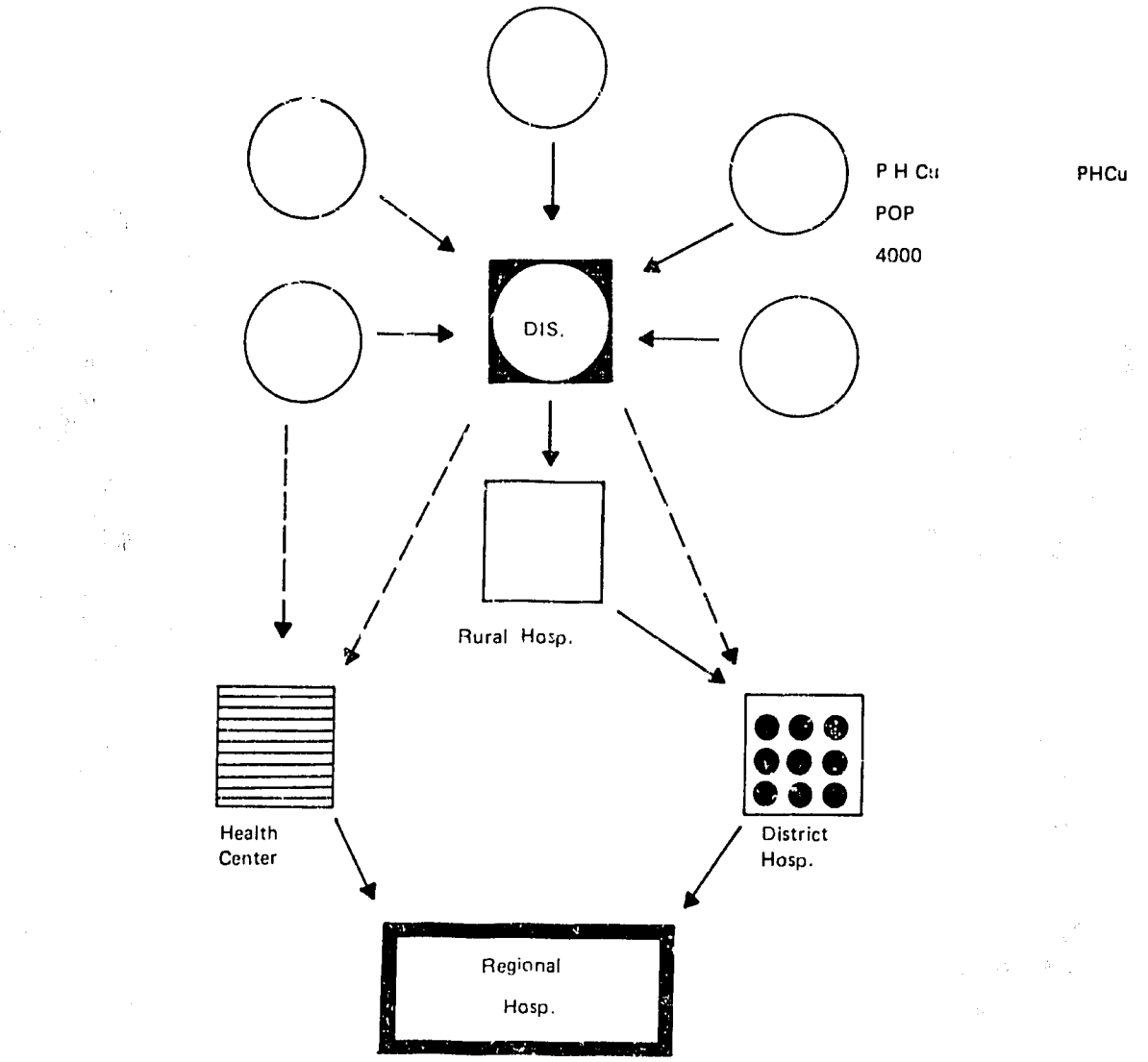

Normal referrel

Emergency referrel

PHCu Primary health care unit

Fig. 1. Primary health care.

