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Africa Leadership Forum

The Challenges of Agricultural
Production and Food Security
in Africa

By
Dr. M.S. Swaminathan

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I. WHERE ARE WE NOW?

In the Arturo Tanco Memorial Lecture of the Royal Society of Arts delivered in 1987, I stressed that development to be sustainable must be based on a better common present.

In his Arturo Tanco Memorial Lecture delivered in 1987, General Olusegun Obasanjo said, "the economic future of Africa depends on the future of agriculture". This point was also underlined by President Robert G. Mugabe in his Africa Prize for Leadership address delivered in London on 30 January, 1989 in the following words.

"Agriculture will continue to be the backbone of Zimbabwe's economic development for the foreseeable future. This section accounts for nearly half of our foreign exchange earnings. While in 1980 the exportation of some of our surplus accounted for Z\$282 million, this contribution had risen to nearly Z\$ one billion in 1988." In other words, agricultural progress is the key not only to food security but to rural and national prosperity. This is why in my Aggrey-Fraser-Giguiseberg Lectures delivered at the University of Ghana in 1981, I pleaded for a wider concept of food security. A national food security system, I emphasized, can be built only on the twin foundations of ecological security and employment guarantee (Swaminathan 1981).

In the first Arturo Tanco Memorial Lecture delivered in 1986, I stressed the need for building sustainable national nutrition security systems in all developing countries. I defined **Nutrition Security as physical and economic access to balanced diets and safe drinking water to all children, women and men at all times.** This is absolutely vital for ensuring that all the citizens of a country have an opportunity for the full expression of their innate genetic potential for physical and mental development. Also, in the Andrew Sharman Lecture of the Royal Society of Arts delivered in 1987, I stressed that development to be sustainable must be also equitable. There is no point in talking about a better common future for humankind, unless we are also committed to the cause of promoting a better common present.

It is now widely acknowledged that while current food security problems in Africa clearly originate in part from the stagnation or decline in food production, ensuring food security also implies the provision of what Prof. Amartya Sen calls "food entitlements" such as land, credit, income and family support systems (Sen 1981). The example of Botswana in introducing a multi-pronged strategy involving cash and food for work programmes, supplementary feeding for underweight children, school feeding programmes and development of irrigation projects, is often cited as an example of tackling concurrently the production and distribution aspects of the hunger problem.

A recent report of the World Bank titled "The Challenge of hunger in Africa - a call to Action" (The World Bank, 1988) lays stress on a multi-pronged strategy for dealing with the problem of more

than 100 million people, i.e. a quarter of Africa's population, not being able to eat enough food for an active working life. The World Bank paper deals in detail with the quantitative and qualitative dimensions of the food insecurity problem in Africa and offers useful suggestions for a "mid-course correction" in current attitudes and approaches to food security problems in African nations.

A publication titled "Compact for African Development" (1985) and another paper titled "Transforming African Agriculture" by Carl K. Eicher (1986) also contain useful insights and suggestions. The African food security challenge has led to the rapid growth of both a vast library and an eloquent vocabulary, generated by eminent scholars, social workers, bilateral and multilateral donors all concerned with the question, "Can Africa double the rate of growth of agricultural production over the next 15 to 20 years to keep up with population growth rates of 3 to 4 percent?"

One example of the new awareness of foreign experts on Africa is the realisation that womens' economic contributions to households appear to be even more important in periods of economic contraction than in stages of economic prosperity. They are also more critical among low-income than high-income families and they are central to ensuring the nutritional welfare of infants in poor families. Nearly all experts now agree that only a sustained process of agricultural diversification to provide higher incomes and more job opportunities in rural areas and the building of grassroot institutions to enable the rural poor to

youth in

Region	Undernourished Number (81-85)	Percentage of Total
Far East	291	22
Near East	26	11
512		

take advantage of the development opportunities, will help to lasting solutions to the food insecurity problem. In this context, I will commend the book "Strengthening the poor; what have we learned?" edited by John P. Lewis (1988) for widespread reading.

Obviously, a more of the same approach is not going to help us to The report of the President of the World Food Council titled "The Cyprus initiative against hunger in the world" presented at Cairo in May 1989, describes the nature of the global food security challenge as follows:

"The number of hungry people increased 5 times faster in 1980s than in the previous decades. There were more malnourished children in 1984 than in 1975. Although the world is now feeding one billion more people than at the time of the 1974 World Food Conference, the objective of assuring food security for all people has been moving further away". The number of undernourished in 1983-85 was great not only in Africa but also in Asia and the Far East.

Region	Undernourished	
	Number (83-85) in millions	Percentage of population
Africa	140	32
Far East	291	22
Latin America	55	14
Near East	26	11
	<hr/> 512	

The President of WFC concluded that the deterioration of the human condition in terms of hunger, malnutrition, and poverty will not diminish in the prevailing policy environment. On the

contrary, with population growth, ecological deterioration and a mixed outlook for the world economy and the economics of developing countries, the challenges of dealing with hunger and poverty will be increasing.

Obviously, a more of the same approach is not going to help us to reverse current trends. What then are the pathways the Africa Leadership Forum should consider?

II. THE WAY AHEAD

The African Alternative places a high priority on attaining food self sufficiency. Having concluded that if agriculture goes wrong nothing else will go right, how can we make agriculture go right? Examples of countries like China and India which have been able to enhance agricultural production to the extent needed for national self-reliance in food output, indicate that farm women and men will be able to help the country to achieve its food security goals provided they are enabled to do so. The Lagos Plan of Action adopted in April 1980 established Africa's primary objective as the alleviation of mass poverty and improvement in the people's standard of living. Subsequent discussions and meetings have dealt with the causes for not realising the goals of the Lagos Plan of Action during the decade of the eighties.

