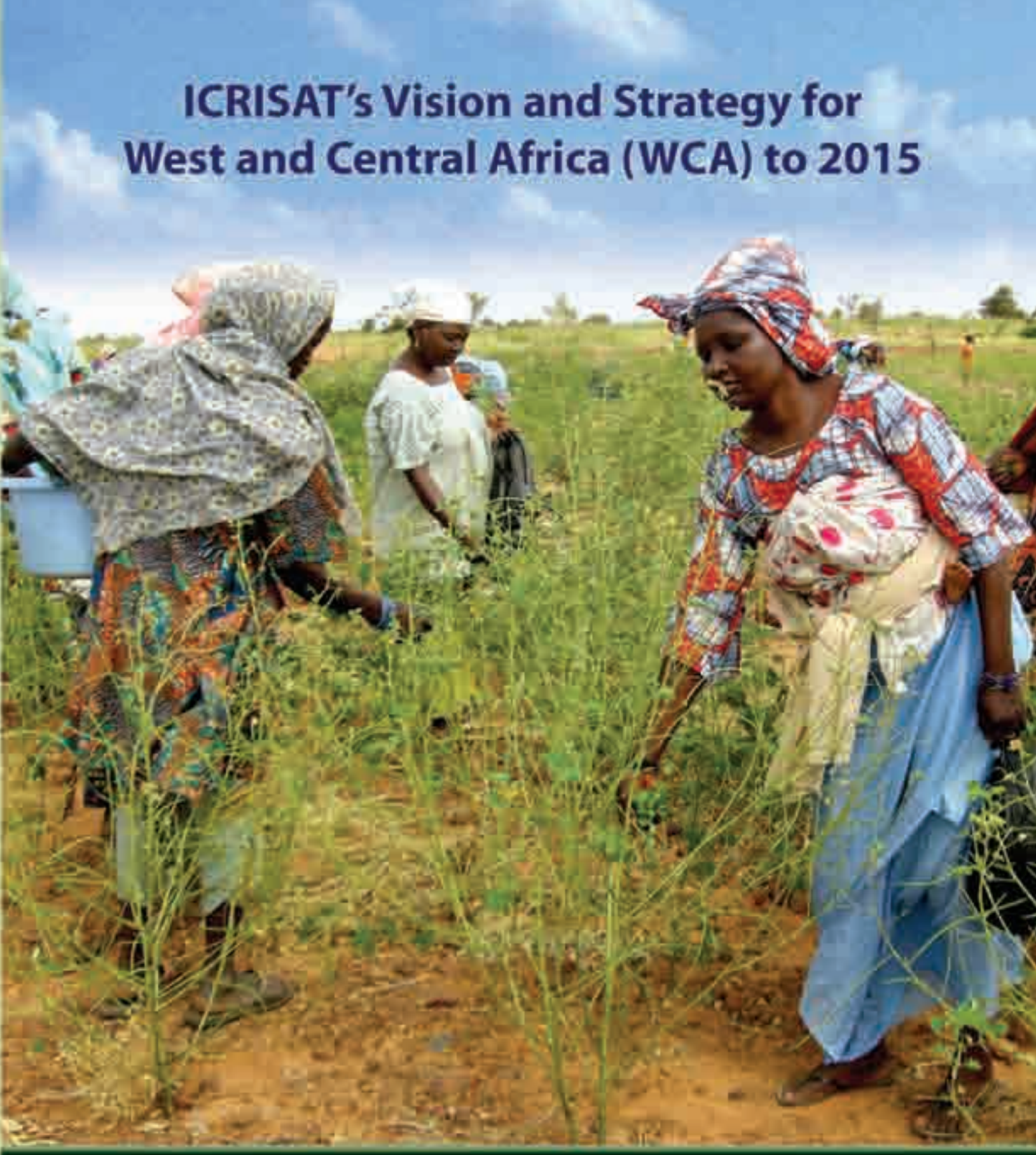
ICRISAT's Vision and Strategy for West and Central Africa (WCA) to 2015



International Crops Research Institute for the Semi-Arid Tropics

ICRISAT's Vision and Strategy for West and Central Africa (WCA) to 2015

Chapter 1

Context

Overview

ICRISAT WCA, as the apex dryland agricultural research organization for the West and Central Africa, seeks in this document to refine its strategic thinking towards 2015 from 2010. More so, ICRISAT WCA wishes to exemplify the importance and growing vulnerability of its mandated area --- the SAT which is home to a substantial majority of the truly poor people where population growth rates remain very high and the vulnerability of agriculture to the vagaries of weather and the potential of further climate change is high. Additionally, it wishes to articulate more clearly its alignment with the MDGs, CGIAR strategic directions and the new CGIAR System priorities. These are seen to be the necessary basis for future medium term planning (following the Governing Board's advice in September 2005). These are viewed presently as suitable frameworks on which a robust research strategy can be formulated to account for changes in the likely external environment for the foreseeable future.

Likewise, some refinement in earlier thinking is appropriate and timely in response to increasing globalization of markets, greater environmental insecurity, lower prices for agricultural commodities and higher fuel prices, new intellectual property right regimes, the growing importance biotechnology, and research partnerships health, ICT/KM and private sectors and finally the emergence of the Alliance for CGIAR centers (including associated centers such as AVRDC, IFDC) as a major driver in concerted research actions.

In refining its new strategic thinking, ICRISAT WCA has adopted a fully participatory solicitation of partner opinion that is reflected in the diversity of regional and disciplinary emphases. These are expressed in 5 supplementary documents that include separate strategic papers for WCA region, and for the four global themes --- Institutions, Markets, Policy and Impacts (IMPI), Biotechnology (Biotech), Crop Improvement (CI) and Agroecosystems (AE). ICRISAT seeks to derive additional positive synergies from its new structural arrangements which give it the ability to act regionally and yet produce IPGs that have global impact. This type of regional/global matrix structure allows the institution to derive maximum benefit from its research investment from local-national-regional-global levels. ICRISAT seeks positively to maximize the spillovers of research knowledge from Asia to Africa and from Africa to Asia and at the same time to link its disciplinary efforts at both regional and global levels. Not only does ICRISAT wish to operate effectively at all geographic scales within its mandate area but it also intends to position itself broadly throughout the research for development spectrum. This implies both the production of upstream science and the conduct of more downstream research activities which can more directly facilitate development impact. For ICRISAT, the advantage of being broadly positioned on the research for development spectrum means that potential bottlenecks to the emergence, or application, of research outputs can be directly forestalled by ICRISAT, thereby preventing such constraints from jeopardizing fruitful outcomes from our research with our key partners.

In addition in 2001, ICRISAT completed a major, long-view research report on the "Future Challenges and Opportunities for Agricultural Research and Development in the Semi-arid Tropics" (Ryan and Spencer 2001) that detail the dimensions of poverty and the dynamics of agriculture throughout the SAT. The findings of this study, along with the CGIAR's Seven Planks mission statement, guided ICRISAT's deliberations as it charted a new vision and research strategy for the next ten years (ICRISAT 2002) .

Agriculture in the WCASAT

The semi-arid tropics (SAT) of W**est and** C**entral Africa covers parts of** 18 **countries**[1] **where the 75-180 day growing period has a mean daily temperature of more than 20 degrees Celsius.** The semi-arid tropics have very short growing seasons, separated by very hot and dry periods in which growth without irrigation or stored soil moisture is impossible. Natural soil fertility is often low and pest and disease pressure can be intense. Farmers face further substantive risks, even within the growing season, as there are irregular periods of drought and high evaporative demand which can seriously compromise crop productivity.

Agriculture accounts for more than 30% of the gross domestic product, employs between 82 and 92% of the total labor force and is the main source of livelihood for the poor. Domestic food production has not kept pace with rising population. Between 1990 and 1999, the annual rate of growth per capita food production declined or remained modest, varying from –1.9% in Mauritania to +1.9% in Chad and Cape Verde.

Sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) are the main staple foods for the over 100 million people living in the west and central African semi-arid tropics (WCA SAT). These crops account for 70% of the total cereal cropping area, 60% of cereal production, 75% of total caloric intake, 52% of per capita grain consumption and 1/3 of protein content. Since 1984, production of these crops has increased due to area expansion into the marginal areas contributing to severe environmental degradation. Average yields of these crops, low by global standards, are decreasing, ranging from 300 to 1100 kg/ha for pearl millet and 500 to 1300 kg/ha for sorghum. Pearl millet and sorghum grain yields have increased in some countries and decreased in others. Average annual rainfall has decreased markedly over the past 30 years with estimates ranging from 100 to 200 mm/annum in all the semi-arid areas. This has led to a shortening of the length of the growing season in all the agro-ecological zones. Coupled with the trends of more extensive production on marginal lands and reduced length of fallows, ICRISAT regards it as a positive achievement that cereal productivity could be maintained at these levels. Sorghum and millet residues are stored and fed to ruminants during the dry season. These crops are poorly traded in the national, regional and international markets.

Contemporary issues, challenges and opportunities

Poverty, food insecurity and malnutrition

Countries in the West African SAT cover an area of 5,339 sq km or about 22% of the total land area in sub-Saharan Africa. In 2000, these countries had a population of over 100 million. All these countries are classified by the United Nations as being among the least developed in the world. The low level of economic activity coupled with high population growth rates over the past decade has led to negative or stagnant growth in real per capita incomes. In many Sahelian countries, more than 30% of the population falls below the international poverty line of $1 a day and the same percentage is undernourished. Life expectancy at birth and the human development index indicate low levels of human welfare. Human population in these countries is projected to grow between 2.1 and 2.9% per year over the next 15 years.

Water, climate and soils

Water constitutes one of the most limiting factors to rainfed agriculture in the Sahel. The water limitation arises from low and variable rainfall, but is also partly due to high temperatures and solar radiation during the rainy season which cause substantial evaporation and reduce available soil water. Rainfall distribution is erratic with frequent drought periods of up to two weeks or longer. Rainfall data show the tendency for abnormal years of rainfall (with successive periods of deficit or excessive water) to occur continuously for as many as 15 years.

However the rainfall in West Africa shows some strong patterns of distribution, to which local varieties of cereals are very well adapted. It has been shown that the variability of the onset of rains is extremely high, and can occur from mid-May to mid-July, even in the Sudan Savannah zones. However, the end of the rainy season is much more stable, with a variability of 10 to 14 days for any one location. For each location the normal end of the rainy season is predictable, and is earlier in the more northerly locations, which also have a lower average annual rainfall.

The soils have low inherent fertility. They are predominantly sandy with a low clay and organic matter content, and their effective cation exchange capacity is also low in the Sahelian zone. Phosphorus and nitrogen are the most limiting nutrients, however other deficiencies (potassium, trace elements) and acidification are readily induced by intensified

[1] Countries are Niger, Nigeria, Chad, Cameroon, Mali, Senegal, Cape verde, Gambia, Mauritania, Guinea Bissau, Burkina Faso, Togo, Ghana, Benin, Cote d'Ivoire, etc…

continuous cropping. Other physical properties of soils in the Sahelian systems that limit crop production potential include: (a) high bulk density and very low structural porosity; (b) a tendency for compacting and hardening during the dry season; (c) generally poor water infiltration due to rapid surface crusting of soils, except on eolian sandy soils, and; (d) increasing susceptibility to erosion with continuous cultivation. Annual losses of nutrients per hectare due to soil erosion and soil mining among other factors are important.

Genetic resources and crop improvement

The WCA SAT is the center of origin of pearl millet and is a center of high diversity, primarily for Guinea race sorghums. During the last 25 years, pearl millet, sorghum and groundnut improvement programs have developed and released a range of early to medium maturing new varieties which escape end-of-season drought and are tolerant or resistant to major pests the parasitic weed *Striga* and diseases, downy mildew of pearl millet, grain mold, foliar diseases of groundnut, rosette, aflatoxin producing *A. flavus*). Some of these varieties have been released and their utilization by farmers in increasing. Reasons for the slow uptake may be the absence of functioning seed and extensions systems in most WCA countries, but also relate to the low productivity gains, the unsuitability of some varieties to farmer or market preferences, as well as poor access to information and experimentation on modern varieties., A range of opportunities is available in the promotion of existing varieties preferred by farmers or required by the market. Farmers and processors are being exposed to these technologies through participatory approaches. In addition, an assessment of institutional arrangements likely to improve a sustainable and consistent flow of seed to end-users continues to be warranted.

In WCA, as elsewhere, varietal improvement for yield was based largely on conventional and participatory breeding methods. Promising approaches include the development of hybrids that exploit heterosis, the novel shorter statured varieties based on highly adapted germplasm, and the characterization and use of a full range of genetic diversity.

Biotechnology

Biotechnology facilities for agricultural applications are poorly developed in WCA countries. Only one country, Burkina Faso, has ratified biosafety regulations. Many countries are interested in developing their national capacities and facilities to conduct agriculturally relevant biotechnology research. Progress is being achieved in regional coordination of biosafety and biotechnology issues through the Institut du Sahel (INSAH), ECOWAS and CORAF. ICRISAT is supporting these while moving forward in conducting targeted biotechnology research in and with scientists from the region. Molecular genetic tools are beginning to be applied; for example, molecular marker characterization of the structure of genetic diversity in Guinea race sorghums has been conducted, and marker assisted selection is being applied to increase Striga resistance in sorghum.

Pests, diseases and weeds

Major sorghum insect pests include sorghum midge (*Contarinia sorghicola*) and a complex of head bugs (*Eurystylus immaculatus* and others). The major insect pests of pearl millet in West Africa are head miner (*Heliochelus albi punctella*), stem borers (*Coniesta ignefusalis*) and blister beetles (*Psadolytta* spp.). *Striga hermonthica* is a frequent parasitic weed of both sorghum and millet and constitutes a significant constraint, especially in areas where low soil fertility and continuous mono-cropping of cereals prevail. It has been estimated that grain production on 44 million ha in Africa is threatened by *Striga*, translating into a yearly economic loss of US$ 3 to 7 billion.

Institutions, markets, infrastructure and policy

Regional surveys in the WCA SAT show that rural households have little access to key inputs (seed of improved varieties and fertilizers) because of poorly functioning, incomplete or underdeveloped markets and lack of infrastructure. When available, inputs are used on high value crops. Furthermore, farmers are often not aware of the existence of technologies and their potential benefits. Policies that could encourage the use of inputs, the output markets and linkages between input and output markets are also lacking.

Farmers' livelihood strategies

Many studies in the SAT of West Africa show that households pursue a range of livelihood strategies and may diversify as a response to climatic, production and market risks. The returns to investment from cropping may be less than those from livestock activities or other alternative sources of income such as temporary migration, or off-farm agricultural employment. Therefore, farmers may not necessarily invest in cropping activities.

More than two decades have passed since the last village level studies in Burkina Faso and Senegal. These studies helped to understand household production and consumption decisions and set research priorities. Since then, many changes have occurred which deserve further understanding and could have a significant impact on poor livelihoods.

Renewed efforts are necessary to understand these changes, identify development pathways and reset research priorities and development interventions.

National capacity
In WCA, there is a weakness in agricultural research and development capacity not only at the national level but also in the NGO and private sectors, the latter being, as yet, barely developed. This lack of capacity is both at human and infrastructural levels and though the agricultural sector is recognized by WCA governments, there is presently no corresponding recognition of the need to provide adequate funding to R&D in this sector.

The future of ICRISAT's mandate crops appropriate to WCA

WCA SAT agriculture has demonstrated appreciable dynamism, with the growth rate in agriculture production and total factor productivity moderate, if not high. A brief outlook of each ICRISAT mandate crop is presented below (details in ICRISAT, 2004). Cropping pattern shifts are taking place and coarse cereals are being replaced in more favoured areas by maize. Dietary changes are significant across all income brackets. Not withstanding this dynamism, production-related risk, poverty, natural resource degradation, and bio-diversity loss persist and are projected to worsen under the impact of globalization, climate change, modernization, and inadequate or ineffective public sector interventions in terms of investment, service and support system.

Increasing population and higher expectations of lifestyle has placed greater demand on increasing crop/animal production and for raising incomes. There is a need for greater attention from the public sector to WCASAT agriculture as the profits from the small, fragmented markets are often too low to attract attention from the private sector. Improving the efficiency of both the input as well as the output markets would substantially help emerging commercial and semi-commercial farmers in resource poor areas. Combining various enterprises, which can enhance profit-earning opportunities, will help SAT farmers in West and Central Africa to improve their income and employment levels. Formal and informal extension systems should develop further capacity to render advice to the farmers on new opportunities such as alternative land use and marketing systems, livestock enterprises, and better watershed management practices.

Sorghum and pearl millet:
Sorghum and pearl millet are the 2 most important cereal crops and are staple food crops for millions of poor in the west and central Africa semi-arid tropics (WCA SAT). Sorghum is the cheapest energy, protein, zinc and iron after pearl millet. It remains an important food crop in the major growing regions in WCA. However, considering the substantial increase in the demand for animal products (meat, milk and eggs) in developing countries by 2020 (Ryan and Spencer 2001) there would be a greater demand for sorghum grain in poultry feed industry and its stover and forage for dairy industry. In addition, sorghum grain has potential for use in producing potable alcohol, stalks for bio-fuel production and malt for the brewery industries. The value-added product diversification of sorghum would, however require innovative institutional and industrial alliances.