Approaches to the Red Sea Nutrition Project

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The Red Sea Nutrition Project area is roughly a triangle that has as its southwestern border Musmar and Deradeb on the Kassala frontier, Mohamed Qol on the northern limits, and the area just after Suakin but before Tokar on the south limits of the triangle. Around 200,000 inhabitants (excluding Port Sudan) are thought to live in the area. The inhabitants, for the purposes of this paper, can be divided into three main groups:

a. Nomads.
b. Sedentarized or settled nomads.
c. Small farmers, fisherman, railway workers, and traders.

The main project target groups are composed of Hedendawa (Beja) tribesmen belonging to the first two groups. They are divided into several culturally distinct subgroups. About 55% of the population in the Red Sea Province is "nomadic" (Ref. Cencus 1983), yet more and more are settling in small towns and villages. Whatever their mode of life, their nutrition situation is extremely poor. A recent survey, supported by UNICEF Sudan and the Department of community Medicine, estimated that around 50% of the approximately 3000 children surveyed are in serious stages of malnourishment, with around 5 to 10% showing signs of acute malnutrition. Most women, as well as many men, also show signs of undernourishment, with clearly documented anemia, and a host of parasitic and communicable diseases, notably tuberculosis.

Food production is either nonexistent in most of these communities or, at most, restricted to small informal patches situated in narrow khors in the hills that become flooded during the rainy season. Sorghum is grown, but the amounts are not very large or dependable.

The exception to this is the Tokar Deeta area, where irrigation and food and cash crop production is more established. This area is, however, not the main project area. It is in fact most difficult to link the Tokar Delta with the main triangular area mentioned above, since the only road

proceeds northward to Port Sudan. (Road is a misnomer here, since it is a rough desert track that gradually gets worse as one leaves the Tokar Delta.)

In the areas outside the Tokar Delta, the inhabitants are said to be ignorant of basic agricultural radiations. Their origins are nomadic, and very few of them have evolved beyond the pastoralist stage. Poverty is widespread, especially among sedentarized former nomads. They are at the mercy of a cash economy (food being trucked in from Kassala) and their traditional barter system involving goats and camels is gradually being reduced due to increasing desertification and loss of animals. (A UNDRO mission in 1980 calculated that approximately 80% of the population of Red Sea was affected by drought.) An indeterminate few however are heavily involved in smuggling, and these are probably relatively better off. Migration to Port Sudan is another large problem.

Further details are given below on additional characteristics of the project area obtained from the nutrition survey.

Village Focus Groups (VFG)

Important people in villages were interviewed. Sometimes one village focus group (VFG) represented more than one village as each was very small and houses are widely scattered.

A VFG was usually composed of five to nine people, including heads or members of the district or village councils, tribal chiefs (Omdas and Sheikh el hila), religious leaders (Imams), SSU members, teachers, rail workers, wood cutters, old people in the villages, traders, or others.

Fifty-three VFGs were interviewed, representing about 73 villages and three rural towns (Sinkat, Haya, and Dureidab) within the study area. A random group of mothers was also interviewed in each village.

Villages vary in size. The majority consist of 50-200 houses each. Houses are usually small huts made of plant mats (Zaof) and are scattered over a wide area very far from each other.

Water Supply

During the rainy season the main sources of water are shallow wells (52.8% of the villages) and hafirs (39.8%). Hafirs are depressions resulting

from removing sand to build the Khartoum-Port Sudan road.

In dry seasons people depend mainly on shallow wells (75.5% of villages). However, a village may have no, one, or more sources of water. Other sources include seasonal streams (khors), springs, and water tanks at the railway stations.

Eighty-one per cent of the sources of water supply are not covered. In more than half of the villages (52.8%) water is not sufficient for daily use. Shallow wells had to be deepened during the winter. Only 16 VFGs (30.2%) thought that water supply was sufficient.

