

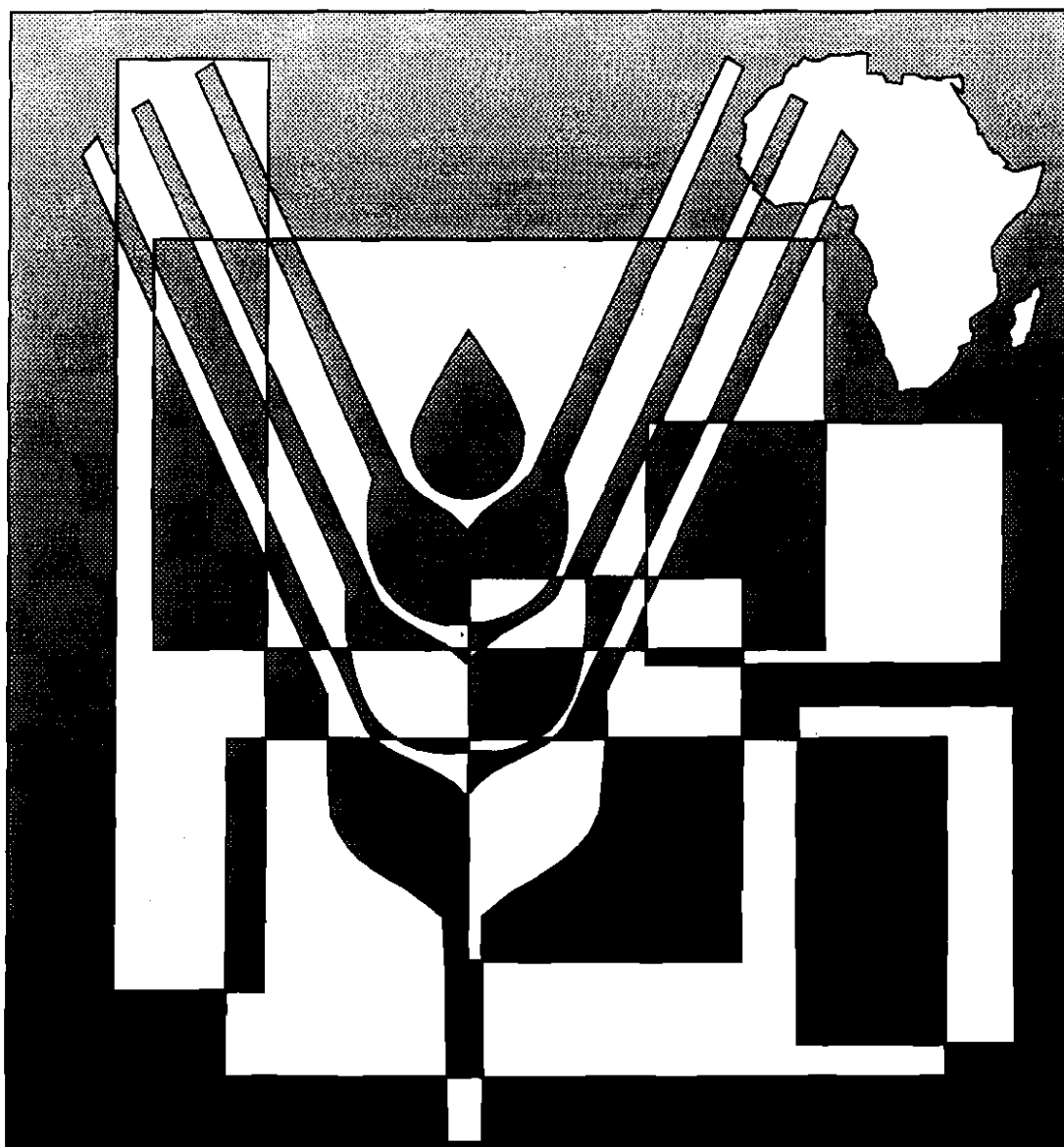


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IMPROVING FOOD SECURITY IN AFRICA: THE IGNORED CONTRIBUTION OF LIVESTOCK



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IMPROVING FOOD SECURITY IN AFRICA: THE IGNORED CONTRIBUTION OF LIVESTOCK

by

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The views expressed in this paper are those of the author and do not necessarily reflect the views of the United Nations Economic Commission for Africa (UNECA) or of the United Nations Food and Agriculture Organization (FAO)

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ABBREVIATIONS

CBC	Crossbred Cows
CCWS	Care for Children and Women Support
CGIAR	Consultative Group on International Agricultural Research
CU	Consumer Unit
FAO	Food and Agriculture Organization
FS	Food Security
FSS	Food Self-Sufficiency
HAF	Household Access to Food
HAHS	Household Access to Health Services
ILCA	International Livestock Centre for Africa
LBC	Local Breed Cows
LEB	Life Expectancy at Birth
MSSR	Meat Self-Sufficiency
PIAF	Proportion of Income Allocated to Food
PEM	Protein Energy Malnutrition
SADCC	Southern Africa Development Coordination Conference
TLU	Tropical Livestock Unit
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNICEF-ESARO	United Nations Children Fund - Eastern and Southern Africa Region
US	United States
WHO	World Health Organization

EXECUTIVE SUMMARY

The Setting

Africa fails to formulate adequate development programmes that are required to provide for the basic needs of its populations. The continent is so overwhelmed by oppression, illiteracy, civil strife, mismanagement and neglect of agriculture that good food, good health, adequate housing and education which form the essential of these needs seem to be relegated to a low priority. It is also a continent where the world highest human population growth is found and where human factor ironically appears to be neglected in the development process.

Africa is chronically malnourished. This causes poor health, unsatisfactory working efficiency and considerable suffering among its human populations, and prevents good socio-economic growth and development from taking place. Food security and nutrition concepts are misunderstood as the quality food and balanced diets are generally substituted for food quantity. Cereals seem to be portrayed as necessary and sufficient food source while food security is wrongly equated with food self-sufficiency. Livestock is poorly covered in the food security debate and seems to be poorly recognized as a source of high quality food and a potentially important factor in the improvement of food security in the region.

The main thrust and vision highlighted in this monograph are concerned with the eradication of hunger and malnutrition in Africa. Prerequisites for the realization of such thrust and vision include good understanding of the concepts of good food and food security, the intricate relation between public health and food security and the need to recognize and exploit the considerable potential of livestock as a means to foster poverty alleviation and access to healthy nutrition in Africa.

Concept and Indicators of Food Security

The Concept

The concept of food security which was based on the security of food reserves and avoidance of transitory shortfalls in aggregate food supply has been replaced with that which recognizes the lack of access to food by households and individuals due to low income or entitlements as cause of food insecurity and not only the inadequate levels of global food supply. The new concept differentiates the permanent food insecurity from the temporary food deficits and recognizes that famine, hunger and malnutrition are caused by both poverty and shortage of food. In this context, food

security is defined as access by all people at all times to enough food for an active and healthy life. It is worth noting that this definition is formulated with reference to food grains.

For access to food to be adequate, it must be physical, financial and biological as well. Quantity and quality requirements of food and their relation with public health and welfare must be met if enough food for active life prescribed in the definition is to be expected. In this respect, the reference to food grains in the definition of food security is misleading as it counts out livestock, roots and tubers which are a major source of food and income in many world poor countries.

Food Self-sufficiency

Policy makers' great concern about poor food self-sufficiency (FSS) is legitimate particularly where shortfalls in domestic food supply result in massive commercial imports of food that drain foreign exchange reserves. Thus the campaign for FSS in Africa is valuable in this context as it is believed that a nation/region which opts for FSS is logically one that also opts for the necessary development of its agriculture in general and the food production and distribution sub-sectors in particular. However, FSS cannot be equated with food security as it does not guarantee adequate access to food everywhere in a country or a region neither does it ensure adequate distribution of available food within a household. The fact is the global FSS in a country or a region does not mean much to the poor who cannot have financial, biological and physical access to the food the need.

Moreover, the drive for FSS at all costs can result in serious mismanagement of financial resources and a consequent further deterioration of food security situation. This may be true of a nation, a subregion or a region where the lack of natural and other resources constrains FSS achievement efforts.

Overall, FSS is a poor indicator of household and individual food security in Africa where poor market, road and transport related infrastructure prevails and where cultural taboos highly prevent equal distribution of food in the households and where poverty is the major constraint to access to food. Nevertheless, the continent can use FSS initiatives where these are economically sound to boost its global domestic production of food.

Household Access to Food

Household access to food (HAF) is the access to food adequate in quantity and quality to fulfil all nutritional requirements for all members of the household throughout the year. Financial access and physical access are HAF's commonly used indicators. Physical access is measured by the amount of time spent walking or travelling in order to reach available food and the financial access by the proportion of total income allocated to food. Biological access proposed in this monograph is the actual access of the body to the nutrients of food ingested through an adequate absorption and utilisation. This third indicator is intended to complement the Household Access to Health Services.

HAF has many advantages over FSS but is limited to household as consumer unit and fails to address individual food security issues. HAF also fails to deal with the inadequate health and sanitation as well as the inappropriate feeding practices that prevent consumption security from translating into satisfactory nutritional status in most vulnerable household members especially preschool children, pregnant and lactating women. HAF further fails to provide for the evaluation of protein-energy malnutrition as measured by anthropometrics and protein inadequacy in the diet. Overall HAF is a necessary but not a sufficient condition for adequate dietary intake and food security.

Protein Energy Malnutrition

Dietary energy deficiency is a major cause of chronic malnutrition in adults and serious ill-conditions in children of the world poor households. But the term energy or calorie adequacy generates a lot of confusion. In fact, where populations are unable to obtain good quality proteins to complement their usual cereal or root diets, high morbidity and even extension ensue. Studies point to increased possibilities of lysine being a limiting amino-acid in populations living on high cereal diets. Studies also show that food intake, food availability and dietary energy requirement used to measure malnutrition are each notoriously unreliable and that anthropometric indices form the most convenient and reliable basis for the determination of protein-energy malnutrition. These indices which include under-weight (ie., low weight for age), wasting (ie., low weight for height) and stunting (ie., low height for age), are particularly valuable in determining childhood malnutrition.

Household Access to Health Services

Household access to health services (HAHS) is the access to culturally acceptable health services and a healthy environment in adequate quality and quantity

for all members of the household throughout the year. A lack of appetite due to fever reduces intake of food. Parasite infections interfere with adequate absorption and utilization of nutrients. Drinking unclean water leads to diarrhoea which is an important cause of malnutrition.

