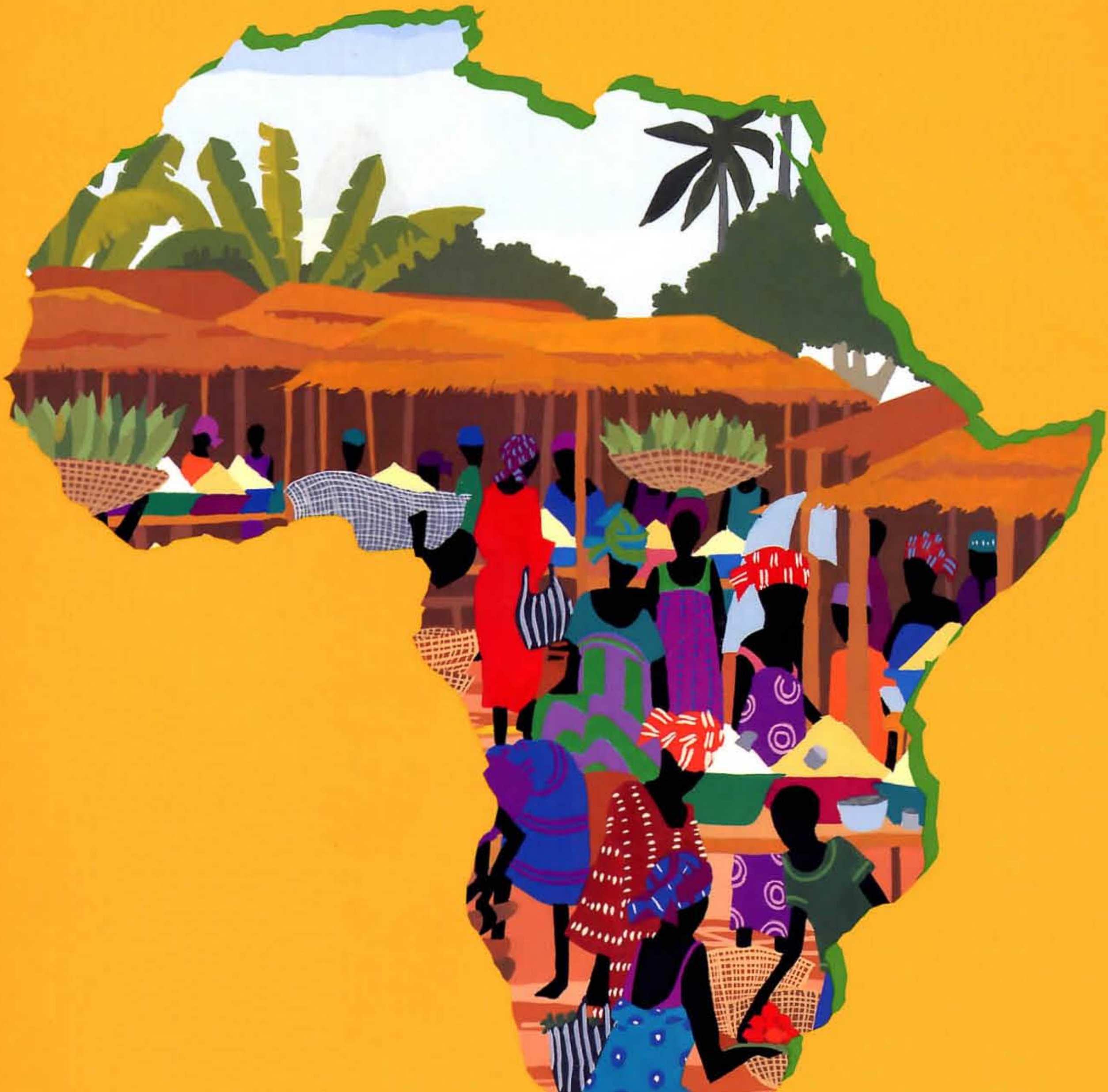
IITA Strategic Plan 2001–2010

supporting document



International Institute of Tropical Agriculture

In preparing the strategic plan for IITA for the period 2001–2010 an extensive review of a wide range of documents was carried out and numerous brain-storming sessions were held with different stakeholder groups. These led to the development of an extensive strategic plan document. However, during the last review of the plan by the Board of Trustees it was decided that the plan should be a very concise document. Thus, in addition to the strategic plan itself, these background materials have now been regrouped in this publication.

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Contents

Development needs and prospects in sub-Saharan Africa

Sub-Saharan Africa still has low agricultural productivity and a high percentage of poor and undernourished people, both adults and children (Figures 1 and 2). As a proxy indicator of the present state of deprivation amongst all age groups, it is evident from Figure 2 that low infant weight is predominantly characteristic of West and Central Africa and the Great Lakes region of eastern Africa. These are the focus regions for IITA research.

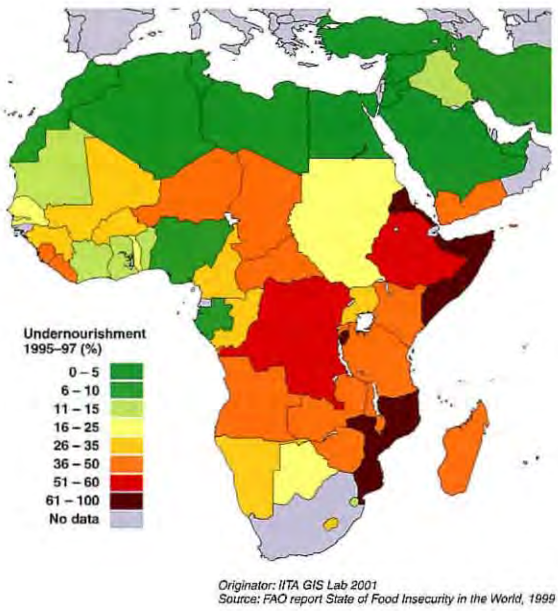


Figure 1. Distribution of undernourishment in Africa.

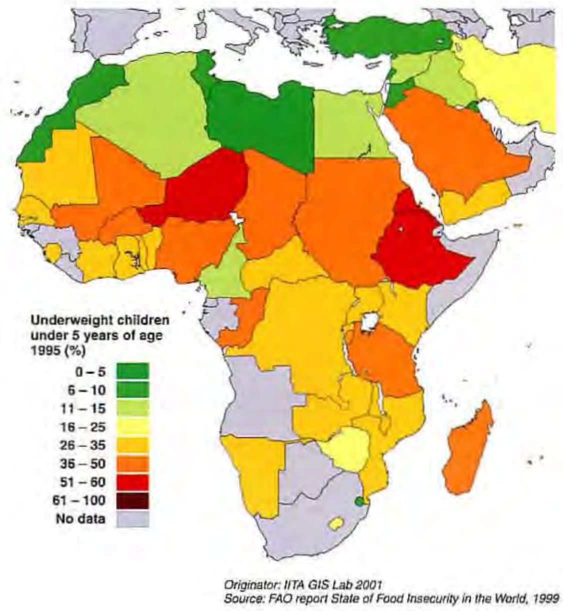


Figure 2. Distribution of underweight infants in Africa.

Demographic trends

Demographic trends in sub-Saharan Africa, of key importance in determining IITA's strategy, clearly show the need for increased agricultural productivity. In 1970 there were 3.7 ha of agricultural land per rural inhabitant of sub-Saharan Africa; by 1998 the ratio had declined to 2.2 ha. In West and Central Africa 2.3 and 1.5 ha per rural inhabitant were available in 1970 and 1998, respectively. The annual decline in this ratio over this period was –1.26% and –0.9% for sub-Saharan Africa and West and Central Africa, respectively. However, from 1993 to 1998, declines slowed significantly to –0.50% and –0.1% for sub-Saharan Africa and West and Central Africa, respectively. This change in trend reflects rural to urban migration, and in some areas the negative effects of the HIV/AIDS pandemic on the life expectancy of rural populations.

In sub-Saharan Africa more than 65% of the labor force was employed in the agricultural sector in 1996, with 15% in industry and about 20% in services (ADB 1999). Some 60% of the economically active population are projected to be still employed in agriculture by 2010. In 1998, the GDP was $554,000 million at constant 1990 prices

(ADB 1999). Agriculture, accounting for more than 33% of GDP and 40% of exports, remains the dominant factor in economic development in the majority of African economies. As most of the poor are dependent on the rural economy for their livelihoods, the performance of the agricultural sector has far-reaching implications for food security, poverty reduction, and income generation.

Yet, urban populations in sub-Saharan Africa have grown at an average annual rate of 5.3% since 1960. Unlike the structural transformations in North America and Europe, where technical change pushed many farmers off the land, in Africa urban bias and a lack of technical progress in agriculture have driven poor farmers into becoming poor urban dwellers. Urban growth has been particularly pronounced in the humid coastal West African countries, with an average rate of 5.7%. In the 1990s urban growth rates slowed marginally to 5.1% for both sub-Saharan Africa and coastal West Africa, reflecting in part improved agricultural terms of trade following the many structural adjustment programs implemented in the 1980s and 1990s.

Projecting recent urban population growth rates, more than 103 million of the expected 206 million people in coastal West Africa will live in an urban setting by 2007 (compared to 80 million in 2000). This implies a minimum increase in the size of the urban food market of 29%, assuming urban incomes remain constant. If urban incomes increase, and given the assumption of positive food income elasticities, the increase in the market will be even larger. This rapid demographic change, which has witnessed the doubling of urban populations every 14 years in Africa at large, offers opportunities for farmers able to successfully commercialize their farming activities.

Food demand and supply

Domestic demand for food in sub-Saharan Africa is expected to grow 3.3%, while growth in agricultural production is expected to reach only 3.0% per year for the period 1990–2010 (FAO 1995). As a result, per capita food supplies in sub-Saharan Africa will remain at very low levels: they are projected to reach only 2170 calories per day by 2010, compared to 2730 for the developing countries as a whole. The number of malnourished people will grow to some 300 million or 32% of the total population. Sub-Saharan Africa will take over from South Asia as the region with the highest number of persons chronically malnourished.

Pinstrup-Andersen et al. (1999) note that the prospects for economic growth in the developing world appear favorable, and rising incomes will push people to more diversified diets. The International Food Policy Research Institute (IFPRI) projects that income in the developing world will increase at an average 4.3% annually between 1995 and 2020; in sub-Saharan Africa this increase will be 3.4%. As a result per capita income in all major developing regions, including sub-Saharan Africa, is expected

to increase over this period. However, even by 2020 sub-Saharan Africa's per capita income is projected to be on average still less than a dollar a day; poverty of this magnitude will condemn many people in this region to food insecurity. In particular, poor households in rural areas are vulnerable. For example, in Benin, where both nutritional deficit and lack of financial resources to purchase essential nonfood goods and services are considered essential indicators of deprivation, it is clearly shown that poverty is more prevalent in rural than in urban areas (UNDP 1996).