The distance to the source of water from the center of the village ranged from less than half a kilometer (26.4%) to more than 30 km; 24.5% of the VFGs gave a range of 5-10 km.

Transporting water is difficult. Some people use camels and donkeys, while a large proportion have to carry it by hand.

The water is usually salty, the salinity declining during the rainy season.

Food

The main food crop in the study area is sorghum. It is eaten as boiled grains (balila) or as porridge (asceda or lugma) to which sugar, salt, and diluted milk is added. Soft dates are also eaten occasionally.

Usually two meals are taken per day, early in the morning and late in the evening. Food usually does not change with the season. A few people eat vegetables, especially tomatoes, during the rainy season. Meat is not a common dish.

Although families have a few hens, they do not eat eggs. Eggs are sold to buy sorghum, coffee, and sugar. Milk and milk products are also sold.

Food Taboos

Pregnant women are not allowed to take sugar, butter, or camel milk. They think that these would fatten the mother and foetus and eventually lead to delayed or obstructed labor. Goat and camel meats, chickens, fish and other foods are also proscribed. In many villages pregnant women take sorghum porridge with water after the 28th week of pregnancy (the third trimester). However, during the confinement period, the women are given much porridge, butter, milk, and sugar.

In many villages children do not eat eggs or chicken or drink cold milk.

Sick people are advised not to eat meat, butter, or to drink goat and camel milk during the course of the illness. However, 32 VFGs (60%) said that they have no alternatives. People depend on sorghum porridge, with or without diluted milk, regardless to age, sex, or general health condition.

Food Storage

At the time of the study, 40.5% of villages had no stored sorghum. Among th remainder, store types included traders stores (18.7%), matamir (17.0%) and shunas (3.8%).

Matamir (singular:matmura) are holes in the ground where grain is stored; they are situated on land that does not permit influx of water or suit ants.

A shuna is an open area where sacks of grain are stored. A guard from the village is appointed, and is usually paid a portion of the stored grain.

The amount of sorghum stored is very little, usually a few sacks, and is not enough for more than a few months. Additional supplies are brought from the nearest towns.

Breastfeeding and Supplementary Feeding

Breastfeeding is usually continued for more than eighteen months. In many places it continues upto three years of age. Ignorance of correct supplementary feeding is wide-spread.

Diarrheal Diseases

Rural and urban mothers tend to reduce breastfeeding when their child is suffering from diarrhea (56.4 and 88.2%, respectively). There are number of different traditional treatements applied for diarrhea among infants and young children. The majority of rural mothers (84%) are not familiar with oral rehydration salts (ORS).

Health Problems

Adult Males

Pulmonary tuberculosis and chronic cough (most probably due to tuberculosis) are the most common health problems, mentioned by 76.3% of the VFGs. Other major health problems in this sector of the population are related to poor nutrition and bad sanitation, e.g., hepatitis, diarrhea, dysentry, abdominal pains, night blindness, and anemia.

Adult Females

Women suffer mainly from anemia, difficulties and complications during labor, fevers, and chronic cough.

Young Children and Infants

The main diseases among this group are diarrhea and vomiting, chest infections, conjunctivitis, measles, whooping cough, malnutrition, chickenpox, anemia, and fevers.

Education

There are no schools in 25 villages (47.2%). In nine villages (17.0%) children never go to school. Their parents say that it is expensive and the schools very far from home. However, boys generally have better education opportunities than girls.

Challenges Identified

The project thus presents many challanges:

- How to provide sufficent food and water ?
- How to communicate and win the trust of a traditionally suspicious, conservative, and relatively unskilled population ?

- Transportation and logistics in some of the most inhospitable terrain in the world.

- Mutually suspicious and sometimes antagonistic communities with a high propensity to violence and superstition.

- Out-migration of able-bodied males to Port Sudan.

- Health conditions which are abysmal.

- Lack of reliable population statistics and vital records.