Pearl millet is a hardy cereal crop, grown mostly in marginal environments of the arid and semi-arid tropical regions for grain and fodder production production. The stover is valued for its fodder, the importance of which has been rising in the recent years. The crop residue/straw of dual-purpose pearl millet is an important source of fodder (particularly in low rainfall regions) accounting for 40-50% of the dry matter intake and is often the only source of feed in dry months. Owing to growing demand for milk and meat the demand for crop residues is increasing as reflected in the rising grain to straw price ratio for coarse cereals like sorghum and pearl millet.

Although food use of pearl millet is predicted to decline due to urbanization and income growth, the crop will continue to be an important staple for low-income consumers in the major growing regions in the foreseeable future. There are however, prospects for a rise in demand for processed pearl millet products as urban consumers become more nutrition-conscious. With the on-going livestock revolution, the demand for pearl millet grain in poultry feed, and its straw as well as green forage for dairy animals will continue to rise in the coming decades.

Groundnut:
During the last 4 decades, West Africa has lost its world groundnut production and export shares. Groundnut production shares declined from 23% to 15% whereas export shares decreased from 55% to 20%. China, the leading producer, has significantly increased its shares from 11% to 41%. Argentina, the leading oil exporter, has more than doubled its world share from 12% to 29%. In addition, imports from other oil seeds have significantly increased in West Africa. Soybean and palm oil imports have more than doubled. However, since 1984, groundnut production in West Africa has been increasing by about 6% annually mainly due to area expansion. Senegal and Nigeria remain among the largest world

groundnut producers. Groundnut still remains a major source of employment, income and foreign exchange in many West African countries. Therefore there is a need to reassess market prospects and highlights opportunities for West Africa to regain to its market shares.

The competitiveness of west African groundnut in the domestic, regional and international markets has been limited by the low productivity, aflatoxin regulations, and stricter grades and standards. Relative prices of groundnut oils are higher in the international markets making these products less competitive compared to oil palms, cotton oil and others oil fruits. There are market niches for confectionary groundnut. Access to this market would require knowledge of market requirements. To regain its competitiveness, groundnut productivity and production has to increase significantly, technologies to reduce aflatoxin contamination have to be promoted and grades and standards satisfied.

Chapter 2

ICRISAT WCA's Task Environment

As ICRISAT maps out its vision and strategy to 2015, there are a number of significant developments that must be reckoned with in its rapidly changing task environment. Foremost among these are the attainment of the Millennium Development Goals and the System wide research priorities to 2015. As a proactive organization, ICRISAT WCA recognizes the influence of these developments and has considered them in charting its research direction.

The Millennium Development Goals

Background

In September 2000, member states of the United Nations (UN) unanimously adopted the Millennium Declaration - a common commitment to end global poverty and suffering. Following consultations among international agencies, including the World Bank, IMF, OECD and specialized UN agencies, the UN General Assembly recognized the Millennium Development Goals (MDGs) as part of the road map for implementing the Millennium Declaration. Endorsed by 189 nations, the MDGs represent broad international consensus. They have also galvanized unprecedented global efforts to meet the needs of the world's poorest.

In general, the MDGs commit the international community to an expanded vision of development which promotes human development as the key to sustaining social and economic progress throughout the world. Recognizing the importance of creating global partnerships for development, MDGs have been commonly accepted as a framework for measuring development progress in the 21st century.

More specifically, the MDGs establish yardsticks for measuring results, not just for developing countries but also for rich countries that help to fund development programs and for the multilateral institutions that help countries implement them. The first seven goals are mutually reinforcing and are directed at reducing poverty in all its forms. The last goal -- global partnership for development -- is about the means to achieve the first seven.

Summary of the MDGs

The MDGs set 8 goals, 18 targets and 48 performance indicators on poverty reduction, including income and other measures of human well-being. The goals and corresponding targets are indicated below.

1. Eradicate extreme poverty and hunger:
   - Reduce by half the proportion of people living on less than a dollar a day
   - Reduce by half the proportion of people who suffer from hunger

2. Achieve universal primary education:
   - Ensure that all boys and girls complete a full course of primary schooling

3. Promote gender equality and empower women:
   - Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015

4. Reduce child mortality:
   - Reduce by two thirds the mortality rate among children under five

5. Improve maternal health:
   - Reduce by three quarters the maternal mortality ratio

6. Combat HIV/AIDS, malaria and other diseases:
   - Halt and begin to reverse the spread of HIV/AIDS
   - Halt and begin to reverse the incidence of malaria and other major diseases

7. Ensure environmental sustainability:

Integrate the principles of sustainable development into country policies and programs; reverse loss of environmental resources

Reduce by half the proportion of people without sustainable access to safe drinking water

Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020

8. Develop a global partnership for development:

Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory, includes a commitment to good governance, development and poverty reduction— nationally and internationally

Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction

Address the special needs of landlocked and small island developing states

Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term

In cooperation with the developing countries, develop decent and productive work for youth

In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries

In cooperation with the private sector, make available the benefits of new technologies— especially information and communications technologies.

New CGIAR Systemwide Priorities to 2015

Background

At the CGIAR Annual General Meeting in 2005, the CGIAR adopted a new set of research priorities for the System. Spearheaded by the Science Council, priority setting resulted in a set of 20 research themes, bundled within five priority areas. On the whole, the priorities provide a set of specific goals for research activities around which the Centers will organize their scientific and related capacities.

The new priorities were selected on the basis of: (1) expected impact on poverty alleviation, food security and nutrition, and sustainable management of natural resources, taking into account the expected probability of success and expected impact if successful; (2) degree to which the research provides international public goods; and (3) existence of alternative sources of supply of the research and the CGIAR's comparative advantage in undertaking the research.

Part II of this document shows in detail how ICRISAT WCA has aligned its research strategy to 2015 with the new CGIAR Systemwide priorities as shown below.

The new CGIAR Systemwide priorities

Priority area 1: Sustaining biodiversity for current and future generations:

a. Promoting conservation and characterization of staple crops
b. Promoting conservation and characterization of underutilized plant genetic resources
c. Promoting conservation of indigenous livestock
d. Promoting conservation of aquatic animal genetic resources

Priority area 2: Producing more and better food at lower cost through genetic improvements:

a. Maintaining and enhancing yields and yield potential of food staples
b. Improving tolerance to selected biotic stresses
c. Enhancing nutritional quality and safety
d. Genetically enhancing selected high-value species

Priority area 3: Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products:

a. Increasing income from fruit and vegetables
b. Increasing income from livestock
c. Enhancing income through increased productivity of fisheries and aquaculture
d. Promoting sustainable income generation from forests and trees

Priority area 4: Promoting poverty alleviation and sustainable management of water, land, and forest resources:

a. Promoting integrated land, water and forest management at landscape level
b. Sustaining and managing aquatic ecosystems for food and livelihoods
c. Improving water productivity
d. Promoting sustainable agro-ecological intensification in low- and high-potential areas

Priority area 5: Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger:

a. Improving science and technology policies and institutions
b. Making international and domestic markets work for the poor
c. Improving rural institutions and their governance
d. Improving research and development options to reduce rural poverty and vulnerability.

Implications for ICRISAT WCA's strategy and resource allocation

As the foregoing discussion implies, the task environment in which ICRISAT operates has significantly changed over the past several years. The MDGs have tremendously broadened the agricultural research agenda from increasing food supply to embrace poverty and hunger reduction, environmental sustainability and social issues such as gender equality, health and nutrition.

Likewise, the CGIAR vision and strategy indicate a strong imperative for ICRISAT to adopt a people and poverty focus, mobilizing new science tools, addressing sub-Saharan Africa, follow a regional approach to research planning, establish strategic partnerships and assume a catalytic role in technology exchange. In the same manner, the new CGIAR research priorities require that ICRISAT thematic and regional strategies be aligned with sustaining biodiversity, producing more, better and cheaper food, reducing rural poverty, sustainable natural resource management, improving policies and facilitating institutional innovation.

With the recognition that ICRISAT's research strategy can contribute substantially to MDGs 1 and 8 and more indirectly to the remaining goals, it is appropriate that ICRISAT's vision and mission are in accordance with the mainstream of those of other research and development agencies though it is clear that our principal contribution would be in the area of assisting in the insurance of food and nutritional security. It is also appropriate that the attainment of ICRISAT's goal would be a substantial contribution to the attainment of the CGIAR System's overall goal. This assumes that the research carried out by the CGIAR and its partners continues to improve the livelihood of low-income people in developing countries through reduced poverty, food insecurity, eradicating malnutrition, gender inequality and child mortality, to help cope with HIV/AIDS and to foster better institutions, policies, and sustainable management of natural resources of particular importance to agriculture and poor people.

During the past decade, publicly funded agricultural research has declined by over 50%. The private sector has assumed an increasing share of agricultural research and ownership of new technologies, leading to a gradual convergence of the public sector's pro-poor development goals and private sector commercial interests. The emergence of global markets, biotechnology and information and communication technologies (ICTs) have a strong influence in changing the strategic direction of ICRISAT's research.

These changes are happening at a time when international agricultural research is seeing the emergence of a new set of institutional arrangements where public-private partnerships are mainstreamed towards a new vision of agriculture and rural development. Similarly, new patterns of accountability and governance are changing the role of agricultural research institutions and their relationships with civil society. Now that the solid foundations of the Future Harvest Alliance are established, ICRISAT will pursue its new vision and strategy within the collective action framework of the 15 Centers in the CGIAR. Moreover, it will undertake its research efforts, where possible, in as participatory a manner as possible. It will seek to build new strategic partnerships or alliances and generate as much community support for its research agenda as it can. ICRISAT believes that this type of people- and partner-based approach can lead to the rapid and effective attainment of its development-oriented goals.

Starting in 2006, ICRISAT-WCA annually seeks to effectively allocate $10 million for its new strategy and by 2015, this may be approaching $15 million. Since this is a large annual investment, ICRISAT recognizes the importance of

rigorous research prioritization. This is clearly indicated in its series of rolling global medium term plans (MTPs), of which the one for 2008-2010 has been prepared to help pursue this regional strategic plan. Currently, about 46% of resources are invested in biotechnology and Crop Improvement, 32% in agro-ecosystems and 15% in institutions, markets, policy and impacts and 5% for Knowledge Management Systems. This level of investment based on themes will, more or less, continue for the next three years and depending on institutional priorities and new global developments, may change over time.

ICRISAT-WCA Long Term Visioning Initiative

The development of ICRISAT WCA's long term vision and strategy to 2015 generated contributions from all global themes and regions, whereby a total of five regional and global research strategies evolved to reflect regional needs and global priorities. This was simultaneously complemented by an assessment of the Institute's overall strengths, challenges, opportunities and threats (SCOT) through a participatory visioning exercise designed to encompass the wide-ranging perspectives of ICRISAT stakeholders and pressing issues both in research and research management. An open-ended questionnaire was developed for the SCOT survey to elicit responses from scientists and stakeholders across all locations. The exercise provided an avenue to "think out of the box" in identifying priorities and new innovations within the context of the environmental and socio-economic-political concerns especially affecting the semi-arid tropics.

Chapter 3

Vision, Mission, Goal and Strategy

ICRISAT-WCA's vision, mission and goal

Vision
Improved well-being of the poor of the semi-arid tropics in WCA.

Mission
To reduce poverty, enhance food and nutritional security and protect the environment of the semi-arid tropics by helping empower the poor of WCA through science with a human face.

Goal and purpose
To mobilize cutting edge science for technology development and institutional innovations for poverty alleviation, food security, human development and environmental protection for poor rural families in the semi-arid farming systems of West and Central Africa.

This is sub-divided into four intermediary development-oriented areas in accordance with ICRISAT's global strategy, and these are to:

Achieve an improved, diversified and further commercialized agricultural production as well as improved food security and health status in the semi-arid tropics of Africa;
Improve the health and nutritional status of both people and livestock in the SAT, as these can be intimately associated with agricultural issues;
Reduce the vulnerability of poor households to short-term shocks resulting from drought, pest and disease outbreaks by encouraging governments, NGOs and relief agencies to adopt more effective and efficient disaster prediction and relief strategies; and
Increase the effectiveness of regional research partnerships and networks working on poverty reduction by enabling regional research partners to adopt and further adapt innovative research and development strategies.

Strategy
A primary driver for ICRISAT's strategy in WCA is to spur market demand. We will create incentives and opportunities for the poor to grow their way out of poverty through market-orientated production and value addition, in addition to ensuring their own food security. We will focus our research on enhancing and stabilizing yields. We will work to increase agricultural income for farmers with the expansion and increased viability of the commercial agricultural sector. We will also generate cutting edge innovations to help farmers reduce mycotoxin contamination, pesticide residues and other food contaminants and produce nutritionally superior crop and livestock products.

Moreover, we will implement the WCA priorities identified by the FHA based on the new CGIAR Systemwide priorities, which include sustaining biodiversity; maintaining and enhancing yields and yield potential of food staples; increasing income; integrated land, water and forest management at landscape level; and science and technology policies and institutions.

We will pursue our work using an IGNRM approach and by enhancing our network of collaborators and providing capacity building for our partners which include NARES, various sub-regional and regional fora (i.e., CORAF/WECARD, FARA, NEPAD), Alliance of Future Harvest Centers, advanced research institutes, civil society organizations and the private sector.

Table 1. Achieving the Millennium Development Goals through ICRISAT WCA's research.

MDGs	ICRISAT WCA's research thrust
1. Eradicate extreme poverty and hunger.	The semi-arid tropics of West and Central Africa (WCA SAT) is home to more than XX million poor. ICRISAT contributes to improved food security, livelihood resilience and poverty reduction in this agro-ecological zone through its Integrated Genetic and Natural Resource Management and people-oriented, partnership-based research. ICRISAT's research outputs empower the poor to mitigate market and non-market generated shocks, inequalities and risks.
2. Achieve universal primary education.	ICRISAT WCA's impact-oriented research endows farmers with innovations that facilitate risk reduction, income diversification, ensure better quality of marketable products and commercialization strategies. These lead to higher incomes and consequently greater investment in children's education. With more efficient technologies at their disposal, stakeholders have the time to acquire primary education.
3. Promote gender equality and empower women.	ICRISAT WCA acknowledges the contribution of men and women in decision making. With its gender-sensitive innovations, skills and knowledge, ICRISAT makes WCASAT farming systems more efficient, thereby empowering women to pursue profitable on-farm and off-farm activities.
4. Reduce child mortality.	Child mortality can be reduced considerably with nutritious crops. ICRISAT WCA's improved cultivars and integrated crop management technologies produce more nutritious crops. Eating nutritious and safe cereal grains and legumes protect the most vulnerable, especially children, from hidden hunger and malnutrition.
5. Improve maternal health.	Nutritious cereals (sorghum and millet) and legumes (pigeonpea, chickpea and groundnut) and mycotoxin-free foods contribute to enhanced maternal health, ensuring that poor pregnant and lactating women get the right quality of food. ICRISAT WCA's research on women's social networks identifies entry points for better access to markets and health services.
6. Combat HIV/AIDS, malaria and other diseases.	ICRISAT WCA's village-level studies identify intervention points at which agricultural innovations, policy and practice help prevent and mitigate shocks at the village level. Likewise, ICRISAT's research on controlling aflatoxin contamination leads to safer and more nutritious food through genetic enhancement and helps people challenged by HIV-AIDS.
7. Ensure environmental sustainability.	ICRISAT WCA promotes integrated pest and disease management methods that improve the soil and are environment-friendly and affordable to poor farmers. Research on carbon sequestration contributes directly to fertility replenishment in depleted soils. Moreover, *in situ* conservation of locally relevant biodiversity improves adaptation in stressed environments of the SAT.
8. Develop a global partnership for development.	ICRISAT works through strategic partnerships with diverse sectors, like the Future Harvest Alliance, advanced research institutes, regional and sub-regional organizations, NARS, international and national civil society organizations and the private sector .

Regional research programs (RRP): Thematic goals and strategies

RRP3. Improving markets and facilitating institutional innovations (System priority 5 and ICRISAT project 1)

In keeping with recent recommendations of our external reviews, ICRISAT focused research programs through four global research themes, one of them being Institutions, Markets, Policy and Impacts (earlier known as SAT Futures and Development Pathways). The program's objective is to inform and provide strategic direction and prioritization of research issues within an IGNRM context and to provide appropriate capacity building. It scrutinizes the key driving factors influencing farmer to market linkages, optimal input and output options (including seed systems) and on more effective policy and impact generation. The poor face a wide range of social and economic constraints, so we maintain constant communication with them to understand their needs and seek solutions. In addition, following subsequent Governing Board advice in September 2005, ICRISAT reviewed its priorities to ensure that they are closely aligned with the CGIAR Systemwide priorities.

Goal and purpose
The goal of the Global Theme on Institutions, Markets, Policy and Impacts is to help generate policies, tools, lessons, and investment guidelines that contribute to improved food security, livelihood resilience and poverty reduction while protecting the environment of the production systems in the semi-arid tropics.