Lack of adequate food in sub-Saharan Africa will in particular affect children. It is projected that sub-Saharan Africa will be the only developing region where the number of malnourished children will increase, and will reach some 40 million by 2020. Not only the quantity of food but also the quality of food needs to be increased; more efforts are needed to increase the consumption of micronutrients, vitamins, and minerals. For example, anemia stemming from insufficient iron intake is widespread among women and children: 42% of pre-school children in sub-Saharan Africa and 50% of pregnant women are affected by anemia (Pinstrup-Andersen et al. 1999). The debilitating effect of malnutrition and anemia is further exacerbated by the presence of endemic malaria. Another major concern is the contamination of food with toxins and antinutritional factors such as mycotoxins.

The food supply situation in sub-Saharan Africa could be strongly improved if agricultural production increases were well above the projected 3.0% per annum. For example, in the SPAAR/FARA Vision for African Agricultural Research the following is noted:

> *To meet the needs of growing populations and rapid urbanisation (feeding an additional 10 million people per year), the productivity improvement challenge has become more urgent now than ever before. For these food needs to be met and income generation to be assured, a rate of economic growth of no less than 4 percent per annum will be required. Given the economic structure of Africa, and taking into consideration the need for sustainable utilisation of the natural resources base, agriculture must contribute a significant portion of this growth by growing itself at 6–8 percent per annum.* (SPAAR/FARA 1999)

Under the current situation such a growth rate is a formidable challenge requiring many changes, in addition to better support for agricultural research.

In 1998, the most important crops used for meeting the energy requirements of the 595 million people in sub-Saharan Africa were cassava (107 billion kcal), maize (86 billion kcal), rice (37 billion kcal), groundnut (32 billion kcal), yam (30 billion kcal), and plantain (27 billion kcal); in terms of crude protein content the most important contributions were from maize (1.9 million tonnes), groundnut (1.5 million tonnes), cassava (0.91 million tonnes), rice (0.69 million tonnes), yam

(0.66 million tonnes), plantain (0.19 million tonnes), cowpea (0.17 million tonnes), and soybean (0.16 million tonnes). According to the FAO 2010 study (FAO 1995), sub-Saharan Africa per capita consumption increase would depend to a large extent on the prospect that domestic cereal production, mostly coarse grains, would grow at 3.4% per annum. But combined with the increase in demand for cereals, that would still leave a 19 million tonne shortfall by 2010. Notwithstanding this shortfall, sub-Saharan Africa's net cereal imports are expected to remain low because of lack of foreign exchange and entrenched poverty (Pinstrup-Andersen et al. 1999).

Among the major developing regions, sub-Saharan Africa is expected to experience the largest increase in demand for all the major food commodities. For the period 1993–2020 demand for cereals is expected to grow by about 120%, demand for roots and tubers by some 90%, and demand for meat by over 140% (Pinstrup-Andersen et al. 1997). More precise local estimates are being actively sought by current IITA research efforts (IITA 2000a).

Annual production growth rates of starchy foods (roots, tubers, and plantains) for the next 10 years are projected at 2.8% for countries with high annual consumption rates (over 200 kg per capita) of these staples and at 3.3% for countries with a medium consumption rate (100–200 kg per capita) (FAO 1995). This means that per capita food supply of starchy staples will stay at about the same level. No radical structural change of diets away from the high dependence on these starchy products is expected. Root and tuber crops have the important advantage that they produce large quantities of calories in less time than other crops. However, they need to be integrated with other food basket components to balance protein and mineral needs.

Pulses are an important source of protein, and in developing countries both demand and production are expected to grow at about 2.2% per annum. A relatively strong growth is expected for the production of soybeans in sub-Saharan Africa, from an annual production of 46,000 tonnes oil equivalent in 1988/90 to 120,000 tonnes in 2010 (FAO 1995). However, this will still be less than 1% of total soybean production in all the developing countries together, which clearly shows the need for more emphasis on this very valuable crop in sub-Saharan Africa.

Estimates of a doubling in demand for milk and meat products have been made, which if compared to the current and projected production levels means that sub-Saharan Africa has the greatest deficit between supply and demand (Delgado et al. 1999). Since crop–livestock systems are so important in the region, it is necessary to take cognizance of these implications when planning IITA's research agenda.

Tree crops are important in African agriculture and contribute significantly to the income of farmers. Tree crop systems also play a critical

role in sustaining biodiversity and sound management of natural resources. Important constraints to the development of tree crop systems include the same as for other agricultural production systems in sub-Saharan Africa. IITA, in collaboration with the International Centre for Research in Agroforestry (ICRAF) and others, will contribute to the development of sustainable tree crop systems to improve household income and to provide additional pathways for the intensification of food crop systems.

Sustainability of agriculture in sub-Saharan Africa

In 1995 in sub-Saharan Africa some 213 million hectares of land was used for crop production, with slightly over 5 million hectares under irrigation. Sub-Saharan Africa has a relatively large proportion of land with potential for rainfed crop production not yet in use—almost 800 million hectares. However, 72% of the total land with crop potential suffers from one or more of the following soil and terrain constraints: low natural fertility (42%), poor soil drainage (15%), steep slopes (11%), shallow soils (1%), sandy or stony soils (36%), and soil chemical constraints (1%). It is projected that an additional 42 million hectares of land will be put in use for crop production by 2010 (FAO 1995).

By 1990 soil degradation had affected 321 million hectares of land in sub-Saharan Africa, water erosion 170 million hectares, wind erosion 98 million hectares, chemical degradation 36 million hectares, and physical degradation 17 million hectares. Yet, the use of input-intensive technologies to combat this degradation remains very limited. On average, the consumption of chemical fertilizers per hectare of arable land and permanent crops in 1997 was only 18 kg in Africa versus about 91 kg for the world. These figures were even lower for West (7 kg) and Central (2 kg) Africa. During the early- to mid-1990s, about 96% of countries in Africa showed negative balances of nutrients greater than 40 kg NPK/ha/year. Use of fertilizers in Africa is largely limited to export crops, confirming the very limited input use in food crops. Another indicator of agricultural intensification is the number of tractors in use per 1000 hectares: in 1998 that indicator showed only 2.68 for Africa against 17.37 for the world (0.67 for West and 0.63 for Central Africa).

Given the current agricultural practices, in particular the very low fertilizer use and input-hostile policy environment, soil degradation will have further advanced in a significant manner by 2010. In sub-Saharan Africa production levels of the major crops are among the lowest in the world. Only about 55% of the land in regular crop production is cropped and harvested in any given year. In contrast to this, the cropping intensity in south Asia is 110%. Increases in agricultural production must be based on more intensive land use and increased yields, and not on a further expansion of the area in use, to avoid further environmental degradation.

Increased use of both organic and inorganic fertilizer will be the only way to significantly improve the food production situation in the region. This needs to be supported by comprehensive fertilizer policy research, advice on proper use, and improved marketing infrastructure. In this respect, where mixed crop–livestock systems are important, the roles of livestock in promoting sustainable intensification, through the provision of draught power, manure, food products, and income, will be given appropriate attention in future research and development efforts in close collaboration with the International Livestock Research Institute (ILRI).

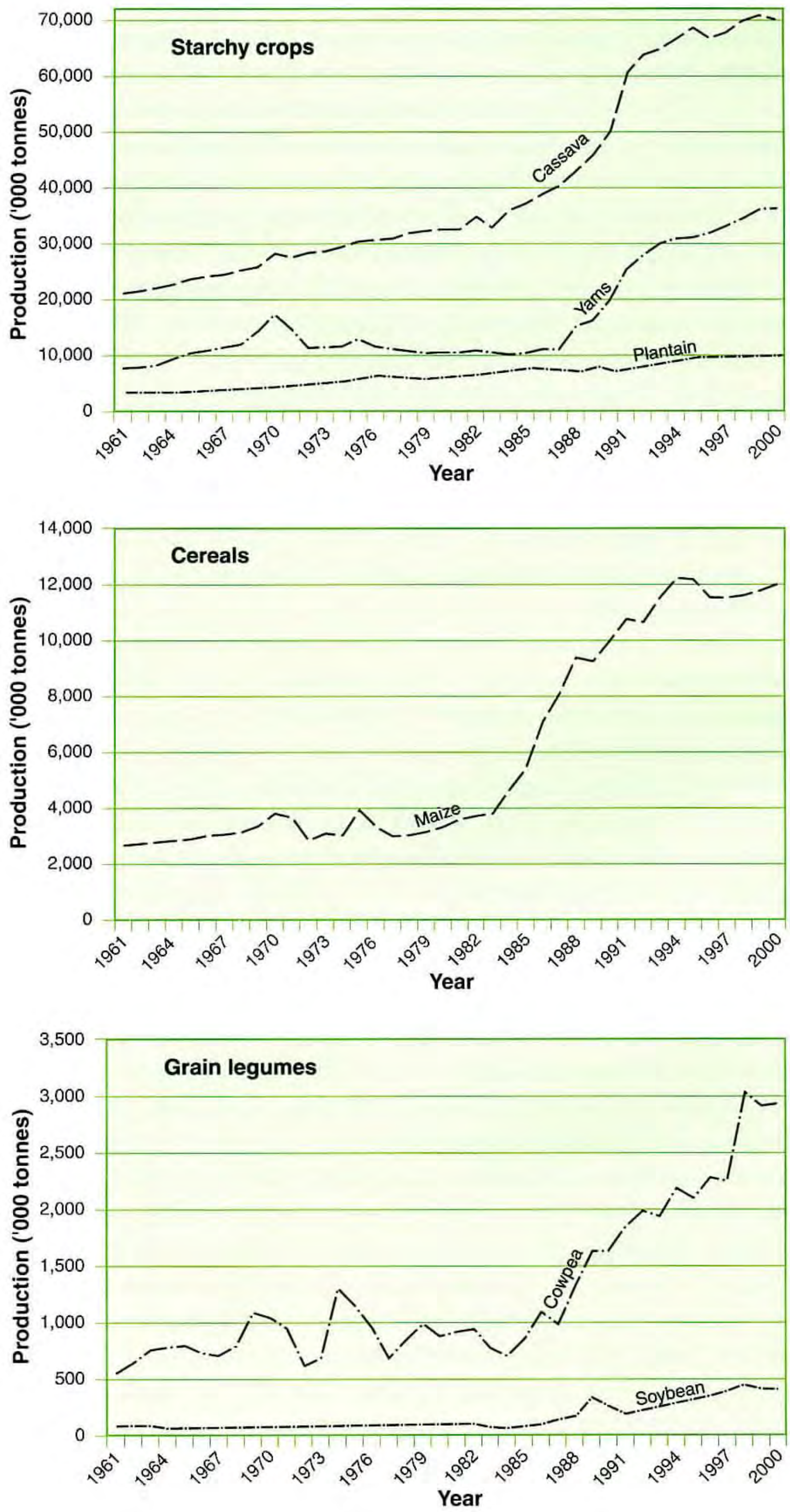
Improved agricultural diversity and productivity and better balanced use of nutrients will help engender greater system resilience against the predicted changes associated with global climatic change and will help abate negative effects by sequestering additional carbon in the soil.

