

Promoting Appropriate Intercropping Technologies for Sustainable Agricultural Production in Africa: a farmer centered approach

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ABSTRACT

Many African and developing country governments have realized that agricultural development is the key to overall economic development. The bulk of the populations of these governments are farmers who are faced with numerous constraints ranging from the lack of appropriate technologies, inputs, infrastructure and natural hazards. A range of initiatives varying widely with individual country governments have been taken to redress these problems. In addition to various policies, the development and dissemination of appropriate production technologies that could improve farmers' production have been a major strategy in achieving food security in Africa. However, the deliberate promotion of monocropping technologies by many scientists and extension workers as a better alternative to the farmers' traditional mixed cropping is perhaps one of the major factors responsible for the low adoption of these technologies and consequently the lack of desired impact on the production of farmers. In their traditional mixed cropping systems, the diverse crop species usually grown together complement one another by using resources in different ways. Scarce labour is efficiently utilized, weeds and insects are suppressed, erosion is controlled, there is sequential harvesting and the risk of total crop loss is averted. It has also been shown that diverse plant communities are more resistant to environmental stresses such as drought. It is now clear that technologies appropriate for monocropping cannot be transferred directly to mixed cropping systems without appropriate modification in order to have a sustainable production system. In Sub-Saharan Africa, over 80% of rain fed upland which is the major ecology is under mixed cropping. There is therefore need to develop and promote appropriate technologies that will improve productivity of this system. Evidently, there are challenges in trying to improve this system. In addition, inappropriate government policies, political conflicts and natural disasters have also adversely affected agricultural production in Africa. These are mainly related to inappropriate mechanization of various operations in the complex system. Appropriate solutions to these problems could be sought through consultations among the various stakeholders including farmers, social and natural scientists together with policy makers. It is time to engage in a participatory approach in problem identification and finding solutions. This paper will further delve into the fundamental flaws in the inappropriate and biased conception of farmers' problems with examples from Sierra Leone and the West African region. The paper also highlights the consequences of such approach, lessons learned and how this has influenced the planning and implementation of demand driven research in Sierra Leone.

Introduction

In Africa particularly in sub-Saharan Africa (SSA), agriculture remains the largest single sector employing the bulk of the population. In most of these countries agriculture accounts for 35 percent of Gross Domestic Product (GDP), employs about 62 percent of the population, represents 60 percent of export earnings, contributes to food security and supplies raw materials to domestic industries (Taylor *et al.* 1996) By supplying raw materials to domestic and commercial inputs, agriculture has direct impact on the performance of the non-agricultural sectors of the economy. Agriculture plays a critical role in food security at the national and household levels.

However, agriculture in SSA since 1965 had an average growth rate of 1.7 percent to 1.9 percent per annum. Population growth rate has increased from 2.7 percent per annum during the period 1965 – 1980,

to about 3.1 percent per annum since then. Africa was falling behind in its traditional export crops compared to other regions, while its per capita food production was declining (Taylor, 1996). This resulted in rapid increases in food imports and food aid. West and Central Africa now import about 3.2 million tonnes of rice a year, at a staggering cost of US\$ 1 billion – a cruel strain on the regions economies (WARDA, 2000).

The most important cause of the decline in agriculture was government policies and actions that favoured the industrial sector and urban consumers. The most important characteristics of this policy were: the overvalued exchange rate, price control of agricultural commodities by parastatal monopolies, taxation of agricultural sector, inappropriate land tenure, concentration of social services and infrastructure in urban areas and an inappropriate emphasis on state led industrialization (Taylor *et al.* 1996) These policies tended to reduce the profitability of agriculture and resulted in rapid migration to urban centers. Reduced profitability of agriculture discouraged the adoption of productivity-enhancing technologies which often require additional resources. In addition, the consequences of increased population pressure have been a reduction in the bush fallow period which is relied upon in traditional agriculture for the restoration of soil fertility. Crop yields have decreased and rapid deforestation is taking place.

There is urgent need to increase food production to feed the rising population, the majority which is concentrated in urban areas. Appropriate research interventions in developing technologies that will ensure sustainable crop production without adversely affecting the natural resource base are required. Government policies relating to agriculture require re-examination to provide an enabling environment for increased participation of the private sector. Increased participation of all stakeholders including farmers, natural and social scientists together with extension agents will ensure proper identification of problems and greater chances of finding appropriate solutions.