The indicators of HAHS are related to physical access and financial access which are complemented by those of cultural and organizational accessibility. HAHS fails to provide for the determination of the actual use by the body of food nutrients ingested (ie., biological access) where cultural accessibility is constrained and where illiteracy and ignorance prevent access to and the use of health services.

Like HAF, HAHS is a necessary but not a sufficient condition for adequate dietary intake and alleviation of malnutrition. To guarantee food security, these two determinants must be combined with another cluster referred to as care for women and children support and with many other determinants that reflect all the livelihood security needs. This points to the fact that food security issues are complex and need to be addressed with precaution.

Contribution of Livestock to Food Security in Africa

Contribution to Income-generation and to Physical Accessibility

The contributions of livestock sector to farm income and wealth in 1994 were estimated at US\$ 5.6 billion and US\$ 558.4 million, respectively. The sector's share of agriculture commodity value is high in many African countries among which are Botswana (88 per cent), Mauritania (84 per cent), Namibia (82 per cent), Lesotho (70 per cent) and Sudan (58 per cent). It is estimated that half or more of the cash income earned by farmers engaged in mixed crop-livestock production in tropical Africa is obtained from livestock products. Livestock is used as food shortage insurance and is essential for livelihood security in many parts of the continent. In the semi-arid zone, ruminants are the only practical means of transforming pasture and browse forage into food and income. Overall, the money generated by the livestock sector is said to contribute to food purchase, underscoring the contribution of the sector to financial access to food in Africa. There is no doubt that asses and camels and other species contribute to physical access to food given their important transportation services in many countries of the region; published estimations on such a contribution remain to be widely made available.

Contribution to Food Production

Current growth of livestock population in Africa (about 1 per cent per year) is poor. The continent is the only Third World region where the caput beef production has been in decline since 1977 and where such decline will prevail until the year 2000. Total meat self-sufficiency is also inadequate as it is currently estimated at less than 95 per cent in Africa as whole and less than 68 per cent in the war-torn Great Lake subregion. Growth of total milk production is currently estimated at less than 0.6 per cent per year. Overall, meat and milk output growths are mediocre as they fall far below the 4 per cent annual growth value which is needed to feed the continent's burgeoning population. Africa's trade deficit in livestock and livestock products is currently estimated at 3.2 billion with the biggest share (about 64 per cent) ascribed to dairy products and egg imports. This reflects the weak base and poor support for dairy development in the region.

Contribution to Food Quality

Animals are important source of food of high quality proteins that are generally lacking in food of plant origin. To be well fed only on proteins of plant origin, the consumer must properly select a number of plant proteins of divergent composition. This supposes that this consumer has some degree of nutritional education and he/she is not financially constrained in the formulation of his/her diets. These conditions are not met by African rural and urban poor and they cannot be asked to live only on plant proteins.

The degenerative diseases associated with high intake of food of animal origin can be a problem in the more affluent individuals in Africa but cannot be used to discourage the consumption of such food by African poor who generally rely on cereals, tuber and roots for long periods of time. Zoonoses, as far as they are concerned, are beyond doubt enemies of food security but to blame food of animal origin per se for their role in transmitting these diseases to humans is to avoid solving the problem at hand. The issue is not to just tell people to stop eating raw meat. It is an issue of maintaining food producing animals in good health and using public health programmes that prevent food borne diseases and provide awareness-driven health and nutrition education.

Diets with low protein concentration and/or poor quality protein limit growth and development and lead to high morbidity and death especially in children. Protein-energy malnutrition (PEM), an imbalance aggravated by lack in the diets of proteins of high biological value such as animal proteins, causes preschool children to be stunted,

wasted and mentally retarded. Studies show that in 13 Eastern and Southern African countries, 29 per cent of children suffer from underweight, 10.6 per cent are wasted and 43 per cent are stunted. There is little or no doubt that malnutrition is at the origin of the overall poor longevity in Africa. Life expectancy at birth in 1985-1990 was estimated at 66.5 years in Latin America, 62.9 years in Asia and only 51.7 years in Africa, and is expected to be respectively 69.2, 66.5 and 54.4 years in 1995-2000 in these regions. Infant mortality per 1000 births in 1995-2000 is projected to be 87 for Africa, 56 for Asia and 42 for Latin America.

Strategies for Increasing Livestock Contribution to Food Security in Africa

Understanding Food Security Concept

As indicated earlier, the definition of food security with reference to food grains is misleading and needs to be reformulated. Cereal grains alone cannot provide adequate diets and nutrition; they need to be complemented with proteins of high biological value. The reformulation will help avoid the tendency to ignore livestock products in the food security debate and assessment. Further, it is crucially important to understand that poverty and food insecurity cannot be dissociated and that the former is essentially at the origin of hunger and malnutrition.

Research and Development

Adequate policies will be formulated and greater impacts achieved if the appropriate picture of malnutrition is obtained in individuals of all vulnerable groups such as rural and urban poor, children, pregnant and nursing women. This calls for the identification of appropriate indicators and for the use of clinical data including anthropometrics required for PEM assessment. A combination of all appropriate clusters and their indicators are essential for food security assessment because of the complexity of issues involved. The true contribution of insufficient intake and actual body supply of animal originated food to malnutrition and related consequences must be determined in the diagnosis stage of food insecurity. Data on household access to food (including biological access), adequate health services and healthy environment must be complemented by detailed information on each individual in the household. Research must also be intensified to realize Africa's great potential for livestock development. Biotechnology in this context must not be neglected. But first, extensive use of universally well known and available conventional technologies must be fostered which contributed to accelerated development elsewhere and which can help move the continent's livestock sector from its actual primitive stage to a modern and productive enterprise.

Access to Food and Health Services

Important progress toward food security will be achieved if Africa refrains from perpetuating the neglect of rural poor and practices that cause nutritional discrimination within the household. Oppression and civil strife must be prevented and people most concerned by food insecurity must be allowed to participate actively in their own socio-economic development.

Food self-sufficiency is not a blue print for food security achievement and should not obscure the debate about food security in Africa. Success will come from policies which discourage the drive for food self-sufficiency at all costs and use it to promote global domestic food production through sub-regional or regional cooperation and integration.

Greater improvement in food security can be expected only if Africa uses corrective measures aimed at reversing the current poor to mediocre infrastructure situation that undermines food production and distribution.

Education and Training

It is counter-productive and unrewarding to blame people for their ignorance and eating habits. Instead, African poor as well as a large proportion of its more affluent people who ignore the notion of balanced diet and quality food along with the need of animal proteins in children diets must be given nutritional training and education. Greater impact will be obtained if African governments recognize the important and strong relation between nutrition, health and food security and endeavour to improve public health.

I. INTRODUCTION

The Problem

1. The ultimate goal of national or regional development programmes is expected to entail adequate provision of basic needs to the community. Essentially, these needs include good food, good health, adequate housing, education and employment opportunities. The trouble is that Africa virtually offers none of these; instead, the continent is prominent in sustaining war, oppression, illiteracy, mismanagement and neglect of agriculture as well as helplessness as regards weather vagaries, unprecedented burgeoning human population growth and debt burden. In essence, the continent seems to favour massive births only to neglect human factor in the development process and to settle for a notorious inability to save its people from hunger and pronounced deprivation. Such is the image of a continent most invariably associated with famine and famine related misery and death.

2. Misery and mortalities from famine are easily perceivable. They generate fast spreading and shocking news that usually puts the world's machinery for relief services to work. It is argued, however, that though famine can be long-lasting in some African countries, it cannot be seen as a generalized and permanent 'hazard' in the continent where it is usually endemic and recurrent in nature. That 6 million people were vulnerable to severe hunger in Zimbabwe during the 1991-92 drought in southern Africa and that yet famine did not occur (CGIAR, 1994)^{4/} appears to be a good example in this context. What is more general and permanent, at least in sub-Saharan Africa, is malnutrition. Said (1972)^{20/} observes that "there is no country in Africa south of the Sahara whose people have attained, on the average, a level of nutrition commensurate with good growth and development, good health and satisfactory working efficiency". That this statement remains valid, today, more than two decades after it was issued, is overwhelmingly recognized.

3. Africa is chronically malnourished, which causes considerable suffering, morbidity and death most especially among children, pregnant and nursing women, and other vulnerable groups. This is a major stumbling block in the continent's way to development. Unfortunately, the situation is hardly appreciated by government policy makers as malnutrition is not an obvious communicable disease that would deserve an immediate and constant attention, and compute for existing financial resources.

4. Food production, the basis of all nutrition, is poorly organized, lacks good government supports and adequate agricultural structure¹, relies almost exclusively on rainfalls and on what many observers refer to as backward technologies. Food quantity and energy-giving food are wrongly equated with adequacy of nutrition. A food self-sufficient nation tends to be thought of as a food secure one. The notions of quality protein and balanced diet, and the cause-and-effect relationship between nutrition and public health seem to be quite ignored in the development-based debates. It is in this context that livestock, as a source of high quality food and a potentially important factor in African food security achievement is generally ignored.

5. Overall, the prescription of the United Nations Declaration of Human Rights that everyone has the right to sufficient and proper food is increasingly seen as a wishful dream in the African region. This may be ascribed to the fact that the concept of food security is misunderstood or taken for granted or both, a sad situation as Maribe (1992)^{18/} characterizes it when he quotes the August 1990's report of Southern Africa Development Coordination Conference (SADCC) that acknowledges the current dearth of understanding of food security concept and the 'too little' recognition of its importance even in the education and training of professionals destined to health, nutrition and food policy work in Southern Africa.

¹ This is made up of roads, irrigation, research, input delivery systems, level of farmer education, access to agricultural services, etc.

6. In this monograph, issues related to the concept and indicators of food security and their application to food of animal origin will be discussed and data on food insecurity in Africa presented. The actual and potential roles of livestock as an important determinant in alleviating malnutrition and its adverse effects in the continent will also be discussed. A particular attention will be given to the identification of major intervention domains and to the strategies likely to increase livestock sector's contribution to food security in the region.

II. THE CONCEPT OF FOOD SECURITY AND RELATED INDICATORS

Historical Background

7. The notion of food security is not new. Man, since his creation, has always endeavoured to secure food for times of crisis as a means to preserve life. In other words, one of the keys to survival since the early days has been in the security of food reserves. However, much attention began to be focused on the concept only recently at the 1974 World Food Conference. The international debate that resulted from or followed this conference, led to a move of the concept from the avoidance of transitory shortfalls in the aggregate food supply, its initial meaning, to the recognition with Sen (1981)^{22/} that it is the lack of access to food by households and individuals due to low incomes or entitlements that causes food insecurity and not only the inadequate levels of global food supply. Many other researchers, as Staaz et al. (1990)^{25/} indicate, have confirmed this finding and shown that this lack of access is chronic and not transitory for most of the world's hungry. Food security concept, therefore, has gradually evolved to entail not only transitory problems due to inadequate supply but also chronic lack of access and unequal distribution at the household level.