Towards this, the theme aims to facilitate:

- Adoption and implementation of new tools, policy recommendations and best practices by researchers and policymakers in the SAT to make efficient choices in support of SAT agriculture;
- Adoption of alternative risk reducing, income diversification and commercialization strategies and innovations for improved livelihoods by SAT farmers; and
- Utilization of innovation systems (institutional arrangements, alliances, and monitoring and evaluation) by researchers in the NARS, IARCs and other actors in the research for development continuum to promote learning and impact.

Strategy
The Global Theme on Institutions, Markets, Policy and Impacts will generate and share vital information and analytical tools that will provide a rational foundation for decisions that affect the welfare of farmers and consumers in the semi-arid tropics. It will widen and expand the scope of village level studies both in WCA to contribute to research relevance and policy formulation

It will continue to build from ICRISAT's strong socio-economics and policy research experience rooted in a long tradition of working at the farm level through Village Level Studies and Impact surveys. It will further strengthen participatory and multi-disciplinary approaches to ensure that ICRISAT addresses the urgent concerns in SAT agriculture and the changing external environment both at the micro and macro levels. It will complement the micro-level analysis of village level databases with the analysis of macro-level data for policy formulation and development of research priorities.

Likewise, it will further intensify innovative partnerships with the NARS and other stakeholders to effectively contribute to the global research agenda by complementing national programs to improve the well-being of SAT populations in WCA.

Participatory Monitoring and Evaluation in support of the ICRISAT-WCA Strategy
In March 2004, ICRISAT Governing Board adopted a framework for monitoring and evaluation for technology exchange. At the global level, the M&E framework is an integral component of all research questions. The Global Theme of Institutions, Markets, Policy and Impacts is the focal point in monitoring and implementing the framework and oversees the provision of technical assistance in M&E. Regional M&E teams should ensure compliance with processes and indicators and the results of M&E will be part of all research reports.

During the next 5 years (2006-2010), in its regional strategy, ICRISAT WCA will undertake 6 projects. These projects are:

Project I (RRP3 and ICRISAT Project I) entitled "Improving markets and facilitating institutional Innovations",
Project II (RRP1 and ICRISAT Projects 1 and 2) entitled "Conservation, Management and enhancing Genetic Resources"
Project III (RRP2 and ICRISAT Projects 7, 8 and 9) entitled "Agricultural diversification and sustainable agro-ecosystems)
Project IV (RRP4 and ICRISAT Project 8) entitled "Desert margins Program"
Project V (System non-priority) entitled "Knowledge management and sharing"
Project VI. "Resource mobilization"

These projects will have built in a Participatory Monitoring and Evaluation (PM&E) system. The major functions of the PM&E will be to:

provide stakeholders and beneficiaries an opportunity to reflect on progress of project and obstacles

generate knowledge that results in the application of lessons learned and leads to joint corrective action and improvement

provide beneficiaries and other stakeholders with tools to transform their environment, i.e. it is empowering

help to ensure accountability to stakeholders, managers and donors by supplying information on how project objectives have been met and resource use

improve the quality of M&E data/information.

The whole process will be guided by four broad principles:

Participation: from design of M&E to analysis of data

Inclusiveness: through negotiation to agree on:
- What will be monitored and evaluated
- How and when data will be collected and analyzed
- What the data actually means
- How findings will be shared and action taken

Learning: basis for subsequent improvement and corrective action

Flexibility: since the number, roles and skills of stakeholders and external environment change over time.

The monitoring and evaluation system will be established in each project to document project processes and to measure both the intermediate and final outcomes of activities and the project's impact. It will provide a 'reality check' which can be used to determine to what extent the project's objectives have been achieved. Continuous and periodic monitoring and evaluation of the project's processes will also serve to identify, in a timely fashion, constraints that might prevent the project achieving specific goals. This will allow the project to take corrective action in order to ensure maximum impact. The capacity-building component of the project will increase (both quantitatively and qualitatively) the ability of local partners to conduct scientific monitoring and evaluation (M&E) studies in the future.

For each project, the major steps in designing the Participatory M&E framework will include:

M&E steps	***Outputs in project appraisal report (the M&E framework)***	***Tasks during Project start-up to develop a detailed M&E Plan***
1. Establish the purpose and scope *(Why do we need M&E and how comprehensive should be M&E system be?)*	Broadly defined purpose and scope of M&E in the project context	Review the purpose and scope with key stakeholders
2. Identify performance questions, indicators and information needs *(what do we need to know in order to monitor and evaluate the project so that it can be managed effectively?)*	List of indicative key questions and indicators for the goal, purpose, outcomes and output levels	Assess the information needs and interests of all stakeholders Precisely define all questions, indicators and information needs for all levels of the objective hierarchy Check each bit of information for relevance and end-use

M&E steps	*Outputs in project appraisal report (the M&E framework)*	*Tasks during Project start-up to develop a detailed M&E Plan*
3. Plan information gathering and organizing *(How will the required information be gathered and organized?)*	Generally described information gathering and organizing methods to enable resource allocation	Plan information gathering and organizing in detail (who will do, use, which method to gather/synthesize what information, how often and when, where, with whom, with what expected information product) Check the technical and resource feasibility of information needs, indicators and methods Develop format for data collection and synthesis
4. Plan for communication and reporting (h*ow will we make sense of the outcome of the information gathered and how will it be used to make improvements in project implementation)*	Broad description of key audiences and types of information that should be communicated to them to enable resource allocation	Make a precise list of all the audiences, what information they need, when they need it and in which format Define what is to be done with the information – simply send it, provide a discussion for analysis, seek relevant feedback for verification, etc Make a comprehensive schedule for information production showing who is to do what by when in order to have the information ready on time
5. Plan critical reflection processes and events *(How and to whom do we want to communicate project results? What project activities and processes do we need to communicate?)*	General outline of the key processes and events	Precisely detailed which methods/approaches are to be used with which stakeholder groups and for what purpose Identify who is responsible for which reflective events Make a schedule that integrates all the keys events and reporting/decision making moments
6. Plan for the necessary conditions and capacities *(What resources and capacity do we need to ensure that our M&E system works effectively.)*	Indicative staffing levels and types, clear description or organizational structure of M&E , indicate budget	Come to a precise definition of: the number of M&E staff, their responsibilities and their linkages, incentives needed to make M&E work, organizational relationship between key M&E stakeholders, the types of information management system to be established and a detailed budget

Local Monitoring and Evaluation Teams

The RCC (Regional Coordination Committee) will oversee the project's activities and Project Teams (PT) will be responsible for their implementation. Annual Review and Work plan Meetings will be discussed following In-House Reviews with all scientists to evaluate and reflect on the results obtained in the previous year(s) using the monitoring and evaluation indicators and prepare work plans for the following year accordingly.

Project evaluation will assess how much progress has been made towards achieving goals. This will take into account (i) the appropriateness of goals and objectives in relation to assessed needs, (ii) the extent to which the objectives have been achieved, (iii) the cost-effectiveness of the activities, and (iv) the impacts of the project. Scientists from all disciplines (e.g., socio-economists, agronomists, soil scientists, breeders and seed-system specialists) are all team players. The PM&E team will identify and agree on the indicators to be used, based on needs assessments and baseline information surveys. These will be used to monitor the implementation and progress of activities. Indicators and

milestones will be modified, if necessary, as new demands and strategies emerge over time. Stakeholder participation in PM&E will strengthen collective ownership of each project as well as responsibility for its implementation.

Uptake, adoption and impact studies will be undertaken to identify constraints to adoption, assess the levels of adoption and the extent to which the introduction of improved technologies has been successful in meeting socio-economic objectives and satisfying the needs and priorities of SAT households and other groups in the target population.

RRP1. Conservation, Management and Enhancement of Genetic Resources (System Priorities 1 and 2; ICRISAT Projects 2 and 3)

Supporting exploration, conservation, characterisation and exchange of plant genetic resources of pearl millet, sorghum, groundnut is one of the main objectives of ICRISAT in WCA. A regional genebank ensures that the germplasm accessions are easily accessible to research workers in the region. Similarly the genebank provides a safety duplication of accession in long term storage at the Patancheru genebank. Currently, the ICRISAT regional genebank at Sadore holds 36485 germplasm accessions of 25 species, as well a living collection of 115 varieties of 40 species.

The target ecoregion of crop improvement research is the semi-arid tropics of west and central Africa, specifically the Sahelian, Sudanian and northern Guinea savannah zones of agricultural production. The immediate beneficiaries of this research are our varied research and development partners from the NARES, the NGO and CBO communities. We are also trying to assist the few private sector marketing and seed enterprises. The end users are village communities benefiting from more secure and nutritious staple food production and more secure annual incomes, as well as more and better quality crop residues for increased animal production. Opportunities to develop sustainable pro-poor bio-power options will be explored.

Farmers and consumers in the semi-arid tropics of West and Central Africa, depending on sorghum and pearl millet as their staple food face a number of basic issues that limit production, productivity increases, food security as well as nutrition and health.

1. **Increasing demands on the natural resource base:** A number of abiotic, biotic and socio-economic constraints limit pearl millet, sorghum and groundnut production and marketing in WCA.
2. **Increasing intensification of sorghum production systems:** Sorghum, and to a lesser extent pearl millet production systems are intensifying. Sorghum begins to benefit from inputs such as fertilizers, either as residuals from cash crops such as cotton or with direct application. Farmers are also increasingly harvesting stover for controlled feeding of livestock.
3. **SAT the home of the poor -- Food security, nutritional and health status remain low:** High child mortality, low life expectancy and poor women's health are distressingly common issues throughout the region. Farming in WCA is primarily labor limited and thus the poor health status of the potential workforce seriously compromises agricultural productivity.
4. **Emerging markets for cereal grain:** Increasingly sorghum and pearl millet grain are important as an income source as well as for food sufficiency, while groundnut is a key source of income, primarily for women farmers. Poor infrastructure, institutional framework, price variability, and farmer cash flow problems however represent significant challenges. Farmer organizations are undertaking collective marketing of grain and seeing increased opportunities for animal and poultry feed (These issues are linked to research in Project 1).

Overall, it must be noted that there is a strong need for integrated solutions towards production intensification and marketing, focusing on the opportunities and constraints of specific agro-ecological regions and farming systems. The strategy to increase groundnut, pearl millet and sorghum production and marketing in WCA is based on integrated genetic and natural resource management (IGNRM). Breeders and geneticists cooperate with systems agronomists, animal scientists and socio-economists to develop sustainable, integrated solutions which can profit from positive genotype x management interactions, as well as newly established market opportunities.

The pearl millet breeding research as a component of the IGNRM approach will focus on the Sahelian and northern Sudanian zones, whereas sorghum improvement research focuses on the Sudanian and to a lesser extent on the northern Guinea savannah zones. Groundnut improvement is focusing on areas with sandy soils in both the Sahelian and

Sudanian zones. The research will pursue the following three focal areas of research that encompass many of the ongoing and emerging activities largely in accordance with the CGIAR System priorities.

Exploitation of heterotic relationships between different germplasm pools of sorghum and pearl millet.
Development of tools and methodologies for effective implementation of genetic enhancement research within an INGRM approach across the region.
Addressing specific nutrition and health concerns through targeted crop improvement

Integration of Biotechnology with Crop Improvement

ICRISAT believes in the potential of biotechnology to enhance the speed, precision, efficiency and value addition in many aspects of its crop improvement and IGNRM efforts. This is especially true in addressing traits that have remained intransigent to conventional breeding approaches. In addition, ICRISAT is developing diagnostic tools for mycotoxin contamination, and virus detection.

Short term priorities for the application of marker tools for the two cereals include diversity studies to guide decisions about heterotic grouping, identification of markers for *Striga* resistance, downy mildew resistance, and photoperiodic response. In the longer term markers for phosphorus efficiency and associated root traits, male sterility and fertility restoration , as well as heat/drought tolerance are of high priority for the WCA region..

For groundnut genetically modified virus resistant (Peanut clump and Rosette) cultivars are available for field testing, once biosafety protocols have been approved. In the longer term marker applications for groundnut are expected, once efficient marker systems have been identified and reference maps developed. .Priority traits are heat/ drought tolerance, and aflatoxin resistance.

ICRISAT will continue to support WCA countries and their subregional organizations in the development of biosafety legislations, regionalization of seed regulations and other enabling policies.

.In the short term we expect to develop DNA extraction facilities in collaboration with partners in Niger and Mali. Genotyping will be carried out in collaboration with ICRISAT colleagues in the BeCA lab in Nairobi, and at the Center of Excellence in Patancheru . A multidisciplinary team of scientists assigned to the theme provides expertise in both the laboratory and field aspects of biotechnology applications to crop improvement. In the longer term ICRISAT expects to support the development of a WCA regional biotechnology training and service facility, similar to Beca.

Goal and purpose
The overall goal of the Global Themes on Biotechnology and Crop Improvement is a reduction of poverty, hunger, malnutrition and environmental degradation in the SAT by applying promising genomic, genetic engineering, wide-hybridization, diagnostic and bio-informatics tools and approaches to the improvement of diversified cultivars ICRISAT's mandate crops with eco-friendly and cost-effective pest and disease management practices, efficient seed systems, and diversified and alternative uses of crop produce.

In our efforts to reach the above goal for WCA , we will focus our strategic direction to:

Improve the efficiency, effectiveness, speed and precision of plant breeding for abiotic stress tolerance, pest and disease resistance, better agronomic traits, and improved food, feed and fodder quality; and
Develop diagnostic tools for the detection of viral infections, toxic contaminants in crops and crop-based products, presence of transgenes, and purity of seed production systems.
Collect, conserve, characterize and share germplasm within the R&D community;
Develop cost-effective and eco-friendly integrated pest management (IPM) technologies;
Address alternative crop utilization strategies, including food and feed safety issues, and the prospects for commercialization;
Increase adoption of improved varieties by farmers through the development of farmer participatory methods, and sustainable seed-supply systems;
Accelerate technology exchange and information sharing, using both conventional methods and information and communication technologies (ICT) for capacity building of partners to achieve on-farm impact, and improve food security and livelihoods of the poor in SAT regions.

Strategy

ICRISAT's scientific team has made great progress in the application of various tools and techniques of biotechnology to crops important for poor farmers in WCA. To ensure that the above objectives are met during the next strategic period, scientists in ICRISAT's Global Themes on Biotechnology and Crop Improvement will continue to evaluate advances in modern science and acquire, adapt and apply the most relevant of these in their research programs. ICRISAT's crop improvement program will pursue a global approach with a regional focus. Since each region has to cater to many countries having varied agro-climatic zones, the emphasis will be on enhancing and strengthening partnerships with national programs where mandate crops are important for national food and nutritional security. Strengthening NARS crop improvement programs and capacity building of partners will be priority, especially in WCA.

Biotechnology is a broad field, and ICRISAT employs techniques in many areas. These include the more traditional technologies such as the use of tissue culture and immunological methods for antibody production; modern genomic technologies such as structural and functional genomics to identify, isolate and manipulate genes for traits of interest; and genetic engineering to introduce novel genetic variability for traits lacking sufficient inheritable diversity. In addition to these technologies, ICRISAT employs a bioinformatics platform to provide the necessary links, databases and analysis tools to ICRISAT's researchers and partners.

As being done at present, specific target traits and crops will be determined with ICRISAT's various partners. These close interactions will ensure that the highest priority traits are being addressed in each crop, as well as the most appropriate technologies are being used in each case. Research will be carried out by an inter-disciplinary research team. Often, improved cultivars serve as catalysts for adoption of other technologies (agronomy, fertilizers, etc). Therefore, GT Crop Improvement will work closely with the GT on Agro-ecosystems (soil, water and biodiversity) and the GT on Institutions Markets, Policy and Impacts.

Most of the research activities will be undertaken in partnership with NARS, private sector, research and technology exchange networks, non-governmental organizations (NGOs), advanced research institutions, farmers' organizations, and farmers in the target areas. Technology exchange and capacity building (using both conventional and the emerging information and communication technologies) will be important components in all regional projects.

RRP2. Agricultural diversification and sustainable agroecosystems (Systems priorities 3 and 4; ICRISAT Projects 7, 8 and 9)

Agro-ecosystem development

ICRISAT has expanded the Integrated Natural Resource Management paradigm to acknowledge the role which crops and genetic improvement can play in enabling SAT agriculture to achieve its potential. There is a growing acceptance of the expanded version of this term to include both genetic and non-genetic solutions – Integrated Genetic and Natural Resource Management (IGNRM).

In response to the recommendations of the 5th External Program Reviews recommendations, core resources have been subsequently redeployed in a phased manner to better address the major challenges in SSA. However, given the availability of opportunities for special project funding in the area of natural resources management in Asia, it was agreed that ICRISAT would continue to pursue these simultaneously and create a self-supporting natural resource management (NRM) team in Asia. In this way, NRM scientists would continue to contribute to ICRISAT's IGNRM new science strategies and draw lessons from long-term development programs in Asia to help translate these for impact in WCA. In addition, they will make substantive contributions to capacity development amongst their partners.