Since most of the crops grown in sub-Saharan Africa are of exotic origin there will be a continuous risk of introduction of exotic pests and diseases. Examples are the cassava mealybug, the cassava green mite, and black Sigatoka affecting banana and plantain. It has been demonstrated that solutions can be found through classical biological control, resistance breeding, and integrated pest management approaches. Such solutions require an adequate research capacity and effective partnerships with national agricultural research systems (NARS) and advanced research organizations.

The implications of the above for agricultural research are a continuous need for:

- the development and introduction of crop varieties well adapted to the varied and poor growing conditions
- integration of these crops into sustainable production systems
- monitoring of soil carbon and nitrogen dynamics and improving nitrogen use efficiency and carbon sequestration in agroecosystems
- improved soil fertility and weed management practices
- continued work on effective plant health management systems
- improving production practices that will lead to significant increases in labor productivity and yields per hectare
- diversifying production systems to increase income generation and reduce risk
- the creation of a conducive policy environment for sustainable production systems
- strengthening of local capacity to undertake agricultural research and extension to effectively deliver development impact.

Figure 3. Trends in production of the IITA mandate crops in West and Central Africa.



Impact of appropriate technologies

Over the past 30 years, IITA in partnership with national and international scientists has developed numerous improved varieties of cassava, cowpea, maize, plantain and banana, soybean, and yam which combine multiple disease and insect resistance with higher yield potential than local varieties in varied agroclimatic zones. The trends in crop production indicate a steady increase in output for IITA mandate crops from 1961 to 1998, in West and Central Africa in particular (Figure 3). The curve of the trend for most crops is positive from the mid-1980s onwards. This period is characterized by the release by NARS of new improved varieties that had incorporated germplasm from IITA (Manyong et al. 1999), and the successful biological control of cassava pests.

These increases in crop production corresponded, in the case of cassava, to an average annual agricultural growth of 2.21% for the decade 1967–1976, 2.18% for the decade 1977–1986, and 4.87% for the decade 1978–1996 (calculated from FAO data from the FAO website). The corresponding growth rates for the other IITA mandate crops in the same decades were 3.65%, 4.85%, and 8.19% for cowpea; 0.68%, 9.23%, and 3.15% for maize; –0.64%, 0.22%, and 11.30% for yam; and 2.77%, 2.03%, and 2.69% for plantain.

A large proportion of these agricultural growth rates is explained by the expansion of crops into new areas. However, the contribution of crop yield to the total growth rate was significant. For example, crop yield contributed 37%, 69%, and 21% to the agricultural growth rate for cassava for the three successive decades, while the results for maize were 166%, 32%, and 22%. Case studies indicate there were high rates of adoption of the improved varieties, and there is substantial social impact on the nutritional status of children, poverty reduction, and egalitarian distribution of income among adopters. Further production increases for plantain are expected following the releases of black Sigatoka-resistant hybrids in recent years.

Stagnation in production increases from 1994 to 1998 may be partly due to the overall decline in the economic activity in most of the countries in the region over that period. For cassava the area cultivated in Nigeria, which produces 48% of the total production in the region, has declined by almost 2% per year. This could be due to a saturation of the traditional markets. Both yield and area cultivated have also decreased in the second major producer in the region, the Democratic Republic of Congo, as a result of civil strife. Increase in yam production was partly due to the extension of the crop in the savanna. This phase has come to an end. Yam is increasingly suffering from losses caused by diseases and declining soil fertility because of reduction in fallow length. There has been a reduction in areas cultivated of –0.38% per year for cowpea, and of –2.9% per year for maize in Nigeria, the major producing country, mainly because of lack of access to inputs. The devaluation of the FCFA

in francophone countries, the removal of subsidies, and the withdrawal of government agencies from the marketing of inputs without replacement by the private sector, are the major policy reasons for the lack of, and the high costs of inputs, and the subsequent stagnation or even decline in the overall production of these crops.

The considerable achievement of the agricultural sector in West Africa over the past 20 years is further illustrated by the fact that, while in 1980 regional food supply lagged 5 years behind regional demand, i.e., the amount produced in 1980 was equal to the amount consumed in 1975, by 1993 the gap between supply and demand had been reduced to 3 years, with regional food production in 1993 equal to consumption requirements of 1990. This clearly indicates that West African farmers are capable of increasing production faster than the rate of population growth, and that they are beginning to respond to the food needs of a rapidly growing and increasingly urbanized population by gradually becoming more market orientated (Snrech 1995).

Thus, excellent progress has been made in sub-Saharan Africa during the last 30 years. But given the rapid population increases, overall poor economic conditions and infrastructure, grossly inadequate investment in agricultural research and development, the frequency of civil strife, etc., overall development needs remain among the highest in the world. The agricultural sector, in which 65% of the population is involved, must become one of the foundations of economic growth in sub-Saharan Africa, and this must be catalyzed by the need to satisfy growing commercial demand for higher quality and reliable supply of agricultural products at prices competitive in world markets. This in turn should initiate the development of a vibrant agroprocessing industry capable of adding value to basic commodities and providing substantial rural and urban employment opportunities.

The creation of a favorable policy environment to assist such changes and to develop effective local capacity for agricultural research is an important condition for this. Failure in this regard will result in further reliance on imported food staples, inadequate development of local productive capacity, and thus increasingly severe food insecurity in times of political and economic upheaval.

Agricultural research in sub-Saharan Africa

Role of agricultural research

IITA recognizes that agricultural research and increased food supply, better food quality, higher incomes, reduced drudgery, and more conducive agricultural policies can make important, but nevertheless only partial contributions to overall poverty alleviation. Other development factors such as health, water supply, education, etc., are all necessary accompanying issues, which need to be resolved if indicators of poverty reduction are to be clearly positive. However, because poverty is a complex human issue with a range of different root causes, it is appropriate for IITA to see its particular role as encapsulated by the International Fund for Agricultural Development (IFAD) in addressing two specific types of poverty: overcrowding poverty, a combination of population pressure and strain on marginal resources; and traumatic poverty, resulting from natural disasters such as catastrophic drought, floods, or pest attack (Jazairy et al. 1992).

An example of IITA's efforts to address overcrowding poverty may be seen in its successful campaign with its nongovernmental organization (NGO) and NARS partners to convince farmers of the need to adopt balanced nutrient management strategies and improved crop rotations of cereals and legumes in the moist savannas of Nigeria and the Benin Republic (BNMS 1999, 2000). An example of IITA's role in minimizing the effects of traumatic poverty would be its swift response to the cassava mosaic disease pandemic in the Great Lakes region of East Africa. The institute assisted NARS and NGOs in the very rapid provision of replacement disease-resistant planting material and the development of emergency cooperative plant quarantine arrangements between the governments of Uganda, Kenya, and Tanzania (IITA 2000b). Such direct assistance to development efforts by IITA may increasingly become a feature of its activities given the importance that its donors place on actions in support of post-war and post-natural disaster recovery and reconstruction in the alleviation of poverty (Maxwell 1998).

Developments in agricultural research in sub-Saharan Africa have been mixed during the past three decades. The number of scientists grew fourfold. Their levels of training increased markedly, and the research systems are now largely staffed by nationals rather than expatriates. Expenditures on agricultural research also grew. But the growth in spending generally failed to keep pace with the increase in personnel. In consequence, spending per scientist has been squeezed, particularly in government agencies. In 1991 it averaged about 66% of the 1961 level (Pardey et al. 1995). The situation has certainly not improved during the rest of the 1990s. Moreover, based on an analysis of the sources of funding in 13 countries, it is shown that over time NARS in sub-Saharan Africa have become increasingly reliant on donor-sourced funds.

In general, investments by the private sector in agricultural research in sub-Saharan Africa have been extremely limited, and seed companies, for example, are relying almost exclusively on publicly funded research. It may be expected that over the next decade the demand of the private sector for raw materials and consumer products will increase. This will lead to increased emphasis on improved quality standards, among other things. The greater presence of private companies over time should become of increasing importance for the development and distribution of improved technologies.

To make significant progress, research will have to deliver technologies that can really make a change for the better in sub-Saharan Africa. Research organizations will need to consider the requirements of small- and medium-scale farmers that can intensify their production systems based on market demands. Farm size will generally have to increase, together with intensification of farm practices, to permit farmers to raise their total production and income to significantly higher levels. Special efforts have to be made to identify conditions for developing rural-based agroindustries.

Agricultural research plans

In sub-Saharan Africa, most of the NARS have developed their own national research plans. They are now organized within the three subregional organizations, the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the West and Central African Council for Agricultural Research and Development (CORAF/WECARD), and the Southern Africa Centre for Cooperation in Agricultural Research and Training (SACCAR). Each of these regional bodies has developed a regional strategic plan, which includes priority setting at the regional level. Recently the NARS and the regional bodies have established an apex body called the Forum for Agricultural Research in Africa (FARA). For many years agricultural research in sub-Saharan Africa has also been promoted through the Special Program for African Agricultural Research (SPAAR). SPAAR and FARA have jointly developed a vision for African Agricultural Research (SPAAR/FARA 1999).

The SPAAR/FARA vision highlights a number of elements essential for positive change in agricultural development trends in sub-Saharan Africa:

- recognition of the importance of agriculture as the mainstay of economic growth
- the need for a significant increase in the quantity, quality, and variety of technologies available to users
- further strengthening of subregional and Africa-wide collaboration and exchange of experience in agricultural research in order to benefit from economies of scale and thus enhance the competitiveness of African agriculture

- enhancing the capacity of Africa to influence the agenda of the emerging global research system.

The vision stresses that at the dawn of the 21st century, Africa must reposition itself in a fast evolving global world economy by carving its own model of development and leadership. An African model must evolve and must aim beyond food security; it must promote a modern, open, and pluralistic society that is based on a competitive agricultural sector, that preserves the diversity of African cultures, and that identifies with its natural resource base. The best of science should be harnessed for the development of advanced but appropriate agricultural technologies that are adapted to local conditions, and take into account sociocultural characteristics and value systems. Research efforts in Africa should place greater attention on the synergy between genetic improvement and natural resource management, incorporating social, economic, gender, and environmental dimensions.

In ASARECA's strategic plan it is noted that at the beginning of the 1960s in the region the national policies and hence research emphasis began shifting towards food crops and problems of small-scale farmers. But the structures and technologies that existed then were found to be inadequate for addressing the new agenda. Improved technologies were lacking, and the support services created for large-scale farmers and export crops were found to be poorly adapted to this new orientation (ASARECA 1997).

The CORAF/WECARD draft strategic plan lists the following guiding principles for regional collaboration (CORAF/WECARD 1999):

- regional collaboration must allow for the efficient and effective use of resources to overcome the constraints to agricultural production improvement and to reduce the effects of natural resource degradation
- the NARS should be considered as the basic elements for an effective and sustainable regional collaboration in the area of agricultural research
- regional collaboration is expected to assist and not replace the efforts of the NARS.