Constraints to Sustainable Agricultural Production in sub-Saharan Africa

Political conflicts

One critical constraint to the attainment of sustainable food production in Africa is the continued prevalence of political conflicts. In the North of Africa, the war in Sudan has continued for almost two decades. Algeria is grappling with an uprising by Islamic fundamentalists. In Eastern Africa Somalia and Ethiopia are the boiling points while in Southern Africa, Mozambique and Angola were problem areas for a long time. West Africa joined the brawl since the Liberian civil war which has spread to Sierra Leone and Guinea. The recent developments in the Ivory Coast are indicative of more trouble to come. No development strategy, however important or elaborately carved out and well meaning will ensure sustainable food production unless there is peace.

Political turmoil in sub-Saharan Africa over the past two decades as a result of bad governance has provided the ground for both the formulation of ineffective agricultural programmes and strategies and in cases where the strategies and programmes are appropriate, such programmes cannot be effectively implemented. Sustainable agriculture in Africa requires an uninterrupted war free environment such that the little gains that are made can be crystallized and built upon. The situation is such that when there is war in a particular country all the neighboring countries are vulnerable. Even if the war does not spill over, neighboring countries are affected by the refugee populations which create pressure on their own limited resources.

Government policies

Apart from the countries political environment, a significant hurdle constraining sustainable food production is the adverse planning and policy setting prevailing in them. Very few countries appear to have formulated their development plan and policy objectives based on a rational diagnosis of the diverse variable affecting their sustainable food production possibilities. The most important cause of the decline in agriculture was government policies and actions that favoured the industrial sector and urban consumers. The most important characteristics of this policy were: the overvalued exchange rate, price

control of agricultural commodities by parastatal monopolies, taxation of agricultural sector, inappropriate land tenure, concentration of social services and infrastructure in urban areas and an inappropriate emphasis on state led industrialization (Taylor *et al.* 1996) These policies tended to reduce the profitability of agriculture and resulted in rapid migration to urban centers particularly by young people who are able to till the soil. This migration from the rural areas results in labour shortages which adversely affects farming and causes congestion in the urban areas on the other hand.

Degradation of the regions natural resource base

A critical impediment to sustainable food production, which has also been adversely affecting agriculture, is the degradation of the regions natural resource base. Only 56% of Africa's land is suitable for agricultural activities. Nonetheless, a major portion of the continents 521 million hectares of potentially arable land is practically unusable owing to pest infestations, such as those of tsetse flies. Only 19% of the total land of the continent is free from inherent fertility limitations, while 44% of this is dry (World Bank, 1989). Many countries have, for instance, been losing and continue to lose their limited, fertile top soil through land impoverishment, including water erosion, overgrazing, and overcultivation. Water erosion poses grave hazards to countries like Lesotho, Sierra Leone, Guinea, Ghana, Zaire, and Liberia, while wind erosion menaces Mauritania, Senegal, Somalia, and Sudan (World Bank 1989).

Natural calamities

The degradation of the regions resource base is also partly caused by inhospitable climatic conditions and natural calamities. The majority of farmers in Africa depend on the rain for crop production. In Africa as a whole, land under irrigation is estimated at 3% (World Bank, 1989). Along with holistic climatic conditions, periodic natural calamities have aborted the regions efforts to bring about sustainable food production. The most critical have been drought, and floods.

In recent years, the climate has been very unpredictable. There are floods in hitherto dry areas like upper Mali and drought in areas that received reasonable amount of rains annually. At present, Zimbabwe and Malawi in Southern Africa are severely affected by a prolonged drought causing acute food shortages.

Deforestation

The depletion of the regions soil and water resources has been exacerbated by appalling deforestation. The rate of deforestation in Africa is believed to be about 4 million hectares annually (ECA, 1987). The reasons for deforestation in the region are numerous. Chief among these are bushfires, shifting cultivation, utilization of wood for fuel and construction, water and wind erosion, timber exploitation, industrial use, and fish processing. In urban areas in Africa, the per capita mean total fuel wood consumption is in the neighborhood of 3.09 m³ annually, compared to 1.42 m³ in rural areas (World Bank, 1989).