Goal and purpose

Agro-ecosystem development aims to improve rural livelihoods, increase food security and sustainable natural resource management throughout the semi-arid tropics as a result of a greater impact of agricultural research for development. Moreover, it is committed to help achieve sustainable increases in food security and income growth in the semi-arid farming systems of WCA through the use of evolving research tools and approaches in the fields of soil, water, agro-biodiversity and climatic management (IGNRM). To pursue the foregoing, GTAE will:

Develop and promote affordable and sustainable soil, water, crop and nutrient management options and integrated approaches to watershed management;

Identify and promote options for systems diversification (high-value crops, trees and livestock) to improve rural livelihood security;

Enhance capacity of research and development partners, and regional networks to formulate and implement research for impact;

Develop and promote appropriate methodologies and approaches for agricultural rehabilitation following natural and/or civil disasters including HIV/ AIDS; and

Forge strategic partnerships with government agencies, donors, non-governmental organizations, community-based organizations and the private sector to ensure options are tailored to fit farmers' diverse investment and risk management options.

Strategy

Towards 2015, GTAE will develop and promote sustainable IGNRM innovations relevant to the needs of smallholders in the SAT. To pursue this, GTAE will focus on the development of methodologies, approaches and resource conserving technologies and practices.

Moreover, GTAE will play multiple roles in its research on agro-ecosystem development. It will serve as a catalyst, facilitator and enabler of two broadly based consortia relevant to WCA on the: (1) Agricultural implications of current climate variability and potential changes; and (2) Desert Margins Program. At the national level, ICRISAT will play the role of enabler and facilitator in developing and evaluating IGNRM interventions that will help rural households to better cope with climate variability and alleviate food insecurity. In addition, ICRISATs rich information base and network with IARCs and ARI's will enable it to work closely with ILRI in developing alternative feed/fodder resources within crop-livestock systems.

Towards 2015, GTAE will also serve as a primary and secondary research provider. As a primary research provider in WCA, it will develop new science tools such as systems simulation, climate forecasting and farmer participatory approaches that integrate genetic and non-genetic solutions. As a secondary provider, it will support and coordinate the emerging consortium to evaluate the agricultural implications of current climatic variability and planning for future climate change.

Research by IWMI on water productivity, ICRISAT on dryland crops and ILRI on livestock feeds/fodders suggests that under rainfed systems, enhanced water productivity is possible through improvements in water and soil fertility management, agronomic practices such as conservation tillage, and use of improved genotypes of food-feed crops. In most of the semi-arid tropics of Africa and Asia, the nexus between water and feed limitation is the primary constraint to effective livestock production.

ICRISAT in WCA continues to work with an ever expanding range of partners from both the public and the private sectors to pursue more participatory strategies, linking on-farm trials with crop systems simulation in order to increase the impacts of soil fertility research. Farmer participation ensures that technology development and testing are based on farmers' needs and perspectives; simulation allows the testing of a wider array of options in different (simulated) seasons and environments. Project innovations that have resulted from interactions between ICRISAT staff from West Africa include: better targeting of small doses of macro-nutrients (phosphorus), sale of fertilizer in smaller, more affordable packages; and new methods of disseminating information on technology options. The results continue to be promising, with large yield gains, higher water-use efficiency, and increasing adoption by smallholder farmers when input supply constraints are addressed.

RRP 4. Desert margins Program (System priority 4 and ICRISAT project 8)

The research proposed in this project is in specific accordance with System Priority1—Sustaining biodiversity for current and future generations, System Priority 4—Poverty alleviation and sustainable management of water, land, and forest resources and System Priority 5—Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger.

The overall objective of the DMP is to arrest land degradation in Africa's desert margins through demonstration and capacity building activities. The GEF increment to this project will enable the programme to address issues of global environmental importance, in addition to the issues of national economic and environmental importance, and in particular the loss of biological diversity, reduced sequestration of carbon, and increased soil erosion and sedimentation. Key sites harbouring globally significant ecosystems and threatened biodiversity have been selected in each of the nine countries to serve as field laboratories for demonstrations activities related to monitoring and evaluation of biodiversity

status, testing of most promising natural resources options, developing sustainable alternative livelihoods and policy guidelines and replicating successful models. The project will make a significant contribution in reducing land degradation in the marginal areas and help conserve biodiversity. Guidelines, recommendations, appropriate technologies and supportive national policies that address biodiversity concerns are envisaged to be in place in implementing countries.

This project fits with ICRISAT mandate to enhance the livelihoods of the poor in semi-arid farming systems through integrated genetic and natural resource management strategies. It is particularly relevant to the Institute focus of initiating and supporting partnership-based research for impact, gender sensitivity, capacity building and enhanced knowledge and technology flows. By producing guidelines, recommendations and supportive national policies for the 9 national participating countries that address biodiversity concerns and sustainable livelihood options, the program reinforces ICRISAT mandate as stated above. The DMP will further make a positive contribution to MDGs 1,4,5,6 and 7 and will also make a contribution to the Millennium Ecosystem Assessment (MEA), especially with respect to the types of ecosystems services and functions derived from the biodiversity of the desert margins of SSA. This will further include exchange of information on the vulnerability of the socio-economic and natural systems at multiple scales under multiple pressures.

Goal and purpose

Specific goals being addressed include:

under System Priority 1, goal 1b, promoting conservation and characterization of underutilized genetic resources to increase income of the poor;

under System Priority 4, goal 4b, integrated land, water and forest management at landscape level and goal 4d, sustainable agro-ecological intensification in low-and high- potential areas;

System Priority 5, goal5a, science and technology policies and institutions.

Strategy

The DMP project will focus most of the effort on a small number of well monitored sites where the work of the soil, plant, and animal scientists can be integrated with the studies performed by the socio-economists, policy analysts, and institutional analysts. These sites will also act as sub regional "field laboratories", where the necessary interactions will be established between farmers, researchers, and development workers. It is the partnerships formed by this integration of disciplines and combination of farmers/resource users contemporary knowledge, research and development that is the strength of the DMP project. The strategy of focusing on a few sites of this kind will also avoid duplication of effort and will give a critical mass of work that can achieve the progress necessary for tackling the complex problem of land degradation.

System non-priority. Knowledge management and sharing

National agricultural research and extension systems (NARES) are characterized by variability among and within countries and regions with respect to their capabilities in undertaking agricultural RD&E. At present, there is a very strong and persistent need from the NARES (especially in sub-Saharan Africa) for capacity building due to the continued lack of a critical mass and resources to implement strong IGNRM RD&E programs. Hence, increasing demands are being addressed to ICRISAT and other CGIAR Centers to assist in building and/or strengthening national RD&E capacity.

On the whole, ICRISAT has a strong capacity to set trends, organize and share knowledge, provide strategic direction, and enhance the quality of agricultural science and its utilization in the Asian and sub-Saharan SAT. Amidst the continued decline of core resources, this task is a big challenge which calls for the design, development and up scaling of innovative ways in capacity building. ICRISAT is committed to improve the human and institutional capacity of SAT NARES to conduct agricultural R&D by building partner power through:

Assessing and addressing partners' training and education needs;

Enhancing the capacity of partners to conduct joint research on cutting edge concepts, methodologies, and knowledge sharing; and

Organizing and sharing information, knowledge and best practices on SAT agriculture.

Goal and purpose
ICRISAT envisions a world in which all stakeholders in the agricultural innovation process can easily access and share information, knowledge and skills they need - anywhere and anytime – to enhance the food security and livelihoods of the poor. Hence, ICRISAT is committed to harness innovative tools and concepts in learning, information and communication technologies and knowledge management to build partner power in the SAT.

Strategy
Towards 2015, ICRISAT's strategy for knowledge sharing will be fully aligned with the CGIAR's new research priority on facilitating institutional innovations to support sustainable reduction of poverty and hunger. This will be pursued by generating innovative approaches of linking policymakers, researchers, development workers, farmers, private support providers and other stakeholders of the agricultural innovation process.

The ICRISAT-led Virtual Academy for the Semi-Arid Tropics (VASAT) will be upscaled with partners to enable dynamic linkages among diverse, distributed human and information resources in the SAT. By doing this, ICRISAT will facilitate institutional learning and provide a platform for becoming a leading provider of relevant content through the interface of ICT and open-distance learning. Moreover, VASAT will accelerate pursuit of the CGIAR's ICT-KM strategy of incorporating new practices to preserve, produce and improve access to the agricultural global public goods needed by the poor in developing countries. Linkages will be established with partners such as the Global Open Food and Agriculture University (GOFAU) and national open universities to develop courses in distance mode and other innovative learning opportunities.

Towards 2015, ICRISAT will offer vast opportunities for value-added collaboration among CGIAR Centers as well as with other partners, and will deploy novel platforms for knowledge sharing. ICRISAT will work with partners to enable capacity building within the CGIAR in designing, maintaining and upgrading knowledge management systems. It will also develop expertise in assessing and deploying various connectivity technologies in sharing information and knowledge with remote regions in the SAT.

Chapter 4

Resource mobilization and staffing

The West and Central Africa Integrated Resource Mobilization and Communication Strategy for the period 2008-2015.

The new corporate vision and strategy to 2015 espouses new ideas and approaches to research for development, which promise to deliver on its mission. A sustainable resource base accompanied by an enhanced information sharing and communication strategy will however be required for the mission to be accomplished. On the one hand, effective implementation of these ideas would require additional in-house expertise and broad based partnership with other stakeholders, and on the other hand, our contribution to development has to be effectively communicated to partners and investors to ensure future investments and partnership. Hence the appropriateness of developing an integrated resource mobilization and communication strategy

Goals

a) To mobilize special project funding required to implement Regional Research Programmes (RRP) and contribute to the realization of the corporate vision, mission and strategy to 2015
b) To generate and share information on ICRISAT including its vision, programs, projects and activities as well as the outputs, outcomes and impacts achieved in order to ensure that identified beneficiaries are reached in a timely manner, and to sensitize its partners and investors to its contributions to development.

Strategy

Development of a donor database to provide information on their priority areas of support to research for development in order to identify congruence between these areas, our partners' priorities and ICRISAT's mandate.

Development and marketing of research proposals, programmes and activities in these areas of congruence to a variety of traditional and non-traditional donors for support.

Establishment of an Information Communication Management Unit to provide technical support and backstopping to scientists acting as champions and management group personnel acting as advocates in order to:

- Build research result dissemination strategies into each and every proposal marketed by ICRISAT
- Package research outputs, outcomes and impacts for sharing with a variety of targets and beneficiaries
- Identify and use appropriate approaches (interpersonal and mediated), as well as conventional (print, CD ROM, exhibitions) and new age (rural radio, web sites, video web clips) media for sharing and disseminating such packages.

Milestones

Yearly increment of about $ US1.0 million special projects funding over the starting level of $ US 4 million in 2007, to reach a yearly special funding level of $ US 10 million by 2015. A review will be carried out in 2012 to readjust the 2015 milestone as appropriate.

Significant improvement in the adoption, up-scaling and out-scaling of knowledge and technologies generated by ICRISAT and its partners by the end of the plan period.

Improved knowledge and acknowledgement of the contribution of ICRISAT to food security, income generation, improved livelihood system and regeneration of degraded natural resources in West and Central Africa during the plan period

Action/implementation plan.

Resource Mobilization: This will be carried out by marketing programmes, projects and activities developed within the context of 4 regional research focal areas that reflect the Regional Research Programs (RRP) Efforts will be concentrated on the development within each focal area of a few multi-year mega-initiatives with potential for several phases.

The agreed upon focal areas with examples of mega-initiatives in brackets are:

i) Staple food crops production, productivity and quality (the West Africa Seed Alliance; sustainable increase of pearl millet production and commercialisation in WCA; managing soil fertility using an IGNRM approach).

ii) Crop Diversification for poverty reduction (Dates for the Sahel-the AMG complex; fruit trees, crops and vegetables systems; dual-purpose crops in West Africa: maximizing total value from grain and residues).

iii) Land Degradation and Desertification (Desert Margins Program; the Sahelian Eco-farm; Challenge Programme on coping with climatic variability and change)

iv) Markets, Institutions and Policies (Market access and market information systems for poor crop/livestock producers; decision and risk management support systems for rural producers).

v) West and Central Africa VASAT (VASTA technology Exchange)

Communication. Identified champions of each research focal area will work with the ICM unit, and other scientists to implement the strategy described above. They will make use of the senior management group in Sadore and at HQ as appropriate especially for inter-personal communications, participation in high-level regional and international events and the production of marketing messages via digital media such as video web clips and CDs.

Staffing

Core competencies and additional manpower requirements

ICRISAT is currently endowed with core competencies in the areas agronomy (2), soil scientists (2), pearl millet breeding (1), sorghum breeding (1), groundnut breeding (1), a vegetable breeder (joint ICRISAT-AVRDC appointment) and socio-economists (1). To achieve the objectives described in the present research strategy, there is need for additional man power including 1 Pearl millet breeder, 1 animal nutritionist, 1 systems agronomist, 1 socio-–economist; 4 to 5 adjunct scientists in the areas of agronomy, technology exchange, sorghum pathologylist/ entomologists, millet/breeding, social science with knowledge on – institutional and , technology exchange issues.

Annex 1. CGIAR SYSTEM PRIORITIES: OUTPUTS, IMPACTS AND IMPACTS PATHWAYS IN WEST AFRICA

System Priority 5. Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger

5A. Science and technology policies and institutions

The agricultural economies in WCA have witnessed a number of changes over the last thirty years. Firstly, two major macro-policy reforms have occurred in the form of the liberalization of economies in the 1980s or currency devaluations in 1994. Secondly, in some areas, input and product markets have expanded providing a new range of livelihood options to the rural poor and thirdly, there are potentially more partnership opportunities with the emergence of more institutions in the research and development continuum (NGOs, farmers' associations, farmer help-organizations, NARS, the private sector). The extent and implications of these changes justify a reassessment of research and development priorities in agriculture.

Despite these changes, the adoption of modern varieties remains low. Low rates of adoption and stagnation in agricultural productivity in Sahelian countries are partially explained by the lack of appropriate policy and institutional support. In many Sahelian countries, government pro-urban policies of dumping cereals in the market in years following drought and selling at low prices discourage farmers from investing in yield enhancing technologies. Similarly debt forgiveness near elections discourages the private sector to supply necessary goods and services to rural communities. Import bans on some cereals such as barley, wheat, rice etc. may increase the demand for local cereals and encourage farmers to adopt modern technologies. The policy and institutional environment – input and output markets, credit and interest rates, rural infrastructure, extension services and farmer self-help organizations – remains very weak. In the absence of planned improvements in physical infrastructure, the returns to uptake of improved technologies and other interventions are likely to be limited as the policy and institutional constraints quickly become binding. Structural adjustment policies in the form of market liberalization or currency devaluation were imposed with the hope –amongst others- of boosting agricultural productivity of non-tradable goods and enhance export of tradable goods. The impact of these policies on poverty reduction are not known and deserve further investigation.

On the extension front, low uptake of modern technologies has been attributed to inappropriate institutions and institutional arrangements. Well functioning technology delivery systems convey prescriptive information to farmers and also play an educational role in improving farmer, particularly women farmer, technical skills and understanding of new innovations. On the research front, over the last 3 decades, NARS have grown in size, with a growing number of qualified scientists but without sufficient budget expansion implying declining funding per scientist. In order to enhance research sustainability, quality and impact, there is a need to design new partnership arrangements between NARS, IARCs and the private sector.

The relationship between formal and informal institutions is weak. Research on options to strengthen formal, as well as local-level, institutions governing property rights, credit and extension services are important in order to minimize the costs and risks poor smallholders face in adopting new technical innovations and to overcome market imperfections. Better policy support for well-defined and secured property rights would provide good incentive for investments and sustainable use of land. Secured property rights give greater security over future land use and allow for long-term planning. Also, innovative institutional arrangements involving community-based organizations will be needed to strengthen extension services in many Sahelian countries.

Within the context of changes as described above, ICRISAT West Africa will continue to search for options and opportunities for optimizing it's contribution to R&D and the allocation of research resources. This implies:

- Continuous monitoring of changes in the research environment at regional and national levels for implications on research strategies and priority setting,
- Carrying out ex-ante and ex-post research evaluation for accountability and allocation purposes
- Evaluating and understanding the causes of inefficiency of technology delivery services to better design and devise institutional innovations that will improve access and availability of technologies to farmers.
- Enhance capacity building in areas such as priority setting (e.g. commodities in face for market demand), impact assessment, research management and policy formulation
- Monitor and assess the impact of major domestic and regional policies on Sahelian agriculture.

There have been extensive failures of public extension systems in many developing countries. There is a need to evaluate and understand the causes of this insufficiency to better devise institutional innovations. For instance, risk-reducing technologies may provide higher incentives to adoption in dry or low potential areas. Gender-specific approaches will be appropriate depending upon technology and region. Coupled with the active research programs of the CGIAR, research will analyze the implications of a range of incentive mechanisms that can enhance international cooperation in research, natural resource management, sharing of methodologies and technologies and the generation of international public goods. This will encompass various forms of intellectual property rights—e.g., farmers and plant breeders' rights, participatory research, patents, trade secrets, and trademarks—as well as contracts, grants, prizes, tax-related instruments etc. on the generation, access, and use of agricultural technologies.