ASARECA considers that the most important objectives and advantages of collaborative regional research programs are to:

- address common constraints that cut across several countries
- enhance complementarity and reduce duplication
- increase the efficiency of agricultural research through the optimum utilization of human, financial, and other research resources
- facilitate the spill-over and transfer of technology among cooperating countries.

In its strategic plan, ASARECA highlights the need to focus on activities that are likely to provide the highest return to research investment. It notes that food security can best be met by stimulating growth in market-oriented production systems which should generate additional cash resources for smallholders and increase off-farm employment for rural and urban poor.

The following challenges facing the agricultural sector are highlighted by ASARECA:

- increased utilization of modern technological inputs to increase on-farm production and productivity
- the development of an appropriate technology transfer system to ensure its efficient supply and utilization
- a system, which should largely be privately owned, needs to be developed to ensure that agricultural produce is efficiently stored, transported, processed, and marketed in the urban areas and to export markets
- maintenance of the sustainability of the agricultural resource base.

With respect to sustainable resource use, the ASARECA strategic plan notes the following:

> *Farmers are likely to adopt solid conservation technologies if these lead to a more productive agriculture and improve living standards through economic growth. In this respect, conservation technologies which lead to the farming enterprise becoming more productive and able to sell a surplus and hence be able to purchase inputs such as fertilizers, are likely to be the ones which will play a critical and successful role in reducing degradation on agricultural lands in the eastern and central Africa sub-region as well as the entire continent... It is only when the peasant farmers are assured of at least one square meal a day that they can become good conservationists and environmentalists. This can only occur if the farmers are able to purchase and use modern inputs and they can only do so when they are able to produce a surplus to sell in the increasingly competitive markets.*

Details of the research priorities developed by the three subregional organizations are given in the next chapter. Surprisingly, the regional plans give very little attention to grain legumes, in particular soybeans. Global production statistics clearly confirm the lack of soybean production in sub-Saharan Africa, while the crop is highly valued in all other tropical regions. There is definitely a need to place more emphasis on this crop.

The priority setting exercises of the subregional organizations highlight the need for:

- crop improvement research on the major food crops, with increased emphasis on food quality and stress resistance, and an

increased demand for research on cash crops, vegetables, fruits, and tree crops

- research on market-oriented production systems, in particular crop processing and commercialization to raise income for farmers
- development and implementation of sustainable production practices, including crop–livestock integration, ensuring significantly higher yields, soil fertility improvement, and effective integrated weed and pest management
- exploiting effectively the synergy between genetic improvement and natural resource management research, incorporating social, economic, gender, and environmental dimensions
- policy research to create a supportive environment for agricultural development
- continued strengthening of the research capacity of the NARS and its partners.

Related to the above, it may be useful to note the following statement from the ASARECA strategic plan:

> *Increase in on-farm production and productivity can only occur through increased utilization of modern technological inputs. In this respect there is need to ensure that both the 'hardware' (e.g. high yielding plant and animal varieties, fertilizers, machinery and implements, irrigation systems, etc.) and the 'software' (i.e. the husbandry and management technologies which facilitate the optimal and economical utilization of the hardware) aspects of the technologies are developed and adopted by the farmers.*

In this respect it is also important to note that increase in agricultural productivity requires support of a well-functioning research and development continuum. Effective interaction must be promoted between all the relevant structures, and these should be adequately supported to be able to fulfill their complementary roles.

CORAF/WECARD

Research priorities developed by the subregional organizations

Regional research priorities have been established by CORAF/WECARD by using the national strategic plans of each country in the region. Given the wide range of agroecological conditions, the region has been divided into three zones: West African Sahelian zone, West African coastal zone, and Central African zone. Working groups for each of the three zones identified on the basis of the national plans the development objectives for the specific zone and established a list of priority research programs for collaboration at the zonal level. Following this, a figure was given reflecting the degree of priority of each of the research programs. The totals of

Table 1. CORAF/WECARD research priorities (see text for explanation of scoring).

	West African Sahelian Zone	West African Coastal Zone	Central African Zone
Plant production			
Vegetable crops	17.62 (1)	13.19 (4)	12.14 (3)
Rice	13.15 (2)	14.94 (1)	6.28 (12)
Cowpea	12.19 (3)	10.97 (7)	1.40 (22)
Fruit crops	12.14 (4)		
Groundnuts	11.53 (5)	8.25 (11)	8.64 (9)
Millet	10.36 (6)	6.94 (13)	1.84 (19)
Maize	9.64 (7)	14.00 (3)	12.08 (4)
Root crops	9.64 (8)		
Forage crops	8.82 (9)		
Sorghum	7.89 (10)	10.22 (9)	4.09 (16)
Cassava		14.17 (2)	17.00 (1)
Yam		13.14 (5)	5.51 (14)
Cotton	7.60 (11)	12.19 (6)	4.78 (15)
Plantain		10.67 (8)	
Pineapple		10.11 (10)	10.31 (6)
Banana		7.64 (12)	
Soybean		5.67 (16)	2.60 (18)
Plantain/banana			13.91 (2)
Natural resource management and production systems			
Soil fertility	18.25 (1)	16.19 (1)	12.05 (6)
Intensification/diversification	17.75 (2)		
Irrigation systems management	16.67 (3)		
Crop/livestock interaction	16.51 (4)	16.06 (2)	15.21 (1)
Land ownership	16.43 (5)		
Biodiversity	15.75 (6)		14.04 (2)
Agroforestry	15.00 (7)	14.33 (3)	13.03 (4)
Impact of agric. practices	14.25 (8)		
Water management		13.89 (4)	
Land management		11.42 (5)	
Soil acidity			13.59 (3)
Water and soil pollution			8.96 (7)
Soil erosion			8.79 (8)

these for the countries in the zone give an initial score for the priority. Next, each research program is classified according to its contribution to the development objectives. This gives a weighted score that is multiplied by the initial score to give the final score. The latter is transformed to a common denominator of 20 for easier comparison. The results are presented in Table 1. Figures in brackets give ranking in the three different zones.

ASARECA

ASARECA has established priorities for regional research based on the review of national research priorities. The results are presented in Table 2, which gives the program, ranking, score, and percentage, the latter representing the weighted score divided by 5.

Table 2. ASARECA research priorities.

	Rank	Score	Percentage
Program			
Maize	1	3.79	75.8
Beans	2	3.67	73.4
Sorghum	3	3.42	68.4
Banana	4	3.37	67.4
Soil and water	5	3.34	66.8
Soil fertility	6	3.33	66.6
Dairy	7	3.32	66.4
Wheat	8	3.32	66.4
Beef	9	3.25	65.0
Potatoes	10	3.16	63.2
Coffee	11	3.15	63.0
Sheep and goats	12	3.12	62.4
Cotton	13	3.10	62.0
Rice	14	3.03	60.6
Forestry	15	2.98	59.6
Cassava	16	2.94	58.8
Socioeconomics	17	2.94	58.8
Groundnuts	18	2.80	56.0
Citrus	19	2.46	49.2

SACCAR

SACCAR carried out a priority setting exercise in 1995 on the basis of which commodities were ranked in three groups as indicated in Table 3. For each of the commodities listed, production constraints were identified based on the best available data and discussions with NARS and individual sector staff; these constraints were used to identify the researchable areas.

In addition to these rankings it is noted that, in terms of productivity over the years, cash crops have made substantial progress compared to food crops and other enterprises. It is noted that for most cash crops research was carried out by the private sector and was well funded. This emphasizes the need for increased research resources to support

Table 3. SACCAR research priorities.

	Priority ranking		
	High	**Medium**	**Low**
Food Crops	Maize Cassava Beans Sorghum and millet Wheat and barley	Groundnuts Sweetpotato Exotic vegetables Cowpea	Fruit trees Irish potato Pigeonpea Rice
Cash crops	Cotton Sugarcane Tobacco	Sunflower Tea	Coffee Nuts

food crop research. Consequently there is also a need for greater private sector participation in selected areas of research to complement the public sector research efforts.

With respect to both food and cash crops, crop improvement should receive higher priority over crop management due to location specificity of the latter. This is consistent with the emphasis of the current Southern Africa Development Community (SADC) research projects. However, for food crops, because of the gains already made with respect to improvement in yields, the emphasis should be shifted to specific stress factors. For example, in maize emphasis should now be on drought tolerance and nitrogen use efficiency.

Postharvest technology is a priority area in all the highly perishable food crops and crops of limited alternative uses such as sorghum and millets. Future research initiatives should address this issue.

Despite its low ranking at regional level, crop management research offers a better short-term opportunity in boosting crop productivity. This is due to the fact that improved varieties are available both from national and regional programs.

Greater emphasis should be given to technology transfer to ensure that new technologies that are currently being developed by the ongoing research programs reach the needy farmers.

Research challenges for IITA and its partners in sub-Saharan Africa

Agricultural development challenges and research needs in different agroecological zones

IITA research activities cover three major agroecological zones: the savanna, the humid forest, and the midaltitude zones. The agro-ecological and socioeconomic conditions of these zones determine the development needs of the agricultural systems, which in turn drive the required research agenda.

Savanna zone

The lowland savanna zone is characterized by a length of growing period of 150–270 days and an elevation below 800 m. The zone covers over 370 million hectares in sub-Saharan Africa, and has a relatively high production potential. The growing season is at least 4 months, enough for most cereal and grain legume crops, and in the more humid part it surpasses 6 months, adequate for root and tuber cropping or two crops of maize or grain legumes. The dry season of 3 or more months helps to reduce pathogen inoculum compared with the forest zone. Rainfall does not often exceed crop needs for long periods, therefore leaching of nitrate and potassium is limited. Soil acidity is not a major issue in large parts of the zone.

On the other hand, there are very clear production risks in the zone. The risk of soil erosion is highest for the savanna zone with monomodal rainfall because of low vegetative cover and high-intensity rainfall. Soil organic matter falls below a critical threshold level after 15–20 years of cultivation. Water retention and nutrient supply are low and physical properties are very susceptible to degradation.

Major weeds are *Imperata cylindrica* in the moist savanna and *Striga hermonthica* in the dry savanna zone. Major insect pests are those which attack cowpea in the field in all zones, maize in the moist savanna, and cowpea, maize, and yam in storage. The latter reduce yield and food quality. Other pests of common importance are termites and nematodes on maize, cowpea, and yam. Important diseases in the field are yam anthracnose, yam viruses, cassava mosaic, cowpea bacterial blight and bacterial pustule, and several cowpea fungal diseases. Aflatoxins can be a serious postharvest quality problem in maize, particularly when maize is produced under stress conditions such as low fertility and occasional drought.

