AGRICULTURAL INTENSIFICATION: FEEDING OURSELVES AND SUSTAINING AFRICA'S LAND RESOURCES IN THE NEW MILLENNIUM


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ABSTRACT

The Green revolution provided humanity a tool to ameliorate the impact of impending global hunger and poverty for a brief period. Inequities in the distribution of the green revolution's benefits reflected intrinsic and widening disparities between people of the world at global, national, community and family level, and also even by gender. Current population trends are contributing to a growing escalation in global poverty and hunger that threaten to wipe out the current global food surplus. In sub-Saharan Africa, the depth of poverty and hunger is already great and environmental degradation is further reducing the productive resource capacity. A new vision of humanity's welfare is that our common future demands a second green revolution that will redress inequities in distribution of the benefits of agricultural intensification in favor of the rural poor. Furthermore, future gains in food security should not be achieved at the expense of environmental conservation. A third and more difficult challenge for future advances in agricultural innovation is that it must also encompass much broader objectives for rural development and address the full scope of rural livelihood opportunities provided by increased urban migration. Measures needed to ensure future food security demand clear, effective and synchronized strategies for an accelerated intensification of agriculture and hence economic growth. This will require a climate of greater political stability and fundamental social change. Such strategies must target poverty as a root cause of hunger and low development of rural economies. Above all such strategies must create the necessary framework for broader application of productivity-enhancing technologies as the engines for sustainable economic growth. Greater progress and efficiency can be achieved through more appropriate institutional approaches that permit greater flexibility and collaboration between existing institutions. Alternatively, new institutions that provide a shift in the focus for development can be created. However, such institutions must also permit a broader and well-synchronized approach that generates strong synergies between countries and existing institutions.

Key words: *Food Security, Agricultural Intensification and Green Revolution.*

INTRODUCTION

The definition of food security has changed to include a concept of entitlement that demands that the poor and hungry have access to food at all times for a normal healthy active life [1]. Humanity's pursuit of food

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security has also broadened to include conservation of the environment and broader opportunities for rural livelihood [2]. Agricultural intensification has in the recent past shouldered the burden of delivering humanity's aspirations for food security [2]. Can it also now deliver environmental conservation and diversification of rural livelihoods simultaneously in the face of rapidly increasing population growth?

The trend of decreasing per capita food production in Africa poses unique and significant challenges because of an unprecedented population growth rate in most of Africa [3]. In addition Africa also has many inherent biological, social and infrastructural limitations that set most of her countries apart among the world's nations [3]. Opportunities for exceptional growth and prosperity are, nevertheless, also embedded in these very conditions that seem so daunting.

Africans must evolve their own solutions to their own challenges. However, the age of the global village is here and permits no one, rich or poor, weak or powerful, the luxury of seclusion [4]. The task of wielding agricultural intensification as a tool for achieving food security and sustainable prosperity is made manyfold more difficult on a continent that has limited financial capital. Africa is also on the fringe of international trade with little political clout and meager capital investments.

What then is the current status of Africa's food deficit and how do African institutions develop the capacity to address Africa's food crisis effectively and in a manner that also conserves the natural resource base? To what extent can Africa rely on tried and tested methods and what role can the new advances in biotechnology and ecology play in achieving food security for future African generations? Will technology alone be sufficient? If not, how will scientists and development workers cope with more powerful determinants of social and economic stability that are prerequisites for progress on any front?