The Economic Commission for Africa released on 6th July 1989, a proposal entitled "African alternative frame work to structural adjustment programmes for socio-economic recovery and transformation". The alternative blue print for economic revival thus, the African Alternative places considerable stress on the takes into account the following facts.

a) Per capita output declined from \$ 752 in 1980 to \$ 641 (in constant dollars) in 1987.

b) Per capita incomes declined in the same period by an annual average of 2.6 percent and

c) Africa may begin the next millennium with a greater proportion of its population being illiterate and unskilled that it did at the beginning of the post-independence era in the 1960s.

The African Alternative places a high priority on attaining food self sufficiency. The various measures suggested for this purpose include :

a) Allocation of 20 to 25 percent of the total public investment to agriculture

b) Land reform

c) Enhancing the role of women

d) Technological upgrading of the food production and

processing sectors

e) Minimum price for food crops

1. Social Factors:

f) Reorientation of credit policies to favour food production and the manufacture of essential goods

g) Strengthening of rural financial institutions

h) Greater focusing on African markets and

i) Building and managing strategic food reserves.

Thus, the African Alternative places considerable stress on the development of mutually reinforcing packages of technology,

services and public policies. Above all, it emphasises the need for local solutions to local problems.

Prescriptions for reversing current trends are many, resources are scarce and time is running out. The biological impoverishment of the countryside and a continuous diminution in the biological potential of the land are compounding the difficulties arising from the already serious constraints confronting small farm families. Fortunately, land is not the most limiting factor in Africa, since the continent occupies 11.70 million sq.miles of land as compared with 11.06 million sq.miles of the combined area of the United States, Western Europe and China. Also in Africa only 25 percent of the potentially arable land area is now under cultivation, as compared to over 70 percent in Asia. Africa is also fairly well endowed with good national and international research centres and training institutions. What then is the problem ?

Without adequate availability of energy sources productivity and efficiency cannot be improved. There is need for more power

III. NATURE OF CHALLENGES :

1. Social Factors:

The average size of a farm holding is decreasing. Livestock ownership is skewed and there is a heavy overgrazing in some areas. The number of landless labour families is increasing. Women usually perform jobs involving much drudgery and little remuneration. Youth constitute the majority of the rural population and the educated among them are not satisfied either with the infrastructure available in villages for health care and education or with the prevailing opportunities for skilled

employment. Consequently there is a drain of brains from the village to the city and town.

2. Economic factors:

Small farm families are affected more by the cost-risk-return structure of farming than the more well-to-do sections of the farming community. For them stability of income is as important as yield per hectare. There is a mismatch between production and post - harvest technologies, particularly with regard to perishable commodities. Knowledge-intensive techniques which can reduce the cost of production without reducing yield become particularly relevant. Also, income from farming alone will not be adequate to meet the needs of the family for a better quality of life. Farm income will have to be supplemented by off-farm income.

3. Energy:

Without adequate availability of energy sources productivity and efficiency cannot be improved. There is need for more power for the farm sector, if the efficiency of farm operations at the production and post-production stages is to undergo marked improvement. Energy is particularly needed in dry and drought-prone areas both for the timely preparation of land for sowing and for taking advantage of ground water resources. An integrated energy supply system involving both renewable and non-renewable sources of energy, needs to be developed for every agro-ecological region.

4. Employment:

The farm sector plays a dominant role in providing employment. In order to attract and retain educated youth in agricultural occupations, farm technologies should be both intellectually satisfying and economically rewarding. A knowledge - intensive agricultural system which can also generate considerable downstream employment in the secondary and tertiary sectors

will be necessary to create more skilled jobs for rural men and women. An integrated approach to on-farm and off-farm technical resources available to small farmers and agricultural labor families, it is essential that the organisational aspects is urgently needed. For this purpose, the on-going Farming Systems Research (FSR) programme will have to be modified and converted into a Rural Systems Research (RSR) programme, specifically designed to generate better growth linkages (Swaminathan, 1988).

5. Ecology:

In the ultimate analysis, only ecological security can safeguard both food and water security and livelihood security. The conservation and sustainable management of land, water, flora, fauna, and the atmosphere are essential for safeguarding the future of African agriculture. The unique coastal, mountain, wetland and dry land ecosystems of Africa need urgent attention from the point of view of conservation and rehabilitation. Sustainable land use systems will require detailed attention with reference to the following three categories of land:

a) land which needs to be conserved in its pristine purity because of its rich endowments of forests, wild life and other

forms of biological diversity;

b) land which is degraded and which needs to be upgraded through appropriate techniques of restoration ecology. These lands are usually referred to as "waste lands" and,

c) land which can be subjected to sustainable intensification through scientific agriculture and aquaculture.

6. Social Engineering:

In view of the small size of holdings and limited financial and technical resources available to small farmers and agricultural labor families, it is essential that the organisational aspects of small farm agriculture receive adequate attention. A small farm has great potential for intensive agriculture but a small farmer is usually confronted with serious economic problems arising from the cost and risks involved in intensive farming. It is only by helping the small farmer to overcome his/her economic and technological problems that the potential of a small farm for high productivity can be realised. Also, knowledge intensive and ecologically sound agricultural practices, such as scientific water management, integrated pest management, and improved post-harvest technology, require for their efficient adoption, cooperation among a group of farmers living in a village or watershed or the command area of an irrigation project. We can realise the full potential of small farm agriculture if individual initiative, group co-operation and government support can be promoted in a mutually reinforcing manner. Group insurance schemes, group subsidy, group oriented extension and other services and incentives for group-cooperation

need to be devised and introduced soon, if we are to maximise the efficiency of small farm agriculture. We should develop organisational structures which can promote decentralised production supported by a few key centralised services. This will also help to generate more skilled jobs in the services sector in rural areas. Special attention is needed in the case of perishable commodities for promoting producer-oriented marketing. For example, it will be useful to promote the organisation of Horticulture Estates, Poultry Estates and Aquaculture Estates, to provide the needed infrastructure facilities and services to small producers of vegetables, fruits, flower, eggs, broilers and fish. Social engineering techniques should ensure that new technologies reach the unreached and at the same time help to promote the growth of a socially relevant and dynamic services sector which can provide skilled jobs in villages to the young men and women belonging to families without productive assets.