8. In Africa, the evolvement patterns of food security concept do not differ fundamentally from those described above. The continent is even said to have played

an important role in bringing first to prominence the term food security. A UN report (UNECA, 1987)^{27/}, in fact, indicates that the 1973-1975 drought in the sahelian zone of sub-Saharan Africa was at the origin of the FAO-led World Food Conference in 1974. Until 1984, food security related debates and programmes centred on cereal reserves to be used against crop failures and storage policy. Essentially, the focus was on short-term food security.

9. The concept, then, shifted from its initial meaning to that which differentiates the permanent food insecurity from the temporary food deficits and which recognizes that famine, hunger and malnutrition result as well from poverty as from shortage in available food. The pursued goal in the continent, henceforth, is not only to secure food reserves against short-term fluctuations or shortages but also to find long-term solutions to structural or permanent food insecurity problems. It is this goal which approximates that formulated and laid down earlier in 1980 by Lagos Plan of Action and which has never been translated into impact-driven actions.

Some Indicators of Food Security

10. The new understanding embodied in the preceding forms the basis of the definition suggested by the World Bank (1986)^{32/}. According to this definition, "food security is access by all people at all times to enough food for an active and healthy life". However clear and understandable the definition may be, it hides a number of important points in the food security concept debate.

11. First, the word access should not only mean 'physical access' and 'financial access' but also "biological access". The latter which can be referred to as the actual and efficient use by the body of the food ingested is generally not covered in the food security assessment process.

12. Secondly, the terms "enough food for an active and healthy life" must be directed to both the quantity and quality dimensions of food and their relation with public health and welfare. This raises the issue of the validity of the reference used to define food security in the theoretical and empirical literature. In fact, food security is defined with reference to food grains, which is misleading where roots, livestock and tubers are major sources of food and income. FAO (1993) quoted in Sansoucy et al. (1995) reports that 40 per cent of total food energy for half of the sub-Saharan African population are supplied by non-cereals.

13. Thirdly, the terms 'all people' accounts for each and every member of the consumer unit (CU) be it at the level of the household, the village, the district, the country, the subregion or the region. Of the panoply of determinants proposed or used in food security assessment effort, only a few that are relevant to the scope of the current presentation will be discussed. These are food self-sufficiency, household access to food, food protein-energy adequacy and access to adequate health services.

1. Food Self-Sufficiency (FSS)

14. Self-sufficiency is defined as the state or quality of being capable of effecting one's own ends or fulfilling one's own desires without the aid of others. This implies that a country/region is food self-sufficient when its domestic food production is enough to cover its own national/regional consumption in the absence of food imports, aids or donations. Certainly, the drive for food self-sufficiency is noble, particularly when shortfalls in domestic supply of food result in massive commercial imports of food that drain foreign exchange reserves. This calls on the nation/region that opts to achieve FSS to opt also for a necessary development of its agriculture sector, particularly the food production sub-sectors of it.

15. However, food self-sufficiency cannot be equated with food security as it does not guarantee adequate access to food everywhere in a country or a region neither does

it ensure adequate distribution of food in a household or a CU. Moreover, FSS does not guarantee that a household with little or no financial resource will have access to and consume food items available in the region, district or village.

16. Studies by the World Bank (1986) in 53 developing countries including 25 African countries, over many years, indicate that the energy value of the national food ration (used to measure chronic food insecurity) and the per caput income are highly correlated. The studies also show that the variations in cereals FSS have little or nothing to do with the variations in the energy value of the national food ration. Though these results need to be interpreted with care, they tend to prove that FSS, in its capacity, cannot eliminate food insecurity.

17. Other studies by Binswanger and Quizon (1984) show that the increase in national food production in India does not lead to reduction in food insecurity in the face of relatively high food prices. The fact is that the per caput consumption in this country has remained relatively constant for many years despite the increase in per caput food production. This is consistent with the abundance of well documented examples highlighting the coexistence of aggregate food self-sufficiency and widespread malnutrition/hunger complex (Sansoucy et al., 1995).

18. The thirst for food self-sufficiency can lead to yet another serious problem. A country that endeavours to achieve food self-sufficiency in a food commodity at all cost despite the lack of adequate resource for the purpose inevitably runs the risk of misusing its scarce financial resources that could be directed to better alternative uses. This, essentially, can be a cause of further deterioration of food security situation.

19. Furthermore, assuming that, quantitatively, food security is reached in a nation and in every household, a rare event, the claim that each member of such household has access to enough food and that quality adequacy and biological access are guaranteed both at the household and the individual levels is hardly acceptable as a situation of the kind is in itself a rare event in poor countries.

20. In Africa where infrastructure is poor particularly in the areas of road, transport and market, where sub-regional or regional integration and cooperation remain a very difficult task, where food policy is lacking or inadequate and where cultural taboos highly affect the nutritional status of the individual in the household, national, sub-regional or regional food self-sufficiency is a mediocre indicator of household food security. FSS initiative at sub-regional and/or regional levels can, nevertheless, boost the continent's domestic production of food provide that other initiatives aimed at removing constraints to adequate access are taken.

2. Household Access to Food (HAF)

21. One of the best accounts on HAF is provided in a study by UNICEF-ESARO (1993)^{30/}. According to this study, HAF is the 'access to food adequate in quantity and quality to fulfil all nutritional requirements for all members of the household throughout the year'. In this context, a household is food insecure (a) if it cannot obtain food within a reachable distance (a reflection of physical accessibility), (b) if its purchasing power is too low which is required to acquire the food needed (a reflection of financial accessibility), (c) if access to food producing land or to other means for own food production is lacking or inadequate, or if (d) all above prevails. The study also lists the factors affecting HAF; these are access and control of resources, land holding, labour, employment and income, environment condition and seasonality, traditions and beliefs, infrastructure and institutions.

22. The study further elaborates on the two indicators generally used to measure household access to food and which are:

- the amount of time spent walking or travelling in order to reach available food (a measure of physical access), and

- the proportion of total income allocated to food (PIAF) (a measure of financial access).

Where the above indicators are not available, the study adds, their respective components can be used. These are family stocks used for physical access and food purchasing power for financial access (Table 1). In the specific area of livestock, a surrogate indicator is used to measure household financial access to food. For the nomadic communities, such access is best measured by the household asset status with livestock being the most important asset.

23. In its study in Eastern and Southern Africa, the author (ie., UNICEF-ESARO, 1993) uses a threshold of one hour as indicator of physical access and for the indicator of financial access a PIAF of 60 per cent. This proportion (ie., 60 per cent), the author indicates is the limit reported in several studies in Africa. Above this limit, the author also indicates, access to other services, including housing, transport, health, sanitation and mother's time, is adversely affected. In an earlier report, however, Lipton (1983)^{17/} rejects any PIAF lower than 75 per cent or greater than 80 per cent and observes that the persons in least developed countries seldom spend less than two-thirds of income on food and that part of the differences in the PIAFs reported may be ascribed to different relative prices between food and non-food items or to different needs for non-food essentials.

24. In the above study, PIAF is reported to be the main mechanism mediating the relationship between poverty and malnutrition in Eastern and Southern Africa. The study shows, using a multivariate analysis involving malnutrition as dependent variable and a series of explanatory variables, a strong association between malnutrition and the percentage of rural population below absolute poverty level. This association disappears, however, once PIAF is introduced in the model and becomes the best predictor of nutritional status. The study concludes that since PIAF is an indicator of financial access and therefore of HAF, the latter may be considered as the most important determinant of malnutrition in the region.

25. HAF has many advantages over FSS as shown by the above indicators. However, a number of shortcomings prevents it from predicting fully malnutrition. Firstly, the concept of HAF is limited to household as CU and fails to cover individual consumer cases. A food secure household can have malnourished individuals due to many reasons such as taboos, gender considerations and inadequate child care. In this context, HAF will not guarantee food quantity and quality adequacy to each member of the household and is, thus, a poor means for individual food security assessment.

26. The second shortcoming is related to poor health and sanitation as well as to inappropriate feeding practices that can prevent adequate levels of consumption security from translating into satisfactory nutritional status in most vulnerable members of CU, especially preschool children, pregnant and lactating women.

27. Thirdly, HAF makes no provision for the assessment of protein-energy malnutrition (PEM) as measured, for example, by anthropometrics and of protein inadequacy in the diet. Clearly, HAF is a necessary but not a sufficient condition for adequate dietary intake though insufficient household access to food leads to inadequate dietary intake (Fig 1).

28. Finally, the poor emphasis on the household food production for direct home consumption in the assessment of HAF can be considered as a major constraint to adequate conduct of such assessment. This is so because rural communities in most African countries eke out a subsistence life which almost exclusively relies on agriculture. Due to various factors including poor modern technology utilization, agricultural production growth remains inadequate, resulting in poor incomes and little or no food surplus for sale. In turn, inadequate incomes limit food purchase, indicating that these rural households will mostly try to meet their food demand with their own food production. As expected, food insecurity inevitably sets in since such production is generally poor and fails to satisfy adequately the underlying demand. This agrees with the observation of FAO (1995)^{11/} which points out that in the societies of low-

income countries where the bulk of the populations relies on agriculture, "it is proper to speak of food insecurity as being a problem of production".

3. Protein-Energy Malnutrition (PEM)

29. Dietary energy deficiency is overwhelmingly known as a cause of chronic under-nutrition in adults and serious ill-conditions in African children (see section on livestock contribution to food quality). Indicators used to assess the status of PEM are:

- dietary energy supply and
- anthropometrics.

30. The dietary energy supplies is always considered in relation to the proportion of the recommended daily energy intake. It can be calculated for any CU and used for individual malnutrition appraisal. However, the data requirements for calorie-base assessment are very large (Glewwe and van der Gaag, 1988)^{13/}. Further, the term calorie adequacy generates a lot of confusion. In fact, it is commonly stated that, if individuals, CU or populations obtain sufficient calories from their usual diets, protein adequacy is automatically assured. A latest report (Scrimshaw, 1994)^{21/} indicates that this generally true statement often leads to false conclusions and that high morbidity and even extinction characterize societies which, for specified reasons, are unable to obtain complementary protein on which their usual cereal or root diets depend.