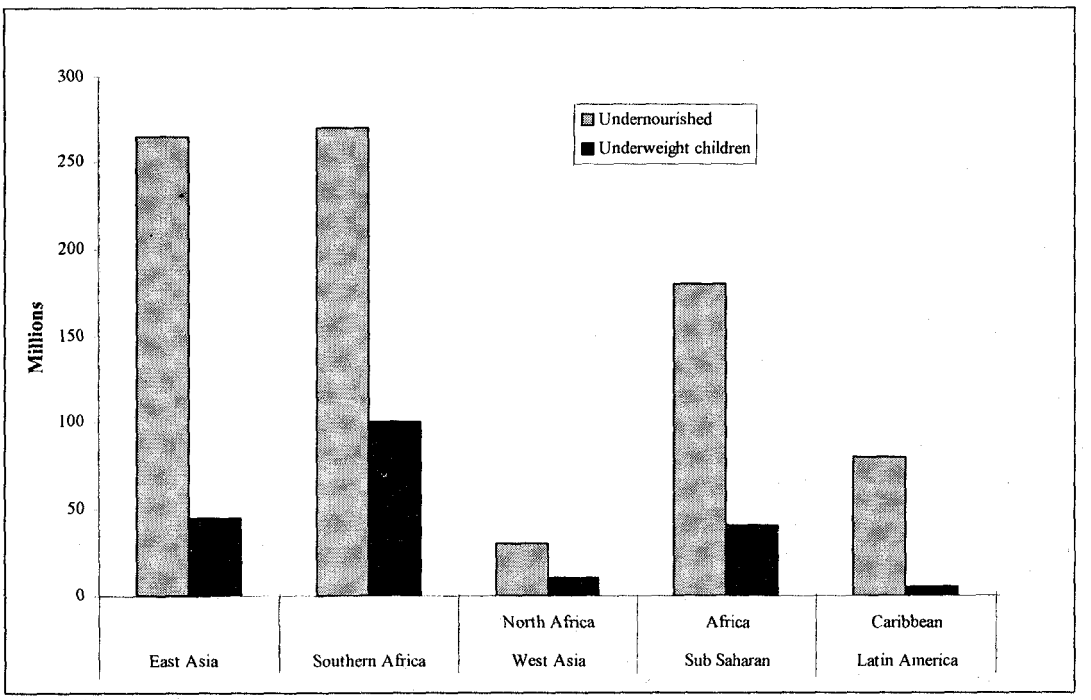
PERCEPTION OF THE HIDDEN FOOD GAP AND FUTURE THREATS

Policy makers need a clear perception of Africa's food gap to help strengthen their resolve to act decisively. The global food gap is hidden except in times of crisis because on average the human population lives longer, eats better, produces and consumes more food than at any other time in the world's history [5]. As the world celebrated the birth of its 6 billionth child however, nearly 800 million people (15% of world population) lived below the poverty line and went and faced nightfall hungry on most days [6]. Africa is home to an estimated 286 million of the worlds hungry [7]. Half of Africa's 794 million people are poor and live on less than $1 per day. The twin perils of hunger and poverty disproportionately afflict the rural populace, especially in Africa where over 70% of the poorest people live in rural areas [8]. Although the proportion of the world's hungry has fallen in recent years, the number and proportion of Africa's undernourished and malnourished has risen as the population has grown (Figure 1).

Already 37% of Africa's population is undernourished and 31% of children are underweight [9]. Africa's average energy intake per person is only 2100 kilocalories, 600 kilocalories short of the required minimum (2700) for an active life. Access to food by the hungry poor has diminished in spite of falling food prices because even these reduced food prices remain high relative to their earning capacity. The poor are hungry because they can neither grow, buy, nor beg for enough food [10].

Stark as these realities may be, they are cushioned in part by the fact that at least 50% of Africa's poor live on high potential agricultural land and only 15- 20 % live in urban centers [11]. This provides the possibility to grow more food and also to stem rural-urban migration. Using FAO data, Borlaug [12], predicts that at current per capita food consumption, population growth will require production of 2.6 billion additional tonnes of

Figure 1: *Hunger by region in the developing world*



cereals to feed nearly 8.3 billion people by 2025. More than 1.3 billion of these people will be in Africa. This will mean almost a doubling of production of all cereals on the basis that cereals provide more than 80% of global calorie intake (Table 1). It is unlikely that the people who need this food most will be able to buy surpluses from USA and Europe, assuming that there will be a surplus to sell. The only real alternative is that Africans themselves will have to grow more than double the current amount of food and fibre just to keep up with population demands.

Prospects of achieving a doubling of food production in Africa in the short term are bleak but many observers believe it is possible in the long term provided that the right attention, focus and resources are given. In the short term, prospects for progress are severely hampered by more powerful crisis of social, economic and political transformation that take precedence over food and agriculture for available resources. It is against this background that Africa's response to her food crisis must be measured.

High rates of population growth and little application of improved production technology have resulted during the last two decades in declining per capita food production, escalating food deficits, and deteriorating nutritional levels, especially among the rural poor in Africa (Table 2).

STRATEGIC RESPONSE TO AFRICA'S FOOD CRISIS

Food AID has so far been the most significant response to Africa's looming food crisis. Billion US$3.2 has been spent on agricultural development efforts in Africa through bilateral and multilateral programs [13]. Agriculture attracts between 2-4% of GDP in most African countries although it contributes between 40- 60 % of GDP [14]. Africa has no comprehensive continental strategy that is integrated and takes account of comparative advantages and capacities with respect to individual countries' situations. Regional organs of the Africa Union such as ECOWAS, EAC and SADC collaborate on

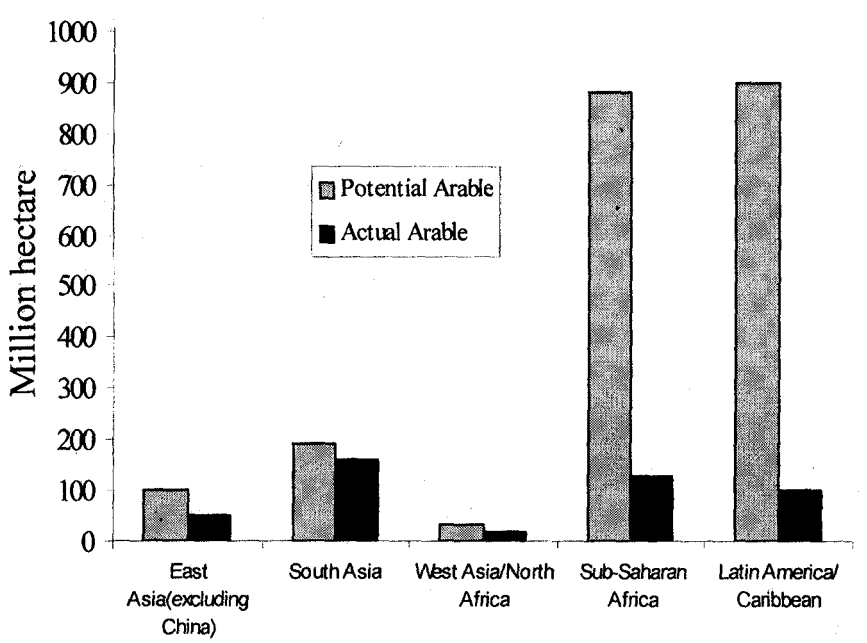
trade and tariffs but little is known about their joint strategic plans for food security. Where such strategies exist, they are not publicized. African countries have instead pursued individual agricultural development programs usually within the framework of World Bank assisted country assistance programs. The result is usually a multiplicity of bilateral and multilateral projects composed of piecemeal agricultural projects that are run through centralized bureaucracies or independently by non-governmental agencies. The guiding principles for development and attainment of food security are outlined in various declarations of international meetings in relation to child nutrition, environmental conservation, population, social transformation and gender equity. The declarations only serve as reference points for information on the design and launching of new programs. The World Food Summit declaration (FAO 1996) captured the horizontal linkages between these key areas that represent major challenges to achieving food security for all, eradicating hunger and halving the current number of undernourished people of each country by 2015 [15].