IV. MEETING THE CHALLENGES:

The following are some of the principles which should form the basic guidelines for the agricultural strategy for the nineties:

- a) **Water, Energy and cost saving crop husbandry, i.e.,** productivity advance and water and energy use efficiency become the major pathways for enhanced production;
- b) **Grain saving animal husbandry i.e.,** the avoidance of animal husbandry practices which need large quantities of cereal grains

to feed animals and the initiation of a programme for the establishment of Rural Biomass Refineries; ng to yield further.

This will call for the introduction of frontier technologies
c) **To the factory but not to the town**, i.e., the generation of including the development of crop varieties which can give higher adequate number of skilled jobs in the secondary agro-processing yields per cubic metre of water. Post-harvest technology will and rural industries sector and tertiary services sector, so that also need additional attention so that all links in the producer-those without assets or work need not migrate to towns and consumer chain are attended to in an integrated manner. Through cities;

cereal-legume crop rotations, animal husbandry programmes can be
d) **Sustainable management of the basic agricultural assets** of land, water, flora, fauna and the atmosphere: for this purpose, current patterns of productivity measurement should be changed,
b) **Green but no green revolution areas:**
as will be pointed out later.

Several parts of Africa where water is not the most limiting
e) **Income and employment orientation to agricultural research** and development, so that agriculture becomes not only an instrument for the production of more foodgrains and other commodities but also a catalyst for the production of more jobs and income in rural areas. these areas. New methods of feeding the crops are necessary in these areas.

V. STRATEGIES:

c) **Dry Land Farming:**

India has the

It would be useful to divide each African nation into the following Science and Technology Zones; in each Science and Technology zone, the precise technology should be tailored to the prevailing agro-climatic conditions. ill have to receive such

greater attention. Steps to tap ground water on a sustainable
a) **Green Revolution areas:**

These areas occur practically in most nations and or based on different rainfall and moisture availability patterns characterised by substantial improvements in the productivity of are needed. Such computer simulation models should be supported

crops. A major challenge in these areas is to defend the progress already made and raise the ceiling to yield further. This will call for the introduction of frontier technologies including the development of crop varieties which can give higher yields per cubic metre of water. Post-harvest technology will also need additional attention so that all links in the producer-high quality seed production, arid horticulture and animal consumer chain are attended to in an integrated manner. Through cereal-legume crop rotations, animal husbandry programmes can be supported at a higher level of efficiency of stall fed animal rearing.

b) Green but no green revolution areas:

Several parts of Africa where water is not the most limiting factor, fall under this category. Here, availability of water is not the primary constraint and the land is green most of the year. Underground water is yet to be tapped extensively. Scientific management of water and nutrients holds the key to improving productivity in these areas. New methods of feeding the crops are necessary in these areas.

c) Dry Land Farming:

Saving and sharing water, new approaches to breeding and feeding of crops, agro-forestry systems with particular reference to leguminous shrubs and trees, animal husbandry and off-farm employment - all these aspects will have to receive much greater attention. Steps to tap ground water on a sustainable basis and the development of alternative cropping strategies based on different rainfall and moisture availability patterns are needed. Such computer simulation models should be supported

by appropriate seed reserves of alternative crops. Just as grain reserves are essential for food security, seed reserves are essential for crop security.

d) Arid Ecosystems:

The desert areas of the Sahel provide unique opportunities for high quality seed production, arid horticulture and animal husbandry.

e) Coastal area planning

The coastal areas afford opportunities for integrated agriculture and aquaculture production systems. Also coastal agriculture can be given an export orientation since transport costs can be minimised. For the purpose of planning coastal agricultural systems, 20 kilometers of sea surface and 20 kilometers of land surface can be considered as an integrated entity.

f) Wet lands:

Africa has a rich endowment of wetlands. Detailed planning is necessary for the sustainable management of wetlands to produce a variety of aquatic products and to avoid biological impoverishment.

g) Waste lands:

The rehabilitation of degraded lands has to be undertaken using technologies most appropriate to each situation. Every effort should be made to restore to wastelands their full biological potential by the year 2000. A simple method of measuring the biological potential of land will have to be developed and popularised.

VI. WATER: A KEY DETERMINANT OF THE AGRICULTURAL FUTURE

Global water use has doubled between 1940 and 1980. It is expected to double again by 2000, with two thirds of the projected use going to agriculture. Yet 80 countries, with 40% of the world's population, already suffer serious water shortage (WCED, 1987). There will be growing competition for water for irrigation, industry and domestic use. River water disputes are becoming common in the world between nations and between states within a nation. Compounding these problems is the increasing pollution of water due to a wide variety of causes - industrial effluents, agricultural activities, chemical and human wastes. The conservation and scientific use of water must occupy a very high priority in any national agenda for sustainable development. I would like to suggest nine areas which need urgent attention:

1. Irrigation Extension:

There is a vast pool of know-how already available on water management. Yet, the application of this knowledge, at the field level is poor. **Group endeavour** on the part of water-shed or command-area or catchment-area community is essential for efficient water use. We need an efficient extension system which can promote both individual and group action for the economic and effective use of the available water.