Outputs 2010:

Impact database available and maintained in West Africa

Individual case studies and Meta-analysis on impact assessment of agricultural technologies in West Africa published

Research priority setting in West Africa described and published

Seed supply systems in West Africa: lessons learned for R&D published

Capacity development associated with the four previous bullet points

Outcomes:

Partner social scientists in WCA use new knowledge available on research prioritization and impact studies to improve the efficiency of their research

Public and private sector partners in the seed supply industry use knowledge gained by ICRISAT over the last decade to ensure modern varieties are more quickly available and more widely distributed to farmers

Potential impact:

The availability of HYV varieties to a much greater proportion of farmers in WCA would have a very beneficial impact on sustained productivity

Impact pathway:

The FHA WCA partners will adopt and implement the concept of a Technology Forecasting function or "*Observatoire*" for research trend development. This will require the FHA to:

Monitor changes in the research environment at the global, regional, sub-regional and national levels for implications for strategies and priorities

Carry out ex ante and ex post research evaluation for accountability and allocation purposes

Develop and maintain appropriate agricultural science and technology databases (the intention is to access and use internationally available data sources in conjunction with CGIAR results, rather than to develop and maintain static databases)

Develop quantitative and qualitative information on changing environment and institutional change (e.g. enhancing the start made by the ASTI initiative)

Develop appropriate processes and mechanisms for allocating research resources.

Predominant capability:

ICRISAT's long expertise in VLS, social science studies and other mechanisms for research prioritization and in efficient strategies for improved seed systems is not presently duplicated in either the WCA NARS or private sector

Counterfactual:

Social science and seed system research in WCA would be severely compromised as these are currently very poorly developed in WCA at present

5A: Science and technology policies and institutions

Sound policy intervention/guidelines for sustainable resource use in desert margins formulated, adopted and implemented

A number of initiatives are planned to generate a policy and regulatory environment to encourage sustainable use of natural resources. Zimbabwe is developing policy guidelines to further facilitate community-based management of natural resources, as well as monitoring and evaluation of the natural resource base. Namibia has evaluated policy issues effecting land degradation, and plans to develop policy guidance to address the problem. Burkina Faso is finalizing its Biodiversity Strategy and Action Plan, and is developing a national eco-strategy. These efforts will be consolidated and expended under the DMP

Priority 6. Building Partner Power

The GEF will fund costs of reviewing project lessons and existing policy and regulation and their impacts, developing recommendations to support sustainable land use; conduct a national consultation process to draft/ modify regulation and policy for consideration by national legislature; and build government capacity to implement new regulations and policy. Governments will co-finance the costs of considering, adopting and administering new policy and legislation.

Outputs by 2010:

One to two policy briefs published on institutional linkages facilitating the uptake of NRM and intensification/diversification options in West and Central Africa

One to two sound policies for the conservation of biodiversity and reducing land degradation promoted

Outcomes:

Pro-agricultural development policies promulgated by governments regionally.

Desertification mitigation and biodiversity conservation strategies promoted & adopted by governments regionally.

Disaster preparedness and rehabilitation strategies promoted & adopted by governments regionally

Potential impact:

Consortia consisting of NGOs, NARES, government organizations and relief agencies put into place plans for disaster prevention, rehabilitation and a pro-agricultural development policy environment

Counterfactual:

Lack of pro-agricultural development policies impedes adoption of desertification mitigation and biodiversity conservation strategies. Farmers lack incentives to protect and conserve their productive assets (land and water resources) and a downward spiral of land degradation and biodiversity loss lead to more poverty and misery in the desert margins.

Capacity of stakeholders and target populations in the nine DMP countries for desert margins research enhanced

Two initiatives are planned to build local government natural resource management capacity, and improve extension services to farmers. (Namibia, Senegal). Zimbabwe is planning to build the capacity of pastoralists to monitor the condition of their own pastoral resources. Natural resource management initiatives are planned to help communities organize, plan and manage the use of their own natural resources, especially community lands. Activities include the formation of rural management units; building conflict resolution skills; helping pastoral communities to reduce their risk exposure to the effects of climatic variation; and to help communities manage village woodlots (Kenya, Namibia, Burkina Faso, Senegal, Niger).

The GEF will fund the full costs of ensuring full participation of stakeholder groups in project design and implementation. This will include training project staff, extension workers, and participating government agents in participatory approaches; the costs of ongoing consultations with local stakeholders during project implementation, and the costs of institutionalising the consultation process to ensure sustainability of participatory approaches beyond the life of the project. Institutionalised participatory processes set-up by the project will be fully cofinanced from sustainable sources by the second last year, to demonstrate sustainability of project impact. The GEF will also fund the costs of stakeholder participation in regional project management processes.

Outputs by 2010:

Training on biodiversity management strategies and the assessment, monitoring and prevention of land degradation provided to at least 50 NGOs and farmer's groups each in West & Central Africa and East & Southern Africa

Outcomes:

Pro-agricultural development policies promulgated by governments regionally Desertification mitigation and biodiversity conservation strategies promoted & adopted by governments regionally Disaster preparedness and rehabilitation strategies promoted & adopted by governments regionally

Potential impact:

Consortia consisting of NGOs, NARES, government organizations and relief agencies put into place plans for disaster prevention, rehabilitation and a pro-agricultural development policy environment

Counterfactual:

Weakened institutions provide inadequate support to rural communities. Disasters strike more severely due to lack of preventive measures

Participatory natural resources management methods are implemented in desert margins research
Most activities under output 2 above will be implemented through a participatory approach. Zimbabwe in particular is approaching stakeholder participation as a central strategy to foster sustainable land use.

The GEF will finance limited small-scale demonstrations in projects sites where necessary to foster adoption of new practices. As successful approaches are identified the GEF will finance the costs of developing a scaling-up strategy with participating governments, including a broad consultation process; assist in setting-up government implementation units and build the capacity of implementation units to implement a scaling up strategy; and help identify co-financing for implementation of these strategies to match government commitments. The costs of implementing these strategies will be fully co-financed and implementation will begin by the second last year of the project.

Outputs by 2009:
Three (3) best bet technologies s for conserving and restoring biodiversity and degraded lands up/out scaled to a wider geographical area touching at least 10 more rural communities
Adoption and constraints to adoption of best bet technologies for conserving and restoring biodiversity and degraded lands assessed and published

Outcomes:

Pro-agricultural development policies promulgated by governments regionally Desertification mitigation and biodiversity conservation strategies promoted & adopted by governments regionally Disaster preparedness and rehabilitation strategies promoted & adopted by governments regionally

Potential impact:

Consortia consisting of NGOs, NARES, government organizations and relief agencies put into place plans for disaster prevention, rehabilitation and a pro-agricultural development policy environment

Counterfactual:

Weakened institutions provide inadequate support to rural communities. Disasters strike more severely due to lack of preventive measures

5B. Making international and domestic markets work for the poor

Increasing productivity growth at farm-level is not enough to reduce poverty in West and Central Africa. To generate the productivity increases necessary to bring about lower food prices, while still maintaining incentives for different economic actors (farmers, traders, and processors), improvements must be made in input and output markets and market-supporting infrastructure including information systems.

Markets are characterized by the interaction of buyers and sellers of any good or service. As such, markets are fundamental to the operation of an economy. Movements in supply and demand send signals to economic actors through changes in prices, and these guide the actions of individuals. Where markets are well-organized and completely "coordinated", supply and demand interact without impediment or distortion, and prices move quickly to reflect changes in the demand or supply of any good or service. In other words, productive resources such as land, labor and capital will be allocated effectively between alternative and competing uses, specialization will occur according to the principle of comparative advantage and the benefits of growth in one area of the economy will be effectively translated to other parts. In addition, economies will generate the maximum benefit to individuals – including the poor – as markets provide the vehicle through which people can engage in a growing economy.

However, in order to function well from a pro-poor perspective, markets need not just to be "efficient", but also to work in ways that enable participation by the poor and improve their terms of access. Pro-poor markets are markets that contribute to social and economic outcomes in which the poor gain substantially and often more than proportionately. Therefore, improving the functioning of such markets contributes to reducing and ultimately eradicating poverty. The integration of domestic and international markets and trade liberalization offer countries the opportunity to participate in expanded export markets and to take advantage of the reductions in subsidies of developed countries under trade agreements. Gains, however, depend in part, on factors and actions not directly related to trade including domestic policies, institutions and input and output market functioning.

Market development, leading to reductions in transactions costs, improvements in information flows, and increase in integration, is necessary for broad-based growth, not just for the poor. The development of market institutions will increase potential growth rates through, for example, reducing the transactions costs involved in exchange, enabling more types of goods and services to be bought and sold (including through changes to property rights) and allowing

prices to reflect scarcity and information. Expanded access to markets can both empower the poor and expand their livelihood opportunities.

Therefore, measures to make markets work better for the poor need to be taken not just at national and local level, but also internationally. As at national levels, well-functioning markets internationally call for an agenda of institutional development that is both accountable and effective. Policy reforms that integrate local or national food markets into international markets will reduce vulnerability to locally generated supply or demand instability, but will increase vulnerability to exchange rate or international market fluctuations. Market development that supports more efficient ways of sharing risk is on the whole likely to be favorable to the poor.

Investments in instruments that can increase agricultural productivity will enable poor people to benefit from agricultural growth only when they are paralleled by simultaneous investments in market coordination. The extent to which farmers will invest and innovate (with the objective of increasing agricultural productivity) and the strength of the transmission mechanisms linking agricultural productivity with poverty reduction depend critically upon several factors, including the coordination of markets. Thus, a framework for determining whether markets are working well from a pro-poor perspective must consider specific areas of analysis in terms of market coordination. The main features of markets can be categorized this way: i) the enabling framework; ii) market failures; iii) power relationships and exclusion; and iv) linkages to other markets.

Given that pro-poor markets characterization is highly country, sector, and institution specific, it is more productive to focus on the ways in which such markets work. Market development research is necessary to determine how to make markets work for the poor. Such type of research can be useful in examining and testing solutions to a range of constraints, including transport, market information, transaction costs, and food quality and safety. It is based on the analysis of market systems that have the potential to benefit the poor. This focuses on the market chain actors and their linkages, the services required by those actors and the enabling environment affecting the chain. Methodologies and tools such as participatory market chain analysis and/or structure, conduct and performance (SCP) approach can be explored and lessons from the work shared with development practitioners and policy makers.

Nevertheless, market failures are potentially present in all areas, some forms may be more severe in rural than urban areas. Typically, rural markets are affected by: the lower population densities and greater incidence and depth of poverty that combine to diffuse and diminish demand; seasonal and year-to-year variability reflecting the importance of renewable-natural-resource based sectors; particular difficulty in achieving cost-effectiveness in providing infrastructure, social and economic services, and other public goods; high transactions costs; and social capital that includes stronger traditional relationships than is the norm in cities. Both the analysis of markets and the measures to strengthen their pro-poor functioning need to take into account such local realities.

Outputs 2010:

Availability of knowledge base on market structure, traders' behavior, and marketing costs for selected food and tree crops made available to policy makers, donors, NGOs, the private sectors, farmers etc.

Policy syntheses and bulletins published and distributed to partners to increase awareness amongst policy makers of the usefulness of marketing systems analysis in decision-making and of the transfer of real-time market information.

Capacity strengthening measures associated with improved partner marketing efficiency

Outcome 2015:

Options for improving access to markets by vulnerable groups in the short-run in a manner that also promotes long-run agricultural productivity and income growth in WCA will be used by partners.

Potential impact:

The long-term impact will be an efficient, fair and competitive food and tree crop marketing system based on sound and effective policies, which promote such a marketing system.

Impact Pathways:

Conducting research on the different components of the system - farmers, assemblers, brokers, retailers, transporters, warehousing, etc., in order to get a better understanding of the entire marketing system of selected commodities. Our approach will emphasize: a) the joint definition of policy issues and research problems with host country analysts and policy makers, b) the participation of local analysts in the entire research and policy analysis process thereby generating local capacity and increasing local ownership of the results, and c) timely dissemination of policy analysis and research findings through short internal policy memos for senior decision makers, research notes and policy syntheses, meetings and seminars, and in-depth research reports.

Predominant capability:

Talent in the analysis of agricultural commodities marketing systems analysis is still scarce in most WCA countries. The strengthening of food marketing systems analysis by ICRISAT should be viewed as part of efforts to strengthen the capacity of local institutions and to generate more participation. Furthermore, ICRISAT has a mandate to produce International Public Goods (IPGs), which are freely available to all users regionally.

Counterfactual:

More poorly developed markets and infrastructure, and farmers trying to produce for them will find this a more risky and economically unattractive business

5D. Improving research and development options to reduce rural poverty and vulnerability

Increasing productivity, improving food security and stimulating income-growth for the rural poor in the West and Central African Semi-Arid Tropics have been a major challenge for policy makers, development agencies and national and international research organizations. Adoption of new technologies and availability of improved market opportunities especially in less favored areas characterized by a hostile environment with high risk of drought and pest incidence, scarcity of water, land degradation and low productivity of soils have been low, and WAC SAT remains the poorest, most food-insecure and vulnerable region in the world.

Opportunities for agricultural technology development and adaptation in the SAT have changed substantially in recent years in response to liberalization of markets and trade policies and the increasing importance of high-value and marketable products in the commodity mix and production portfolio of the smallholders. Removal of market impediments and input subsidies has changed the relative competitiveness of the different enterprises and created new opportunities to diversify livelihoods within and outside agriculture. Diversification of income sources is a vital response to harness the diversity in biophysical conditions as well as cushion the households against pervasive risk in the WCA SAT. Hence, almost all rural households seek to diversify their livelihoods to reduce risk and to respond to changing market conditions. The ability to seize existing opportunities varies according to household, socioeconomic and geographical fixed factors indicating that different households adopt different livelihood strategies and development pathways out of poverty. This calls for region-specific research strategies and careful alignment of research and development interventions to address priorities and constraints identified in WCA SAT. This will contribute to better target interventions to specific recommendation domains. In addition, given the complexity of issues involved, there has been an increasing realization that research must shift from a narrow agricultural perspective or focus on few commodities to a broader perspective that encompasses the rural economy, including the non-farm sector. This calls for a revisit of research priorities.

Furthermore, over the last few decades agricultural research institutions and systems, both national and international, have been under significant pressure to adapt their research to be more relevant for development. Although progress has been made and acceptance of the need for integrative research is recognized, there are still large efforts to be made and mechanism to be found to effectively implement research strategies that are holistic, integrative and truly participative. For integrative research to have global impact, mechanisms to communicate knowledge to policy/decision makers and donors must also be designed and put into place.

West and Central Africa is a very vast region with a broad palette of agro-ecosystems and a multitude of biophysical and socio-economic environments usually requiring tailored solutions to improve the livelihoods of populations according to the specific constraints and opportunities of those environments. In addition to the spatial heterogeneity, very rapid changes occur today in those systems due to the high population growth rate, inter-annual rainfall variability and droughts which require to research solutions for future problems that may be very different from today's. At a finer scale, heterogeneity between households and farms demands specific solutions, which take into account the specific endowment, vulnerability and knowledge of each without exposing farmers to unbearable risks. Under those conditions, the use and integration of models at various scales is a must.

Outputs 2010:

Ten benchmark sites representing the palette of production systems in term of market access, population density and land use pressure, climatic risks (collaboration with FARA SSACP) characterized, instrumented and regularly monitored for changes and response to crises and knowledge made available to partners.

Role of information on decision making assessed and information needs for different stakeholders identified and made available to partners

Major typologies of households obtained for all production systems, specific development pathways identified and regional development pathway map produced and made available to partners

First version of Sahelian household model released to partners

Capacity building measures associated with households and household modeling undertaken with, and at the request of, partners

Outputs 2015:

Integrative and multi-scale approaches on carefully selected representative benchmark sites of the WCASAT region will be used by partners to greatly improve their understanding of the complex mechanisms and dynamics of production systems and permit identification of pathways out of poverty.

Potential impact:

Framework that increases dialogue and information exchange between research, development, rural communities and policy makers is established

Site/household specific development options increase positive impact of technologies

Research partners are strengthened in multi-disciplinary multi-scale approaches

Impact pathway:

Improve characterization of the rural poor (assets, context, depth and duration of poverty, vulnerability, basic needs, and choice of livelihood strategies) in relation to agriculture, forestry and fisheries production systems and their environment, including patterns of adoption of improved technologies and natural resources management practices and participation in higher-value product markets.

Identify options for the rural poor to access, acquire, protect (in the case of shocks) and use assets to improve their livelihoods and move out of chronic rural poverty.

Improve the quality of the context (markets, institutions, public goods, policies and governance) where the poor use their assets and reduce the risks affecting livelihoods of smallholders and the rural poor.

Identify and evaluate means to improve *ex ante* risk management through livelihood diversification, formal and informal insurance mechanisms, financial and in-kind savings, futures and forward markets and improved information systems.

Identity and evaluate means to improve the availability and effectiveness of *ex post* risk coping mechanisms through credit, safety nets (not just food-based, but also inputs distribution, asset restocking, etc.) and more efficient, accessible and stable asset and labor markets.

Analyze the effectiveness of rural development strategies and programs to reduce rural poverty and vulnerability; and design new strategies to achieve those goals combining agricultural and non-agricultural sources of employment and income.