Global opportunities to meet the food gap in Africa emanate from two sources: farm lands that have been set aside in Europe and USA could be brought back into production but would probably get absorbed in the world grain market and therefore become unaffordable by the poor. Additional land mostly in Latin America and Africa can be brought under cultivation. In either case existing land and new land will have to be cultivated intensively to meet expected food demands (Figure2).

APPROACHES AND APPLICATION OF TECHNOLOGY OPTIONS

Most of Africa lies in the tropical region and therefore has lower production potential than temperate areas due to higher plant metabolic rates, higher pest incidence and frequent droughts [3]. The technology options for intensifying agriculture are nevertheless based on the same scientific principles of good choice of improved germplasm, adequate plant nutrition, effective pest management and response to market demand. The ineffective application of these

***Figure 2:** Potential arable land in the developing countries*



principles under Africa's conditions has resulted in large gaps between actual and potential yields in most field crops and animals [16]. The inability to apply the science of agriculture appropriately is attributed in large measure to limited capacity of subsistence farmers to adopt productivity enhancing technologies. Poor market infrastructure and market failures constrain the more progressive farmers from higher levels of production in favorable environments. The response to low adoption rates has fueled debates and research on technology options available to small-scale farmers and the mode of information dissemination techniques among farmers.

SUCCESSES AND FAILURES

Africa's focus on industrialization led to a draining of resources away from agriculture and created the beginning of current food gaps shortly after independence. Collective farming of large commercial-scale state owned farms was abandoned and as it became clear that not only were some of the methods and crops unsuited to Africa, but that there simply did not exist the management capacity needed to run them. The question then was, why did large-scale commercial farming in South Africa, Kenya and Zimbabwe succeed? Privatization of large-scale commercial farming has increased at a rapid pace and there are now many successful cases, for example, pineapple farming in Ghana, snap beans in Senegal and flower farms in East Africa. Commercial-scale farming still remains a small part of total agricultural land in most African countries.

The small-scale subsistence-farming sector has provided most of Africa's food and therefore merits more attention when seeking solutions to Africa's food crises. In spite of significant investments in the training aimed at millions of small-scale farmers, the results have been disappointing in several countries [17]. Productivity did not increase significantly because the approach was message- based and did not take into account the alleviation of other limiting resource constraints such as access to recommended agricultural inputs. On the other hand, input- based technology transfer methods have shown demonstrable impact that has been difficult to sustain because of the limitations imposed by rudimentary physical and market infrastructure. Traditional technology transfer approaches based on seed and fertilizer inputs have shown significant impact on yields (doubling of cereal yields), initially in Ghana, Tanzania and elsewhere in Africa but was difficult to sustain. Whilst the participatory models have shown more effective capacity to utilize locally available resources, their adoption is also low because they focused on low input production technologies that are often more labor intensive with limited immediate benefits to the farmer. A modification of technology transfer programs to focus on maximizing returns to small capital investments that depend on integrated approaches has shown promising results in Uganda [18]. These prospects for sustainability are hinged on the integration of available technologies and fostering of a network of private rural stockists of agricultural inputs [19].

Regional action plans to meet food security demands are now rightly focused on the poor to help them produce the food they need in the environments that they live in. Under FAO's global food-for-all campaign, national committees, the private sector and civil society combine efforts in a special program aimed at increasing food production in 75 Low-Income Food- Deficit countries out of which 35 are in Africa. Whilst it has been possible to demonstrate significant production increases in small projects, scaling them up has been a problem. Similar types of projects on bigger scales had been previously launched under the Sasakawa Global 2000 initiative with remarkable results in the short term in Ghana, Tanzania, Sudan and Ethiopia. However, resolving second-generation problems of excess local production, lack of effective market demand and reduced profit margins have diminished the enthusiasm of farmers for greater investments in production.