Shifting cultivation

True shifting cultivation as the term implies involves gradual movement of entire communities onto new land is now rare in Africa. Most of what we see is more accurately described as bush fallow cultivation, a term that stresses the role of fallow vegetation in restoring the fertility of soils on which nutrients have been depleted through several seasons of crop production. In actual fact, it is not the system as it originally evolved which is to be blamed, but the deterioration brought about by the reduction of the fallow period due to pressure of increasing population. One of the immediate effects of bush fallow is decrease in yield.

Other effects include increase in runoff, soil erosion, occurrence and intensity of weeds and pests, as well as changes in soil structure, pH and moisture regime. Vast areas of forest have been cleared and reduced to secondary forest or savannah grasslands. This has led to the loss of several plant and animal species, and the existence of many more is being threatened by the continued clearing of forest areas. The usual practice of burning which is associated with shifting cultivation has also been shown to be

detrimental to the existence of micro-organisms which inhibit the soil and are responsible for the breaking down of plant material into humus which the crops need.

Insufficient mechanization

Africa is still the world's least mechanized region. According to the Hunger Project (1990), 1% of farm power is provided by mechanical means, while 10% comes from animals. Human power accounts for 89%. With such limited mechanization, farm sizes are bound to be small and the gains of economics of scale will delude the African farmer for the foreseeable future.

Rural Infrastructure

The rural infrastructure in Africa is seriously deficient, particularly as regards transportation. Distances from villages to major towns and to all-weather roads are substantial. For example, in West Africa in 1987, rural road density was estimated at about 32m/km², compared with 90m/km² in India in 1951 (Pingali *et al*, 1987). Where rural roads exist, they are often poorly maintained, maintenance standards fell significantly during the 1980s e.g. 42% of unpaved roads were judged to be in poor condition in 1988 compared to 28 % in 1984 (Riverson *et al*. 1991). The cardinal obstacles behind the ineffectiveness of the road networks are the regions topography, bad weather, excessive heat, vast deserts, untamed rivers, unsuitable railway lines, congestion of port cities, dilapidated locomotives or vehicles, poorly maintained and extremely rough roads and scarcity of spare parts for vehicles (Yaker, 1993).

In sub-Saharan Africa a good percentage of farmers headload their produce from the farm site to their villages and may require walking distances varying from 3 – 10 miles to periodic markets to sell their produce or to access a motorable road for onward transportation to urban markets. Due to these difficulties, over 80% of the farmers producing cassava in Sierra Leone sell their produce in their villages to traders coming from bigger towns to the villages mainly at harvest time. These traders usually have the advantage to determine the farm gate price of such produce, particularly for perishable produce like cassava, tomato, pepper etc. The farmers are therefore at the disadvantaged end of bargaining, thus the price dictates of traders in most situations act as a disincentive to increased production (Jalloh *et al*. 2000).

Marketing services also leave much to be desired. Storage structures are poor and processing facilities are obsolete. Packaging and handling services are wasteful and time-consuming. Public expenditures have tended to focus on large infrastructural developments, including primary roads, ports and telecommunications, which have largely benefited the urban sector. The overall infrastructural deficiencies have had a detrimental effect on agricultural development through high transportation costs, poorly integrated markets and low profitability (Taylor *et al*.1996).

Inadequate support for agricultural research

Many poor countries which depend the most on productivity increases in agriculture, grossly under invest in agricultural research. Per capita agricultural research expenditure in low income countries are one tenth those in high income countries, even though agriculture accounts for much larger shares of average incomes. Unfortunately, agricultural research has low public visibility and a small constituency. In times of financial stringency, its budget are among the first to be cut (Stifel, 1989).

Undue research focus on monocropping

Research in the region on food crops is limited when compared to export crops (Taylor *et al* 1996). Research emphasis should be concentrated on food crops in Africa. In the past 10 – 15 years there has been conscious effort by the International Agricultural Research Centers in collaborating with National Agricultural Research Institutes in Africa to concentrate on major food crops grown and consumed in the various regions. The International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria has developed improved varieties of cassava and lately yam which are major staples in West and Central Africa. The West Africa Rice Development Association (WARDA) in Cote d'Ivoire has introduced high yielding rice

varieties and has recently succeeded in crossing the Asian rice (*sativa*) with the African rice (*glaberrima*) resulting in the production of the New African Rice (NERICA) with great potential to increase rice production in Africa.

The Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) have also contributed significantly in leading and collaborating with national programs in developing improved maize varieties. The International Livestock Center for Africa (ILCA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) have also made significant contributions in improving livestock and sorghum, millet and groundnut, respectively.

However, most of the component technologies associated with these improved crop varieties are related to monocropping regardless of the fact that the majority of farmers in Africa grow their crops in mixture. There is the likelihood that the envisaged benefits from a monocropping situation will not be achieved when these crops are grown in association with other crops. There is therefore need for a systems approach.

Uncoordinated and ineffective linkage between research and technology users

Linkages between research, technology-transfer agencies and farmers are far from effective in African countries. The reasons for the poor status of linkages may vary from one country to another, but several factors contributing to the situation shared by most countries are outlined by Eponou, 1996 as:

- Absence of a systems perspective and an effective system of leadership
- Lack of transparent , agreed upon research policy
- Inappropriate linkage strategies and management
- Donor driven development strategy

Only a few systems have formal mechanisms for ensuring that farmers have an influence on the research agenda. This is despite the fact that farmers' participation has been well established as one of the key factors ensuring the success of agricultural technology systems. Farmers' involvement is often limited to on-farm trials, but there is evidence that only involving farmers in on-farm trials does not allow them any real input into the research agenda, nor does it allow them to become part of the decision making process.

The failure of farming systems research and the T&V model of extension in Africa, in spite of heavy investment, highlights the importance of the policy dimension of linkages. Farming systems research and T&V model of extension merely put mechanisms in place and believe that this will be enough to improve linkages between research, extension and farmers. No effort is made to create an enabling policy environment for the institutions or for the individuals involved in the technology generation and transfer process (Eponou, 1996).

INTERVENTIONS FOR SUSTAINABLE AGRICULTUEAL PRODUCTION IN AFRICA

Good governance:

It has become clear that the root cause of virtually all the wars on Africa is bad governance. It is therefore imperative that efforts should be made to establish structures that will encourage good governance based on the rule of law. Unless this is done and the roots of democracy grow, agriculture will not flourish. Farmers need a peaceful and stable environment to clear their fields, plant and tend their crops till maturity. Any interruption that will move them for some time leaving their fields unattended will severely affect yield. At times farmers would be forced to abandon their fields completely thereby not only loosing their harvest but also seed for the next cropping season.

The mounting influx of food aid to Africa is related to natural calamities such as droughts and floods as well as the civil wars that are growing like wild fire. An end to these civil wars will create an opportunity to

divert limited resources to developmental initiatives of which agriculture will be paramount in most African countries.

Agriculture friendly government policies

Governments in Africa should reflect the importance of agriculture in their overall economies by formulating and supporting clear cut policies that will favour rapid agricultural growth thereby providing a solid foundation for the growth of other sectors of the economy. Governments should make producer prices that will attract and encourage farmers to produce above subsistence level and to also encourage private entrepreneurs to invest into agriculture. Exchange rates should be realistic so as not to give advantage to foreign products. Taxation in favour of the local products and possible subsidy together with readily available credit facilities particularly in the rural areas will greatly promote domestic production.

Market structures including appropriate storage facilities and rural roads need to be upgraded to facilitate easy evacuation of produce particularly the perishable ones. The access to markets will give farmers the opportunity to fetch better prices for their produce. Reliable transportation and telephone network will greatly enhance farmers' capacity to access favourable market information.

Adequate support for Agricultural Research

Accelerated investment in agricultural research is needed for African countries in order to achieve reasonable economic growth and poverty. African country governments need to realize that it is only through increased agricultural production that the entire economies of these countries will be adequately energized for overall development. Agricultural research has a crucial role in a) generating and adapting technologies which can increase agricultural productivity including intensive production of food and cash crops; b) provide efficient methods of processing, marketing and utilization of food commodities and non food cash crops; c) developing sustainable production systems, particularly for the more fragile areas d) generating technologies which can provide productive employment and greater returns to labour in rural areas and e) contributing to food security for the nation and family (SPAAR, 1987). A national allocation to agricultural research of 0.5 % of the agricultural gross domestic product (AGDP) is almost certainly too low and a target figure of at least 1 % of the AGDP would be desirable (SPAAR, 1987).