Predominant capability:

ICRISAT's long standing active benchmark sites in the region

Already good connection/on going work with other CGIAR centers such as ILRI and IPGRI and ARIs

Good interaction with development partners in WCA

Counterfactual:

Lack of adoption and difficulties to obtain significant impact from existing technologies

Difficulties experienced in recommending sound development options

Thematic research not well guided by priorities and clear research gaps evident

Lost opportunities to develop a framework that enhances interaction between stakeholders

System priority 1. Sustaining biodiversity for current and future generations

1A. Conservation and characterization of staple crops

The gene bank of ICRISAT-Niamey has as major objective to assemble and conserve phytogenetic material developed from research or obtained from collections of phytogenetic material particularly from West and Central Africa. In May 2005, the gene bank had stored 17,683 accessions from base collections. In order to safeguard the West and Central African germplasm stored at ICRISAT-Patancheru gene bank, activities are underway to duplicate this germplasm at ICRISAT - Niamey gene bank. This safety duplication program includes 15,000 accessions of groundnut *(Arachis hypogaea*) and 6,000 accessions of pearl millet *(Pennisetum glaucum).* Efforts are underway to increase the characterization and use of these locally adapted genetic resources in crop improvement. Breeding programs need to screen the genetic resources to detect sources of specific adaptation to the regional environments.

On sorghum, targeted samples from the general collection, known for their local ability, have been used to characterize resistance or tolerance to *Striga*, head bugs and storage insects, downy mildew and anthracnose. Core-collections have been extracted from the general collection 10 years ago and are now currently utilized for this purpose. One, managed by ICRISAT, contains 293 guinea-race accessions while another, managed by CIRAD, contains 214 representing the world diversity. They have been evaluated for their photoperiod-sensitivity and fodder-quality. The CIRAD collection is under characterization for rate of development during the vegetative phase. The rate of panicle development in relation to photoperiod-sensitivity will be the next character to be evaluated, in order to find photoperiod-sensitive sources able to grow large panicles. Collections done in Mali, Niger and Burkina-Faso in the seventies have also been evaluated and are currently compared with recent collections to estimate regional genetic changes within the last 25 years.

For pearl millet a West African collection of 450 accessions, done by IRD and ICRISAT, is currently under characterization and will be structured in genetically diverse heterotic groups within the next years. Results will be used to coordinate the regional breeding program and to assist population and hybrid cultivar creation. The diversity existing in the collections done in 1975 and 2003 in Niger and Mali are currently compared to study the genetic changes occurred during this lap of 28 years.

On groundnut, a groundnut-working collection of 7000 accessions has been assembled and fully characterized. Activities are underway for safety duplication of the entire global groundnut germplasm of 15,000 accessions. The regional working collections provide ready access to a greater range of diversity for crop improvement scientists. Besides they will provide opportunities to conduct in-country, regional multi-location evaluations to identify elite germplasm for direct release or conduct further improvement to remove constraints and sustain productivity. Focus will be on 1) monitoring of germination and regeneration of those with low seed quantities; 2) distribution to bona fide users for utilization, update in documentation; 3) assure risk free export and import of germplasm and breeding material

Sorghum, Pearl Millet and Groundnut

Output:

The state and dynamics of diversity of germplasm at local and regional levels for sorghum pearl millet and groundnut described with associated NARS capacity building measures.

Outcome:

A representative range of germplasm of the three crops preserved ex-situ, in working collections, and in-situ conservation efforts is used by a strengthened breeding community to counter key threats to diversity.

Potential impact:

Characterized germplasm is used more widely by breeders, and farmer associations which will contribute to improved food security and stability of production. Threatened germplasm will be conserved in-situ in the regional genebank. Tools for in-situ conservation will be applied by a range of different actors increasing awareness and capacity for managing diversity. Biosafety protocols for sorghum and groundnut will be developed based on sound understanding of ecosystem, seed management and geneflow dynamics.

Impact pathways:

Collaborative research on germplasm evaluation, and diversity dynamics at different levels of analysis and integration, joint presentations at appropriate fora workshops, conferences and meetings; publication of results in ways that scientists and development actors in WCA can readily access and use; timely distribution of seed

to those requesting it; joint monitoring of participatory germplasm utilization and in situ conservation activities and the publication of those results; changes in national conservation and germplasm use strategies.

Predominant capability:

ICRISAT's unique combination of a well-integrated, multidisciplinary research team, mandated to maintain germplasm collections of mandate crops, strong linkages to national programs, regional networks and farmer organizations and NGO's interested in germplasm conservation issues

Counterfactual:

Progress of breeding programs slowed down with effects on farmers' capacity to address changes in climate, market environment and cropping system. Genetic erosion may continue, and strategies to understand and address such threats will not be developed.

Groundnut

A. Conservation and safety duplication

Present status: a) 7000 working accessions conserved in medium term storage
b) 2500 accessions as safety duplication

Output 2010:

Global Groundnut germplasm safely duplicated in deep freezers

Outcome:

100% germplasm preserved in perpetuity and available as a back up collection.

Potential impacts:

Germplasm conserved safely and available for repatriation and supply to R&D partners

Impact pathways:

Germplasm regenerated, tested for seed health, and conserved in medium term storage and safely duplicated

Germplasm supplied for repatriation and for R&D by partners

B. Characterization and evaluation

Present status: a) Newly acquired germplasm from Chad and Mali not characterized, and there are gaps in the available characterization data

Output :

Morpho-agronomic characterization of newly acquired germplasm completed and gaps in data for existing germplasm filled and made available to partners on the database with associated capacity building measures

Outcome:

Partners have access to better characterized regional collections for use in breeding programs

Potential impacts:

Data more complete and freely available leading to increased interest in using germplasm

Impact pathways :

Newly acquired germplasm and germplasm with incomplete data grown and data recorded on morpho-agronomic characters. Database upgraded.

C. Utilization

Output:

A set of trait specific germplasm as requested by breeder partners with associated capacity building is made available

Outcome:

Germplasm sources for important traits (resistance to foliar diseases, rosette, aflatoxin contamination, oil content and edible groundnut) are used by strengthened partner breeders

Potential impacts:

Greater use of trait-specific germplasm by breeders ensures development of genetically enhanced broad-based cultivars and more efficient breeding programs

Impact pathway:

Germplasm supplied for repatriation and used for R&D by partners

1B. Promoting conservation and characterization of under-utilized plant genetic resources to increase poor incomes

Interest in underutilized species stems from a variety of factors, including their contribution to: i) agricultural diversification and better use of marginal land; ii) food security and a more balanced diet; iii) better safeguarding of agrobiodiversity and associated cultural heritage; iv) better self reliance of agricultural systems; v) additional source of income to farmers; and vi) employment opportunities. ICRISAT is currently executing a number of crop diversification programs in the Sahel (e.g. Africa Market Gardens and Sahelian Eco-farm) involving new crops, fruit trees and vegetables. The presence of only a limited amount of germplasm of underutilized species in gene banks and its poor representation in terms of genetic diversity present a great challenge for the successful improvement and promotion of this group of species. The lack of research on genetic diversity assessment and use of many useful underutilized species justifies the need to characterize, evaluate and develop descriptor lists. The International Plant Genetic Resources Institute (IPGRI) has spearheaded over the last few years, specific activities at national and international level for a better conservation and use of underutilized species. Thus, collaboration with IPGRI will focus on the following: 1) Enhancing conservation through the use of plant genetic resources of a wider range of useful species, 2) Strengthening the work of other actors dealing with the documentation, evaluation, and domestication of underutilized species, 3) Strengthening research on the choice of species based on strategic factors for conservation, development, and food security, 4) Identifying criteria for research, development, and conservation actions on underutilized species that place the conservation and use of these genetic resources in the context of national and global strategies for sustainable agriculture, to improve poor rural livelihoods, and to broaden the basis of food security.

Under-utilized crops (Sesame, fonio digitaria, bambara groundnut) (IITA has the global collection)

A. Characterization and evaluation

Present status: Newly acquired germplasm not characterized

Output 2010:

Morpho-agronomic characterization of newly acquired germplasm with associated capacity building measures completed and made available to partners

Outcome:

Characterization data on germplasm documented and used by partner breeders to potentially diversify agricultural systems

Potential Impact:

Data available and increased interest in use of under-utilized crops enhances system resilience

Genetically diverse germplasm are used as parents by breeders

Impact pathways:

Newly acquired germplasm and germplasm with incomplete data grown and data recorded on morpho-agronomic characters and made available to partners

B. Utilization

Output:

Working collection of sesame, fonio and Bambara groundnut established with associated capacity building and made available to partners

Outcome:

NARS breeders use new germplasm of unutilised species and these are made available in core collections

Potential Impacts:

Enhanced use of trait-specific germplasm by breeders to develop genetically enhanced broad-based cultivars which can improve system resilience and marketing opportunities

Impact pathways:

Selected germplasm of sesame, fonio and bambara evaluated for specific traits and agronomically superior germplasm identified, regenerated and conserved and made available to partners

Promoting conservation and characterization of under-utilized plant genetic resources to increase the income of the poor under the desert margins

Improved understanding of ecosystem and dynamics with regard to loss of biodiversity in the desert margins of SSA

Soil and vegetation inventories, including biodiversity are fairly widespread across the project sites (Kenya, Zimbabwe, Burkina Faso, Mali, Niger). Levels of details, coverage and the age of data vary across countries. Supplementary work by the DMP project will be necessary to generate consistent baseline data. Some countries, and project sites have begun modeling climate change, hydrological cycles (Kenya, Zimbabwe, Burkina Faso, Senegal, Mali, Niger) and are studying the impact of land use on the resource base, including levels of degradation, soil fertility, and changes in biodiversity and cover. These programmes will be strengthened by the DMP, and harmonized to generate regional sub-Sahelian perspective on the impacts of land use and climate change on the resource base. Finally some countries are looking into socio-economic change in the project sites and potential measures for adapting to climate change, including deriving lessons learned from indigenous and project practices in agriculture, pastoralism and agro-forestry (Kenya, Burkina Faso). The project will link together all project sites for information sharing to derive best practices across the eco-region.

The GEF will fund all activities to complete inventories of biodiversity and ecosystem functions in each of the project sites; identify temporal and spatial changes and trends in baseline data and their causes, including the development and application of indicators; and regional synthesis and interpretation of data sets; and provide necessary data for an adaptive management approach to project implementation. All additional data collection beyond that required for adaptive management will be co-financed. To show sustainability of M&E beyond the life of the project, all M&E activities should be funded from independent sustainable financial backers by the beginning of the second last year of the project.

Outputs by 2010:

Nine benchmark sites characterization on the improved understanding of ecosystem status and dynamics with regard to loss of biodiversity completed and a synthesis book prepared and published.

Outcomes:

Status of biodiversity, causes, dynamics and indicators of land degradation are established and used in research and development activities by Research institutes, NGOs, extension units, development agencies throughout the desert margins of the semi-arid regions.

Potential impact:

R&D partners adopt and implement innovative IGNRM Strategies with strong emphasis on improving water and nutrient use efficiency, combating desertification and conserving biodiversity

Counterfactual:

Due to a lack of proper understanding of ecosystem and dynamics, rural communities and development projects will continue promoting unsustainable land use practices adding more pressure on biodiversity.

System Priority 2. Producing more and better food at lower cost through genetic improvements

In West and Central Africa maintaining and enhancing yield of staples and other major food crops need to be targeted in the broader context of improved food security and health as well as increased income generation for farmers. As several analyses of national cereal production figures have shown, farmers do not necessarily target yield increases as a means to increase cereal production on their farms. As population densities in most of West-Africa remain low, in many systems the key limiting factor remains labor availability, rather than access to land, as in Asia. Thus, research and technology development have to take into consideration labor constraints, as well as other socio-economic constraints, when developing strategies for yield enhancement.

ICRISAT has over the past 5 years examined and revised its research priorities for crop improvement in WCA in several different ways:

1. SAT-futures analysis in 2001
2. Pearl Millet Research Planning Workshop for WCA in 2002
3. Farmer participatory analysis for priority setting in ICRISAT Sorghum and Pearl millet breeding programs, 1998-2003
4. Expert meeting on Pearl millet and Sorghum in 2002, funded by CFC
5. SEPP CCER in 2001
6. 2003 EPR

These reviews have used different entry points for the analyses of key constraints and opportunities for crop improvement in WCA. All of these reviews have very clearly indicated that the three "pillars" of any agricultural production system, soils, markets, and crops, need to be addressed jointly to achieve real and lasting impact. Therefore all of these domains need to be addressed in a complementary fashion in order to achieve sustainable yield improvements at farm level. To remain focused, we have chosen two main entry points: the agro-ecological focus and the sector approach.

1. The agro-ecological focus: The narrow East-West rainfall isohyetal zones in west Africa are a major environmental determinant of natural resource availability. The similarity of environmental constraints and opportunities within each agro-ecological zone results in the need for cooperation within each zone that reaches across national boundaries. Thus, we are fostering regional collaboration between NARS for strategic research and technology development to resolve key constraints for specific zones.

2. The sector approach: Through strategic partnerships, we propose to integrate a wide range of research and development activities across the commodity chain. This will involve integration of technology development, dissemination and, wherever possible, commercialization of this technology, and support of post-harvest marketing and value-assurance/value-added activities to maximize benefits. This approach will assure each specific intervention has a synergistic effect, by stimulating demand for, and benefit from interventions in the other parts of the sector. While implementing this approach, we focus on the development of models and methodologies for specific technology creation, so that the approach can be replicated in similar circumstances.

Some national foci remain important. Each country differs in its policy environment and institutional context (e.g. level of organization and importance of farmers' organizations, market sector integration, infrastructure, government and non-governmental development actors). As these factors are important determinants of what impacts can be achieved, they require documentation and analysis.

Genetic improvement of yield of West-African cereals is thus highly dependent on the specific context.

2A. Maintaining and enhancing yields and yield potential of food staples

Sorghum and Pearl Millet

West and Central Africa is the center of diversity and possibly the origin of cultivated pearl millet and sorghum. Local diversity of these crops is thus high, and farmers' knowledge and culture associated with these crops play an important role in local crop and seed management systems.

Genetic base for yield improvements

The genetic base of sorghum and pearl millet for ICRISAT's breeding activities is primarily the locally adapted, preferred landrace germplasm from the entire West-African region. For sorghum this implies that the focus of the breeding activities is on the Guinea race. To effectively use this enormous range of diversity, we have been using the core collection approach for sampling the existing germplasm collections, including guinea race accessions from southern and eastern Africa, as well as from Asia. Initial germplasm evaluations focus on adaptation to specific target zones, and diversity in yield components. Molecular level diversity assessments are being used, wherever possible. The identification and evaluation of heterotic patterns among different groups of pearl millet and sorghum germplasm and the establishment of a few major heterotic groups for each crop, shall guide the process of germplasm enhancement for more effective variety development.

The broadening of the germplasm base of pearl millet and sorghum for genetic improvements of yield and other factors is mainly being achieved through the establishment and recurrent improvement of broad based populations. The establishment and diversification of new populations is guided by the need for adaptation to the major agro-ecological zones in West- and Central Africa, as well by specific opportunities envisaged for specific new traits, e.g. improved stover quality.

Regionally adapted varieties and hybrids

For sorghum, the program is targeting primarily the material adapted to the Sudanian eco-zones, where sorghum is the main cereal. For pearl millet, the Sahelian zone remains the focus. Minor efforts on sorghum for the northern guinea zone, as well as pearl millet for the higher rainfall areas are being pursued. Existing sorghum varieties from previous research efforts, and from introductions with adaptation to the Sahelian zone will be maintained.

While developing and adapting recurrent selection methodologies to the needs and opportunities of the region, open-pollinated varieties remain a key output from the pearl millet and sorghum improvement programs. However the development of hybrids, hybrid parents, and corresponding seed production technologies are receiving priority attention for sorghum improvement, based on the high levels of heterosis found within the guinea race. For pearl millet the potential for hybrid development will continue to be explored.

While maintaining a focus on improving grain yield, other traits of economic importance are also being explored. For sorghum, this is primarily the quality of stover as animal feed.

Methodologies of genetic enhancement for grain productivity

Research for the development of breeding methodology is focusing on the issues related to combining good adaptation to the predominant patterns of water availability with higher grain yield, and yield potential. As both local cereals, pearl millet and sorghum, require strong photoperiod sensitivity for yield stability and consistent grain quality, methodology research focuses on tools, selection criteria, and protocols for combining the evaluation of the photoperiod response and the yield related traits during the early stages of selection.

Similarly, we are developing tools and methodologies for the effective testing of new experimental varieties within specific zones of adaptation and the necessary range of stakeholders. The specific problem encountered in West-Africa is that every country and thus every national research program has to address the needs of a multitude of agro-ecological zones. Thus, within any country, resources for multi-location yield-testing within any one zone of adaptation are very limited. Hence, regional collaboration is being pursued as a key resource.

Similarly, farmer participatory methods for variety evaluation, starting with the earliest stages of yield evaluations are being developed, as a tool to achieve multilocation yield testing, as well as to obtain farmer and other users' feedback during the early technology testing stage.