2. Area Specific Water Management:

Water logging is a problem in the irrigated areas of several African nations. Drainage and ground water use could improve yield as well as the infiltration capacity of the soil. On-farm

water management and energy management will hold the key to improved production in semi-arid areas. The precise priorities in water management will vary from region to region.

3. Farming System Specific Water Management:

The water management system will have to be tailored to each farming system. In the design of farming systems, the optimum use of the available water should be a major aim. Farming systems may involve multiple cropping, crop-livestock integration or crop-fish combined production system. The productivity of a farming system can be improved if the soil-water-plant relationships are studied in an integrated manner.

4. Aquifer Management :

It is high time that every African nation develops, with the co-operation of farmers, a scientific ground water management strategy. This should ensure that we do not live on our capital. In chronically drought prone areas, "Ground Water Sanctuaries" efficient water management. However, in practice it is usually less than 0.4 Kg/m. Agronomists should express yield not only deserve establishment.

5. Problem soils:

Water management in alkaline and saline soils and heavy clay soils needs greater attention in relation to the farming system in use.

6. Problem Water

Sewage water, effluents from industries and other forms of water which normally causes pollution can be utilised for fisheries, vegetable production and other purposes after careful treatment

and handling.

7. Management of Irrigation Commands:

Unless the management of command areas of irrigations projects and water sheds becomes a joint sector activity, based on shared goals and perceptions between farmers and Government officers, inefficient and often scientifically harmful methods of water use will continue.

8. Operational Research Projects on Water Management:

Operational research projects involving Irrigation Departments, appropriate Universities and Institutes and farmers, should be designed to demonstrate the value of water cooperatives for improving farm income.

9. Generating consciousness of water use efficiency

In many parts of Africa, cereal productivity per unit of water has been found to exceed 1 Kg / cubic meter (Kg/m) under efficient water management. However, in practice it is usually less than 0.4 Kg/m. Agronomists should express yield not only in terms of Kg/hectare but also in terms of Kg/cubic meter of water. There is also a need to sensitize farmers and administrators on the potential adverse effects of improper water use. Salinization, water logging and the spread of water borne diseases can be avoided if anticipatory steps are taken.

VII ECOLOGICAL AND FOOD SECURITY AND BIOTECHNOLOGY:

Ecological security implies the conservation and sustainable management of the basic life support systems of land, water,

flora, fauna, and the atmosphere. It involves concurrent and integrated attention to all the components of the biosphere and geosphere. **Ecological security is the only foundation on which enduring edifices of food and livelihood security can be built.** To reverse these trends, the world Commission on Environment and Development chaired by Mrs. Gro Harlem Brundtland, Prime Minister of Norway, has in its report titled "Our Common Future", urged all nations to accord the highest priority to making economic development and urbanisation. Population growth is exceeding the capacity of natural ecosystems to support them on an ecologically sustainable basis in several parts of Africa. Increased emissions of carbon-di-oxide and other "green house" gases arising from various human activities, particularly in developed countries, are leading to the phenomenon referred to as global warming. Deforestation of tropical forests is leading to a loss of biological diversity. These threats to the quality of life on earth are leading to a more widespread awareness of the fact that nature's patience is not inexhaustible.

A disregard for the long term consequences of current patterns of development as well as population growth are leading to:

- a. air and water pollution
- b. soil erosion and land degradation.
- c. deforestation and changes in micro-climate.
- d. loss of biological diversity leading to enhanced vulnerability to pests, pathogens and abiotic stresses such as salinity and alkalinity.
- e. migration of the rural poor to towns and cities as a result of the loss of their livelihoods in their native villages (some times referred to as "environmental refugees")

- f. global warming, acid rain and increased ultra violent radiation.

To reverse these trends, the world Commission on Environment and Development chaired by Mrs. Gro Harlem Brundtland, Prime Minister of Norway, has in its report titled "Our Common Future", urged all nations to accord the highest priority to making development, ecologically sustainable.

While it is important to think about the future, what is even more important is to plan for a **better common present**. The disparities in the lifestyles of the poor and the well-to-do and in the amenities available in rural and urban areas are ever widening. It is in this context that we should examine the opportunities opened up by new technologies.

Biotechnology Applications:

It is now becoming apparent that the new tools of molecular biology, genetic engineering, cell and tissue culture, microbiology and chemical engineering can help to add a dimension of resource neutrality to scale neutrality in technology development. We can now plan to increase yield and at the same time reduce the cost of production. The tools of bio-technology and bio-processing will particularly help to enhance the efficiency and economics of small farm agriculture. If appropriate safeguards are strictly enforced, the environmental hazards associated with recombinant-DNA technologies can be avoided. **If properly utilised, biotechnology can help to promote land, water, energy and cost saving crop husbandry and grain**

saving animal husbandry. This in turn will release the pressure on forest land being converted into crop land. Ecological security can be enhanced by an integrated application of market purchased chemical inputs and farm grown organic inputs. Considering that the population of most African countries is predominantly young, the integration of frontier technologies with traditional technologies will help to make farming both intellectually satisfying and economically rewarding, which are necessary pre-conditions for attracting and retaining educated youth in rural professions.