A shift towards an integrated nutrient management approach for crop production is now being espoused by the Rockefeller Foundation. FAO is also promoting an integrated pest management approach in farmer field schools in several African countries. These action research programs hold some promise and many NGOs are moving in the direction of participatory action research. It should be noted, however, that an overreliance on a research-focused approach with no institutional mechanisms that support broad-scale dissemination of findings has not proved effective in the past and is unlikely to be in the future. Overall the impacts of agricultural intensification so far in developing countries have been small. There are, however, indications that intensification is making land savings in Malawi and Burkina Faso although contributions to yield are modest [1,19]

Viable agro-ecology models have been reported in widely disparate places like the United States and India [20]. In the United States, a landmark study by the prestigious National Research Council found that *"alternative farmers often produce high per-acre yields with significant reductions in costs per unit of crop harvested, despite the fact that many federal policies discourage adoption of alternative practices"*. The Council concluded that Federal commodity programs must be restructured to help farmers realize the full benefits of the productivity gains possible through alternative practices [20].

In South India, a 1993 study was carried out to compare "ecological farms" with matched "conventional" or chemical-intensive farms. Ausubel found that the ecological farms were just as productive and profitable as the chemical ones [21]. He concluded that if extrapolated nationally, ecological farming would have "no negative impact on food security," and would reduce soil erosion, and the depletion of soil fertility while greatly lessening dependence on external inputs.

Cuba is where alternative agriculture has been put to its greatest test. Changes underway on that island nation since the collapse of trade with the former socialist bloc provide evidence that the alternative approach can work on a large scale. Before 1989, Cuba was a model Green Revolution-style farm economy, based on enormous production units, using vast quantities of imported chemicals and machinery to produce export crops, while over half of the island's food was imported. Although the government's commitment to equity, as well as favorable terms of trade offered by eastern Europe, meant that Cubans were not undernourished, the underlying vulnerability of this style of farming was exposed when after the collapse of the socialist bloc Cuba faced an already existing U.S. trade embargo [21].

Cuba was plunged into the worst food crisis in its history, with consumption of energy and protein dropping by as much as 30%. Nevertheless, by 1997, Cubans were eating almost as well as they did before 1989, yet comparatively little food and agrochemicals were being imported [22].

Faced with the impossibility of importing either food or agrochemical inputs, Cuba turned inward to create a more self-reliant agriculture based on higher crop prices to farmers, agro-ecological technology, smaller production units, and urban agriculture. The combination of a trade embargo, food shortages, and the opening of farmers' markets meant that farmers began to receive much better prices for their products. Given this incentive to produce, they did so, even in the absence of Green Revolution-style inputs. They were given a huge boost by the reorientation of government education, research, and extension toward alternative methods, as well as the rediscovery of traditional farming techniques.

Small- scale farmers and cooperatives responded by increasing production while large-scale state farms stagnated and faced plunging yields. The Cuban government then initiated the newest phase of revolutionary land reforms, parceling out the state farms to their former employees as smaller-scale production units. Finally, the government mobilized support for

a growing urban agriculture movement comprised of small-scale organic farming on vacant lots that, together with the other changes, transformed Cuban cities and urban diets in just a few years [22].

The Cuban experience tells us that we can feed a nation's people with a small-farm model based on agro-ecological technology, and in so doing we can become more self-reliant in food production [21]. However, one begs to question if a success that was contingent on higher food prices can be replicated in countries where the populace earn less than $1 per day and already spend more than 67% of their income on food? [21].