Refocusing of research on mixed cropping prevalent in Africa

The practice of growing several crops on the same piece of land is an ancient strategy for crop production among farmers in the tropics. Traditionally, it is used by subsistence farmers primarily to increase the diversity of their products (Gomez and Gomez, 1983). Ruthenberg (1971) stated that mixed cropping is the expression of African farmers desire to minimize risk. This system offers the farmers insurance against total crop failure, It helps to control soil erosion and weeds, and it brings about a more even distribution of farm labour than in sole cropping (Ikeogwu et al, 1989).

Historically, however, it has been regarded as a primitive practice which would give way to sole cropping as a natural and inevitable consequence of agricultural development (Wiley, 1979). On the contrary, Steiner (1982) pointed out that the African husbandman has continued to use his traditional multiple cropping system, and where possible he has improved the system by adopting new crops and techniques, despite the efforts of expensive extension services to induce him to adopt monocropping practices.

Earlier, Webster and Wilson (1966) observed that for the tropical small scale farmer, there was no advantage to be gained by replacing the traditional practice of mixed cropping. The system has evolved in different areas and is so deeply established among peasant farmers that a complete change of the system may not be acceptable to most farmers (Nnko and Doto, 1980). In addition to relying on forest or bush vegetation to regenerate the soil, traditional farming systems in sub-Saharan Africa imitate the diversity of compatible species in natural fallows (though in a greatly simplified form) through the practice of intercropping. Any attempt to develop alternative technology for this region must do likewise if it is to

result in options that improve on indigenous practices as opposed to replacing it with modes of cultivation derived from experience in the temperate zone (IITA, 1992).

Considering the nature of the African farmer, it is a realistic proposition to first of all encourage him/her to achieve food self sufficiency which will provide the basis for overall attainment of food security on the continent. These farmers try to grow most of the food they need and hence intercrop. Over the years the system has evolved consisting of only the major crops ranging from 2 to 4. In the western part of West Africa, rice is the staple crop. Rice is mostly intercropped with cassava, maize and millet. In the rest of West Africa and central Africa, cassava and yam predominate and they are mostly intercropped with maize. In Eastern and Southern Africa intercropping often involves a cereal and a legume, lately though cassava is gaining importance among the farmers in this region.

A careful intervention strategy into the predominant cropping systems in these regions will yield fruitful dividends. Possible interventions should include:

1. Developing varieties of these crops that are compatible with associated crops
2. Establishing effective multiplication and distribution schemes for the improved planting materials of these varieties
3. Determining appropriate times of planting the intercrops
4. Determining appropriate fertilization rates and regimes
5. Developing appropriate planting patterns
6. Developing appropriate machinery for key tasks such as planting, weeding fertilizing and harvesting

Complementary studies relating to growth, nutrient requirement and possible synergistic benefits of the various crop combinations should be pursued. The possible advantages of temporal and special advantages in intercropping should be exploited to the fullest. No need to emphasize a thorough study of the socio-economics of mixed cropping and its implications on developing and modernizing the system.

Strengthening the linkage between research institutions, technology transfer institutions and farmers organizations

Most farmers in Africa still produce food by subsistence farming. Their ability to adopt new technologies is constrained by their difficult economic conditions and by their beliefs and culture. They are logically risk averse, and they do not respond to market signals, as do commercial farmers, even when reliable signals are forthcoming. Because of this, all aspects of their production systems and economic behaviour must be taken into account when technologies are developed (Eponou, 1996).

Farmers' contribution must be very prominent in diagnosing problems that affect them and in finding appropriate solutions to such problems. The socio-cultural aspect of farming and farmers must be delicately handled in order to be able to communicate effectively with farmers. It is only through equal footing dialogue that researchers and extension agents will gain the confidence of farmers which will facilitate the sharing of ideas. Mutual respect by the stakeholders in problem identification and seeking of appropriate solution is a prerequisite for assured adoption of technologies that will be generated.

One important mistake that is still been made is that even though natural and social scientists realize the importance of each other and that of the farmer in generating and disseminating technology, there is little evidence that team work is as involving as it should be. To a large extent collaboration between the natural and social scientist has been upgraded but the farmer who is central to all this exercise is not quite involved. This situation has resulted in the production of technologies that are not required by the farmers and consequently the adoption rate has been dismal.