VIII ORIENTING STRATEGIES TO SPECIFIC TARGET GROUPS

A. SUSTAINABLE DEVELOPMENT SYSTEMS FOR SMALL FARMERS:

The concept of a small farm varies from country to country. In India, a small farm is one which is below 2 ha in size. Those cultivating farms below 1 ha in size are classified as **Marginal farmers**. The cultivable land per capita declined in India from 0.48 ha in 1951 to 0.26 in 1981. It is expected to be 0.15 ha in 2000. In China, the per capita land availability is 0.11 ha. In the semi-arid, rain-fed areas of Africa, small farmers may often be cultivating 10 to 20 ha of land but the yields are low and uncertain. FAO's study of Agriculture at 2000 shows that in most developing countries the average size of an operational holding will continue to decline. Besides the growth in population, the other factors contributing to this trend are (a) the withdrawal of farm land for industrial, communication, housing and other uses and (b) inadequate opportunities for employment in the non-

farm sector. Between 60-90% of the population in most developing countries live in rural areas and for them, land and water based occupations consisting of crop and animal husbandry, fisheries and forestry constitute both a way of life and a means to livelihood security. If current global trends continue, we will witness at the end of this century two contrasting systems of agriculture. In one system, farmers will disappear and will be replaced by large agri-business companies. In the other, millions of families operating small holdings will be struggling to improve the productivity, profitability, stability and sustainability of the farming systems which determine both the quality of their life and the dependability of the food security system of their countries. How can they be helped ?

Before specific methods of helping small farmers are discussed, it would be useful to define the concept of sustainability

1. Measurement of Sustainability

The core of this concept lies in equal and concurrent attention to intra-generational and inter-generational equity.

Intra-generational equity which aims at giving a fair deal to the socially and economically disadvantaged groups, involves attention to issues such as adding a dimension of resource neutrality to scale neutrality in technology development and transfer, thereby helping all farmers irrespective of the size of their holdings and innate input mobilizing and risk-taking capacity to derive economic benefit from new technologies.

Inter-generational equity involves attention to the protection of

the productive base of agriculture. This implies the use of the basic agricultural assets of land, water, flora, fauna and the atmosphere in such a manner that today's progress does not ruin tomorrow's prospects. Thus, sustainability has both economic and ecological dimensions. What are the operational implications?

The first requirement is a new definition of productivity. At a meeting organised at the International Rice Research Institute in December 1987, the following definition was agreed to for the purpose of integrating economic and ecological sustainability in one measurable equation.

<u>Productivity:</u>	Output value	changes in
	-----	+ environmental
	Input value	capital stocks
<u>Sustainability:</u>	Stability of productivity	
	over time.	

The value of output and input can be calculated with precision. We do not yet have readily usable methods of measuring with reasonable accuracy the impact on environmental capital stocks. At least three areas need measurement tools.

(a) **Soil Health:** What is the impact of a given level of productivity on the biological potential of land? Soil health is the summation of the physical, chemical, microbiological and erodability characteristics of the soil. Can we develop a reliable, speedy and low-cost method of measuring the biological potential of land?

(b) **Water quality and availability:** We need suitable criteria for measuring the impact of irrigation and crop intensification

on the water resources of an area, such as the rate of exhaustion of the aquifer, increase in salinity etc.

(c) **Biological diversity:** What is the impact of new technology on genetic erosion both in crops and farm animals? Again, can we develop methods of giving expression to the impact of the spread of new technologies on biological diversity?

It is obvious that an urgent need is the standardisation of reliable and low-cost methods of measuring and expressing productivity in terms of its impact on the environmental assets on which sustained agricultural advance depends. This area of methodology development merits adequate technical and financial support. The emphasis should however be on simple tools of measurement which farmers can readily understand and adopt.

Measuring sustainability by estimating the stability of productivity over time is best done taking an entire village or a water shed or the command area of an irrigation project or the catchment area of a river system as the spatial unit for measurement.

2. Support Services

i) Package of Technology

To promote agricultural production on an economically and ecologically sustainable basis under conditions of small farm holdings, there is need for re-orientation of agricultural research in the following areas.

This will involve particular attention to breeding varieties which can optimise yield under a given moisture regime and to

1. Yield enhancement: Yield is the product of an interaction between the genetic efficiency of the crop plant or farm animal and the management efficiency of the farm family. The major management areas which need concurrent attention are:

- a. Land and water management
- b. Energy management
- c. Crop and/or farm animal management
- d. Post-harvest management
- e. Farming systems management.

Some areas of research which merit added attention are briefly described below:

a) Land and Water management

Scientific land and water management holds the key to sustainable agriculture. As mentioned earlier, we need simple methods of measuring the biological potential of land. Agronomic and agricultural engineering research will have to help the watershed community to get degraded lands upgraded through appropriate cultural and cropping practices including date, density and manner of sowing and growing two or more crops together in such a manner that the companion crops extract moisture and nutrients from different depths of the rhizosphere, will help to reduce and distribute risks and enhance yield and income. Risk aversion and distribution should be important goals of agronomic research. There is inadequate attention now on the social engineering aspects of soil health management.

b) Crop Management

This will involve particular attention to **breeding varieties** which can optimise yield under a given moisture regime and to

feeding plants in a manner so that the genetic potential for yield of a new strain can be fully realised. The breeding strategy in particular needs re-orientation. We need to initiate a selection strategy where the F₂, F₃ and subsequent generations are grown alternately under conditions of moisture sufficiency and deficiency. Such selections under divergent conditions of moisture stress will help to breed varieties with the capacity to give high yields when moisture is adequate and reasonable yields when drought conditions prevail. The crop feeding strategy should involve the use of legumes in the rotation (including stem nodulating green manure crops) organic recycling and balanced fertilizer application in accordance with the requirements for macro -and micro nutrients in different soil types. The discovery of stem nodulating Sesbania species such as S.rostrata in Senegal has opened up new opportunities for green manuring . A third aspect of crop management relates to the managements of weeds, pests and pathogens. In addition, cultural and cropping practices including date, density and manner of sowing and growing two or more crops together in such a manner that the companion crops extract moisture and nutrients from different depths of the rhizosphere, will help to reduce and distribute risks and enhance yield and income. Risk aversion and distribution should be important goals of agronomic research, particularly in dryland areas, since often small farmers do not have access to protective irrigation.