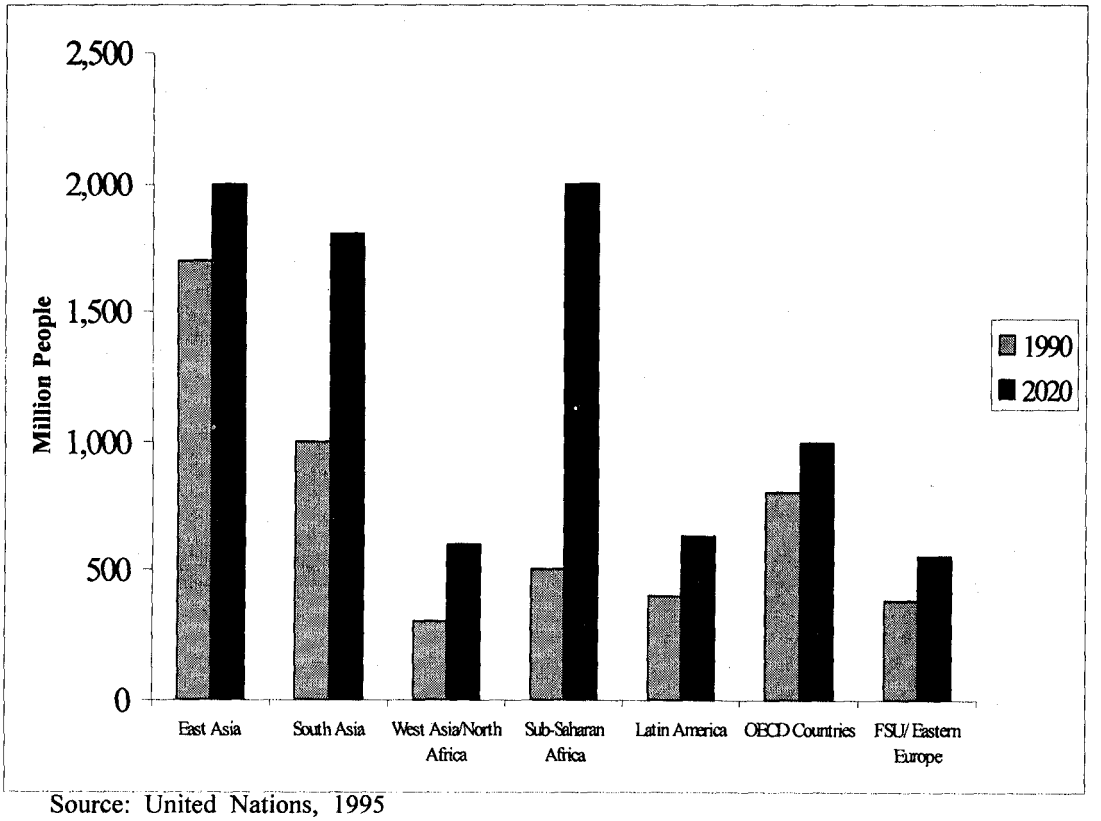
CHALLENGES FOR ACHIEVING SUSTAINABLE FOOD SECURITY

The major challenges for achieving sustainable food security in Africa arise from population growth, land degradation and unreliable weather (rainfall).

Population Growth

Whilst there are some signs that population growth rates in a few African countries (Kenya and Botswana) are slowing down, the overall rates continue to increase for the sub continent [22, 23]. Predictions of population in 2020 show more than a trebling of Africa's population (Figure 3). Emphasis on a population control approach has not struck a chord in Africa. This is not surprising because few if any of the conditions that preceded reduction in population growth rates elsewhere exist in Africa. Infant mortality rates, malnutrition associated deaths and implacable diseases still claim many people everyday of every year. A population besieged by insecurity and fatality reproduces to ensure survival. Studies have shown the most significant factors that reduce population growth are improved health facilities, greater access to education and employment for women and security. Until these critical factors improve, Africa's population growth will

Figure 3: Population growth to 2020



Source: United Nations, 1995

remain in a survival mode -high/replenishment growth rates [7].

LAND DEGRADATION

In Africa, chemical and air pollution from agriculture is relatively small although land degradation is high and a source of great concern. The most significant source of land degradation in Africa is deforestation (Table 3) and the subsequent soil erosion that ensues. At least 64% of the land area is moderately to strongly degraded and water erosion alone accounts for 46 % of the total land degradation (Table 4).

The impact of land degradation on crop productivity is severe in many parts of Africa ranging from frequent droughts to soil infertility. This condition is further exasperated by widespread soil mining. Africa's farmers are yet to grasp the concept that the "soil is a bank and therefore withdrawals without deposits lead to bankruptcy". For most farmers the spiraling cycle of diminishing returns has set in and cannot be broken without intervention of mineral fertilizer inputs applied in judicious amounts to responsive crops that also have value for food or a cash crop. Appropriate Technology Uganda, USAID's IDEA project and SG2000 Uganda have demonstrated amply that mineral fertilization can be used productively by farmers with due care. Furthermore, productivity of farmers can be sustained if farmers are supported by a network of rural stockists from whom they can buy small amounts of agricultural inputs as per recommendations and sometimes even get informal credit [24]. This approach, however, also needs to be coupled with an aggressive farmer-to-farmer seed multiplication program for pulses that combine well with cereal farming systems (beans, groundnuts and pigeon peas). In less favorable environments, emphasis was placed on small grain traditional staples like sorghum and millet. External nutrients applied on small grains were minimal and only supplemented organic manure. Rotations were encouraged and tree crops coffee and bananas were managed as part of the total farm system. Additional incomes generated from this approach empowers farmers to transfer investments between farm and off-farm enterprises and hence broaden their rural livelihoods. Prosperous farmers are better able to exploit the resources around them either in fishing, forestry, livestock or agro-processing.

WAR AND CIVIL STRIFE

War and civil strife has disrupted infrastructure and agricultural production in most African countries. Even long after a war is over, its effects on populations of refugees internally and in neighboring countries puts pressure on already strained resources. There is therefore the double negative effect of lost productivity where refugees flee from and disrupted productivity where they settle. Refugees also attract food aid some of which invariably finds its way into local markets and distorts market prices [25].

WATER

The impact of water on intensification has been to render the productivity gains unstable and prone to risk. This is because Africa's production is predominantly rain fed with only 4 % under irrigation [3]. There is potentially a high payoff from developing Africa's capacity for irrigation especially as there is more cultivatable land available. Water is highly complementary to improved varieties of fertilizer [26]. Water is often needed to take full advantage of the seed-fertilizer technology. The future challenges posed by global warming and climate all point to a much drier Africa with more frequent drought. In addition to irrigation, there will be need for production of drought tolerant germplasm and use of associated management practices for drier lands. The introduction of pigeon pea in maize farming systems in Arusha and now in Uganda demonstrates that leguminous shrubs can successfully be integrated with food production in a win-win situation [26]. Policy makers need to pay attention to the institutional

arrangements that preserve and protect the available water supplies to ensure that their potential for agriculture can be realized with minimal conflict in the future as water becomes a scarce resource. Special attention should be paid to the agreements that govern the sharing of water resources between countries that lie along Africa's three great rivers: the Nile, Niger and Zambezi [18].