How to Tackle the Problem

We are faced with two points of view of how to tackle the problems. The first states that this is a nutrition project, and since nutrition is a branch of health, the main focus is to strengthen the primary health network. Presumably this means that if a reliable health network is created, then hygienic and nutritional practices can be modified so as to reduce malnutriton. At the same time, treatment of many communicable and non-communicable diseases would reduce the well known syngergism between ill health and malnutrition.

The second point of view is more ambitious. It largely rejects the view that a better health network by itself will reduce malnutrition. It argues that financially and logistically there could never be a sufficient number of primary health workers to cover a significant part of the population, and furthermore, even if this were possible, the underlying problems leading to malnutrition are lack of income, ignorance, lack of food, and, most importantly, lack of water. Further, that unless attempts are made to achieve some manner of economic self-sufficiency, these populations are doomed.

A further conflict develops; nutrition falls between the aegis of the Ministries of Planning, Finance, Agriculture (food, exports, community welfare), and Health (reduction of morbidity and mortality). The Ministries of Planning, Finance, and Agriculture, and regional authorities argue that economic and political investments are to be made and have to be made wisely. The Ministry of Health argues that these will take time, but in the meantime one must do something about the terrible ill health and malnutrition.

Further down the scale, the wants and needs of the communities should be considered.

University of Khartoum and UNICEF-supported teams interviewed village leaders in 76 villages and settlements. Some were fairly new settlements resembling camps, while others had been there some time and resembled towns. The main demands were for (a) water, (b) food, (c) income, and (d) health care. The order is not surprising. It is heard in most communities that are poor. It is heard in Brazil and India. It is heard in eastern Sudan and western Sudan. It is even heard in the more lush southern Sudan where you would imagine that water and food are not such a problem.

Thus we have a typical conflict that often confronts the nutrition planner. One branch of Government demands investments to ease its financial and political burdens, another demands expansion and improvement of the medical infrastructure, and the people ask first for water.

Is it possible to satisfy all three ?

At first, the answer is yes. It is possible for instance, to dig shallow wells, provide skills and education, deliver food more efficiently perhaps, and to introduce and expand health services.

The investment cost, and perhaps even the returns, can be calculated. It would cost around US$2000 to install a handpump and well serving about 200 people. For 200,000 people the total cost would be US$2 million. To improve food delivery and consumption, perhaps more can be done in the way of taxing food supplies that do not go to that particular area of the Eastern region and to reduce exports of sorghum to Saudi Arabia (around 0.5 million t/year), which would undoubtedly reduce the market price of sorghum and make it locally more available, at least for sorghum grown in Kassala. Perhaps it is possible to provide tax and other incentives to food retailers and truckers so that food prices to the consumer fall in that area. More attention could also be paid to channelling food from the nearby Tokar area and to improve the regional control of foodstuffs. It is also possible to encourage the population to keep home gardens and small animals, to learn better agricultural techniques for flash flood irrigation, including the construction of small dams or "steps", to do something about food storage and conservation, and to encourage small artisan and craftsmen to train youth in income-generating and agricultural support services. All that is very difficult, especially in the Sudan. But let us give it a tentative cost - perhaps another $1 million.

For health-related services, we can calculate that about $5 per caput may do much, about US$1,500,000 total. Another US$1 million could be allocated to education. The total comes to perhaps US$5.5 million.

Assuming all this to be in place, what should be the next step ?

Will the Red Sea Province, the regional government, or the national government be able to maintain these services with $2 million a year in recurrently expenses ? (Recurrent expenditure is conservatively estimated to be 30% of the infrastructure or investment cost of projects of this nature). At present the whole development budget for the province, with a population of 0.7 million including the large city of Port Sudan, is only $4,326,900. Even if these costs were deemed affordable, there is another problem; how do you supervise and manage such a large project with so many disparate and different parts ?

Experience has shown that you cannot, unless you have a very rich country with a lot of technical expertise, or one with very repressive political system.

This management, supervisory, and maintainance problem is the biggest.