Population density varies from very low to more than 200 inhabitants/km^2. Overall, Nigeria has the highest population but still has an under-populated middle belt, as do most of the coastal countries. Poor road infrastructure will be a major limitation to input and market access. Other socioeconomic constraints are lack of cash, lack of conducive policies, and irregular input supply.

In the savanna zone a distinction can be made between: (i) farming systems that make very limited use of improved technologies and

inputs, but in which intensification is expected to take place over the next 10 years; (ii) systems that already rely rather strongly on improved technologies and significant input use in both the dry and moist savanna; and (iii) peri-urban agriculture, the most input-intensive system. Each system has its specific socioeconomic and technical problems and research needs.

Intensifying systems in the dry and moist savanna

Large numbers of savanna farmers rely on cereals, grain legumes, and roots and tubers for subsistence as well as income. Intensifying these systems will be most important in the areas with relatively poor infrastructure and relatively recent immigration from more populated areas. Access to external inputs is limited and markets are not guaranteed. In these systems, fallows are still used to regenerate soil fertility and to disrupt weed and pest build-up. Fallow lands also provide grazing resources for increasing numbers of ruminant livestock. As fallow periods shorten these problems will become more important. A challenge will be to encourage the use of inorganic fertilizer while maintaining the use of organic inputs. Credit, infrastructure, conducive policies, and decision support will be needed. Control of weeds such as *Imperata cylindrica* requires substantial human labor and has been a major stimulus for adoption of the *Mucuna* fallow system, for example, in southern Benin. Cover crops should be integrated wherever possible with herbicides, mechanization, and varieties that smother weeds. There will be a continued need for integrated pest management practices to reduce pre- and postharvest losses.

The major problems of maize will be nitrogen supply and parasitism by *Striga hermonthica*, which will move with immigrants from the dry savanna. Maize varieties with good resistance to *S. hermonthica* and improved nitrogen use efficiency will be promoted. For their nutrient needs maize-based systems will partly benefit from spill-over of technologies from the more intensified systems (benefiting from grain legumes and livestock).

The use of improved soybean and cowpea varieties that produce high grain yields contributing to improved human nutrition and income will be an important component. These improved varieties also cause suicidal germination of *S. hermonthica*. When they are grown in rotation with cereals such as maize and sorghum they significantly reduce the damage caused by this parasitic plant. In addition, these improved soybean and cowpea varieties fix large amounts of nitrogen and produce good quality fodder. This is important in particular to the increased interaction of crop and livestock production as agriculture intensifies. Cowpea is becoming a key crop on recession flood plains in northern Nigeria, where it is planted at the beginning of the dry season.

With appropriate interventions, the benefits of closer integration of crops and livestock, such as utilization of poor quality crop residues and the provision of manure, traction, and income, can be exploited in order to encourage the sustainable evolution of the systems. Understanding the processes influencing the evolution of crop–livestock systems will be important to ensure appropriate technology targeting in this respect. Herbaceous legumes, which can provide fodder and improve soil fertility, are likely to be important in specific niches.

Cassava is an important cash crop in many areas and could even become an export crop. Market opportunities for chips, starch, and alcohol will transform the production and postharvest handling of cassava. Highly productive varieties are available. Replacement of the exported nutrients will be necessary. Appropriate varieties have been developed to smother weeds.

Yam is an important cash crop, especially in the Guinea savanna zone with a long, monomodal rainfall pattern. Yam responds to good soil quality and therefore the desire to maintain this traditionally important crop can be seen as a window of opportunity for maintaining the resource base. Agroforestry and cover cropping may be targeted to the yam system. On the other hand, the search for new areas for yam cultivation can lead to loss of savanna woodland. The yam chip technology has resulted in a less perishable yam product but postharvest insect damage can lower quality.

Intensified systems in the dry savanna

Intensified systems in the dry savanna are maize or cotton based and include sorghum, cowpea, and soybean. They are characterized by continuous cropping with use of relatively high amounts of external inputs (fertilizer and pesticide). Examples are commercial maize in northern Nigeria as a result of the availability of subsidized fertilizer, and cotton in the francophone countries where the necessary chemical inputs (and sometimes machinery) are provided. Soil productivity can degrade rapidly under continuous cropping due to soil erosion and compaction. Organic matter levels fall below what is necessary to favor retention of applied inorganic fertilizer and water. The seed bank of the parasitic weed *Striga hermonthica* also increases with continuous cropping in the dry savanna. Earlier diagnostic work showed that soil pest problems such as nematodes and *Fusarium* stem and ear disease were prevalent in high-intensity maize systems in northern Nigeria.

Thus a major challenge is to maintain sufficient soil organic matter levels while still producing an economic product. In the dry savanna zone this requires crop residue return, animal manure application, and legume integration. The benefits of soybean and cowpea rotation with appropriate varieties will be the major thrust. Opportunities to exploit

the synergies of crop–livestock integration, for example, through the provision of manure and traction power, will be sought. Whilst there are examples of long-term continuous cropping such as in the close-settled zone of Kano (northern Nigeria) where manure and traction feature predominantly, it will be important to ensure that the benefits of crop–livestock integration are developed in relation to increased productivity, without detriment to the natural resource base. Research on nutrient management, fodder quality and quantity (in particular from crop residues), and the management of crop residues is an important aspect.

None of the nutrient recycling options can succeed in the long term without adequate external inputs. Phosphorus is the most often limiting nutrient in both savanna zones after nitrogen and is needed in particular for legumes. Farmers need cash or credit and good roads and markets to favor access to these nutrient inputs, and support to help guide their decisions on when and where to use them. National fertilizer policy is critical to the process of making fertilizer available.

Intensified systems in the moist savanna

Intensified systems in the moist savanna zone are most likely to be cassava, yam, or maize based as intermediate products such as chips, starch, and alcohol become popular. Nutrient recycling technologies to be encouraged are grain legume and forage legume rotations. These also need to be considered in relation to increasing numbers of ruminant livestock, which have the potential to make a significant contribution to intensified systems. Potassium plays an important role in disease resistance and is exported in large amounts by root and tuber crops and therefore can be expected to become deficient in moist savanna areas before long. Weeds such as *Imperata cylindrica* are a frequent reason for failure in continuous cropping in the moist savanna zone. Extra labor is often needed to fight weeds, even on agricultural research stations, making integrated weed management critical here. Postharvest pests occur in all of the potential commercial crops mentioned above. Policies in favor of input use are needed as in the dry savanna zone.

Peri-urban agriculture and specialty crops

Following the continuous growth of the large cities, horticulture (fruits and vegetables) will become an increasingly important sector. Peri-urban agriculture is extremely productive and a small piece of land can provide income for many families. Peri-urban systems result in high land values and continuous cropping, with insect pests and diseases becoming a problem. The use of pesticides can lead to the occurrence of secondary pests and dependence on pesticides (pesticide treadmill), as has been observed in the Philippines and Thailand. Consumers are confronted with dangerous residues on these crops.

IITA has the competitive advantage of dealing with pests, weeds, and diseases in an environmentally sound way. IITA will be addressing such problems when and where they occur, including pests, diseases, and weeds cutting across agroecozones, for example, termites and water hyacinth. In the savanna region, livestock is often important in peri-urban areas, particularly for dairy and meat production from large and small ruminants, respectively. Such enterprises present opportunities for optimal utilization of crop byproducts, and manure management to promote soil fertility.

Implications for agricultural development and research

In the savanna zone critical agricultural development issues, determining the current research needs, may be summarized as follows:

- arresting soil erosion (dry savanna in particular)
- improving soil, water, carbon, and nutrient management
- managing weeds, especially *Striga* (dry savanna) and *Imperata* (moist savanna), in a more effective manner
- improving access to improved germplasm of major crops
- integrating triple-purpose legumes (food, feed, and soil fertility) into improved cropping systems
- ensuring adequate feed availability and appropriate crop residue management (dry savanna in particular)
- controlling pests and diseases from field to store
- improving agroindustries and market systems
- increasing labor productivity and use of mechanization and animal traction
- developing policy options for sustainable intensification of agriculture
- optimizing the benefits from the integration of crop and livestock production enterprises through better understanding of integration pathways and development of appropriate technologies
- determining effective ways to strengthen local research and extension capacity.

With effective research the agricultural situation in the savanna zone by 2010 is likely to be characterized as follows: continuous cropping generally applied; significant use of man-made inputs; increased crop–livestock integration; improved food processing to meet increased demand; cereals/grain legumes/livestock-dominant production system in the dry savanna, and maize/tubers/grain legumes/vegetables in the moist savanna; cotton-based systems important but diversifying (dry savanna); improved market access; increased peri-urban agriculture; increased

animal-based mechanization (dry savanna); more use of perennial tree crops (moist savanna); reduced women drudgery; policies improved; and diversifying farming systems.

Humid forest zone

The humid forest zone has a length of growing period of 271–365 days and an elevation below 800 m. This zone covers 256 million hectares in sub-Saharan Africa, of which 48 million hectares are located in West Africa and 202 million hectares in Central Africa. In general, a wider diversity of agricultural crops is grown compared to the savanna zone. Root crops tend to be the main source of carbohydrates, with cassava, yams, and cocoyams of major importance; plantain is also a major staple. Both upland and lowland rice are important across West Africa and in the eastern Congo basin. Other cereal crops and grain legumes are cultivated less than in the savanna zone due to poor adaptation of cultivars to the climatic conditions of this zone, pest and disease pressure, and difficulties in storage of grain. All crops suffer from a variety of pests and diseases. Green maize is an increasingly important source of income in areas with good market access to major urban centers. Tree crops are integral to most farming systems, and meet a wide variety of needs ranging from cocoa revenues used, for example, to send children to school, to using the bark from *Alstonia boonei* to treat malaria.

Once established, agroforests such as complex shaded cocoa or coffee systems are dependent on internal nutrient cycling and as such mimic the forest. In contrast, fertility for annual cropping in most farming systems of the region traditionally relies on the ash and litter input from forest and fallow conversion through slash-and-burn techniques. Traditional crop/fallow rotational systems are sustainable as long as the population-to-land ratio remains low. As population increases and fallow periods shorten to below 8–10 years, the total biomass and available plant nutrients in the fallow decline. This has resulted in declining vigor and yields of crops, such as plantain and cocoyam, traditionally planted in forest fields. However, yields of food crops such as cassava and groundnuts do not appear to diminish in 4- to 5-year-old bush fallows dominated by *Chromolaena odorata*. The shortening of fallows is also associated with increasing weed pressure and number of problem weeds, which makes weeding, generally done by woman and children, more tedious and time consuming.

Poverty and poor infrastructure and social services such as extension, primary rural health care, rural roads, rural electrification, and education are among the major social problems in most areas of the humid forest zone. Rural poverty is associated, inter alia, with a degrading natural resource base. Short-term food security risks among rural households are less of a concern than in the savanna zone due to more stable and abundant rainfall patterns. Rural households in most areas (with the possible

exception of the more densely populated portions of Ibo lands in southeast Nigeria) have been able to meet household subsistence food requirements, but this is not to say that a nutritionally balanced diet has been achieved. The dominant goal of these farm households is to strive for greater income through their agricultural activities.