IMPACT OF HEALTH AND NUTRITION

Unabated population growth in Africa also puts pressure on scarce facilities for health and food that can have mitigating effects on labor available to farm homesteads for intensification [15].

Malnutrition in Africa is a silent killer accounting for many premature deaths that are associated with other diseases like malaria, respiratory infections and HIV/AIDS. Malnutrition related deaths are a direct function of the declining per capita food intake [27, 30]. Adult Africans on average survive on 2100 kilo calories, 600 less than the required minimum daily intake for a normal healthy active life. In reality the distribution of energy intake may be skewed in favor of men to the disadvantage of women and children. In 1999, for the third consecutive year, overall agricultural production failed to keep up with the population growth rate (currently 2.5 % per year) and rose to only 2.1 % [13]. In per capita terms, agricultural production continues to stagnate with levels for agriculture, cereals and food items in 2000 being identical to those attained in 1990 [13]. The proportion of undernourished and underweight children however continues to increase (Tables 5 and 6) as more people fail to get the requisite 2700 kilo calories per day.

The benefits of ameliorating some micronutrient deficiencies through iodized salt have been impressive [28]. Possibilities to provide vitamin A through yellow rice offers new hope to millions of Africans and could be one of the first contributions of genetically modified crops to the poor [13].

HIV/AIDS

The pandemic of HIV/AIDS is global in nature but most intense in Africa [28]. Some evidence suggests that hot spots of HIV/AIDS have responded to awareness programs (Uganda) and the level of new infections is falling [28]. The impact of HIV/AIDS on rural populations is made more severe because depletion of the labor pool has been most intense in the younger population (15-45 years). Apart from depleting the labor pool of the most able bodied persons, HIV/AIDS has also served to increase the number of female-headed households in the short term [29, 31]

The potential contribution of agricultural extension staff to raising awareness of HIV/AIDS during extension meetings is thought to be considerable. Extension staff, however, work for a separate ministry from Ministry of Health workers. Also, extension staff do not have the required medical training to give counseling on HIV/AIDS. Extension workers can, however, organize meetings to which the appropriate medical staff can be invited to consult with farmers. The formation of farmers' fora at community level may permit greater flexibility for HIV/AIDS intervention by creating greater opportunity for communal counseling services on demand where they are currently not available. Also the privatization of extension services will mean that AIDS counselors could be contracted by farmers' fora to provide counseling services where it is high on their agenda and affects their agriculture. Population growth rates have, however, not diminished in spite of HIV/AIDS related deaths [29, 31].

REAPING THE HARVEST OF TRANSGENIC CROPS

The application of biotechnology is still the subject of debate on ethical, legal, bio-diversity and bio-safety issues. Much more information and education on transgenic crops is needed, especially in the developing countries. It is not surprising that African

policy makers and even the scientists, who are ill informed on applications of transgenic plants, restrict their testing, ban their importation and refuse to sign international protocols that guarantee the ownership of intellectual property rights associated with GM(genetically modified) crops. Africa, however, must eventually make well-informed judgment on the key issues surrounding use of biotechnology or miss out on the significant potential contribution of GM crops to achieving food security more rapidly. These benefits include:

* More sustainable and resource-efficient crop management practices that require less fuel, conserve soil moisture and control erosion.
* Less dependency on conventional pesticides that are not only hazardous to health, but are also expensive in any case to small scale farmers.

Collectively, these benefits offer growers and society more efficient and higher crop productivity that help contribute to a more sustainable agriculture and significantly enhance prospects for ensuring global food, feed and fibre security in the future.

The International Service for the Acquisition of Agri-biotechnology Applications (ISAAA) reported in a recent press release that Global GM crop area is growing and likely to reach 50 million hectares in 2001. Three quarters of this area is in the United States and only South Africa currently grows Biotechnology (BT) (see also GM) cotton on the African continent [28]. The regulatory framework in most developing countries especially in Africa, is too weak and under-resourced to engage in the necessary safe testing and introduction of GM crops that will create favorable public awareness and inspire public confidence. Kenya and Nigeria are making some attempts with respect to the introduction of BT cotton in the face of stiff opposition. In Uganda current work on cotton has been stopped. The protagonists of progress may be frustrated [28]. It is, however, not unreasonable that policy makers should first get clear answers to the assertions that GM crops will disenfranchise their populace of their stake in a common heritage, the world's gene pool of plant and animal resources. Furthermore if the poor use GM crops, will there be any concessions for them in exchange for giving up their seed security?

The ethical, legal, bio-diversity and bio- safety concerns cannot simply be wished away, not even in countries where the potential returns are big and the need is great. A substantive effort needs to be made to educate the public so that the debate is not only enjoined by an intellectual elite who are perceived to be agents of multinational concerns. Without significant education about GM crops, the status quo will remain in place and therefore limit use of GM crops in Africa. Policy cannot precede information and education in the case of GM crops because there are too many unknowns. Meanwhile Kenya, Zimbabwe and South Africa are on the fast track to using GM crops because of their already well developed large-scale commercial farming sector [28].