Is there a way out ? Do we just invest in better health services and wish the people luck with their other problems ?*
Obviously not, because the basic cause of the malnutrition is lack of food. There is simply insufficeint food in the Red Sea area, insufficient income, and insufficient water.

Why not ask communities to develop their own solutions with a little help from government and donors ?

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* Another warning: Many, in fact nearly all, major health and nutrition projects have failed because the opportunity cost for women of taking themselves and their children to health clinics and the like is too high. And for those advocates of feeding programs and food handouts to bring them there, have they calculated the cost of food supplementation ? What happens when this stops for one reason or other ? Even those food supplementation projects that were logistically successful have usually failed to show any marked effect in health and nutritional status of the population.

If a community decided to build its own well, to manufacture its stone cover, perhaps the pump could be provided. Or if we drill well, they could provide the pulley system and the covers and we do not provide a pump. The cost may fall by half. And the people become involved. Some of the village leaders suggested that sand dams or "steps" can be built to control and store water, as was done in colonial times; let us ask them to build them and to provide them with some incentives.

If they build the health post and help pay for the community health worker or trained birth attendant/midwife, we can provide some of the drugs and equipment and transport. If they wish to set up a rural pharmacy we might also help. And in the process of building and providing this work force, perhaps they will learn to appreciate the health worker and his or her messages more.

And if we ask them to build small schools, home gardens, day-care centers, storage bins, we could provide the attendants, teachers, seeds, and experts. If they agree to train their own women and mothers and youth, then perhaps infant mortality will fall faster that way, as studies have shown, than by the other more traditional ways. Income generation can be enhanced through traditional and new handicrafts. And if the Region decides to experiment with tax and other controls on food manufacturers, producers, retailers, and transporters, perhaps they will do away with the need for and cost of institutionalized feeding programs.

A lot of ifs.

And how to <u>organise</u> all that ?

Bring the leaders of these communities to a meeting or meetings. Assess what resources and problems they have. Explain the concept. Ask for their interest. If it is positive, then help to organize further "development groups" or committees. In fact, these already exist in nearly all settlements that were visited and are made up of tribal, religious, and political leaders. The mix of services they, and we and Government will provide, will of course vary somewhat between the different communities, and priorities will differ. Perhaps some will start with health services, others water, food and education, or day-care centers. This is an advantage. It means each sector can perhaps be supervised more easily.

The effect of the different interventions can be assessed as to their relative efficiency in lowering mortality, improving growth, and so on. (Communities should help record, or be taught to record these themselves.) From a management point of view, by phasing different interventions in

these "clusters" and putting a supervisor for each cluster, it may be possible to proceed with caution with some or all of the above interventions in turn. This way it may be possible to learn what is effective or feasible in the different clusters.

It is also possible to calculate the investment and recurrent costs for each cluster and to evaluate, on an economic basis, the probable rate of return or benefits from better health, more water (for food production), and the effects of income generation and skill training. This information will be shared and explained at the outset with the village leaders. A better health and nutrition condition might for instance, increase their expenditure on medicines and drugs and reduce their all too common laborious and expensive trips to Port Sudan for treatment and hospitalization. Better food productions or storage may in turn reduce food expenditures and in some cases lead to sale of some of these foods, such as eggs. If the local population invests or provides about 50% of the investment and recurrent costs needed, mainly in manpower, materials, or structures (something the villages interviewed said they were willing to do), then the economic viability of the project may be assured.

There are many other ideas that revolve around these themes.

They are worth a try.

SECTION IV

Working Groups and Their Recommendations

The participants to the workshop were divided into two groups:

Group I: Policies and programs for increasing food production and improving consumption.
Chairman: Samir Miladi, Co-Chairman: Mohamed I. Abdel Karim

Group II: Policies and programs required for improving nutritional status.
Chairman: Peter Pellet, Co-Chairman: Ali K. Osman

The two groups have discussed specific policy issue and review on going programs in the fields of agriculture, food science and nutrition. Concrete recommendations were formulated by each group, these were delivered and discussed by the participants at the last session of the workshop.