The combination of increasing population pressures and technologically stagnant agriculture has led to irreversible environmental loss through the expansion of slash-and-burn agriculture and slow rural development. The closed canopy Guinea–Congolian forest originally stretched from Guinea in West Africa to the western rim of the Rift Valley in Central Africa. In West Africa most of it is now gone, replaced by a 'cultivation and forest mosaic'. In Central Africa there are still significant areas of closed canopy forest, however population growth rates and logging pressures are high. Biodiversity hot spots, i.e., areas which have high levels of endemic floral and faunal diversity that are under threat, have been identified in the region by different conservation organizations (Conservation International, the World Conservation Union, the World Wide Fund for Nature). The farmers in these areas need to be presented with technology options that allow them to increase productivity, efficiency, and income on the land that has already been deforested. At the same time, appropriate policies and supportive institutions are required for intensifying agricultural systems and for controlling rural migration patterns. In areas like southeast Nigeria, where the pressure on the land is high and the soil is being rapidly degraded, soil and nutrient conservation and crop protection measures need to be introduced that result in increased productivity.

Increasing land and labor productivity is necessary for reducing poverty and slowing deforestation, and agricultural research has an important role to play in the process. Policy-led agricultural intensification, if successful, will increase farmer welfare, improve regional food security, and in combination with appropriate forestry conservation and migration policies, slow the expansion of the forest margin thereby maintaining vital forest resources and their important ecological services for the needs of both present and future generations. Failure will have both local and global consequences ranging from spiraling poverty to global climate impacts and biodiversity loss.

In the humid forest zone a distinction can be made between: (i) forest field systems, that traditionally rely on long fallow periods; (ii) short fallow food crop systems, where population pressure has resulted in shortened fallow lengths; (iii) speciality field systems, growing crops strictly for commercial purposes with high input use; and (iv) multistrata/perennial tree crop systems usually growing a range of tree crops. Each system has its specific socioeconomic characteristics and technical problems, as well as different research needs.

Traditional forest field system

Traditionally, fields that are directly cleared from the forest are planted to a variety of crops, for marketing as well as for subsistence, depending on the region. In southern Cameroon, forest fields are planted mainly to plantain, cocoyam, and a few other crops that are more location specific. These forest fields are then in a further cycle after a short fallow of 3–4 years converted to mixed food crop fields with cassava, maize, and groundnut. Plantains are one of the preferred starchy crops among consumers in the humid forest zone and in many areas are the most important commercial food crop. In forest fields, yields are primarily limited by the lack of productive ratoons due to constraints in nutrient supply, viral and fungal diseases, and pests such as nematodes and weevils. In areas with declining fallow periods, these problems are further aggravated. Plant crop yields and the length of the productive ratoon period need to be increased by eliminating nematodes at plantation establishment, using improved varieties, and developing appropriate biomass management options in association with the application of economical rates of fertilizer. Adapting such traditionally forest-based systems to land in shorter fallow cycles and to home gardens will allow for greater production of important food crops in already deforested areas and so reduce the pressure on existing forests.

Short fallow food crop systems

Population pressure and growing market demand have resulted in shortening fallow lengths with associated problems of soil degradation, weed and pest and disease problems, and declining crop productivity. The use of external inputs or improved planting material in mainly mixed crop associations is extremely low, especially in Central Africa. This is due to the lack of proven crop responses, limited cash availability of farmers, and failures in producer support services (e.g., extension and planting material multiplication). It is clear that any strategy to increase agricultural productivity will require that farmers have access to improved germplasm adapted to short fallow conditions and acid soils that characterize most of the Congo basin. Policies should encourage farmer organizations and NGOs to propagate improved varieties of cassava, plantains, cocoyams, open-pollinated maize varieties, and grain legumes. NARS in the basin need to support these efforts through the timely provision of foundation planting materials.

Addressing the fertility and weed constraints of these systems requires more research on appropriate combinations of improved biomass management (of either natural fallow or improved planted fallow with leguminous species), crop sequencing, and purchased inputs such as fertilizers and herbicides. To some degree, the abundant and underutilized wood ash generated by kitchens, food processing, and

brick kilns can substitute for purchases of lime and potassium fertilizer. Fertilizer policy options need to be developed to support the intensification of food crop production on already deforested land, given the social costs associated with expanding agricultural production through further deforestation (i.e., biodiversity loss and global warming). Integrated pest management strategies need to be further developed against pests and diseases.

Speciality field systems

Farmers have quickly adopted intensive short fallow or continuously cropped monocrop field systems for strictly commercial purposes when they have access to inputs and markets. Examples include high-value horticultural, green maize, and cassava monocrops commonly observed around the urban peripheries of forest zone cities such as Yaoundé, Lagos, Kumasi, Freetown, Ibadan, and Kinshasa. These speciality field systems, frequently integrated into cropping rotation with staple food crops, help to restore depleted soil nutrients in the farming system. The crops grown in these systems are often the only crops for which farmers find fertilizer application sufficiently profitable. However the sustainability of pest management practices in these intensive systems is under question and poses serious health risks to both consumers (pesticide residues) and producers. One of the major researchable constraints is the build-up of pests and diseases that occurs with continuous cropping. In general, practices need to be developed for more economical use of external inputs adapted to different cropping sequences and management practices.

Multistrata/perennial tree crop systems

Tree crop exports from the humid forest zone are of paramount importance for many West and Central African economies, and it is expected that Africa's comparative advantage will be maintained for many years to come (Deaton 1999). Most households in the humid forest zone pursue diversified production strategies including a broad range of tree crops for both domestic demand and export. Perennial cropping systems such as the biologically complex cocoa agroforest of southern Cameroon and smallholder oil palm are generally acknowledged to be agronomically more suited to the fragile acid soils of the zone than annual crops. In the past, common practice was to convert moist tropical forest, however the high environmental costs of further conversions in West and Central Africa warrant alternative approaches if Africa is to maintain both its comparative advantage and environment.

One potential win–win solution is to reforest degraded fallow lands through the establishment of permanent tree-based systems. Such land conversion can potentially increase farming system sustainability and

income while enhancing environmental services, particularly carbon sequestration, and biodiversity conservation. There are, however, many potential agronomic, pest and disease, and socioeconomic constraints to such a strategy. On the agronomic side are issues of soil fertility, changes in soil microfauna, and excessive weed competition during the establishment phase. A major socioeconomic constraint in much of this area is the land ownership structure and its link to tree planting.

Labor invested in tree crops is one way in which households can increase their productive resources and lift themselves out of poverty. However, resource-poor households are often impeded by land shortages, which, when combined with immediate needs, can limit their participation as they are unable to wait out the lag between tree planting and production. To ensure their participation, profitable and agronomically feasible associations of food crops with perennial crops are needed during the establishment phase. On the policy front, discussions on smallholder participation in carbon trading under the Clean Development Mechanism of the Kyoto Protocol are ongoing and may eventually provide a policy mechanism for rewarding smallholders willing to undertake such land conversions.

Implications for agricultural development and research

In the humid forest zone critical agricultural development issues, determining the current research needs, may be summarized as follows:

- establishing mechanisms to solve agriculture–conservation conflicts
- improving soil fertility and carbon management
- managing weeds and vegetation
- managing pests and diseases from field to store
- improving and adapting crops to different farming systems
- arresting genetic erosion of indigenous crops
- diversifying farming systems
- improving market systems and agrobusinesses
- increasing labor productivity and reducing drudgery
- developing policy options for sustainable agricultural intensification
- organizing farmers and farmer services
- determining effective ways to strengthen local research and dissemination pathways.

With effective research the agricultural situation in the humid forest zone by 2010 is likely to be characterized as follows: reduced deforestation and biodiversity loss; stabilized forest–cultivation mosaics;

improved food processing to meet increased demand; increased peri-urban agricultural production; integrated livestock–home garden systems; increased role of tree crops; intensified and diversified field crop systems; increased use of external inputs and improved varieties; farmer-friendly policies implemented and improved market systems established; and empowered farmer groups.

Midaltitude zone

The midaltitude zone covers a total of 356 million hectares, 24% of sub-Saharan Africa, and is mostly located in eastern and southern Africa. The zone is defined between 800 and 1500 meters above sea level. Unlike the humid forest or savanna zones, it is highly heterogeneous with wide variations in rainfall, soil types, and topography. Its main feature is a relatively cool climate with adequate rainfall in a large part of the zone, creating conditions for good crop growth. The volcanic ash soils are very fertile and support very diverse farming systems, although in the higher rainfall areas soils tend to be acidic. Soil erosion is a major problem due to the sloping nature of the terrain. The midaltitude region has been particularly prone to extreme and adverse climatic effects. Agricultural strategies for this zone therefore need to take into account not only the major socioeconomic factors that are changing the agricultural system in the region, but also provide for mitigation strategies against adverse conditions.

In the last three decades, agricultural growth has resulted rather from expansion in cultivated areas than from increased productivity per unit area. In most countries, intensified land pressure, reflecting rapid population growth, has led to reductions in fallow periods, greater utilization of marginal lands, and smaller farm sizes. However, large-scale mechanized farming is important in some countries such as South Africa and Zimbabwe. Even though population densities are high, there is labor shortage in rural areas because of rural migration to urban areas and the AIDS pandemic, which has affected the most productive segment of the society.

The major food and cash crops are maize, bananas, beans, cowpea, cassava, rice, soybean, sorghum, millets, wheat, and vegetables, while the major export crops are coffee, tea, tobacco, pyrethrum, and sisal. Yields are severely affected by weeds, and pests and diseases cause significant pre- and postharvest losses. Livestock, including large and small ruminants, are well integrated into the farming systems and their manure is used to maintain soil fertility in the banana and coffee farming systems. Wildlife, forest products, and fish processing also contribute considerably to the local economies.

The problems related to agricultural development are comparable to those in the other two zones and include lack of trained manpower,

inappropriate policies, declining soil fertility, soil erosion and degradation, limited market access and lack of market information, lack of adequate processing and storage facilities, inadequate crop protection systems, lack of credit facilities, weak extension systems and poorly developed systems for regional germplasm exchange, and declining export trade.

Due to the heterogeneity of the midaltitude zone and the strong emphasis in the ASARECA strategic plan on income generation, a different approach has been used to identify the agricultural research needs for this zone. The following groupings have been used: (i) defining market opportunities and needs; (ii) sustainable production systems; and (iii) diversification of income-generating activities.

Defining market opportunities and needs

Different households use varying strategies to assure access to available food. Households which rely heavily on earning income to purchase food have more stable consumption patterns throughout the year than those which derive most of their food and income from their own cropping. In most cases farmers grow small amounts of several crops within a mixed farming system. Whilst this may maximize food security, the small-scale cultivation of each crop does not lend itself to gaining efficiencies in crop production as reflected in the poor quality and high prices of agricultural commodities.