GENDER ISSUES

Few women benefit directly from mainstream development programs because resources continue to be captured by those who are already well endowed [28]. Gender disaggregated data on the participation of women in agricultural intensification programs is generally limited, but nonetheless shows that women mostly participate as married and rarely as heads of households or single women [22]. A number of initiatives have begun to address this. In several countries, professional associations of women in Agriculture have been formed and are active (KEPAWE, TAPWAE, UWAPE - separately for Kenya, Tanzania and Uganda, respectively, Women Association for Agriculture and Environment). Food and Agriculture Organization (FAO) has also recently commissioned a study group to examine the use of gender disaggregated data

among development programs especially those in agriculture. Sasakawa Global 2000-Uganda in collaboration with the National Society for the Advancement of Rural Women (NSARWU) has also experimented successfully with the use of vouchers targeted at women's groups [22]. More than 1000 additional rural women were reached in a mainstream agricultural intensification program. Female participation increased from 16 to 52%. Scaling up of this voucher system will now be tried under the National Agricultural Advisory Services Program.

Improved access to rural credit has empowered women to engage in off-farm enterprises, especially agro-processing [29]. Targeting women, therefore, seems to be a prerequisite to reaching them effectively and must be made a mainstream approach in future agricultural intensification strategies. The participation of women can be further enhanced through more effective representation in farmers' groups if it is set as a precondition for participation in larger farmers' fora that allocate community resources. Progress in advancing the co-ownership of land between spouses has been recalcitrant in most countries and needs more fundamental social change that will permit empowerment through legislation. The increasing participation of women in the legislature of democratic governments in Africa is perhaps the most promising avenue to achieve any significant progress on land issues.

WAY FORWARD TOWARDS SUSTAINABLE AGRICULTURE

Farm models for the future will be knowledge intensive and require greater management of a wider range of factors. African farmers will not be exempted from such future trends and the most successful farmers are likely to be the early adopters. Therefore an early understanding of the essential elements of sustainability needs to be built into African farm models.

Although farming systems are typically managed in isolation from ecosystems within a region, the physical, ecological, and biogeochemical changes that take place within them have numerous consequences for adjacent, and even distant, ecosystems. The biological and environmental consequences of agricultural intensification are increasingly apparent and have become a focus of detailed study in Europe and North America. In these regions, where food self-sufficiency has been abundantly realized, legislation has been introduced to promote more sustainable means of production. Even in regions such as sub-Saharan Africa, where self-sufficiency in food production is still a distant target, a focus on sustainability is being applied to agricultural development. The dimensions of sustainable agriculture are multiple [30] but in this context sustainability may be defined as meeting current production goals without compromising the future in terms of resource degradation or depletion.

The challenge, therefore, is to realize increased production while avoiding the more extreme effects detailed above. The development of more ecologically sound agricultural systems that reintegrate features of traditional agricultural knowledge and add new ecological knowledge into the intensification process can contribute to meeting this challenge. The renewed interest in agro-forestry, intercropping, and mixed arable-livestock systems is an indication of the interest in ecologically designed farming systems. Moreover, integrated nutrient-organic matter management and pest management approaches are receiving increasing attention as pathways to sustainable high-production agriculture and reduction of off-site problems. Broad implementation of such strategies will require the contributions and interactions of social as well as natural scientists, national and international agricultural research institutions, industry, policymakers, and farmers.

The use of inorganic, industrially produced fertilizers has been one of the key factors in enabling the enormous increase in food production in the last five decades, yet the biological and environmental consequences of their use are substantial. However, the requirements for increased food production that the world faces, particularly in the tropical regions, cannot conceivably be met without increased soil nutrient inputs. In order to avoid the accompanying acceleration of environmental degradation, the efficiency of use must be increased greatly. The capacity of the soil system to supply nutrients and retain applied nutrients is undermined by practices that diminish the role of soil organisms and lead to depletion in soil organic matter. One key to nutrient use efficiency lies in the spatial and temporal matching of nutrient resources and plant demand. The adoption of emerging technology that allows inputs to be applied differentially across fields to match crop demands ("precision agriculture") provides a technological step toward increased efficiency that will be immediately useful in some regions [16]. Strategies that help synchronize nutrient release from organic matter and nutrient supply from inputs with plant demand are information intensive. The scientific basis for integration and the economic and social cost of such practices, need to be better understood and incorporated into on-going efforts as complementary and not competing practices. These intensive approaches can only be employed by the very best farmers. The impact will, however, be negligible until they are adopted by mainstream subsistence and emergent farmers who are the greater proportion of Africa's farmers. These are examples of success by emergent farmers, which need to be built on. What does it take for a "seemingly" poor farmer to weed?

CONCLUSION

Agricultural intensification is only part of the solution for combating food scarcity associated with population growth. Ensuring the food security of the next generation requires fundamental changes in population policy, energy policy, land use policy, and in water use policy. If increases in yields per hectare cannot keep up with the demands of a growing population, then intensification is not the sole key to solving the problem of feeding a growing world.