While grain yield improvements are a major focus of the crop breeding efforts, they are focused on materials which have the necessary traits for adaptation as well as farmer and consumer acceptance. Yield evaluations are conducted within the appropriate zones, but across a wide range of management and growing conditions, to enssure that new varieties do not increase farmers' risks of crop failures, while increasing the chances to obtain higher yield levels under the predominant crop management options in a zone.

1. Finished products: hybrid parental lines and hybrids

Output:

Seed parents with stable sterility maintenance (10-15 total for both crops) and pollinators with stable restoration capacity (20-30 for both crops), combining appropriate photoperiod sensitivity, acceptable grain quality with combining ability for grain yield and other `pro-poor traits (particularly resistance/tolerance to major biotic stresses), and their hybrids accompanied by the technology produce hybrid seed with good quality at reasonable costs made available to partner breeder networks. Associated capacity building measures will also have been fulfilled.

Outcome:

Hybrid seeds of a range of new hybrids based on ICRISAT and -derived hybrid parents used by local partners and made available to farmers in the Sudanian zone of West-Africa (sorghum) and in the Sahelian zone of West-Africa (pearl millet) by 2015

Potential impact:

Local breeding programs will have been strengthened and the productivity of sorghum and pearl millet will rise, improving food security of farming households, and increasing their options for marketing cereal grain. Consumers may benefit from more stable prices, and the more consistent availability of the two locally preferred grains. Thus food and feed producers will have more options for the cereal components. Seed companies will initiate activities in WCA. The improved quality of the stover will also contribute to the better health of draft animals after the dry season, and this contribute to their better capacity to work, and thus improve the chances of producing higher yields still.

Impact pathways:

Developing and testing of new hybrids with national program and other partner scientists and farmers in the target zones. Joint evaluations during cooperative trials, and for post-harvest qualities. Development of seed production methodology for photoperiod sensitive Guinea race hybrids of sorghum, and pearl millet hybrids. Training seed producers in hybrid seed production methods and tools for marketing hybrid seed. Widespread farmer managed testing of hybrids in the target zones. Field days and consultation meetings to provide information on new materials available, documentation of seed supplied to partners, registration of preferred genetic material.

Predominant capability:

ICRISAT's unique combination of a well-integrated, multidisciplinary research team, informed access to crop genetic resources, strong linkages to national program networks and its mandate to produce and share IPGs requires its involvement in this research field.

Counterfactual:

National programs will become solely responsible for hybrid parent development. This will most likely delay the availability of hybrids to farmers, and will limit it initially to the countries which presently have breeding programs with the capacity to manage hybrid breeding programs.

2. Breeding materials and open-pollinated varieties with special traits

Output:

Trait and adaptation specific populations, for specific demand-driven target markets, production environments and with specific nutritional advantages (50-100 for all three crops by 2015 (e.g., dwarf guinea-race sorghums for the higher input systems in the Sudan Savannah of WCA, sorghum with high available iron content in decorticated grains for cultivation in association with groundnuts in the Sudan Savannah, headminer and downy mildew resistant pearl millet populations with good yield in the southern Sahel Savannah, early maturing, *Aspergillus flavus* resistant groundnut with high oil content). Associated capacity development activities completed. Seed producers organized, and producing seed of preferred materials for different production zones across West-Africa.

Outcome:

Stronger public and private sector, including farmer cooperative crop improvement programs use a more diversified genetic base including open-pollinated varieties of pearl millet, groundnut and sorghum adapted to a range of different target production systems which are available to seed producers and farmers.

Potential impact:

Higher-yielding and more genetically diverse varieties bred and released by national programs and emerging private partners, such as farmer cooperatives, for specific target markets and production environments. Farmers

will achieve higher and more stable yields, will have improved food and nutrition security, and will be able to market more often a substantial part of their cereal production.

Impact pathways:

Scientists' field days and consultation meetings, supply of seed of trait-specific nurseriesand of individual lines as requested, commercial supply of foundation seed , registration of improved genetic material, publication of research results in peer-reviewed journals, presentation of paper/posters in conferences, symposia and workshops, articles in ICRISAT/global theme annual reports.

Predominant capability:

ICRISAT's unique combination of a well-integrated, multidisciplinary research team, informed access to crop genetic resources, good scientific facilities, strong linkages to both public sector breeding programs and with farmer organizations, and focus on IPGs for regional distribution is a major, evident advantage in this research field.

Counterfactual:

The genetic base of national breeding programs for sorghum , pearl millet, and groundnut will be broadened more slowly, and the ability to target special niche opportunities with these crops will be reduced, without access to new ICRISAT breeding lines. This will result in missed opportunities for farmers growing these crops, slowing of the progress in developing host plant resistance (HPR) for various disease and pest problems, and thus there will be an increased risk of disease and pest epidemics, and increased vulnerability from climatic variation.

3. Knowledge from strategic research

Output:

Strategic upstream information available to partners in areas with significant potential to enhance breeding efficiency (heterotic patterns for pearl millet and for guinea race sorghum identified, selection methodology to combine photoperiod sensitivity with increased yielding ability, farmer participatory selection and variety testing methodologies, alternative CMS system in pearl millet evaluated, molecular marker assisted transfer of desired QTL's for Striga tolerance and resistance in sorghum evaluated, molecular diversity assessments, mapping populations and QTLs for stover quality, and specific photoperiod sensitivities, screening/ selection systems for phosphorus acquisition ability and for increased iron content in decorticated sorghum and pearl millet grain, farmers' knowledge and skills in seed management related to patterns of diversity, options for integrating farmers' knowledge and skills in seed management with zone specific breeding programs)

Outcome:

Partner breeding programs demonstrate enhanced efficiency of sorghum groundnut and pearl millet breeding programs in West Africa through the increased use of new breeding methodologies

Potential impact:

Improved varieties, hybrids and breeding materials will be more available to farmers, which combine significantly improved yielding ability with specific qualities, and adaptations. Research programs in West and Central Africa will have the capacity to apply and select appropriately from a range of new breeding methodologies.

Impact pathways:

Publication of results in peer-reviewed journals, and theses, advanced degree and visiting scientist training programs, presentation of papers and posters in conferences, symposia and workshops, articles in ICRISAT reports. Collaborative projects with partners across the research development continuum, and across the commodity chain. Strengthening information exchange among researchers in the region through support to regional research networks, capacity building for rural radio programs, and application of new tools for participatory learning and action.

Predominant capability:

ICRISAT's experienced multidisciplinary research team linked to the extensive breeding resources of the Future harvest Alliance, linkages also to the global research community, linkages to farmer organizations and NGO's, high quality research facilities combine to provide evident capability in this area.

Counterfactual:

Slow growth of the knowledge base of these crops, fewer opportunities to improve grain yield potential combined with specific adaptations and qualities.

Groundnut

Groundnut (*Arachis hypogeae* L.) is an important crop for resource-poor farmers in West and Central Africa (WCA), who rely on it for their economic prosperity and nutritional welfare. Groundnuts are an excellent source of dietary protein (24-35 %), oil/fat (44-56 %), and vitamins such as thiamine, riboflavin and niacin. Groundnut cake after extraction of oil and haulms are used as livestock feed, helping to maintain livestock productivity. At the micro level groundnut contributes significantly to household food security and cash income through the sale of groundnut products. Alongside industrial production of groundnut oil, household extraction remains an important economic activity, particularly for rural women. Groundnut also helps improve soil fertility through biological nitrogen fixation, and can thus improve the sustainability of production systems.
Groundnut is grown in a range of farming situations, from subsistence to high-input farming. In all farming situations, the gap between potential yield and the realized yield remains high due to many biotic and abiotic constraints that limit productivity.

The most important biotic constraints in WCA are the foliar diseases (rust and late leaf spot); virus diseases (peanut clump, and groundnut rosette); soil pests (termites) and aflatoxin contamination. The abiotic constraints are drought and low soil fertility.

The three foliar diseases combined cause yield losses between 10 and 70% depending on the weather conditions and location. They also reduce fodder quality. Groundnut rosette disease (GRD) is the most destructive disease. Yield losses due to GRD can be 100% whenever disease epidemics occur. For example, the disease wiped out nearly a million hectares in 1975 in Nigeria. This resulted in a loss of regional trade estimated at USD 250 million. Subsequent epidemics of 1983 and 1987 discouraged many farmers from growing groundnuts. Aflatoxin contamination of groundnut (due to infection by *Aspergillus flavus*) is also a major hazard to human and animal health and is one of the major constraints to groundnut trade. Drought is the main abiotic constraint responsible for low and unstable yields in the region. Drought also increases the probability of aflatoxin contamination. Soils in WCA are inherently low in phosphorus and other essential elements and farmers rarely use chemical fertilizers.

Genetic enhancement activities are thus geared toward overcoming these constraints. Enhancing groundnut yield and its stability is vital to increase production and make groundnut and its products more competitive. This can be achieved through integrated genetic and natural resources management practices that will involve high-yielding varieties with stable resistance and appropriate agronomic and crop production practices.

Resistant cultivars provide the most appropriate means to control diseases especially for smallholder farmers. Therefore development of rosette and/or early and late leaf spots resistant, high-yielding groundnut varieties with appropriate duration (mostly short duration, but medium and long for target niches) is important to enhance and stabilize productivity in the region. Incorporating resistance to rosette is mandatory in both short and medium duration material, because of the destructive and endemic nature of the disease in West Africa. Developing high quality groundnut (including confectionary), meeting the grades and standards for export will be very useful. Aflatoxin reducing technologies- resistant varieties and appropriate management practices will contribute to boost groundnut export from the region, besides reducing adverse effects (on humans and livestock) of consuming contaminated nuts locally.

Output 2010:

Short- and medium-duration, foliar disease and aflatoxin resistant advanced/elite breeding lines for oil and food use developed in partnership with NARS and available to partners

Promising transgenics at NARS request with proven resistance to groundnut rosette and peanut clump viruses are available for initial local testing in WCA subject to the presence and adherence to local biosafety regulations

Outcome 2015:

Trait and end-use specific and diversified multiple resistant breeding lines received from ICRISAT are used by NARS to enhance the effectiveness of their groundnut breeding programs.

Improved groundnut varieties released by NARS.

Potential Impact:

Productivity and quality of groundnut produce (pod and haulm) improved leading to increased production of the crop in rainfed areas

The enhanced levels of resistance to *rosette and* peanut clump provided by transgenic developed with ICRISAT greatly improve the efficiency of groundnut resistance breeding programs of NARS.

New sources of resistance to groundnut rosette and peanut clump available for deployment and enhancing productivity of groundnut against other constraints.

NARS capacity to mitigate crop losses enhanced

Impact pathways:

Publication of results in peer-reviewed journals, and theses, advanced degree and visiting scientist training programs, presentation of papers and posters in conferences, symposia and workshops, articles in ICRISAT reports. Collaborative projects with partners across the research development continuum, and across the commodity chain. Strengthening information exchange among researchers in the region through support to regional research networks, capacity building for rural radio programs, and application of new tools for participatory learning and action.

Predominant capability:

ICRISAT's experienced multidisciplinary research team linked to the extensive breeding resources of the Future harvest Alliance, linkages also to the global research community, linkages to farmer organizations and NGO's, high quality research facilities combine to provide evident capability in this area.

Counterfactual:

Groundnut improvement and development in WCA continues to depend heavily on ICRISAT. With IPR regimes coming into force, the exchange of germplasm and breeding materials amongst NARS has almost ceased. ICRISAT remains the only source for NARS for obtaining improved germplasm and breeding populations and products of biotechnology for use in breeding programs. If the groundnut research and development at ICRISAT is discontinued, the NARS and ultimately the poor farmers of the rainfed WCA would be the biggest losers as they would be denied annual gains in productivity and access to new technologies and germplasm.

2B. Tolerance to selected abiotic stresses

Climatic variability, drought at any time during the cropping season, and overall low soil fertility are the major abiotic stresses limiting agricultural production in West Africa. The high soil micro-variability in individual fields poses a challenge, especially for tolerance screening under field conditions. A particular feature in WCA is the highly variable beginning of the rainy season (between May and July at any one site), while the end of rains is generally much more predictable.

Maintaining the photoperiodic sensitivity of local germplasm is most important because this specific adaptation trait assures flowering at the end of rains, independent of the (highly variable) date of planting. Classical approaches currently employed to improve abiotic stress tolerance comprise: use of locally adapted germplasm, selection methods that include progeny tests, optimal allocation of resources to locations, replications and years, selection in the target environment, adequate experimental design, and regional cooperation in the evaluation of promising materials. Major research advances by ICRISAT/CIRAD have largely improved the understanding of the crop physiology involved in photoperiodic response. It was shown that the trait does not only assure proper timing of flowering and maturity, but also optimizes shoot/root growth rates so as to maximize the ultimate exploitation of water and nutrients in each year.

A better understanding and geographical mapping of abiotic stresses in WCA would be an important step to increase the efficiency of genetic improvement for stress tolerance. Combined with analyses of genotype x environment interactions (GxE) and GIS-interfaced modeling of GxE patterns, it would allow (i) the identification and focus on adaptation zones which bear similar stresses (qualitatively and quantitatively); (ii) an optimal choice of selection sites; and (iii) an exploitation of specific adaptation in a regionally coordinated manner. Spill-over effects of selection progress made at one selection site to other sites in the region that show a similar stress pattern would be largely facilitated. Regionally coordinated efforts will therefore be a key to advance the genetic improvement for abiotic stress tolerance.

While grain yield performance under field conditions is currently the main (direct) measurement of abiotic stress tolerance, a better understanding of stress physiology and identification of morphological or physiological traits (or trait combinations) linked to stress tolerance could lead to the development of alternative, more efficient indirect selection methods. Efforts are underway to learn from Brazilian colleagues about *in vitro* screening techniques for phosphorus efficiency and adaptation to acid soils. Tillering capacity, cuticle thickness and early root growth parameters are potential selection traits to improve drought tolerance in sorghum and pearl millet.

More investment is required to help enhance abiotic stress tolerance in West African staple crops using biotechnological tools. Mapping of quantitative trait loci (QTL) determining resistance to abiotic stresses and subsequent QTL transfer into actual breeding materials or popular landraces via marker-assisted selection (MAS) seems promising. Once

progress has been made in other crop species like maize or rice, synteny relations could be exploited to identify adaptation genes in the West African cereals.

Last but not least, it is important to realize that genetic improvement alone cannot result in miracles of production increase. Only interdisciplinary approaches that encourage and facilitate integrated genetic and natural resource management will finally result in a more sustainable production increase and risk reduction! It is important to combine best-adapted cultivars with appropriate techniques of water conservation and sustainable soil fertility management to achieve long-term impact.

Outputs 2015:

Sorghum and pearl millet cultivars and hybrids with specific adaptation to defined stress environments in specific ecological zones available to partner breeders and seed producers

Regionally coordinated, agro-ecological zone-specific strategies for improving abiotic stress tolerance made available to partners and private sector organizations

Tools for marker-assisted breeding for components of abiotic stress tolerance available, and used in ICRISAT and partner breeding programs

Physiological mechanisms of adaptation understood and published.

Utility of indirect selection measures for abiotic stress resistance assessed and published

Farmer-friendly IGNRM packages available which can exploit positive genotype x management interactions available to partners and extension agencies

Associated capacity building related to all bullet points in this section

Outcomes:

Strengthened R & D allows significant yield increases from marginal environments through cultivation of improved cultivars and appropriate natural resource management (IGNRM) practices in WCA

Potential impact:

Not definable at present

Impact pathway:

Not definable at present

Predominant capability

Highly trained interdisciplinary research teams at ICRISAT Bamako and Niamey are in position to implement a regionally coordinated, politically neutral strategy in partnership with NARS and the private sector.

High-throughput molecular research facilities at ICRISAT Patancheru and CIRAD Montpellier can be producing IPGs combined in support of phenotyping activities in WCA.

Counterfactual:

Only marginal yield increases or even yield declines in stress environments due to enhanced environmental degradation and lack of sustainable NRM options.

2C. Enhancing nutritional quality and safety

A dietary challenge of growing concern is the presence of mycotoxins in a wide variety of foods. *Aspergillus flavus* that produces aflatoxin in groundnut is widely distributed in nature. Climatic factors, crop management and the genetic vulnerability of the plant all play a role in the susceptibility of crops to *Aspergillus.* Solutions to Aflatoxin contamination are best provided through an integrated approach using aflatoxin tolerant cultivars, and implementing appropriate pre and post-harvest technologies that reduce the risk of aflatoxin contamination in food/feed. In spite of these efforts, aflatoxin contamination remains a problem in West Africa where a holistic approach is needed to translate technological breakthroughs into safer production and consumption patterns of groundnut. The great majority of farmers are unaware of the problems of Aflatoxin contamination. So information dissemination is critical. Once awareness is increased, preventive measures can be more easily adapted.