The findings and recommendations of the groups are set out in the section that follows:

GROUP I: Policies and Programs for Increasing Food Production and Improving Consumption

Agriculture plays the major role in the national economy. Those involved in agriculture are the major consumers of food. The agricultural sector provides the major industries with raw materials, and constitutes over 90% of the foreign exchange earnings. Over 70% of the population is involved in agriculture, which constitutes the major source of income in the country.

In spite of the importance of agriculture in the national economy, its share in the national development plan is not in proportion to its role. Investment in agriculture has been biased towards the irrigated areas, while less emphasis was given to rainfed agriculture. Priority in research, extension, and agricultural inputs was given to cash crops, particularly cotton, whereas food crops received lesser attention. Livestock, which constitute 40% of the total national agricultural output, and in which the nomadic population plays the major role, receives little attention.

There is a trend, especially in the urban areas, towards more wheat consumption, at the expense of traditional cereals, i.e., sorghum and millet. This has resulted in more wheat having to be imported, putting more pressure on the balance of payments. The group noted that the price of wheat flour is controlled, whereas sorghum and millet are on the free market. This is also the case for most food crops, including vegetables. Farmers receive low prices for their produce, while the middle men charge the consumers high prices. This results in low income and incentives to the farmer, and high basic food costs.

Post harvest losses are considerable in handling storage and processing; this was considerable effect upon food availability and prices. Inadequate infrastructure also contributes to the high cost of food, and causes problems in the transport of food stuff from areas of plenty to those in need.

Sea and fresh-water fisheries could play an important role in the diet. However, their potential has not yet been realized due to under exploitation.

A factor which received little attention is that of increasing deforestation, which is related to the increasing costs of fuels. Desertification is also increasing.

In conclusion, the group noted that the agricultural sector, including food production, is facing difficulties aggravated by the unclear policy as regards food imports and exports. The present economic crisis which the country is facing in all the socioeconomic sectors is associated with the present situation of agriculture, the high cost of oil, and the low price on the international markets for cotton, the major agricultural export. Realizing the close links between agriculture, food science, and nutrition, the following recommendations were made:

Policy

1. Agriculture should be given high priority in the national development plan, especially in terms of financial resources.

2. A clear policy should be defined in relation to food production, import and export, taking into consideration consumer demand and national interest.

3. Price policies for food crops should be examined and revised if necessary. They should be directed for the benefit of both the

consumer and producer.

4. Financial resources should not be biased toward a specific region/agroclimatic zone, but should be directed to regions where conditions favour the project in question, and where large rural populations, particularly small farmers, exist.

5. The rural population, which is the primary producer, should be provided with the necessary social services (health care, education, water supply, etc.). This will contribute to the increase in their productivity, and improve the quality of life. In addition it will help stem the increasing migration away from the rural areas, and the consequent increase in urbanization. This effort should also consider the nomadic population.

6. National and international investment schemes for agricultural development should have a nutritional consideration. Improving income distribution and the nutritional status should be among the objectives of rural development projects.

7. Rainfed agriculture, which constitutes the largest percentage of the agricultural land, should receive more attention than irrigated land.

8. More efforts should be devoted to food crops than has been the case previously, especially with regard to research, extension, credit, and agricultural inputs.

9. In increasing the area for food crop production, the importance of pasture lands should not be overlooked.

10. For the efficient utilization of the food produced, consideration should be given to developing better marketing and storage facilities.

11. Efforts should be made to increase the efficiency of the present food industries. Studies into such aspects as the supply of raw material, energy, spare parts, and the improvement of management need to be undertaken.

12. It is essential to develop food conservation at the village level, and to improve the traditional food preservation practices.

13. Efforts should be made to integrate crop and livestock production systems in the crop production areas.

14. With the increase in oil prices, deforestation has become a major problem in Sudan. Efforts should be made to rejuvenate forests, and to combat desertification.

Research

1. It is necessary to conduct food consumption surveys at the national level; these should be coupled with nutritional surveys.