Sustainable agriculture in itself does not guarantee sustainable food security if its main focus is on environmental conservation. Sustainable food security must necessarily focus on people first and the needs of the poor must have greater priority. The poor in developing countries, however, do not live in isolation; they are part of national economies that are weighted down by lack of global market access and unfair trade practices. Even more depressing is the impact of food aid in reducing prices of basic food crops (maize and vegetable oils).

There is a need to create a focus for Africa's agricultural intensification efforts to ensure that development programs meet with Africa's multifaceted food security agenda. Such a special program should emanate from and be centered in Africa's own institutions. If properly implemented and supported in a sustainable manner, agricultural intensification may help Africa catch up with her food demand in the long term. What is clear is that long-term predictions never allow for the catastrophic events that are the prime shapers of human destiny. We must therefore dwell in the realm of hope that Africa will feed herself in the future and proceed with today's pragmatic options. Africa cannot develop when the majority of the population are energy deficient, and fail to meet their micronutrient requirements year round.

Table 1
Current and Projected World Cereal Production: Demand and Yield Requirements (million tonnes)

Crop	Actual Production 1990	2000	Projected Demand 2025	Actual t/ha 1990	Yield 2000	Required yield t/ha 2025
Wheat	600	740	1,200	2.4	2.8	4.4
Rice	520	640	1,030	2.4	3.1	5.3
Maize	480	620	1,070	3.7	4.1	5.8
Barley	180	220	350	2.3	2.7	4.1
Sorghum/millet	85	110	180	1.5	1.8	2.6
All Cereals	1,970	2,450	3,970	2.5	2.9	4.5

Source: FAO Production Yearbook and Norman E. Borlaug's estimates

Table 2
Global Food Production ('000 MT) and Population ('000) in 1999

	Continent					
Type of food	Africa	Oceania	Asia	South America	North America	Europe
Cereals	112912	32063	996974	99638	423925	288001
Root crops	156584	3573	272675	46094	30813	77829
Pulses	7890	2296	29777	3871	7104	6352
Vegetable/Melon	41760	3225	416338	17091	49606	73608
Fruits	59546	5044	177529	70895	52894	70043
Nuts	751	36	3036	240	1227	956
Oil crops	7350	1699	49064	14179	20823	10740
Sugar	8943	6287	43561	28014	20417	21898
Vegetable fibre	1813	720	13020	1289	4913	678
Meat	10603	4951	86587	22873	46908	45118
Milk	26194	21259	148022	46327	94767	160282
Hen eggs	2150	244	26740	198	7292	6953
Population 1999	766623	30019	3562628	340755	477792	728934

Source: FAO Production Yearbook

Table 3

Deforestation and Reforestation in Selected African Countries

Country	Forest area 1980's (Thousand ha)	Deforestation 1980's (Thousand ha)	Reforestation 1980's (Thousand ha)
Guinea-Bissau	2105	57	0
Gambia	215	5	0
Togo	1684	2	0
Benin	3867	67	0
Nigeria	14750	400	14
Ghana	8693	72	3
Liberia	2040	46	1
Guinea	10650	86	0
Senegal	11045	50	2
Ivory Coast	9834	510	3
Democratic Republic of Congo	177590	347	0
Rwanda	230	5	2
Burundi	41	1	1
Central African Republic	35890	55	0
Cameroon	25620	110	1
Gabon	20575	15	0
Angola	53600	84	0

Source: World Resource Institute, World Resources, 1988; and World Bank data.

Table 4

Soil Degradation in Africa

Type	Light	Moderate	Strong	Extreme	Total
	Area million ha		Area million ha		
Loss of topsoil	53.9	60.5	86.6	3.8	204.9
Terrain deformation	3.6	6.9	11.7	0.4	22.5
Water erosion	57.5	67.4	98.3	4.2	227.4 (46%)
Loss of topsoil	79.1	84.2	7.4	-	170.7
Terrain deformation	9.2	5.1	-	-	14.3
Overblowing	-	-	0.5	1.0	1.5
Wind erosion	88.3	89.3	7.9	1.0	186.5 (38%)
Loss of nutrients	20.4	18.8	6.2	-	45.4
Salinization	4.7	7.7	2.4	-	14.8
Pollution	-	0.2	-	-	0.2
Acidification	1.1	0.3	+	-	1.5
Chemical degradation	26.2	27	8.6	-	61.8 (12%)

Table 5
Prevalence of Undernourishment in Africa

Region	Undernourishment population (million) 1996-98	Trends in the share of undernourished in total population (percentage) 1978-81	1990-92	1996-98
North Africa	5.6	8	4	4
Central Africa	38.5	36	37	50
East Africa	79.9	35	44	42
West Africa	33.0	42	22	16

Source: FAO, 2001. The state of food and agriculture[13].

Table 6
Estimated Prevalence of Underweight, Stunted and Wasted Children in Developing Countries

Region	Underweight percentage	Wasted percentage	Stunted percentage
Sub-Saharan Africa	31	10	37
Near East and North Africa	17	8	24
South Asia	49	17	48
East Asia and Pacific	19	6	24
Latin America and Caribbean	9	2	17

Source: FAO, 2001. The state of food and agriculture[13].

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