Strategies which enable farmers to adapt their various food security patterns towards more market-driven options are required. There is need therefore for technical and institutional innovations which will increase efficiency, and improve coordination of the entire set of actors and institutions involved in input supply, farming, processing, and distribution of agricultural products. Investigating market opportunities is an important starting point in developing strategies, which can assist farmers to improve their lot within a rapidly changing market framework. A food systems analysis is essential in developing equitable strategies to gain access to low-cost food with key issues revolving around who is food insecure, what they eat, how they secure access to food, and how changes in technologies, institutions, and policy will affect their food entitlements.

Participation of stakeholders in identifying strengths and weaknesses within the market sectors will be a critical change in the research approach, which can have significant effects on the dynamics of the research agenda. If the research agenda is driven by market conditions, then technical, institutional, socioeconomic, and policy improvements are likely to have the highest pay-off. This in turn will strengthen existing domestic and regional markets as a basis for industrial or export growth.

Sustainable production systems

Rural poverty is associated with low productivity, which is intrinsically linked to how farmers presently manage and invest towards improvement of their natural resources. The current unsustainable production practices, exacerbated by increasing population pressure on land, have led to a decline of the natural resource base and the cultivation of food crops under very marginal conditions. Resource-poor farmers need to employ improved techniques to produce for viable markets, a process that will involve greater reliance on input and output delivery systems and integration with other sectors of the domestic, regional, and international economies.

In order to achieve the goal of sustainable production, urgent attention needs to be paid to improving the current crop and livestock farming systems and soil (fertility, carbon sequestration, acidity, erosion) and water management practices within the midaltitude's agroecological mosaic. Intensified use of organic and inorganic fertilizer and other external inputs will increase productivity on a sustainable basis, although the increased costs associated with these changes will have to be met through the parallel development of enhanced marketing opportunities. Generation of very productive target varieties for different end uses and markets with better crop husbandry practices provide the opportunity for improved production and value-added processing.

Household requirements for fuel and building materials are increasingly being supplemented through growing trees on farms to replace the diminishing forests and woodlands. There is an important potential for integrating diverse fruits and high-value trees into the farming systems of the zone. Farm-level postharvest activities must be addressed, including improved storage for home consumption and more efficient market channels. Appropriate and effective government policies are required to draw the full benefit of these new technologies.

Pests and diseases are likely to become increasingly important with the anticipated intensified production systems. The agroecological zone has been plagued by major pest epidemics, which have led to regional initiatives to mitigate their effects and restrict their spread. Efforts to tackle these problems must be geared towards combining integrated pest management with soil fertility management. The predominantly subsistence pest management strategies involving limited use of pesticides for crops and drugs/dips/vaccines for livestock, have provided an environmentally friendly non-pesticide-based pest control approach. Biological control has been successfully used in the past and will be an important component of future integrated pest management strategies. Significant increases in demand for chemical-based pest and disease control measures associated with intensification and commercialization of production are inevitable. Environmental hazards and human safety

issues related to their use need to be addressed. Controlling weeds will require effective and less labor-intensive management practices including herbicide application.

Diversification of income-generating activities

Most food crops are produced through subsistence farming with its characteristic use of low-input, rudimentary technology, large postharvest losses, and minimal processing. Associated with these are problems of unreliable supply of primary produce, uneven quality of products, and low producer prices, which affect their use for agricultural transformation.

The increased demand for food and industrial needs poses a challenge for increasing production and improving access to good quality products. Understanding market opportunities through commodity price surveys, evaluating market efficiencies, and information dissemination is essential in developing profitable technologies for enterprise development. A market-driven approach should systematically identify opportunities and constraints to successfully address food security and nutritional needs of subsistence farmers and low-income consumers. Institutional and policy measures related to crop harvesting, transportation, storage, processing, and marketing should be identified, and linked to production issues such as development of appropriate germplasm, protection, and production packages.

Most crops are either sold or consumed fresh and often remain underutilized. Processing into higher value food, feed, and industrial products opens new markets which create increased income and provide farmers with incentives to intensify production and avoid seasonal price fluctuations. Improving product quality and developing new products are essential factors in market expansion and increased demand. Developing rural agroenterprises that enhance market opportunities will impact significantly on the economic and social benefits of the rural population.

Appropriate equipment to carry out postharvest operations to minimize crop losses and improve labor productivity and product quality will ensure efficient utilization of food crops. IITA has designed and fabricated improved manual and powered equipment such as graters, dewatering devices, sifters, stoves, chipping machines, and grinders, which need to be tested and disseminated within the ecology. A number of other types of specialized processing equipment are available worldwide but are in limited use within the zone, either due to their high cost or their lack of suitability for use by small-scale processors. Training of manufacturers will be required to evaluate, adapt, and promote equipment that meets the needs of small- to medium-size processing enterprises.

Implications for agricultural development and research

In the midaltitude zone critical agricultural development issues by 2010, determining the current research needs, may be summarized as follows:

- improving soil fertility, carbon sequestration, and reducing soil erosion
- mitigating the adverse effects of drought
- assessing future demand and use of current and potential agricultural products
- optimizing crop–livestock systems
- diversifying income-generating activities
- improving labor productivity and increased farm mechanization
- ensuring participation of women in the development and transfer of technologies
- improving access to improved germplasm of major crops
- addressing crop-specific biotic and abiotic stresses
- developing improved seed production and distribution systems
- determining effective ways to strengthen local research and extension capacity
- developing policy options for sustainable agricultural intensification.

With effective research the agricultural situation in the midaltitude zone by 2010 is likely to be characterized as follows: highly diverse farming systems; major food crops grown: banana, cassava, maize, soybean, yam, grain legumes, and coffee; increased livestock production; farm productivity substantially enhanced; the conflict between agriculture and conservation exacerbated with increasing population growth; increase in the number of agroindustries; increased availability and use of external inputs and improved varieties; integrated pest management methods more widely used; farmer-friendly policies implemented; and improved market systems established.

Development challenges and research needs relevant to all agroecological zones

A number of development challenges and research needs are of relevance to all agroecological zones.

Benchmark approach

The benchmark approach was developed within the framework of the Ecoregional Program for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA). It serves to facilitate research in heterogeneous areas, to increase cooperation between various partners, and to maximize the impact of technology on resource-poor farmers for the achievement of sustainable natural resource management. An important feature of

this approach is the concentration of research activities in a limited number of benchmark areas. These are areas representing major features of ecoregions. Their selection is based on ecoregion, biophysical and socioeconomic criteria, and opportunities for successful execution of research and extrapolation of results. Such research primarily addresses strategic and transnational issues such as pests and diseases, soil nutrients, household decision-making, and development dynamics, although it also leads to local benefits through farmer participatory testing and institutional exchange.

Recommendation domains, characterized by similar household, biophysical, and institutional circumstances, are identified to allow for the development of technology options that fit specific farmer circumstances. Strategic and applied research innovations are developed within the benchmark recommendation domains in on-farm and on-station trials, with findings feeding into adaptive research conducted by NARS, including nontraditional partners such as NGOs and farmer organizations, both within the benchmark areas and in the larger recommendation domains outside the benchmark. Benchmark areas are complemented by pilot sites, which are located outside the benchmark area but fall within the same ecoregion. They serve to test and adapt technologies that were developed in the benchmark areas and to cover specific environments that are not featured there.

Integrated farm and landscape management

There is currently limited knowledge on the impact of farmer decisions and biophysical interactions on scales beyond the plot or household level. Understanding the interactions between cropping practices, pest populations, disease epidemiology, and soil erosion at various scales from field to landscape/watershed will lead to more successful interventions. Effective institutional arrangements for collective action, land tenure, and property rights are all key for effecting positive change.

For instance, the farmer's choice of field position in a landscape has an influence both on pest status and on the efficacy and adoptability of a control option. As an example, the temporal continuum of inland valley upland maize cropping stabilizes the habitat for stemborers and their natural enemies. Increased pressure on agricultural land and concomitant changes in the vegetation may change pest and disease equilibria. Field location in the landscape and its temporal dimension can also have major ramifications on erosion rates and downstream aquatic resources (e.g., siltation of mangrove estuaries). In addition, the use of nitrogen fertilizer or introduction of legumes may enhance pest pressure in adjacent fields. On the other hand, some control options require a community effort to work, e.g., control of cocoa blackpod disease, eradication of downy mildew, and destruction of crop residues.

Policy options for increasing productivity and maintaining the resource base

Achieving sustainable productivity gains and maintaining the functionality of the resource base will not be achieved without an appropriate and supportive policy environment. Analysis of the complementarities and tradeoffs among objectives such as poverty eradication, agricultural growth, and the environment is required for the identification of initiatives in the project, program, and policy arenas that can best achieve these objectives.

There is a strong need for policies to increase the productivity of agriculture in order to relieve pressure on forest and soil resources and reduce poverty. Policy makers need information on conditions which influence farmers' decisions to intensify production in a sustainable manner, in order to design policy options to encourage the intensification process before natural resources degrade. At the same time, land use planning policies and delineation and conservation of hot spots are crucial to maintaining Africa's vitally important stocks of carbon, biodiversity, and genetic resources. Supportive policies are also needed to encourage the development of community-based organizations, including credit and mutual savings cooperatives, and local NGOs that will lead to empowered rural communities. Women, responsible for much of the production, processing, and marketing, have limited access to productive resources such as labor, credit, extension services, and market information, and often see their work burden increase when new innovations are introduced. New policy options targeted to women's particular needs as producers and food processors are required.

For crop protection appropriate policies and mechanisms are needed for pesticide registration and control, but also to promote integrated pest management. The development of alternatives to chemical pesticides helps to reduce the risk to environment and humans. Opportunities include host plant resistance, biological control, habitat management solutions (intercropping with non-hosts, trap plants, management of soil nutrients) and the use of botanicals. With increasing world trade and travel, the risk of the accidental introduction of exotic pests, weeds, and diseases is a permanent risk to African agriculture. Preventative systems have to be strengthened, and NARS need the capacity to respond quickly to such problems.

Technology introduction, monitoring, and impact assessment

Success will depend on how the research and development outputs respond to stakeholders' interests and needs. Identification and involvement of major stakeholders in exploiting a given market opportunity will greatly facilitate technology development and transfer. Collaboration with individuals and institutions that contribute to research and development

issues will be strengthened. This association assures concentration of research on priority needs of stakeholders, enhanced complementarity, promotion of end-user access to information, inputs, and services, and feedback of stakeholders' experiences with new research technologies, which ensures that technologies are adapted to local agroecological and socioeconomic conditions.

Most studies show the important role of women in food crop production and postharvest activities, with very little access to and control over the productive resources and benefits. Gender-related issues will therefore influence problem identification and characteristics of new technologies. There is a need to initiate, test, develop, and build on participatory research and training methods, which create partnership in adapting component technologies whilst ensuring that new technologies generated are technically, socially, legally, economically, and environmentally acceptable.