31. The above report reveals that part of the confusion results from the inaccurate protein allowance and the inadequate amino-acid pattern for adults that are proposed by FAO respectively in 1973 and 1985. The proposed protein allowance was much too low and needed to be increased by about one-third and the amino-acid pattern underestimated essential amino-acid needs per gram of protein by one-half to two-thirds. Interestingly, these were corrected later by FAO. Studies cited by the author point to increased possibility of lysine being a limiting amino-acid in populations living on high cereal diets.

32. Another problem associated with the calorie-based assessment is that dietary energy is expressed in calorie averages which fail to give a distribution that shows the number of families or individuals with low protein intake. Estimated energy requirements are compared only with average dietary energy intake figures. This biases the relative adequacy of protein and calorie in the diets as the higher income groups consume and waste more calories than they need while the poorer groups are left with even less than they need (Scrimshaw, 1994).

33. Finally, calorie-based assessment does not account for the concentration and quality of protein which become critical in case of protein-energy imbalance and/or during recovery from infections nor does it guarantee adequate measure of micronutrients (minerals and vitamins) supply in the diets (also see section on contribution to food quality in chapter III).

34. The anthropometric indicators used to measure malnutrition (especially childhood malnourishment) are intended to determine the incidence of under-weight (ie., low weight for age, wasting (ie., low weight for height) and stunting (ie., low height for age). Scrimshaw (1994) observes that food intake, food availability, energy requirements are "each notoriously unreliable" and that the anthropometric indices are the most convenient and reliable basis for determining the prevalence of protein-energy malnutrition. These indices, the author adds, are more reliable under-nutrition indicators than the "comparison of dietary data with presumed requirements".

4. Household Access to Health Services (HAHS)

35. HAHS is 'the access to culturally acceptable health services and a healthy environment in adequate quality and quantity for all members of the households throughout the year' (UNICEF-ESARO, 1993). It is crucially important because it plays a major role in the reduction of malnutrition and the related child death. As such, it is considered as an immediate determinant of malnutrition.

36. A lack of appetite resulting from a fever leads to inadequate intake and to malnutrition though food may be available in quantity and quality. Nutrition status is worsened by an episode of infections in any individual but the recovery is fast if the individual is well nourished and if his or her diet is adequate for rapid re-establishment of good health. It should be emphasized that parasite infection interferes with the absorption and utilization of nutrients (see chapter III for details). Drinking unclean water, by the same token, generally leads to diarrhoea which is an important cause of malnutrition. In fact, a study reported in UNICEF-ESARO (1993) shows a highly significant correlations ($p=.000$) between proportion of population with access to safe water and nutritional status. As this proportion increases, there is a substantial reduction in under-weight ($r=-.47$, $p=.000$), wasting ($r=-.39$, $p=.000$) and stunting ($r=.54$, $p=.000$).

37. The main indicators of HAHS proposed by UNICEF-ESARO (1993) are physical accessibility (geographical access) and financial accessibility to health services and to healthy environment. Because these services can be out of reach even if the two main conditions are met, social and cultural accessibility and organizational accessibility are usually considered (Table 2).

38. It can be argued that the financial access and the physical access to health services per se do not guarantee the effective use by the illiterate poor of these services neither do they remove the ignorance factor and the cultural taboos and beliefs that dictate ill-fated eating habits and practices, and predispose to diseases. The most devastating effect of these diseases is the hindrance of adequate intake, absorption and utilization of food nutrients. HAHS fails to provide for a test of biological access needed to determine the actual use by the body of nutrients ingested.

39. Like HAF, HAHS is a necessary but not a sufficient condition for adequate dietary intake and alleviation of malnutrition. In other words, neither HAF nor HAHS, when considered individually, is enough to solve food security problems. A combination of these two determinants with another cluster referred to as care for

children and women support (CCWS) (Fig 1) is needed but this combination must come with a package involving other considerations before food security can be guaranteed. Essentially, HAF, HAHS and CCWS must all be satisfied together with the needs for shelter, basic education, tools required to earn a living, good kinship or social network and good relations with neighbours, all of which are part of livelihood security (Maxwell, 1992 quoted in Csete, 1994^{2/}).

5. Conclusion

40. Food security issues are complex. It is hardly acceptable to think of a unique indicator of food insecurity or of malnutrition. Likewise, there seems to be no standard way to deal with the subject everywhere and under all circumstances. It is likely that adequate nutrition is secured at the household level if conditions embodied in household access to food, household access to health services, maternal and child care are met together with other factors considered to be important in the livelihood security. However, since achieving food security must essentially be realized at the individual level (ie., individual food security), household access should be replaced by individual access and anthropometric indices should be used extensively to determine nutritional status of each member of the household. As much as possible, selected indicators applicable in a given or specific situation should be tested in a model using malnutrition as dependent variable.

III. CONTRIBUTION OF LIVESTOCK TO FOOD SECURITY IN AFRICA

Contribution to Income Generation and Physical Accessibility

41. Livestock asset value in Africa was worth about US\$ 53 billion in 1980 and US\$ 58.2 billion in 1990 (UNECA, 1992)^{28/}. The contributions of livestock sector to farm income and to farm wealth were estimated at US\$ 5.6 billion and US\$ 558.4 million, respectively, according to the same source. Studies by Winrock International (1992) indicate that when farm-level value of draft power and manure is considered along with that of meat, milk, eggs, wool, hides and skin produced, livestock production in 1988 represents 35 per cent of agriculture domestic product in tropical Africa. As shown in table 3, this corresponds to a livestock commodity output value of US\$ 11.8 billion in 41 countries of Africa. Table 3 also shows that livestock share of agriculture commodity value (measured in US\$) is high in many African countries. For example, this share is 88 per cent for Botswana, 84 per cent for Mauritania, 82 per cent for Namibia, 70 per cent for Lesotho, 58 per cent for Sudan and more than 30 per cent for each of eight other countries.

42. ILCA (1987)^{15/} reports that half or more of the cash income earned by farmers engaged in mixed crop-livestock production in tropical Africa is obtained from livestock products. A dominant part of the cash income and gross margin in smallholder cereal-livestock farms in the Ethiopian highlands is provided by livestock (Gryseel, 1988)^{14/}. Zimbabwean smallholders who combine livestock and crop production activities have twice the income of their counterparts who are only engaged in subsistence crop production (Gittinger et al., 1990).

43. Gijsman and Rusamsi (1991)^{12/} report that livestock is used as "food shortage insurance" in Sukumaland, Tanzania. Because the rate of money devaluation is very high in this country, farmers there invest their money in livestock as the most reliable

and stable way of saving. The livestock is sold and income so generated is used to purchase food in times of food shortage. The poorer farmers rely on chicken and goats and the wealthier on cattle. In the arid zone where one-tenth of sub-Saharan African population (i.e., 45 million people) lives, ruminants are the only practical means of transforming pasture and browse forage into food and income (Winrock International, 1992).

44. In Debre Berhan (Ethiopia), per caput consumption (translated into monetary terms) is found to be almost double in the households that adopt high-milk producing crossbred cows (CBC) than in those that do not (Shapiro, 1994)^{23/}. As illustrated in table 4, CBC households generate more income and consume much more major staple and other crops than households using local breed cows (LBC).

45. It appears that substantial income is generated from livestock in Africa and that opportunity cost of ignoring livestock raising activities can be very high at resource-poor farmer level. The money generated is often said to have contributed to food purchase. This seems to indicate that livestock provides an important contribution to financial access to food. Whether this generally coexists with physical access to food and individual food security is not known. Nevertheless, given the transportation services provided by asses, horses, camels and other animal species, chances are that the contribution of livestock to physical access is important in Africa though published records on such contribution are yet to be made available.

Contribution to Food Production

46. It was argued in chapter II that food self-sufficiency (FSS) does not guarantee food security for a nation, a region or an individual member of the community. However, it was stated that a nation/region that directs efforts to achieving FSS is likely to opt for the development of its agricultural sector, which could contribute to the improvement of food security. It is in this context that the performances of African livestock sector are presented in the following.

1. Stocks of food producing animals

47. The livestock population (cattle, buffaloes, sheep, goats, pigs, horses, chicken, camels, mules and asses) in Africa was estimated at about 205.38 million tropical livestock units (TLU)² in 1994 compared to 203.34 million TLU in 1993. Such population grew just about 1 per cent in 1994, which compares poorly with the growth of about 2 per cent in 1993 and that of 1.28 per cent per year over the decade 1984-1994. The decreased growth may be due to the carryover adverse effects of the drought that caused havoc in the eastern and southern subregions in 1992 and reduced, according to FAO (1994)^{8/}, the continent's cattle number in 1993.

48. As shown in table 5, eastern and southern parts of Africa are also the only subregions where livestock population growth has been in drastic decline in 1993 and 1994. FAO (1994) also reports that in 1994, a large number of pastoralists in Kenya were faced with critical food shortages because livestock which is their main source of livelihood was severely affected by the drought.

49. The TLU growth remained poor in 1994 and even showed a slight decrease in the Western Africa sub-region, probably due to insufficient time for tangible recovery. It did so despite that the poor pasture conditions recorded for many sahelian countries in 1993 have improved a lot in 1994 thanks to good rains (FAO, 1994)^{9/}. The growth

² One TLU is equivalent 250 kg body weight. Equivalences by species are as follows:

1 camel = 1 TLU
1 horse = .8 TLU
1 buffaloes = .7 TLU
1 cattle = .7 TLU
1 mule = .7 TLU
1 ass = .5 TLU
1 pig = .2 TLU
1 sheep or 1 goat = .1 TLU
1 chicken = .01 TLU

is as well expected to be poor in 1995 as it is predicted to be around 1 per cent, resulting in a total population of 207.42 million TLU.

2. Meat

50. Africa is the only Third World region where the caput beef production has been in decline since 1977 and where such decline will continue until the year 2000 (Table 6). This is consistent with recent trends which indicate a drop in the total meat self-sufficiency ratio (MSSR) to 91.4 per cent in 1994 from its already low level (94.7 per cent) of 1993 (Table 7). At the sub-regional levels, MSSR was unsatisfactory and tended to stagnate in every subregion in 1993/1994 except in the Eastern and Southern Africa where it decreased by 1.3 per cent due undoubtedly to the carryover effects of the drought that prevailed there. MSSR was also poorest in both 1993 (67.6 per cent) and 1994 (67.2 per cent) in the war-torn Great Lake subregion and highest (95.3 for both 1993 and 1994), albeit inadequate, in the West African region. If the trends shown here continue to prevail, the indicator will fall further in the years to come.

51. The drought mentioned earlier was at the origin of animal retention for herd rebuilding and thus of the contraction in the meat output in 1993 (FAO, 1994)³. During this same year, the per caput meat consumption fell in Africa, contrasting with the marginal rise in most other developing regions. According to the same source, significantly higher production of pig meat was obtained in Nigeria and Ghana probably supported by larger availability of cassava for feed in the year (1993). The pig meat production increase was estimated at 5 per cent.