C. Energy Management

Energy management relates to the energy needed (a) for

irrigation, land preparation and crop management including sowing and harvesting, (b) pest management (c) nutrient supply. In irrigated areas energy management, particularly for pumping ground water or distributing conserved water holds the key to the success of farming in years of drought.

D. Post-harvest Management

Besides the handling of the part of direct human value, such as grain, efficient post-harvest management implies detailed attention to every component of the biomass with particular stress on the preparation of value added products from each of the components. Recent advances in bio-processing, microbiological enrichment of cellulosic material and chemical engineering have opened up new opportunities in biomass utilisation.

E. Farming Systems Management

In the ultimate analysis the packaging of the best available technologies into an economically and ecologically desirable farming system, should be the end-point of all scientific efforts. For this purpose, it is necessary to promote the optimum use of the climatic, land, water, labour and credit resources available to the family. To achieve this goal, a two pronged strategy is needed.

First, efforts are needed to achieve appropriate blends of traditional and frontier technologies. The frontier technologies which merit particular attention are : biotechnology including both molecular biology and bio-processing, satellite imagery,

computer technology and microelectronics. to organise effective service organisations will be necessary. Secondly, the design of the farming system- whether it is wholly based on crops or crops and animals or crops, animal husbandry, fisheries and forestry - should give explicit consideration to promoting better linkages among the primary (agricultural), secondary (industrial) and tertiary (services) sectors of economic activity in rural areas. Farming system research (FSR) specifically designed to promote better growth linkages is a must if we are to add the dimensions of income and employment generation in projects designed to increase food production.

ii) **Package of Services:**

Knowledge and skill transfer, credit supply and the timely availability of the inputs needed for higher productivity are areas which have been receiving attention in African countries. However, more research on delivery systems with particular reference to the following is needed :

1. Synchronisation in space and time between knowledge transfer and the inputs needed to apply that knowledge.
2. Synchronisation in space and time between credit supply and the inputs for which the credit is intended.
3. Organisation of the services sector in the villages, as for example seed production and distribution, integrated pest management and improved post-harvest operations, particularly by rural women and youth. For this purpose, both training of women in seed technology, integrated pest management and improved

post-harvest operation and helping them to organise effective service organisations will be necessary.

4. Helping to organise producer-oriented marketing arrangements and assisting farmers to avoid distress sales.

5. Promoting through training and appropriate infrastructure support, the growth of industries designed to produce value-added products from every part of the agricultural biomass available in a village or in a group of adjoining villages. In general, research on delivery systems which enable small farmers to derive full economic benefit from new technologies has not received the attention it deserves. Such research should aim at drawing lessons from successes and failures in the field of technology transfer and help to design self-replicating systems of technology diffusion. Similarly, training procedures should be largely based on learning by doing particularly where illiteracy is still widespread. Adequate attention to software development for the use of mass media like television and radio is also essential, if the investment on the hardware components of such media is to confer the anticipated benefit.

iii) PACKAGE OF PUBLIC POLICIES:

The public policy package should include incentives for group cooperation in areas such as land and water management, integrated pest management, integrated nutrient supply, improved post-harvest technology and organisation of local level associations for sustainable development. In addition to reorienting extension services on a community basis, suitable

incentives such as group insurance, group credit and group awards for community endeavour in the conservation of environmental assets will be helpful.

Besides public policy instruments for promoting community endeavour and participation in environmental management and in the adoption of knowledge-intensive and ecologically desirable technologies, an important but often neglected area of policy is the promotion of activities in areas where ecological linkages over widely separated areas determine a common agricultural future. This is particularly true in the Sahelian region with regard to measures for combating desertification. Public policy should also foster the desirable form of research efforts. As stressed earlier, an area of research relevant to sustainable agriculture is the integration of traditional and frontier technologies. With the powerful tools available today, agricultural technology can help to integrate scale and resource neutralities in technology development and transfer and help to generate skilled jobs in the rural sector. They can also help to generate technologies for women which can help to reduce drudgery and introduce the twin concepts of flexi-time and flexi-location in relation to job opportunities to farm women.

Some emerging technologies which need particular attention from the point of view of integration with traditional technologies are:

- a. Molecular genetics and recombinant DNA technology.

- b. Tissue and cell culture
- C. Sero-diagnostic techniques and vaccines for animal diseases.
- d. Bio-processing and preparation of value added products from agricultural biomass.
- E. Microbiological upgrading of cellulosic material.
- F. Satellite imagery and remote sensing
- G. Computer Technology
- H. Micro-electronics.

In this context, we should make a distinction between science and technology. Scientific research leading to new knowledge and material can be generated in research institutions and Universities. **Technology Development is however, best done in farmers' fields, jointly by scientists and farmers.** The failure to make this distinction often leads to difficulties in the diffusion of new methods and approaches, either because of economic and/or ecological factors. Technology development should become a joint sector activity between scientists and farmers. We need urgently **Centres for technology Blending and Dissemination,** which are inspired by the goal of bringing the best in modern science to the service of the small farm families. In this task, non-governmental organisations can play a key role.