2. Studies should be conducted into the impact of rural development schemes on the nutritional status of the population.

3. A study is proposed on the effect of male migration from rural areas, and the involvement of women in food production and marketing, in relation to the nutritional status of the pre-school child.

4. Improvement of traditional food preservation techniques at the village level.

5. Improvement of food handling and storage at the village and national levels, using locally available materials.

6. Research is required on improving the quality and quantity of raw materials for the food processing industry.

7. Study of the effects of seasonality of production on the food availability, consumption and the nutritional status of the population.

8. A research program is needed to survey, monitor, and reduce food contaminants such as mycotoxins.

9. Greater priority should be given to the development of cultivars and agronomic practices for production of the major food crops under rainfed conditions.

10. Evaluation of the present nutritional intervention programs (school feeding, nutrition education) should be undertaken.

Action

1. It is necessary to establish a coordination mechanism between the different bodies and institutions dealing with food production, food science and nutrition, and marketing, in order to review on-going activities, and to find ways and means for cooperation and complementation.

2. It is recommended that agriculture, food science and nutrition be integrated in the national development plan and at the field level.

3. Development of a national food and nutrition policy, and the establishment of a national body in the form of a council, committee

or agency for the formulation of policy, and the follow-up for its implementation.

4. Present food control systems need to be supported; this includes food laws, regulations and standards, lab facilities and inspection staff.

5. Efforts should be made for the protection of local food industries and to guide food imports.

6. Full support, both financial and moral, should be given to the existing research institutions.

7. It is recommended that multidisciplinary applied research approaches be encouraged in the areas of agriculture, food science, and nutrition.

8. It is essential that improvements in yield and productivity of the major crops through breeding and agronomy is not achieved at the expense of nutritional quality, using the local landraces as the base-line standards. In this respect, routine screening of improved cultivars and varieties is necessary.

GROUP II: Policies and Programs for Improvement of Nutritional Status

Many factors cause malnutrition, but low food production and/or poverty are major determinats. Poverty is also associated with poor hygiene and greater disease prevalence, both of which contribute to malnutrition. Thus, all techniques which allow increased food production and availability and/or reduced poverty (increased purchasing power) are basic to the elimination of malnutrition.

Even within the constraints of poverty and low productivity, steps can be taken which could improve nutritional status. These are considered below. If these were to occur together with increased production of basic food stuff, dramatic improvements in the nutritional status of the population could be possible over a relatively short period of time.

Recommendations on Programs for Improving Nutritional Status

Policy

1. Initiation of a National Food and Nutrition Council responsible to the Council of Ministers, with the following objectives:

a) To incorporate nutrition policy as an integral component of the national socio-economic development plan.

b) To revise the policies of food production, food export and import, and the impact of such policies on the nutritional status of the population, especially those of the low income group.

c) To set up surveillance and food security systems, i.e. improvement of traditional food production, storage, processing, etc. and to monitor food shortages.

2. Formation of sub-committees to investigate nutrition education, food control, and consumer protection, the role of women in food production at the rural level, food production technology, and coordination between government and non-government organizations involved in nutritional activities, both at the central and regional levels.

Research

It is suggested that the following research activities be supported:

- In all research programs, a multi- and inter-disciplinary approach should be encouraged.

- Support of information and statistical units in the different institutes involved in agriculture, food science and technology, nutrition and health research activities.

- Formulation and adoption of suitable methodologies for agriculture, food science and nutrition surveys.

- Support of base-line food and nutrition surveys in the different regions of Sudan; this would follow the collection and evaluation of the information available from previous surveys.

- Support of research on the common nutritional problems in Sudan, e.g. PEM (Protein-Energy Malnutrition), aneamia, goitre etc. and the evaluation of on-going programs.

- The national prevalence of low birth weight infants (2.5 Kg) should be determined, since these infants are at greater risk of malnutrition than normal weight infants. The role of dietary suplementation during pregnancy should be evaluated as a means of aleviating this problem.