52. In the northern Africa, production of poultry meat is expected to expand in Egypt because of rising domestic demand and in Morocco because of the boost ascribed to increased protection against foreign competitions since late 1993 and improved feed

³ See note 2.

supplies. The subsidized barley sales launched by the Government of Tunisia to sustain livestock production were expected to increase the country's cattle meat output in 1994 and beyond. There has not been much change in bovine meat output in 1994 though in some drought-affected countries including Kenya (in the eastern Africa), emergency slaughter has given it a temporary boost.

53. Overall, meat demand in the near future is expected to fall in Africa with a reduction in per caput meat consumption, reflecting depressed economic conditions in the region (FAO, 1994)^{10/}. Such a reduction is expected to be important in parts of Africa where considerable increases in meat prices are brought about by the devaluation in countries of the CFA franc.

3. Milk

54. The total milk production from cattle, buffaloes, sheep and goats in Africa was estimated at 19.6 million tons in 1994, a slight increase of 0.6 per cent over the production of 19.5 million tons in 1993. This trend is expected to be maintained over the year 1995. Cow milk production, however, has been in decline since 1992 as it fell from 15 million tons in 1991 to 14.8 million tons in 1992, 14.7 million tons in 1993 and 14.6 million tons in 1994. This decline could have been due to decrease in dairy cow herds in the drought-affected southern and eastern parts of the continent.

55. The above growth of the overall milk output was mediocre as it fell far below the 4 per cent annual value which, according to the World Bank (1989)^{33/}, is needed to feed sub-Saharan burgeoning population and progressively eliminate milk import. There seems to be no indication of possible drastic changes in production conditions in the near future, which means that growth is likely to remain poor in 1995 and beyond with a total output of about 19.7 tons for 1995.

4. Trade

56. Africa continues to be the destination of large shipments of live cattle and beef exported from EEC though the continent is witnessing a fall in beef imports to the countries of the CFA zone due to currency devaluation related high supply costs. The continent's imports of livestock and livestock products in 1993 were estimated at 4.003 US\$ billion with an overall related trade deficit of US\$ 2.937 billion and with dairy products and eggs accounting for 64.55 per cent of this deficit. In 1994, the imports jumped to US\$ 4.147 billion and the deficit to US\$ 3.063 billion (Table 8). Again, dairy products and eggs continued to account for a considerable proportion (64.19 per cent) of the trade deficit in the total livestock and livestock products, reflecting the weak base and poor support for dairy development in the region, especially in sub-Saharan Africa. The deficit is expected to reach 3.2 billion with the biggest share (63.85) still going to dairy products and eggs at the end of the 1995.

5. Conclusion

57. The food production performance of African livestock sector is inadequate. The various growth rates presented for stocks, meat and milk fall far below the level of 4 per cent per year that is needed to feed African fast growing population and to save income which otherwise will be used to cover imports of food items of animal origin. The huge and increasing trade deficit associated with massive imports of dairy products justifies the concern of many African Governments over the poor self-sufficiency in the these products and its spill-over adverse effects on food security. The deficit further reflects the neglect of the dairy sub-sector in Africa.

58. Because African Governments have tendency to satisfy the needs of urban populations and to neglect the rural poor who represent the bulk of the region's populations, chances are that the imported livestock products rarely or never reach the vulnerable groups that suffer most from food insecurity. Further, it could be argued

that the poor development and productivity of livestock sector which prevails against a background of an unprecedented population growth and a rapid development of cities, exacerbate the overall food insecurity crisis. This is so because the huge imports of live animals and animal products contribute considerably in draining the continent foreign reserves, which in turn increases domestic financial constraints to improved livelihood security thus to increased food security in the continent.

Contribution to Food Quality

1. Food of Animal Origin for Balanced Diets

59. Food security cannot be achieved if food consumed is of poor or inadequate quality. This implies that the household and/or individual diets must be balanced, free of poisonous materials and pathogens contaminations. The food must also be available to and absorbable upon digestion by the body (see zoonoses in this section). A balanced diet is one with adequate level of energy, essential amino acids and needed micronutrients. The essential amino-acids are those that the body cannot synthesize and which must be provided by the food. They must be supplied in a ready-made form. Proteins which do not provide the body with these essential amino-acids upon digestion or which supply some of them in sub-optimal quantities are of no value in supporting body metabolism as are proteins that supply full complement of the essential and non-essential amino-acids. The latter proteins are referred to as proteins of high biological value.

60. Unfortunately, not all types of protein are of high biological value. Of lower value are the plant proteins many of which are low in essential amino-acids such lysine, tryptophan, methionine and threonine. In each of these plant proteins, one or more essential amino-acids may be missing or may be present in such inadequate amounts that the entire protein is of low biological value. The incomplete plant proteins must be supplemented with foods supplying the missing essential amino-acids in order to

provide good quality nutrition. It is to be emphasized that both protein source and energy source foods provide energy but when poor quality proteins prevail in the diet, imbalance ensues. In energy-protein malnutrition (PEM) that leads to kwashiorkor, for example, inappropriate balance of protein relative to calories in the diet is to be blamed.

61. Animals are an important source of food, especially of high-quality proteins. One of the advantages of food of animal origin is the presence in animal products of non-protein materials such as minerals, vitamins and accessory factors that are not found in many plant materials. Another advantage is that amino-acid pattern of animal proteins closely resembles human tissue proteins so that the body receives an ensemble of amino-acids in about adequate proportions, something lacking in plant proteins (Aylward and Jul, 1975)^{1/}. The high protein concentration of animal feedstuffs as compared to plant items is shown in table 9 and the essential amino-acid composition of plant and animal protein foods is found in table 10.

2. Cases used against food of animal origin

62. It is possible to be well fed on proteins of plant origin only provided that the diet contains a properly selected number of plant proteins of divergent composition (Burton, 1980)^{3/}. This is said to have been the case of vegans. Many are those who argue that since biotechnology offers opportunity to incorporate missing essential amino-acids in plant proteins, the whole debate about consuming food of animal origin in order to get these essentials is irrelevant. The most critical remark ever made in this context is from Brown (1991)^{2/} who underscores the irony associated with the fact that just when many nutritionists in industrialized countries encourage greater consumption of plant-derived food and lesser intake of unsaturate fats, less affluent countries are beginning to recognize the need of animal products in their diets.

63. Certainly, the above generally true observations lead to false conclusions. To make an appropriate selection of food items of plant origin that supply all the essentials, two requirements must be met: (a) the consumer must perfectly know of these items

and (b) must have access to them. This requires that the most affected portions of the population have some degree of nutritional education or something related to it and that they are not financially constrained in the formulation of their diets. These conditions, obviously, are not met by African rural and urban poor at the current stage of the continent's development and cannot be expected to be so in the near future. That Africa's notorious debt burden, mismanagement and corruption do not make room for the nutritional education of these poor, justifies why this is so. By the same token, it is believed that prospects of engaging the continent in a forceful exploitation of advanced technology opportunities and/or fostering the poor's access to imported biotechnology-generated food products at affordable prices will remain poor for a long time.

64. Another generally true but misleading fact used against food of animal origin is the potential health risks associated with high intake of such food. These include degenerative diseases which are of major public health concern in developed nations and among the more affluent individuals in poor countries. High-protein diets can also cause deterioration of body calcium balance. However, Africa is far from consuming the levels of protein that cause these adverse effects. In the continent, poor-resource populations may rely exclusively on food from one cereal, tuber or root for a long period of time, and meat is usually reserved for sale in the urban markets or for consumption during small or large festivals because of its high prestige and price. Eggs are generally sold or used for breeding and are denied to infants in many tribes.

65. The transmission of zoonoses to humans via live animals or through the consumption of food of animal origin is yet another fact used against this food. Indeed, the list of zoonoses which can be bacterial, viral or parasitic is considerably long. These zoonoses cause widespread illness and death among humans and are significant deterrent to socio-economic development. They undermine livestock health and productivity, reduce milk, meat and egg production, generate important losses in human work and curtail the biological access to food in sick human consumers. Thus, they contribute a great deal to human malnutrition. In Africa where domestic animals live

in close cohabitation with their owners, where livestock health is poorly protected and where traditional eating habits favour the consumption of non-boiled milk, raw meat and fresh blood, many communities are at high risk.

66. The case of *Taenia saginata* (*T. saginata*) is worth mentioning here. This zoonotic parasite is obligatory of man in its adult form. The larval stage (*Cysticercus bovis*) mainly occurs in cattle and is recently found in reindeer. People infected by eating raw or undercooked meat may carry the adult form of the parasite for many years. They suffer in a number of ways some of which are as follows:

- (1) the parasite shares with its host the food ingested by the latter;
- (2) the sucking tapeworm causes traumatic lesions to the small intestine walls, which greatly curtail the absorption efficiency;
- (3) toxic substances released by the parasite produce pain and weakness in the host; and
- (4) because of its considerable length (3-8 metres on the average), the parasite obstructs the lumen of the small intestine causing serious stomachaches and constipations.

67. These few examples of damages inflicted by *T. saginata* whose prevalence rate is said to exceed 10 per cent in some African countries south of Sahara (WHO, 1979)^{31/}, underscore the great loss of biological access and human work that could result from zoonotic pathogens.

68. Zoonoses are, beyond doubt, enemies of food security. However, to blame animal originated food per se is to avoid tackling the problem at hand and thus to help perpetuate the infections. The issue is not just to tell people to stop eating raw meat. It is an issue of maintaining food producing animals in good health and using adequate

public health programmes that prevent food borne diseases and provide awareness-driven health and nutrition education.

69. Diets with low protein concentration or with poor quality protein limit growth and development in children, and can lead to high morbidity and death. Protein-energy malnutrition (PEM) can cause preschool children to be stunted, wasted and mentally retarded. In addition, PEM leads to a high frequency of diarrhoeal and respiratory infections which in turn prevent adequate intake and absorption. PEM further results in poor performance, high morbidity and death in adult. In both children and adults, malnutrition leads to poor resistance to infections. Such infections increase in children when these are exposed to unhealthy and contaminated environment. It is of paramount importance to know that proteins of high biological value (ie., proteins of animal origin) are essentially needed during recovery from episode of infections, particularly in children. Milk is especially indicated in this case and when infants are recovering from malnutrition.