B. WOMEN.

Equity involves adequate attention to the needs of the economically, ecologically and socially disadvantaged sections of the population. Achieving growth with equity demands concurrent attention to economics, ecology, gender and generations. In terms of gender, the emphasis has to be on enhancing the productive role of women and reducing drudgery in the household and productive aspects of their life. Various in-depth studies have been undertaken in Africa to identify and articulate the real issues confronting women in their triple role. The studies carried out so far in the field of agriculture indicate that in spite of the key role of women in crop husbandry, animal husbandry, fisheries, forestry and post-harvest technology both in the past and now, those in charge of formulating packages of technologies, services and public policies for rural areas have often tended to neglect the productive role of women. Consequently, the development of technologies specifically tailored to women-specific occupations and the involvement of women in technology development and transfer have received inadequate attention from both scientific and administrative departments of Governments. The same is true in the case of training. The very term "Home Science College" used in Universities is indicative of the stress on the household responsibilities of women.

What are some of the critical areas which we should come to grip with ?

Enough information is now available on the priority areas which need urgent and integrated attention. These are:

first, the hardship arising from unemployment, under-employment, uncertain employment and unpaid or underpaid employment;

second, the drudgery involved because of the predominantly unskilled nature of the work assigned;

third, the lack of flexibility in terms of working hours, place of work and duration of work;

fourth the adverse impact of labour displacing technologies;

fifth, the lack of adequate maternity, health care, creche and associated needs;

sixth, little or no access to credit and other production inputs;

seventh, inadequate opportunities for the acquisition of new skills and for extension assistance compounded by the handicaps of illiteracy.

eighth, discriminatory land or other asset ownership rights and social status;

Finally, paucity of organisations which can help women with the needed management, expertise and collective strength.

The response to these challenging problems has to be in two time dimensions from the scientific and educational view points.

First, there are many things which can be done immediately with the technologies on the shelf and the institutional

infrastructure already in existence.

Biological Diversity:

Secondly, we should initiate specific research and development programmes which within the next five to ten years can help to convert unskilled jobs into skilled ones, diversify opportunities for employment and introduce flexibility in the place, time and duration of work.

Let me illustrate with a few examples what can be done immediately.

In the short term, we should build on the historic and current professional skills of rural women and enhance their beneficial impact on income and quality of life, by removing the major handicaps and constraints. For example, since the dawn of agriculture, women of Africa have played a major role in the following areas:

- a) Food Crop Production
- b) Seed production and management and conservation of biological diversity
- c) Renewable energy management
- d) Crop / livestock / fish management
- e) Post -harvest management including the utilisation

of agricultural by-products

What steps can our Research and Development Institutions take to strengthen the role of women in the above areas ?

Experience in the Philippines and elsewhere has shown that women can organise integrated pest management (IPM) involving biological and cultural control, genetic resistance and need based application of chemical pesticides, in a very effective manner. This will help to prevent pest resurgence and epidemics.

a) **Seed production and management and conservation of Biological Diversity:**

Women have traditionally been seed selectors and preservers. Whether literate or illiterate, they have the ability to spot the healthy plants whose seeds they carefully preserve for sowing next year. The skills of rural women to produce hybrid seeds of high purity should be fully utilized.

Similarly, in the area of conservation of biological diversity, women have been traditionally active conservationists. Their involvement in the organisation and conservation of heritage sites, biosphere reserves, national parks and community gene-banks will enhance the effectiveness of the conservation movement.

b) **Renewable energy Management**

Women have not only been collecting fuel for cooking but have also been finding nutrition for both crops and farm animals. Organic recycling and collection of fodder and feed have been their traditional occupations. Today there are many opportunities in the field of renewable energy management and utilisation, which they can handle effectively, if assisted to do so.

c) **Crop /Animal /Fish /Forest Management:**

Experience in the Philippines and elsewhere has shown that women can organise integrated pest management (IPM) involving biological and cultural control, genetic resistance and need based application of chemical pesticides, in a very effective manner. This will help to prevent pest resurgence and epidemics.

Similarly, women can handle effectively bio-fertilizer production programmes and help to organise and implement integrated nutrient supply systems (INS).

In the case of horticultural crops, the spread of IPM and INS techniques becomes even more important. Womens' role in animal husbandry and aquaculture can also be further strengthened through appropriate training.

d) Post-Harvest Management

Here, there are possibilities for considerable improvement in all the links in the producer-consumer chain. Preparation of value-added products is now feasible from every part of the plant and animal biomass.

To achieve all this, agricultural research and training institutions should integrate the following ground rules in all their programmes:

i) Job destruction and job creation must be concurrent events.

ii) The aim of technology should be **labour diversification**, drudgery reduction and better energy conversion and **not** labour displacement.

iii) Knowledge and skill transfer mechanisms should be tailored to the socio-cultural and socio-economic conditions of rural women and to the opportunities for remunerative marketing.

iv) Every effort should be made to increase the active participation of women both in technology development

and dissemination.

v) There should be synchronisation in time and place between knowledge and skill transfer and the supply of the necessary inputs including credit; for this purpose the growth of womens' organisations and the strengthening of their professional management capacity should be promoted.

IX. NEW FRONTIERS

Development in the following fields have opened up new opportunities for making rural jobs knowledge intensive and skilled and introducing the dimension of flexibility in the place and duration of work.

a) **Biotechnology** including bioprocessing, microbiology, tissue culture, genetic engineering and applications in animal breeding and disease control;

b) **Information technology** including computer aided instruction and extension and mobilisation of mass media, particularly T.V. and Radio for awareness generation and knowledge dissemination;

c) **Space technology** including conservation monitoring and supporting ground truth work;

d) **Micro-electronics** which lends itself to decentralised production; and

e) **Management technology** which would help in integrating all the elements of a technological package in a mutually supportive

manner. In particular, the managerial and organisational aspects of decentralised production supported by a few key centralised services need attention. Also, the planned strengthening of the beneficial linkages among the primary, secondary and tertiary sectors will have to be achieved.