Practical Lessons from Sierra Leone

Cassava improvement: *In Sierra Leone, initial improvements in cassava were undertaken without proper consultations with farmers. Root and tuber Breeders and Agronomists presumed that the solution to the low production of cassava in Sierra Leone was to develop high yielding varieties and the farmers will jump at them and putting an end to the country's low cassava production problem. After 5 – 6 years work with*

seeds introduced from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, the first improved cassava varieties, namely ROCASS 1, ROCASS 2 and ROCASS 3, were officially released in 1978. Subsequently, the Njala University College also released NUCASS 1, NUCASS 2 and NUCASS 3. All the released varieties significantly outyielded the local varieties; unfortunately the adoption rate of these varieties was disappointing. With the exception of ROCASS 1 all the varieties did not become soft on boiling.

The dismal adoption rate was due to the disregard of the preference of Sierra Leoneans for cassava roots that readily become soft on boiling. This is the major form in which cassava is eaten in the country. In addition, all the released varieties had white tuber skin and only one had red petioles. The preference for pink tuber skin is associated with cooking quality since all the local varieties that are eaten boiled have pink tuber skin while the bitter and high cyanide content roots are white skinned and with white petiole.

As a result of this experience a lot of emphasis is now put on desirable consumer characteristics in addition to fresh and dry root yield in cassava improvement. In addition to the recognition of consumer preferences, effort is also being made to bring in farmers in the selection process much earlier at the seedling stage than before when the clones have been reduced to not more than 5 at the on-farm trial stage. This farmer participatory varietal selection strategy has greatly increased the chances of adoption of varieties which are jointly selected by scientists and farmers.

The incorporation of farmers input in varietal selection also revealed that farmers desire cassava leaves with light green petioles instead of deep green leaves that will require a larger quantity of palm oil to redden the sauce when the price of palm oil escalates. This year, five cassava varieties, SLICASS 1, SLICASS 2, SLICASS 3 SLICASS 4 and SLICASS 5 have been released. All the varieties outyield the most popular local variety by at least 100% and all but one become readily soft on cooking. However, the roots of SLICASS 4 produce high quality foofoo and starch even though its cooking quality is poor.

Time of planting cassava: Farmers in Southern Sierra Leone plant cassava at the beginning of the rains and intercrop the cassava with rice after about a month. Cassava is also planted sole at the beginning of the rains in the South. When cassava on-farm trials were extended to the North of the country it was difficult to get farmers who could plant the trials at the same time as in the South. It appears that there is more than agronomic considerations with respect to time of planting. The farmers in the north plant cassava at the end of the rains after harvesting rice and groundnut. This is probably because the crop is mostly planted sole and it appears that in the face of limited resources particularly labour, the more important crops are planted first and cassava is planted later (Jalloh and Dahniya, 2001). Research efforts are now geared towards developing cassava clones that can sprout quickly and the young plants are capable of withstanding the ensuing drought.

Yellow versus white maize: maize is mainly eaten on the cob in both the boiled and roasted form. Yellow maize is preferred by consumers. There is now a deliberate effort to select yellow maize for consumers while appropriate white maize lines are selected for the feed industry.

Effective linkage with Non Governmental organizations (NGOs):

One of the major problems with extension services in Africa is the lack of adequate resources and logistics to carry out assignments in time. Linking with NGOs in a well coordinated manner will bring in much needed resources that are available to NGOs. Added manpower together with logistics will facilitate contact with farmers and provide much needed motivation for government extension staff that are usually poorly paid.

The way forward:

Research efforts should be focused on improving the existing mixed cropping system with a view to improving it in a sustainable way in terms of yield and conservation of the natural resource base.

Multidisciplinary research teams involving social land natural scientists together with farmers and extension agents should look at the entire system and not individual crops.

It is absolutely essential that in all of these interventions, the farmer must be the focus. It is also necessary to empower the farmers so that they can participate as equal partners in development. It is vital that farmers are able to articulate their views and needs in a coordinated manner for the purpose of self organization as well as for the purpose to influencing decision makers and for making effective alliances. This can only be done through strong farmers' organizations. In the process of new technology generation and application, including its legal framework such as patent rights and access to genetic resources, care must be taken by governments to discuss with farmers' representative organizations, the consequences for farmers both in the short and long term (King, 1999).

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