3. State of Protein-energy Malnutrition in Africa

70. The available data show that PEM is a serious problem in Africa. Pellet and Young (1987)^{19/} report, based on studies by Young et al. (1988)^{34/}, that for the average diets in Africa, the supply of dietary lysine is marginal both for children and adults. Interestingly, such lysine is abundant in meat and milk. In a study involving 13 Eastern and Southern African countries and in which anthropometric indices were used as indicators, UNICEF-ESARO (1993) found that the mean proportion of underweight (low weight for age) children in the subregion was 29 per cent with a range of 12-48 per cent, which was little lower than the mean proportion of 31 per cent reported for Africa (UNICEF, 1992)^{29/}.

71. In Tanzania, Rwanda, Ethiopia, madagascar and Burundi the proportion of underweight was above 31 per cent with children of 6-23 months of age being the most

affected. An average of 2-10 per cent of under-fives were severely malnourished and needed medical care. About 200,000 children in Kenya and 300,000 in Tanzania were also severely malnourished and needed medical attention.

72. The above study also showed that the mean proportion of wasted children (low weight for height) in the subregion was about 10.6 per cent with a range of 1-20 per cent and with the highest rate reported for Ethiopia, Rwanda and Madagascar, and the lowest for Tanzania, Uganda and Zimbabwe. On the average, 43 per cent of children in the sub-region are stunted (low height for age) the range in this case being 25-60 per cent.

73. Other studies (Gryseel, 1988; Shapiro, 1994^{23/}) related to adoption and non-adoption of high milk-producing crossbred cows by Ethiopian households, showed that more preschool children were below 90 per cent of their height for age (ie., stunted) in non-adopting than in adopting households. Children in non-adopting households were also more prone to sickness and slightly lighter than those in adopting households. Finally, both adult men and adult women weighed more in adopting households than in non-adopting households.

74. Chances are that the above highlighted malnutrition and its public health implications play an important role in lowering the overall poor longevity in Africa. The fact is that life expectancy at birth (LEB) in Africa (51.7 years) compared poorly with that of Asia (62.9 years) and that of Latin America (66.5 years) over the period 1985-1990 (UN, 1993)^{26/}. In other words, Africa's children born over this period will live 11.2 and 14.8 years less than their contemporaries respectively in Asia and Latin America. This is a gap that could prove difficult to bridge as, according to the same source, LEB over 1995-2000 is expected to be 54.4, 66.5 and 69.2 years for Africa, Asia and Latin America, respectively. Infant mortality per 1000 births in 1985-1990 was 103 infants in Africa, 69 in Asia and 59 in Latin America with projected values of respectively 87, 56 and 42 infants for Africa, Asia and Latin America in 1995-2000.

The share of poor consumption and/or inadequate absorption of food of animal origin in the poor longevity is yet to be determined.

3. Conclusion

75. Animals are important source of proteins of high biological value, non-protein materials such as mineral, vitamins and accessory factors that are not found in many plant materials. Lysine is the essential amino-acid that is missing the most in the diets of populations of African poor. Lysine is abundant in meat and milk. Protein-energy malnutrition causes havoc in Africa where stunting, wasting and underweight are widespread. The livestock contribution to the quality of the diets can be substantial provided that food of animal origin is both safe and available at affordable prices to African poor. Indications of poor anthropometrics due to food of animal origin related insecurity appear to be common but the contribution of such insecurity in the poor longevity remains unknown.

IV. STRATEGIES FOR INCREASING THE CONTRIBUTION OF LIVESTOCK TO FOOD SECURITY

Understanding Food Security

76. The current poor understanding of food security (FS) concept and issues may be partly due to the reference used to define FS. It goes without saying that since FS is defined with reference to cereals, many are the people who ignore livestock products and other food commodities in the FS debate and assessment. The need to recognize that cereals are deficient in many essential elements which are required for balanced diets and that they are not and should not be the only items to consider in a food basket cannot be over-emphasised in this context. For greater understanding of FS and better FS related policies, the above mentioned reference must be revisited so as to formulate a more adequate definition and to give to food of animal origin and other food items their deserved place in the fight against hunger and malnutrition in Africa.

Research and Development

77. There is a dearth of information on food security in general and food security associated with livestock products in particular. Further, most of the methodologies reviewed in this document are concerned with household, a situation that is not conducive to the assessment of individual food security. Adequate policies will be formulated and greater impacts achieved if the appropriate picture of malnutrition is obtained on individuals in all vulnerable groups such as rural and urban poor, children, pregnant and nursing women. This calls for a gigantic work that requires mobilization of important financial resources. This also calls for the identification of appropriate indicators some of which are specific to areas under investigation.

78. Statistical models are needed for the selection of the above indicators. Clinical data including anthropometrics are required for PEM assessment and should always be

part of food security research. The true contribution of insufficient body supply of animal originated food to malnutrition and related consequences (eg., morbidity and death) must be determined in the diagnosis stage of food insecurity. Overall, data on household access to food, adequate health services and healthy environment should be complemented by detailed information on each individual in the household. In all cases, appropriate clusters and their indicators must be used in the food security assessment in order to cope with the complexity of issues involved.

79. Research also needs to be intensified in order to realize Africa's great potential for livestock development. Improvement of feed and feeding must be among the top priorities and must be done taking into account the potential of and the constraints associated with each agro-ecological zone. Africa, in all research areas, must take advantage of biotechnologies developed elsewhere and endeavour to develop own specific biotechnologies.

80. It is now recognized that Africa's agriculture in general and livestock sector in particular would have evolved from its primitive stage (ie., the actual stage) to a modern, more productive food and income generating enterprise had the universally well known technologies that contributed a great deal to the development in the North and in many countries in the South been adapted, adopted and used extensively in the continent. Without the move to use massively these technologies now referred to as conventional technologies, the region's base for biotechnologies use will remain very weak with no prospect of harvest from the new developments that are changing the world and its food and agriculture sector.

Access to Food and Health Services

81. It was shown earlier that abundant production of food by a nation does not guarantee access to food by every poor and malnourished individual in that nation. Equal distribution of food to each member of the household is not secured in Africa because of taboos, beliefs, neglect of rural poor, discrimination, repression and injustice. Important progress towards food security will be achieved if the continent refrains from encouraging these behavioral particulars. Essentially, wars must be prevented and people most concerned by food insecurity must be allowed to participate actively in their own socio-economic development.

82. The need for a nation to secure food self-sufficiency should not obscure the debate on the relationship between the notion of such food self-sufficiency and that of food security. For one thing, as it was discussed earlier, food self-sufficient is not a blue print for food security achievement at household and individual levels. The key to success lies in support of policies which discourage the drive for self-sufficiency at all costs where domestic production is severely constrained by natural or other causes. Since no country can be self-sufficient in all components of food basket, efforts to achieve food self-sufficiency must be channelled through sub-regional/regional cooperation and integration. This will also preserve globally African foreign exchange reserves and prevent from financing food and agriculture development outside instead of inside Africa.

83. Greater improvement of food security will come from corrective measures aimed at reversing the poor infrastructure situation that undermines food production and distribution efforts in Africa. In other word, access to food and health services can only be poorly achieved in the continent if the lack of roads, markets, processing facilities and irrigation devices etc continue to prevail.

84. As highlighted earlier in this monograph, access to food is inadequate if such food provides no good nutrition to the body when ingested. Where this prevails, energy

for body maintenance, production and other needed activities cannot be secured neither can the active life much needed for any socio-economic process be sustained. In this context, assessment and improvement of biological access to food by African populations in general and African rural and urban poor in particular must serve as one of the major pillars for the region food security.

Education and Training

85. It is hardly acceptable to blame people for their lack of knowledge and eating habits. Just as nobody blamed Vasco da Gama when 100 out of his 180 men crew died of scurvy during the first sea voyage around Africa from Europe to India (Lathan, 1979)^{16/}, African poor cannot be blamed for their nutrition related ignorance. The crew was ignorant of the fact that scurvy could be prevented by vitamin C in fresh fruit or food.

86. In Africa, city and rural poor as well as a large proportion of the more affluent people, have little or no knowledge of human nutrition and the items needed to balance diets. The importance in such diets of high-value proteins which insure fast recovery and protect against recurrent infections is also ignored along with the critical need to deworm in order to free consumers of secret sharers of food (ie., the parasites) which cause inadequate absorption and reduce both quantitatively and qualitatively body access to needed nutrients. Greater impact from efforts to improve FS should be expected when vulnerable groups are educated and trained to understand the basic rules of human nutrition and public health. This will be achieved if and when governments recognize the important and strong relation between nutrition, health and food security and endeavour to improve public health.

V. GENERAL CONCLUSIONS

87. Food security concept is not new. It used to entail guaranteed stock reserves for times of shortage, particularly transitory insecurity situations due to inadequate supply of food. The concept has evolved from such initial understanding to that which differentiates the permanent food security from temporary food deficits. The lack of access to food is chronic and not temporary for most of the world hungry. Thus, food security is access by all people at all times to enough food for an active and healthy life.

88. However articulate the definition of food security may be, it is generally misleading. This is so because such definition is formulated with reference to food grains as if the consumption of these grains alone guarantees quality diets and food security or as if it is logical to neglect livestock, tubers and roots that are major sources of income and food in many areas of the developing world and particularly in Africa.

89. Some of the major cluster determinants used in food security assessment include household access to food (HAF), household access to health services (HAHS), maternal and child care and level of protein-energy malnutrition. The biological access which is the effective use by the body of the food ingested has so far been given a little attention in the food security debate.

90. Household access to food entails physical and financial access to food. The amount of time spent to reach the available food and the proportion of total income allocated to food are used as indicators of physical access and financial access, respectively. HAHS is determined using physical accessibility and financial accessibility to health services. Protein-energy malnutrition is best determined through the use of anthropometric indices such as underweight, stunting and wasting. There is a dearth of relevant circumstance or location-specific indicators.

91. The use of average dietary energy intake figures biases the relative adequacy of protein and calorie in the diets because the high income groups consume and waste more calories than they need while the poor have less calories than they need.

92. Food self-sufficiency cannot be equated with food security because it does not guarantee an adequate distribution of food among members of a household, among countries or subregions of a continent or among various districts of a country. However, because of the costs and the adverse effects of food imports on African economies, the continent should endeavour to meet its food demand mainly through food self-sufficiency or self reliance at sub-regional and regional levels and use FSS as a contributing factor towards food security achievement.

93. The income generation capacity of Africa's livestock is substantial and so is the potential of this sector to increase its contribution to the improvement of food security in the continent. Some evidence is presented which shows that the money so generated is used to purchase food. Whether each member of the household has adequate physical access to such food is unknown. There is no doubt that livestock contributes considerably to physical access to food in the region.