In order to achieve the above, I would like to suggest the following three immediate steps:

a) **" Technology Blending Centres "** should be organised in each agro-ecological zone in order to combine the good features of traditional and frontier technologies. Such technology blending centres should also aim to upgrade the productive role of women. A focus on the needs of women will help both men and women, while the reverse will not be true, as past experience shows. For example, demonstrations in small farmers' fields help big farmers also, while the reverse will not always be true.

b) We need a dynamic programme for **Training Rural Women in Skilled Employment.** The training methods used should be adjusted to the level of literacy and the domestic obligations of the trainees.

c) We should foster the growth of womens' organisations which can serve as the link between Lab to Land and Land to Lab.

X. AGENDA FOR ACTION

Early in 1980, the late Prime Minister of India, Mrs. Indira Gandhi asked me to act as Deputy Chairman of the Planning

Commission of India and help to develop our 6th Five year plan. I asked her what her principal priorities in resource allocation were. She answered "work, water and power". This in my view, summarises beautifully the priority for many nations in Africa. I would therefore like to deal with them briefly.

a) **Work**

As earlier emphasised, greater opportunities for skilled employment are absolutely essential both for enhancing the purchasing power of poorer households and for attracting and retaining youth in rural professions. A massive effort in the blending of traditional and frontier technologies will be essential for overcoming the famine of work. Technologies that respond to these challenges must be knowledge intensive, replacing unskilled jobs with skilled ones. They must lead to diversification of labour rather than its displacement. In addition, they must be ecologically sound. For this purpose, there has to be an appropriate back up of educational and training opportunities. Pedagogic techniques should be tailored to the needs of each socio-cultural group. Women will need explicit attention.

b) **Water**

Scientific water management holds the key to elevating and stabilising agricultural production. Fortunately, many countries in Africa have considerable untapped supplies of groundwater. To avoid the unsustainable exploitation of the aquifer, every country should develop a policy for the scientific and sustainable management of the aquifer. The management of water

and soil has to be viewed in an integrated manner. Otherwise the process of desertification will get aggravated. In chronically drought prone and arid areas, drinking water sanctuaries will have to be developed for meeting essential human and live stock needs.

c) **Power**

Energy is often a major limiting factor in our efforts to increase productivity and improve post-harvest handling and processing. Energy is also needed for pumping under ground water and for a variety of other tasks. Energy requirements in agriculture include the energy supplied in the form of fertilizers, irrigation water, pesticides and implements. Agriculture is the single most important solar energy harvesting enterprise in the world.

We can maximise the benefits of solar energy by producing a beneficial interaction between solar and cultural energy. An integrated energy supply system involving possible combinations of renewable and nonrenewable energy will have to be developed in each nation.

A carefully designed strategy for generating the needed extent of work, water and power will help in the development of sustainable food and nutrition security systems.

For this purpose, a symphonic agricultural system where there is harmony between the needs for efficiency, equity and ecological sustainability, needs attention. A symphonic agricultural system will also need mutually reinforcing packages of technology,

services and public policies. I would plead for the establishment in every nation of a **National Strategy for Symphonic and Sustainable Agriculture**. Any apex level coordinating committee established for this purpose should include representatives of farmers, women's organisations and mass media.

XI. CONCLUSION

In the ultimate analysis, hunger can be made a problem of the past only by increasing production, enlarging the purchasing power of the rural and urban poor and by designing socially relevant intervention programmes to look after the needs of pre-school children, pregnant and nursing mothers and old and infirm persons. Attention to safe and adequate drinking water supply is as important as attention to the supply of calories, proteins, vitamins and minerals.

The single most important requirement for achieving sustainable nutrition security is political commitment and action. Political will is usually expressed in speeches but often, **political will is not converted into political action**. There is no scientific or economic excuse for hunger today. Wherever hunger persists, the political system must seek the reasons and apply the remedies.

I can cite many examples of political action which will help to reverse current trends in food production. **If today the most important food security challenges in Africa are physical and**

economic access to food, ecological access to food will be the most important food security challenge of the 21st century.

Building the ecological infrastructure essential for sustained agricultural advance is therefore a priority task. This will call for accelerated efforts in tree planting and soil and water conservation during the years when there is adequate soil moisture. Unfortunately, during years of adequate rainfall the resources available for programmes such as "Food for Work" becomes greatly reduced.

We should therefore design a **Good Weather Code** and a long term plan of **Employment Guarantee for Ecological Security**. The employment offered should include skilled and unskilled jobs.

Second, an essential component of the National Strategy for Symphonic and Sustainable Agriculture should be a careful and integrated deployment of the available technical, commodity and financial resources. These triple resources, whether of national or bilateral or multilateral origin, should be used in a mutually reinforcing manner.

Finally, we need to develop innovative approaches for using the know-how and do-how of educated women. Many of them are unable, for a variety of reasons, to take up full time jobs. It is important that methods are devised to establish a **Para Extension Cadre** consisting of women who are willing to help in the training of rural women in new skills on a part-time basis. Harnessing the skills of professionally trained women is an urgent necessity for enhancing the production of agriculture. There is too much

wastage of training and while we should pay attention to minimising brain drain, the great challenge before political leaders is nurturing the brains already in the country.

The African continent is a land of opportunity. It is for the leaders and people of this continent to grab the available opportunities to promote food, work and health for all.

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