Dynamic and innovative public and private sector partnerships will be required to improve institutional capacities for effective participatory approaches in planning, technology development and dissemination, monitoring adoption, and impact assessment.

Monitoring and impact assessment are perceived as an integral part of the research and development agenda since they provide feedback, which enables modification and refinement of ongoing research, evaluation of successes and failures, and provision of lessons for future planning and investment in research.

Commercialization and enterprise development

There is a growing need in all zones to intensify the identification and exploitation of market opportunities for both existing and novel value-added products. This will require the optimization of crop mixtures (traditional food and cash crops) by farmers in the different zones together with the use of appropriate postharvest and marketing technologies to enhance the income-generating capacity of both farmers and small- to medium-scale entrepreneurs. A production-to-consumption strategy using a combination of market analysis, appropriate selection of crops, plus innovative postharvest technologies and food safety measures will be applied.

This should lead towards sustainable systems of integrated production, based on demand-driven market opportunities that address poverty alleviation through increasing the share of added value going to small- and medium-scale producers and agroindustrialists and through enhanced employment opportunities. The end result needs to be commercially viable farm and linked agroindustrial enterprises. Particular emphasis needs to be placed on meeting the needs of women within the target groups, small- to medium-scale farmers, farmer associations, processors, and marketers, and to analyze the changing roles of women and children in such enterprises.

Research programs of IITA

Crop improvement

Crop Improvement Division (CID) scientists will collaborate with scientists in other divisions in addressing the major constraints and opportunities in the major agroecological zones as highlighted below, and will focus on areas prioritized by the institute's research on problems faced in real-life agricultural systems. Crop improvement objectives will include storability and suitability for processing.

Increased demand and production of livestock will also promote the integration of livestock with crop production, and in such systems the role of crop residues as fodder will be emphasized. Incorporating fodder characteristics into breeding and selection programs will be part of the strategy to identify improved crop varieties suitable for these systems. Excellent progress has already been made in recent years through joint research between ILRI, IITA, and national partners.

There is need to further collect, characterize, conserve, and document germplasm, using conventional and molecular tools, to assess diversity, potential use, remove duplicates, and select core collections of IITA's mandate crops (especially cowpea, yams, African cassava, and banana and plantain) and selected African crops. Cryopreservation technologies for long-term conservation of vegetatively propagated crops need to be developed to reduce costs.

IITA will integrate biotechnology in its breeding programs, where it will make greater advances than conventional methods. Molecular markers will be developed and applied for more efficient selection of desired traits. New methods will be used to introduce traits with potential major impact on productivity and quality into crops when use of conventional methods have little or no chance of success. Cellular biotechnology will continue to be employed for micropropagation, disease clean-up, conservation, and distribution of germplasm of vegetatively propagated crops. Following the need to explore as much as possible the comparative advantages of potential partners, IITA has established various collaborative arrangements.

IITA's role in research-for-development for agrobiotechnology in sub-Saharan Africa includes: (i) fostering of the international sharing of knowledge and skills in biotechnology tools important to agriculture improvement in the continent; (ii) helping African national partners to negotiate acceptable terms on intellectual, genetic, and other proprietary biotechnology assets needed for crop breeding; and (iii) launching creative and innovative approaches such as molecular breeding of crops relevant to African agriculture.

IITA will consider the utilization of both functional genomics and transgenics for overcoming barriers to alelle transfer and for an appropriate targeted gene expression in its mandate crops. Likewise, with the

advances in genome sequencing, germplasm collections held in trust in the IITA genebank and associated genotypes and phenotypic databases are potential sources for gene discovery, which will become an important research area in international genomics initiatives, to gain a better understanding of available genes (and their functions) in key agricultural species.

Partnerships with NARS colleagues will be reinforced through further group and individual training. Participants will form invaluable links between IITA scientists and the national systems in joint research and the validation of technologies, as well as in providing feedback.

The list below gives the major areas of work that will be addressed by CID to fulfill the institute's mandate. These were developed after a thorough analysis of the main characteristics and critical development issues of each of the major agroecozones. For example, varieties will be developed to fit into diverse cropping systems of the dry savanna with high grain and fodder yield; another example is the breeding of maize for resistance to the parasitic plant *Striga hermonthica*.

Major areas of work that will be addressed by CID are:

- breeding for increased quantity and quality of produce to target different markets
- improvement of seed multiplication and distribution systems
- improvement of resistance to major pests, diseases, and parasitic plants
- enhance capacity of partners for crop improvement and seed production
- conservation and use of genetic resources
- breeding for adaptation to drought and acidic soils
- development of new varieties through genetic engineering for intractable traits when conventional methods are not effective
- use of molecular markers to improve efficiency of breeding
- breeding for adaptation to predominant farming systems
- breeding for increased nutrient use efficiency
- breeding for increased nitrogen fixation.

Resource and crop management

The Resource and Crop Management Division (RCMD) seeks to operate as the integrator of IITA's research work into real-life agricultural systems. RCMD's work will revolve around the development and testing of new systems to determine their economic and social feasibility, and the interactions of their components within existing farming systems to determine their likely biological, social, and economic sustainability.

Greater emphasis will be given to analyzing whole farming systems by examining the full potential range of agronomic management interven-

tions, including strategies to promote the sustainable integration of crop–livestock systems. Furthermore, increased efforts will be made to facilitate impact by being more open and responsive to technological adaptations feeding back from further down the research and development continuum through efficient technology transfer pathways.

In contrast, less emphasis will be placed on basic process research, with two principal exceptions. RCMD will (a) intensify efforts to find solutions for chronic weed problems, including *Imperata* and *Striga*, and (b) maintain efforts to overcome the lack of understanding of how nutrient use efficiency can be improved using both organic, inorganic, and combined sources of NPK, and how this can stimulate interventions which can further improve productivity, profitability, and sustainability.

RCMD will also place high priority on the analysis of policy options which seek to encourage the adoption of improved pre- and postharvest technologies as well as the conservation of natural resources. More emphasis will be on interventions that are able to generate both immediate and long-term benefits for the poor, with positive implications on equity and gender. Taken together this twin strategy should reduce poverty and improve overall rural livelihoods by helping to ensure the maintenance and enhancement of soil fertility, improved labor use efficiency, reduced drudgery, consistently greater productivity and profitability, better environment services, and improved overall willingness and capabilities of farmers to adopt new technologies and to then share these with their neighbors.

A team-based research approach will be employed, with partners sought wherever talents exist, that can be usefully brought to bear in solving problems. These partners will include NARS in their broadest definition (farmers and farmer organizations; national policy makers; private sector suppliers, manufacturers and marketing agents; local and international NGOs; the mass media; universities, government ministries), international advanced research institutions and commercial organizations, and our natural allies in the other research divisions of IITA and the other CGIAR centers.

The division will maintain a full complement of disciplines across the full spectrum of natural and socioeconomic sciences, and seek in most instances to define and solve the problems it confronts in an interdisciplinary, systematic manner. As a result of our demand-driven approach to research, most of the research will continue to be carried out in the existing benchmark areas, to address critical development issues of high priority for each agroecological zone in the period 2000–2005, with scaling up and impact generation activities beyond the benchmarks becoming increasingly important in the latter half of the decade.

Major areas of work that will be addressed by RCMD are the following:

- soil fertility management with the use of organic and inorganic inputs
- integrated crop and weed management
- development of income-generating enterprises
- integrated crop and livestock management
- increasing labor/mechanization efficiency
- protecting the environment, biodiversity, and natural resource base
- scaling and extrapolation of research findings
- development and use of impact indicators
- policies for the adoption of improved technologies and conservation of natural resources
- analysis of demand and use of food and food products
- understanding key gender roles and equity opportunities for poor farmers
- identifying technology transfer pathways
- evolving mechanisms for priority setting
- partner institutional strengthening.

Plant health management

The Plant Health Management Division (PHMD) will continue to use its strong capacity in areas such as population dynamics, functional biodiversity, biological control, host plant resistance, and habitat management to develop environmentally friendly and sustainable plant health management practices. This will be based on the use of proactive preventive pest control methods, instead of heavy reliance on curative chemical methods.

The impact of plant health management will result in a reduction of pre- and postharvest losses, both qualitative and quantitative. It is best achieved by applying integrated pest management tools. These include different forms of biological control, resistant varieties including transgenics, development and application of botanicals and microbial pesticides (some produced locally), and habitat management and other agronomic practices. This approach to plant health management not only increases income, but also ensures reduction of negative impact on health and improves overall well-being through safeguarding the environment in conserving biodiversity. PHMD makes use of its comparative advantages in plant health issues in collaborating with all stakeholders in agricultural research and extension. Its priorities are based on problems identified in the course of the institute's on-farm research.

PHMD addresses the following plant health-related problems:

- production of healthy seeds and planting material
- integrated management of pests and diseases of staple food crops and speciality crops including vegetables
- effective control of introduced and key native problem weeds
- sustainable control of termites and migratory pests
- reducing loss of functional biodiversity threatening stability of agroecosystems
- control of postharvest pests, reducing postharvest losses and increasing food quality and health
- improved coordination and institutional strengthening in plant health research and implementation.

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About IITA

The International Institute of Tropical Agriculture (IITA) was founded in 1967 as an international agricultural research institute with a mandate for improving food production in the humid tropics and to develop sustainable production systems. It became the first African link in the worldwide network of agricultural research centers known as the Consultative Group on International Agricultural Research (CGIAR), formed in 1971.

IITA is governed by an international board of trustees and is staffed by approximately 80 scientists and other professionals from over 30 countries, and approximately 1200 support staff. Staff are located at the Ibadan campus, and also at stations in other parts of Nigeria, and in Benin, Cameroon, and Uganda. Others are located at work sites in several countries throughout sub-Saharan Africa. Funding for IITA comes from the CGIAR members and from a small number of other donors.

IITA's mission is to enhance the food security, income, and well-being of resource-poor people primarily in the humid and subhumid zones of sub-Saharan Africa by conducting research and related activities to increase agricultural production, improve food systems, and sustainably manage natural resources, in partnership with national and international stakeholders.

To this end, IITA conducts research, germplasm conservation, training, and information exchange activities in partnership with regional bodies and national programs including universities, NGOs, and the private sector. The research agenda addresses crop improvement, plant health, and resource and crop management within a food systems framework and targeted at the identified needs of four major agroecological zones: the dry savanna, the moist savanna, the midaltitude, and the humid forest. Research focuses on small- and medium-scale farmers and on all production systems to fulfill the ecoregional mandate with special emphasis on the following food crops: cassava, cowpea, maize, plantain and banana, soybean, and yam.

Cosponsored by the World Bank, the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Development Programme (UNDP), the CGIAR is an informal association of over 40 governments and about 15 international organizations and private foundations. The CGIAR provides the main financial support for IITA and 15 other international centers around the world, whose collective goal is to improve food security, eradicate poverty, and protect the environment in developing countries.

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