94. The performance of livestock as food producer in Africa is poor. Meat and milk growth generally falls below the recommended average rate of 4 per cent per year that is needed to feed African burgeoning populations. The poor domestic production leads to heavy imports of animal products whose price is above the reach of the vulnerable groups. Imports of milk and eggs account for more than 60 per cent of the deficit associated with animal products trade recorded for the continent.

95. Animals are important source of food of high biological value. Many plant materials are poor or deficient in essential amino-acids and need to be adequately selected or complemented with animal proteins in order to balance the diets. The bulk of African populations has not reach the intake levels of animal proteins that cause degenerative diseases. Food of animal origin should not be blamed for serving as

vehicle for human infected zoonotic pathogens. The real cause of infections from such food are to be found in the lack of appropriate public health programmes and the poor health in food producing animals.

96. Diets with low protein concentration or with poor quality proteins limit growth band development in children and lead to high morbidity and death. Stunting, wasting and underweight of preschool children are widespread in Africa. The continent has more infant mortality and poorer life expectancy than Asia and Latin America. The lack or poor supply of animal protein in these children's diets must certainly be playing an important role in worsening the situation.

97. Information on food insecurity in the vulnerable groups will be best obtained through well planned research that is directed not only to households but also to individuals in these households. Needed resources must be mobilized and clinical data must always be compiled and made available. These include anthropometric indices that are required to determine PEM. Research must also be intensified to develop the continent's livestock sector. Biotechnological development in this context must not be neglected. Africa is a mediocre user of conventional technologies that gave a boost to development elsewhere; this situation needs to be changed without further delay.

98. Best results can be expected in the fight against malnutrition if governments provide incentives to produce and to sell and consider as top priorities, the development of an adequate agriculture infrastructure, the recognition of the important relation between nutrition, health and food security and the improvement of public health.

99. Knowledge of human nutrition needs to be provided extensively through training and education of African food insecure groups. The concept of food security should be well highlighted and the notion of balance diet understood. A reformulation of the definition of food security to take livestock, roots and tubers into account is critically needed.

Table 1. Potential indicators, proposed measures and main sources of information

Indicator	Potential Measure	Possible Source of Data
1. Indicators of Physical accessibility		
= Market availability	= # of hhs within one hours travel one way to the main source of the basic staple food	= HH surveys Key information
= Food stocks	= # hhs with enough food stocks the month before next harvests	= HH surveys
	= amount of food produced as a proportion of the amount of food required for the hh given its size and composition	= HH surveys
= Household food monitoring card	= # of hhs with the basic staple food available at any given time compared to requirement	= Community based HH surveys
Indicators of Financial accessibility		
= Food Expenditure	= # of hhs spending more than 50 % of the hh budget on food	= HH surveys
= Purchasing Power	= # of hhs aiming less than a predetermined minimum income	= HH surveys Key informants
	= # of hhs in a nomadic community with less livestock than the recommended for the hh size	= HH surveys Key informants
Indirect measures of HAF		
= Food balance sheets at household level	= # of hhs with less than 100 % at household level per capita or the requirement	= HH budget surveys
= Market information	= value of the food required for market inventory minimum active life	= Market inventory
	= regional conflicts/infrastructure	= observation, informants
	= production per acre	= government report informants
= Food Production	= # of hhs cultivating drought resistance crops in addition to the staple crops	= HH surveys

Source: UNICEF-ESARO (1993).

Table 2. Factors affecting health accessibility and possible indicators

Factors	Potential Indicators
Physical accessibility	= distance to the service (km.) = travel time by common means of transport
Financial accessibility	= Proportion of income spent on acquiring health in hh, (should include cost of drugs, transport and fees for service)
Cultural accessibility	= acceptance of the services by community members (qualitative) = coverage of different services
Organizational accessibility	= satisfaction by community = waiting time = availability of basic supplies

Source: UNICEF-ESARO (1993).

Table 3. Value of agriculture and livestock products in 41 countries in sub-Saharan Africa, 1988

Country	Value* (\$ millions)		Livestock share of agr. output (%)
	Agriculture	Livestock	
Sudan	3,261	1,901	58
Nigeria	9,780	1,749	18
Ethiopia	3,243	1,299	40
Kenya	2,202	826	38
Tanzania	2,837	642	23
Somalia	709	514	72
Madagascar	1,765	472	27
Uganda	2,840	404	14
Mali	835	368	44
Niger	667	314	47
Zimbabwe	1,137	260	23
Namibia	300	245	82
Cameroon	1,419	224	16
Chad	554	216	39
Angola	632	201	32
Burkina Faso	671	183	27
Senegal	817	172	21
Zambia	527	169	32
Mozambique	796	160	20
Mauritania	188	158	84
Zaire	2,740	143	5
Côte d'Ivoire	2,644	136	5
Ghana	1,321	121	9
Benin	554	115	21
Central Afr. Rep.	363	115	32
Botswana	121	107	88
Guinea	535	101	19
Malawi	831	98	12

	Value* (\$ millions)		
Rwanda	645	70	11
Lesotho	95	66	70
Swaziland	193	47	24
Burundi	739	42	6
Togo	326	37	11
Sierra Leone	300	35	12
Guinea-Bissau	113	25	22
Mauritius	182	24	13
Liberia	241	22	9
Reunion	78	19	24
The Gambia	99	15	15
Congo	155	15	10
Gabon	86	9	10
Total	47,541	11,839	25

* Based on total output of agricultural and livestock products (meat, milk, eggs, wool, hides and skins); calculated at international prices based on IMF and FAO data. Values are in 1979-81 international dollars.

Source: U.S. Department of Agriculture (1990).

Country

Livestock share of agr.
output (%)

Table 4. Per caput consumption differences between households with local cattle only (LBC) and those with crossbred cows (CBC)

Annual consumption (in Eth Birr)		
Consumption items	LBC owners	CBC owners
Major staple crops (barley-teff-wheat)	258	505
Other crops	146	244
Non-dairy livestock and livestock products	63	43
Non-food items and services	160	143
Milk	15	20
Butter	35	57
Cheese	12	17
Total consumption	689	1,029
Leisure	17 days	35 days

Source: Shapiro (1994).

Table 5. Livestock population (TLU) and annual growth rate^A

Subregion	TLU (million)					Annual Growth Rate (%)	
	1984	1992	1993	1994 ^E	1995 ^P	1992-1993	1993-1994
North Africa	33.13	37.95	39.14	40.37	41.63	3.13	3.14
Central Africa	8.63	11.31	11.57	11.38	12.08	2.30	2.24
Great Lakes	2.58	3.05	3.08	3.14	3.19	0.98	1.94
Latin E & S Africa	83.62	81.28	78.14	75.23	74.61	-3.86	-3.72
West Africa	33.19	39.48	39.64	39.79	40.57	0.42	0.39
Africa	182.10	199.43	203.34	205.38	207.42	1.96	1.00

A: Calculations are done with Agrostat data (FAO, 1992)^{7/}.

TLU: Tropical livestock unit

P: Projections

E: Estimates

Table 6. Per caput beef production of country groupings 1975-2000 (kg/caput)

Years	Country groupings/Regions			
	Africa	Latin America	Asia	Developing countries
1975	5.05	22.76	0.95	3.73
1976	5.08	24.38	0.89	3.90
1977	5.30	25.00	0.89	3.99
1978	5.25	24.94	0.90	4.00
1979	5.19	23.05	0.93	3.83
1980	5.18	22.23	0.94	3.74
1981	5.15	22.63	0.94	3.47
1982	5.19	21.85	0.95	3.14
1983	4.96	21.21	0.97	2.82
1984	4.84	20.14	1.01	2.52
1985	4.93	20.95	1.06	3.66
1986	4.66	20.54	1.11	3.63
1987	4.60	20.46	1.16	3.65
1988	4.55	20.97	1.17	3.72
1989	4.55	22.44	1.16	3.88
1990	3.95	22.10	1.21	3.87
1995	4.01	24.10	1.37	4.15
2000	3.67	26.50	1.56	4.49

Source: Adapted from FAO (1990)^{6/}.

Table 7. Meat self-sufficiency by subregion: 1993, 1994 and 1995^A

Subregion	Meat Production (1,000 MT)			Meat Consumption (1,000 MT)			Meat Self-sufficiency (Percentage)		
	1993	1994	1995	1993	1994	1995	1993	1994 ^B	1995 ^P
North	2,274	2,328	2,382	2,748	2,823	2,897	82.7	82.5	82.2
Africa	332	338	344	392	402	412			
Central	196	197	199	290	293	296	84.7	84.1	83.5
Africa	2,423	2,458	2,492	2,613	2,685	2,759			
Great	1,936	1,975	2,013	2,032	2,073	2,114	67.6	67.2	67.2
Lakes									
E & S	8,793	8,961	9,129	9,592	9,799	10,007	92.7	91.5	90.3
Africa									
West							95.3	95.3	95.2
Africa									
							91.7	91.4	91.2
Africa									

A: Calculations are done using Agrostat data (FAO, 1992).

Table 8. Trade in livestock and livestock products (100,000 US\$)^A

	1993	1994 ^E	1995 ^P
Export livestock products	5,332	5,370	5,407
Import livestock products	32,710	33,918	35,125
Trade deficit livestock products	27,378	28,548	29,718
Export live animals	5,330	5,473	5,616
Import live animals	7,323	7,554	7,786
Trade deficit live animals	1,993	2,081	2,170
Total trade deficit	29,371	30,629	31,888
Export dairy products and eggs	229	230	231
Import dairy products and eggs	19,189	19,891	20,592
Trade deficit dairy products and eggs	18,960	19,661	20,361
Share of dairy products and eggs in total trade deficit	64.55	64.19	63.85

A: Calculations are done using Agrostat data (FAO, 1992)

P: Projections

E: Estimates

Table 9. Protein content of animal foodstuffs⁴ and selected plant produce⁵

Source	Fresh Tissue		Protein g/100g dry wt.
	Water g/100g	Protein g/100g	
Meat			
Beef	70	20	67
Pork (lean)	70	20	67
Liver	70	20	67
Milk	87	3.4	26
Eggs (whole)	73	12	46
Fish			
Fatty (herring fillet)	63	17	46
Non-fatty (haddock fillet)	81	16	84
Cereals			
Wheat	15	12	14
Maize	11	10	11
Oats	11	10	11
Rice	12	8	9
Oil-seeds			
Soya	10	33	37
Groundnuts	6	27	28
Cotton-seed	8.5	20	21
Sesame	5.5	21	22
Non-fatty legumes			
Peas	65-80	4.6-8.2	26
Beans	64-89	2.9-4.1	29
Green leafy vegetables			
Cabbage	90	1.4-3.3	24
Spinach	92	2.3-5.1	46
Roots, tubers and plantains			
Cassava (Manioc)	57	0.7	2
Potatoes	76	2.1	9
Yams	69	2.1	7
Plantains	60	1.0	3

Source: Aylward and Jul (1975).