- In-depth studies to identify all relevant means to increase milk yield and the duration of lactation.

- Since daily energy requirements are dependent upon activity, it is inappropriate to use tabular standards for energy requirements unless activity is allowed for. Research should be conducted on energy requirements at the village level during different seasons; these should use simplified approaches based upon activity diaries and estimated activity requirement levels, so as to ascertain the energy balance of individuals and communities.

- Studies of the evaluation of foods and feeds, from a safety stand-point, especially as regards aflatoxins and other such health hazards, and to find suitable means of control.

- Studies to develop national growth standards for the Sudanese children.

- Investigation of local weaning foods, and the formulation of baby food recipies from local food materials.

- Evaluation and improvement of existing food handling practices, e.g. handling, storage, and processing.

- Development of appropriate rural technologies and cottage industries.

Action

1. The group recommends the immediate establishment of a coordination committee from those present at this meeting, possibly augmented by other concerned individuals. The task of this committee should be to follow-up the recommendations of the Workshop, and to study procedures which could lead to the establishment of a National Food and Nutrition Council; the latter will be designed to over-see, at a national level, all activities concerning food availability, pricing, and distribution within Sudan, together with their nutritional implications.

2. Evaluation of all current nutrition education programs should be undertaken, to ascertain their effectiveness in understanding and improving the nutritional status of both the rural and urban populations.

3. The prevalence of protein-energy malnutrition is recognized, and its elimination and cure must be given high priority. The techniques of prevention and cure differ according to the stage and severity of the disease, and are discussed below. It is also recognized that the interactions between nutrition and infection are fundamental. Thus, immunization, improved food handling (especially of baby foods), and better sanitation are all necessary, together with more specifically nutritional measures. These includes:

a) Improved maternal feeding during pregnancy to reduce the incidence of low birth weight infants, who constitute a disproportionately large fraction of the malnourished infant population.

b) Breast feeding should be encouraged for as long as possible, recognizing that introduction of supplementary feeding is essential at four to six months of age, and that special foods should be available for this period, whether they be home produced or centrally processed. In both cases, these should be made from acceptable locally available ingredients at reasonable prices.

c) Early detection of protein-energy malnutrition (PEM) by simple anthropometric criteria (weight for age or arm circumpherence) should be practiced wherever possible. PEM should be attacked by the development of simple nutritional rehabitation activities associated with hospitals, clinics, or other health centers.

d) All families should have access to materials and techniques for oral rehydration in the treatment of dehydration consequent on severe diarrhoea. These should range from instructions for simple salt-sugar mixtures to the more complex pre-formulated mixtures, depending upon availability.

4. The existence of severe nutritional deficiencies of vitamin A, iodine, and iron has been established in various regions of the country, accompanied by the classical signs of clinical deficiency. Current treatment by medical means should be continued, together with dietary fortification, i.e. iodized salt. Future eradication is however, dependent upon the introduction of foods or food varieties which contain higher levels of the difficient nutrients, and also upon general socio-economic improvement.

5. Analytical facilities should be developed for the analysis of the carotene content of various staple cereal varieties and cultivars, so as to be able to advise on those with maximum pro-vitamin A activity; these may be suitable for introduction into areas where hypovitaminosis A is a problem.

6. Many traditional techniques of food storage, preservation and processing are highly effective, and should be encouraged, since they involve appropriate technology, and use available energy sources, e.g. solar energy.

7. The journal of the Food Research Centre, Food Science and Technology, should be supported as a medium of exchange of information between the different disciplines, with the suggestion that the word 'nutrition' be included in the title.

8. Technical and financial support of the existing institutions working in research on agriculture, food science and nutrition needs to be maintained and expanded.

9. Support for, and extension of, training of personnel at all levels involved in research and extension, both internally and externally. It is recommended that training should have an interdisciphinary component.

10. Support of extension and transfer of information on research to the community as well as to nutrition education institutes.

11. Community wide involvement, especially of women, is essential, and the long-term benefit to communities should be evaluated before actions are initiated.

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