^{4/} The figures refer to uncooked produce. As wide variations occur in supplies from different animals, the figures quoted should be regarded as rough indications.

^{5/} The literature shows very wide variations depending on cultivar, cultivation and other conditions and no doubt in some cases analytical methods.

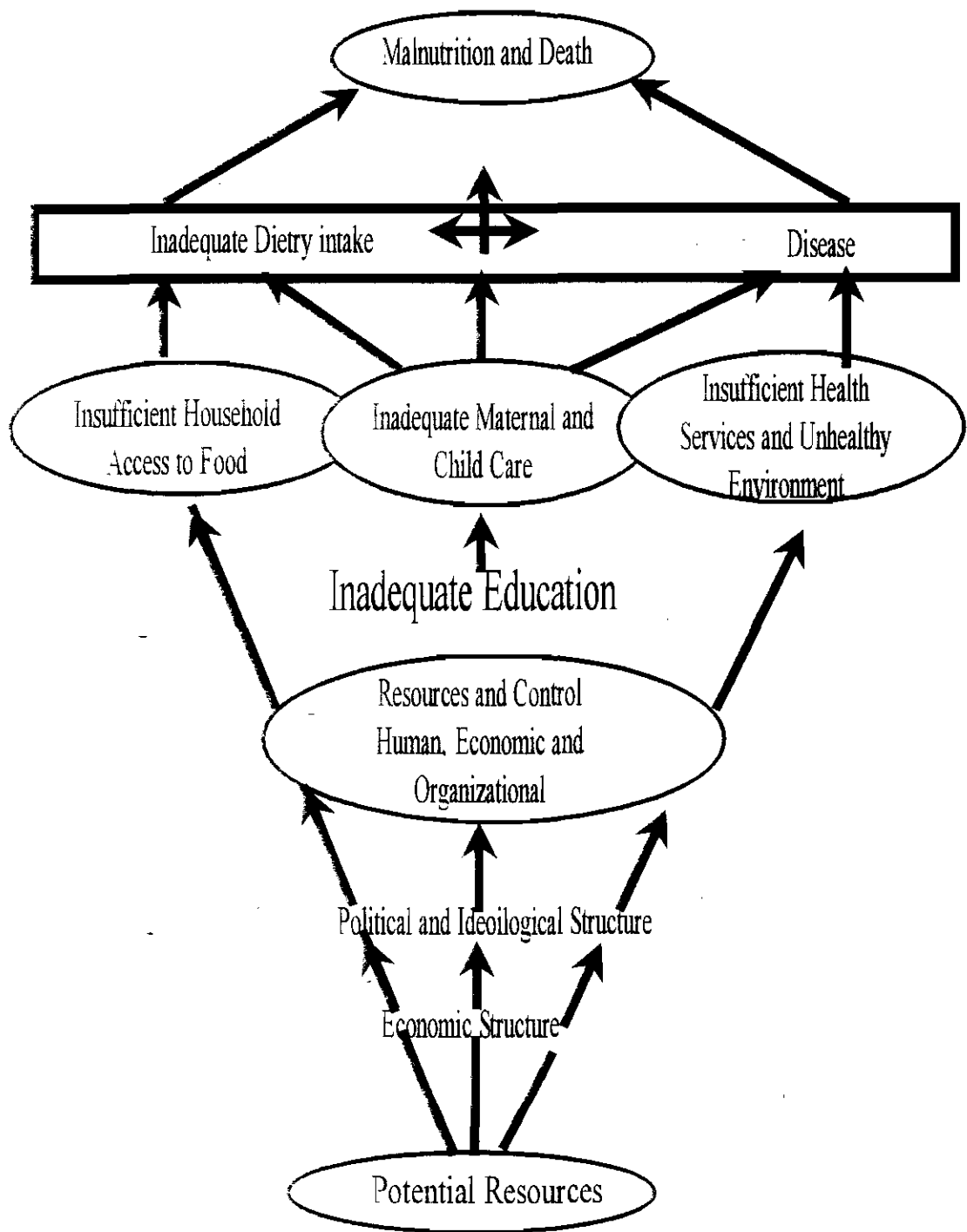
Table 10. Essential amino acid composition of protein foods (listed in decreasing order of biologic value)

Foods and their biologic value	Arginine	Histidine	Threonine	Valine	Leucine	Isoleucine	Lysine	Methionine	Phenylalanine	Tryptophan
Egg whole	700 (6.2)	240 (2.1)	560 (4.9)	790 (7.0)	1,015 (9.0)	700 (6.2)	690 (6.1)	360 (3.2)	640 (5.6)	130 (1.1)
Milk, whole human	50 (4.2)	23 (1.9)	59 (4.9)	87 (7.2)	154 (12.8)	80 (6.7)	75 (6.2)	22 (1.8)	64 (5.3)	22 (1.8)
Milk, whole cows'	122 (3.7)	72 (2.2)	152 (4.6)	233 (7.1)	398 (12.1)	221 (6.7)	243 (7.4)	93 (2.8)	181 (5.5)	46 (1.4)
Egg albumin	5,310 (6.0)	2,140 (2.4)	4,430 (4.9)	6,630 (7.5)	7,790 (8.8)	5,740 (6.4)	6,390 (7.2)	3,690 (4.2)	5,270 (6.0)	1,020 (1.2)
Corn germ, defatted	1,310 (8.1)	475 (3.0)	710 (4.4)	860 (5.3)	1,145 (7.1)	680 (4.2)	940 (5.8)	260 (1.6)	810 (5.0)	210 (1.3)
Liver, animal	1,090 (6.6)	410 (2.5)	875 (5.3)	990 (6.0)	1,390 (8.4)	790 (4.8)	1,150 (7.0)	530 (3.2)	1,000 (6.1)	246 (1.5)
Meat, beef	1,220 (6.5)	620 (3.3)	845 (4.4)	975 (5.1)	1,480 (7.8)	980 (5.2)	1,630 (8.6)	515 (2.7)	740 (3.9)	300 (1.0)
Fish, muscle	1,410 (7.4)	500 (2.6)	890 (4.7)	1,140 (6.0)	1,800 (9.5)	1,235 (6.5)	1,710 (9.0)	610 (3.2)	835 (4.4)	228 (1.2)
Wheat germ	1,510 (6.0)	630 (2.5)	1,590 (6.3)	1,130 (4.5)	1,690 (6.7)	1,130 (4.5)	1,390 (5.5)	330 (1.3)	760 (3.0)	250 (1.0)
Soya bean meal, low fat	3,270 (7.3)	1,300 (2.9)	1,750 (3.9)	2,370 (5.3)	3,580 (8.0)	2,690 (6.0)	3,050 (6.8)	760 (1.7)	2,370 (5.3)	625 (1.4)
Rice, whole	440 (7.2)	100 (1.7)	230 (3.8)	380 (6.2)	500 (8.2)	320 (5.2)	195 (3.2)	205 (3.4)	300 (5.0)	80 (1.3)
Casein	3,720 (3.9)	2,900 (3.0)	4,280 (4.5)	7,000 (7.4)	9,500 (10.0)	6,050 (6.4)	7,740 (8.1)	3,100 (3.3)	5,150 (5.4)	910 (9.60)
Wheat, whole	560 (4.3)	275 (2.1)	430 (3.3)	560 (4.3)	910 (7.0)	520 (4.0)	350 (2.7)	325 (2.5)	665 (5.1)	155 (1.2)
Potatoes, white, raw	100 (5.0)	44 (2.2)	140 (6.9)	110 (5.3)	190 (9.6)	75 (3.7)	170 (8.3)	50 (2.5)	120 (5.9)	40 (2.1)
Wheat, gluten	3,300 (3.7)	1,790 (2.0)	2,500 (2.8)	3,820 (4.3)	6,450 (7.7)	4,080 (4.6)	1,810 (2.0)	1,500 (1.7)	4,520 (5.0)	690 (0.5)
Oats, whole	775 (6.8)	260 (2.3)	410 (3.6)	615 (5.4)	910 (8.0)	560 (4.9)	410 (3.6)	230 (2.0)	625 (5.5)	150 (1.3)
Barley	610 (5.1)	260 (2.2)	480 (4.0)	610 (5.1)	840 (7.0)	510 (4.3)	420 (3.5)	190 (1.6)	620 (5.2)	190 (1.6)
Yeast, dried brewers'	2,140 (4.3)	1,400 (2.8)	2,740 (5.5)	2,490 (5.0)	2,690 (7.4)	2,930 (5.9)	3,730 (7.5)	1,395 (2.7)	2,040 (4.1)	650 (1.3)
Cottonseed meal	3,450 (11.3)	830 (2.7)	920 (3.0)	1,470 (4.8)	1,830 (6.0)	1,230 (4.0)	1,080 (3.5)	520 (1.7)	1,840 (6.0)	400 (1.3)
Corn, whole	380 (4.8)	200 (2.5)	300 (3.7)	425 (5.3)	1,200 (15.0)	510 (6.4)	180 (2.3)	250 (3.1)	400 (5.0)	48 (0.6)
Rye, whole	590 (5.3)	250 (2.2)	370 (3.3)	560 (5.0)	670 (5.0)	440 (3.9)	450 (4.0)	180 (1.6)	470 (4.2)	140 (1.2)
Buckwheat flour	1,050 (8.9)	250 (2.1)	480 (4.0)	660 (5.6)	740 (6.2)	450 (3.8)	700 (5.9)	220 (1.9)	500 (4.2)	200 (1.7)
Peanut flour	7,440 (11.3)	1,465 (2.1)	1,830 (2.8)	3,000 (4.6)	4,650 (7.1)	2,730 (4.1)	2,390 (3.5)	550 (0.8)	520 (4.9)	520 (0.8)
Peas and beans, dried	1,610 (7.0)	500 (2.2)	895 (3.9)	1,265 (5.5)	1,610 (7.0)	1,270 (5.5)	1,490 (6.5)	460 (2.0)	1,150 (5.0)	185 (0.8)

Note: Figures in parentheses represent percentages of the amino acids in the food proteins (corrected on the basis of an ideal protein containing 16 per cent of nitrogen on a moisture- and ash-free basis). Plain figures give the milligrams of essential amino acids provided by 100 g of the food listed.

Source: Burton (1980).

Figure 1. Causes of Malnutrition



Source: UNICEF- ESARO (1993)

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