Aflatoxins are unavoidable 'toxic' contaminants of food substances; they are produced by the toxigenic strains of the fungi, *Aspergillus flavus* and *A. parasiticus.* They are a major concern in groundnut, maize, cotton, chili, pistachoo and other agriculture commodities grown in dry and semi-arid tropical environments, especially in Sub-Saharan Africa and Asia. Aflatoxins are carcinogenic, teratogenic and immuno-suppressive agents and they are highly toxic to livestock and humans. Aflatoxins are implicated in several diseases, especially liver cancer. Interference of aflatoxins with host immune system and nutritional metabolism, especially with Vitamin A, iron, selinium and zinc absorption, modulates several infections, including Hepatitis B and C, HIV/AIDS and contributes to reduced rate of growth especially with children. It is estimated that about 4.5 billion people living in developing countries are chronically exposed to aflatoxins

through their daily dietary intake. There are no accurate estimates of health and economic loss due to aflatoxin contamination in poultry and livestock feed in developing countries.

Therefore, aflatoxin contamination in staple diets is a major source for malnutrition and can directly and indirectly affect food security, health and livelihoods of people in the developing countries. It is often the poor who have inadequate resources and access to quality food and water that are the most exposed to aflatoxin contamination. In the light of the very high malnutrition rate in Sub-Saharan Africa and particularly West and Central Africa, it is important that ICRISAT focuses its research on developing technologies to improve nutrient and vitamin uptake and providing safety measures to decrease risk of food and feed contamination by aflatoxins. This can be achieved through an Integrated Genetic and Natural Resource Management (IGNRM) approach by developing vitamin (betacarotene) and micronutrient (iron and zinc) rich, aflatoxin tolerant cultivars, and implementing appropriate pre and post-harvest technologies that reduce the risk of aflatoxin contamination in food/feed.

Micronutrient nutrition

Levels of anemia in the savannah zones of West Africa are alarming, the highest being amongst children (88%) and women of reproductive age (63%). Iron deficiency is one of the most important causes of childhood anemia and zinc deficiency ranks fifth among the leading 10 risk factors in developing countries. Iron and zinc deficiency with children inhibits optimal cognitive and motor-skill development, and chances for later recovery are limited. Childhood mortality is higher, since their weakened immune systems are unable to fight off malaria and diarrhea. Likewise, anemia is a major underlying cause of maternal mortality in Sub-Saharan Africa. The staple cereals, sorghum and pearl millet, are estimated to currently provide one third to one half of iron per capita per day. Genetic diversity for nutritive value is expected to exist in germplasm adapted to this West African zone, noting that this is a center of diversity and origin of these crops. The use of this genetic variability to enhance micronutrient content is just starting through a support from HarvestPlus and needs to be continued and strengthened. To achieve measurable impact, there will be a need to couple these efforts with the identification of key aspects of grain processing, preparation, and feeding practices that are pivotal to enhance bio-availability. An immediate entry point is to examine genetic variability for retention of micro-nutrients and phytates after grain decortication.

ICRISAT has the relevance, capacity and technology to minimize the risk of aflatoxin contamination and therefore can play a pivotal role in helping the WCA population to access better and improved quality food. Appropriate staff can be posted in WCA to work in collaboration with local health and agriculture organizations, with an overall objective of improving the health of humans and livestock through:

Quantifying the risk of mycotoxins contamination in food and feed in the WCA
Develop cultivars with higher levels of pro-vitamin A and micronutrients (Fe and Zn)
Develop and disseminate technologies that reduce mycotoxins in food and feed.
Increase awareness of aflatoxin risks amongst traders, consumers, exporters, farmers and policy makers.

This collaboration will enhance the capacity of national institutions to understand and take care of health status issues amongst the vulnerable poor in WCA.

Output (1) 2010:

High quality and low cost diagnostic tools for estimating the risk of human exposure to aflatoxins and quantitative estimation of mycotoxins (Aflatoxins, Fumonisins and Ochratoxin-A) in crops, processed foods, feeds and commodities, widely disseminated for use by NARES, farmers, traders and processors in developing countries of WCA with associated capacity building

Outcome 2015:

Low cost diagnostic tools are used for NARES, traders and processors for monitoring human exposure to aflatoxins, and mycotoxin contamination in foods and feeds, thereby enhancing the food quality, food safety and human health in developing countries in WCA

Technology-mediated awareness programs are developed and employed by national media partners

Mycotoxins better regulated in foods and feeds through continued and routine use of diagnostic tools in various production, processing, supply and distribution chains

Potential impacts:

Enables the diagnosis of high risk zones for aflatoxicoses

Enhanced awareness and human capacity will be in place to exclude carcinogenic mycotoxins from food and feeds, thereby mitigating food-borne illnesses in humans and animals

Enhances trade by enabling quality certification of produce providing better market opportunities for farmers and traders

Enables legislators to reliably implement food safety regulations in WCA

Enables processors to monitor food and feed quality in their final products for different markets

Enhanced awareness of aflatoxin risks throughout society

Impact Pathway:

Examination of increased awareness of aflatoxin as a health hazard along the market chain

Predominant capability:

NARES are limited in capacity and skills and depend on organizations like ICRISAT to take the lead in R&D in partnership mode to bring in awareness and capacity building and develop and promote aflatoxin reducing technologies

Counterfactual:

Food safety cannot be ensured; reliable enforcement of food safety regulations is not possible; farmers, traders and processors continue to suffer from trade restrictions and rejections of deliveries; processors in supply chain continue to waste resources on cleaning products; increasing overhead costs due to greater dependency on high-cost diagnostic tools from commercial suppliers; traders exploitation of farmers continue through arbitrary quality estimation. R&D programmes on mitigating mycotoxin contamination in food and feed suffer because of high cost of aflatoxin detection from large number of farmers' production and therefore marketing will remain difficult therefore we need cost-effective diagnostic tools.

Output (2) 2010:

Technology packages combining agronomic and genetic options for reducing aflatoxin contamination in staple and high value crops (groundnut, Sorghum, maize, chilies, pistachio) developed, promoted and made available in WCA at the request of NARES

Outcome (2) 2015:

NARES promote the wide adoption of best-bet technologies for reducing aflatoxin contamination in groundnut and other staple and high value crops grown in diverse farming systems in WCA

WCA traders find enhanced markets opportunities through increase in production of high quality food and feed free of aflatoxin

Potential impacts:

Food and feed quality is improved by reducing health risks due to aflatoxin-related illnesses in humans and animals

Enhanced awareness and human capacity to reduce aflatoxin contamination in food and feed, thereby mitigating food-borne illnesses in humans and animals and enhanced market opportunities for produce from developing countries is in place

Policy support to provide incentive mechanisms in the market to encourage the production of aflatoxin-free produce is available

Poor farmers in marginal farming systems in WCA will benefit from adoption of improved varieties and packages to reduce aflatoxin contamination in groundnut and other staple and high value crops (maize, sorghum, pistachio, chillies etc.)

NARES who adopt and further promote and use the technologies, especially diagnostic tools, will strengthen their research and extension programs

Traders and processing industries who benefit from diagnostic tools in monitoring produce for national and international markets will benefit from clean product produced by farmers using improved packages through these interventions

Policy makers will benefit from supporting data produced to align with state policies on food safety regulations and trade.

Potential uptake pathways:

Technology and products developed are channeled through collaboration with NARES, NGOs and private sector, and training programs. There is high likelihood of rapid adoption of these technologies as there is high demand for "no and low-cost technologies" suitable for poor farmers in diverse cropping systems, as they are facing serious health risks and trade restrictions. Traders and processing industries and policy makers are in need of low cost mycotoxin monitoring tools and management packages.

Predominant capability:

Aflatoxin-management activities are not catered for by the private sector, whose interest lies in high-potential agriculture and thus not on the marginal farming sectors – whose populations are the most vulnerable to mycotoxin contamination related illnesses

Counterfactual:

Aflatoxin contamination in crops and crop-based products continue to be high and unchecked; human and animal health in marginal farming systems continue to be affected due to aflatoxin-related illnesses; outbreaks of human and animal mycotoxicoses cannot be prevented; confidence among exporters and importers remain low due to risk of contamination; trade restrictions on import of crop-based products from developing countries remain unlocked; threat of liver cancer due to aflatoxin accumulation especially among Hepatitis-B and C virus-affected patients remains high; aflatoxin contamination continues to be a major bane on health of children, human and animal productivity and ability of HIV-affected patients to cope with the illnesses.

System Priority 3. Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products

3A. Increasing income from fruit, vegetables and plant products

Food security and poverty reduction at the farm level can be achieved through increased efficiency of the farming system, diversification into higher income-generating crops, opening new markets and adding value to farm products. Traditional food plants such as fruit trees, pulses and leafy vegetables are showing promising economic potential and therefore need technical and scientific support, through domestication, to improve their production and adoption in the farming systems of WCA.

1. Development of more efficient farming systems

The African Market Garden (AMG) is a low-pressure drip irrigation system particularly suitable for small farmers. It has all the advantages of the conventional drip irrigation systems at a fraction of their costs. The AMG can increase farm profits per unit area over traditional dryland farming systems by a factor of seven. Over the last three years, ICRISAT has disseminated 1,500 AMG units in eight countries of West and Central Africa and the effort is continuing through an on going project in Burkina Faso and Ghana and a soon-to-start project in the Air Mountains of Niger.

The Sahelian Eco-Farm (SEF) is an integrated dryland tree-crop-livestock system designed to provide solutions to major constraints of current millet based production systems. Three versions of the SEF are under investigation. The system is still under development in partnership with the NARES of Burkina Faso (INERA) and Ghana and with pilot farmers in Niger. Results of four years of research at Sadore, Niger demonstrated that this system could increase farm profits per unit area by a factor of five as compared to the traditional system. ICRISAT is proposing to study mechanisms to allow a large-scale dissemination of the system.

2. Crop diversification

Crop diversification activity involves improvement of traditional crops and native plants and the identification of new income-generating crops

Domestication of *Acacia Senegal*, the Gum Arabic producing tree. The prices of Gum Arabic, a major export product from the Sahel, are on the increase. Ten trees yielding about 1 kg of Gum Arabic per year (four times higher than average yields) have been selected from a population of 300 trees from the Sudan. Grafting of these clones on local rootstocks has been highly successful. While the domestication process is continuing, the new clones will soon be planted in a total area of 25,000 ha in Niger within the framework of a program conducted in cooperation with a World Bank project called CAP (Community Participatory Action).

Promotion of traditional vegetables. Traditional leafy vegetables that are normally collected by women in the wild are a major source of nutrition for farmers' families. Fresh and dried traditional leafy vegetables are also an important source of income for women who sell them in village markets. Many of these dried leafy vegetables now reach the cities of the Sahel. ICRISAT is identifying major income-generating traditional leafy vegetables, multiplying them and incorporating them into production systems. The dissemination activity is being carried out with women organizations. Research is starting to identify best methods of seed multiplication, agro-management, selection of superior germplasm and processing.

Selection of dual-purpose cowpea varieties. In many places in the Sahel, the value of the forage derived from cowpea is higher than the value of the grains. Dual purpose (grain and forage) cowpeas are indeterminate types that yield both grains and forage. Dual-purpose varieties guarantee income from cowpea, when grain yields fail, mostly due to insect attacks. In cooperation with IITA, INERA and ARI of Nigeria, ICRISAT/WCA is currently selecting high yielding varieties of dual-purpose cowpea varieties and adapting them to various types of soils and cultivation practices (sole cropping and intercropping). Research is being conducted in cooperation with the Niger Extension Service and 70 pilot farmers.

Promoting Roselle (*Hibiscus* sp.) as a cash crop for export. In a series of trials, two Roselle varieties with high calyx yields have been identified. Agro-management of Roselle has been developed. A project for the verification of Roselle production for exports was carried out with 500 farmers (mostly women farmers) in cooperation with a local exporter.

Production of watermelons on stored soil moisture. Watermelons are native to West Africa. They possess a deep and widespread root system that allows them to explore water stored in the soil. Thus, watermelons can grow and produce during the dry season using stored soil moisture. Preliminary research indicated that in the sandy soils of the Sahel, watermelon production is limited by low soil fertility. Watermelons were produced in *zai* holes-a technology originally developed for millet production in degraded lands. Yields of 8-10 t/ha were achieved as compared with 1-2 t/ha in the control. ICRISAT has started the promotion of the technology and the variety selected among the farming community of Niger.

Pomme du Sahel : The introduction to the Sahel of the domesticated *Ziziphus mauritiana* from India is one of the most successful undertakings. This tree was first introduced in 1997 to Mali, Senegal and Burkina Faso. ICRAF-Mali, IER and ISRA started to promote it in 2001. ICRISAT named this tree *Pomme du Sahel* (PDS). The PDS is now promoted by the DMP as a central income-generating tree crop. PDS grows and produces both under rainfed conditions and irrigation. The local population cherishes the very tasty and nutrient rich PDS fruit. The fruit can be dried and preserved for long periods of time. It is estimated that in 2005, some 200,000 PDS trees were planted in the Sahel. It is expected that his number will grow significantly in following years. Research on this important crop includes selection of rootstocks, varietal selection, irrigation management and environmental adaptation. Other income-generating dryland trees under development are the sweet tamarind from Thailand, pomegranates, *Saba senegalensis* and figs.

Dates for the Sahel. Dates have the potential of becoming a major income-generating crop in the Sahel. The climate is suitable and water is available in many places. There are local and regional markets for dates. The African Market Garden was actually developed to allow the planting of dates by resource poor farmers. ICRISAT has been experimenting with dates since 2001, when a date plantation was established at Sadore and dates were planted in the AMGs of pilot farmers in four Sahelian countries. A proposal for large-scale introduction of dates to six Sahelian countries has been submitted to the Islamic and the African Development Banks in cooperation with the UNCCD. The Islamic Development Bank has already approved the training section of the program. Decision on approval of the rest of the program will take place imminently. The proposal includes the establishment of a regional date tissue culture laboratory at Sadore.

Introduction of new species and quality varieties of fruit trees. ICRISAT is continuously introducing, testing and selecting quality varieties of new fruit trees, fruit being a major income-generating product. New quality mango varieties from Israel, Australia, Thailand and Vietnam are being evaluated. Figs were found to be a highly successful tree crop for the region. A new high-yielding, adapted papaya variety was also selected. Work continues on the selection of high yielding, high quality pomegranate, pomelos, tangelos, lime, lemon, orange and mandarin varieties. *Saba senegalensis* a local wild fruit tree is under domestication. A regional nursery that produces about 200,000 grafted tree plants is under operation at Sadore. ICRISAT and its partners are training each year about 100 nurserymen on fruit trees propagation and supporting the establishment of new nurseries in the region.

Heat tolerant quality vegetable varieties. The vegetable varieties grown in Sahelian market gardens are purchased from European seed companies and are not resistant to the high temperatures that typify the local climate. So far, ICRISAT has screened four low bolting lettuce varieties, and heat tolerant tomatoes, melons, sweet corn, and hot pepper varieties. Foundation seeds of all these open pollinated varieties are multiplied at Sadore and distributed to local seed producers. Research is continuing with other vegetable species such as green pepper, cabbage, onions etc. Partnership with the World Vegetable Center through joint appointments will allow this research to flourish further both technically and in funding support terms.

3. Opening new markets

In 2005 ICRISAT has teamed up with the Corporate Council for Africa (CCA) to develop new markets in the USA for African crops and products. The first shipment of chickpeas, an ICRISAT mandate crop, has left Ethiopia for the US. This will soon be followed by exports of sesame from Burkina Faso and Niger. CCA is now conducting a market survey for a very wide range of Sahelian crops in the US (for example, roselle, moringa powder and oil and hot peppers). An in-depth study of marketing opportunities for Sahelian tree products is under way in cooperation with INRAN economists.

4. Adding value

Processing technologies for various agriculture products should significantly increase marketing opportunities for Sahelian products. The food processing industry in the region is in its infancy. ICRISAT is developing a program to establish at Sadore, an incubator for new agro-industries designed to increase value for locally produced plants.

Outputs 2015:

African Market Garden technology and high quality vegetable seeds made available to NARES and private sector partners.

Crop diversification strategies in combination with improved land use technologies (e.g. Sahelian Eco-farm) promoted, published and disseminated to partners with associated capacity building measures

Traditional vegetables and tree crops germplasm for integration in the agricultural production systems made available to partners.

Vegetable production and plants propagation technique capacity building is made available to partner organizations.

Outcomes:

Strengthened partners diffuse AMG technology and improved vegetable seeds and they are adopted by farmer enterprises with access to water

Strengthened partners adopt and promulgate SEF dryland technologies improving the resilience of agricultural systems and increasing farmer income through value-added vegetable, fruit and tree crops.

Potential outcomes and impact in 2015 and beyond:

Farmers' annual income, system resilience and food production increased though adoption of new technologies and crop diversification systems. Improved nutrition of rural and urban populations through greater consumption of fruit and vegetables. Traders and exporters benefit from greater competitiveness in local, regional and international markets.

Potential Impact pathways

Selection of traditional food plants for promotion in Sahelian countries through market and household surveys

Development of seed multiplication and nursery techniques for selected traditional food plants

Establishment of experimental and demonstration sites of AMG and SEF in areas covered by partners (NARS)

Development of regional Research and Development projects for up scaling the adoption of the technologies through building of national R&D nurseries and training centers, the establishment of short-term seed storage facilities.

ICRISAT's predominant capability:

ICRISAT is well placed to organize information and legal germplasm exchanges between partners from different countries.

Highly trained interdisciplinary research teams at Bamako and Niamey are in excellent position to implement regionally coordinated projects in partnership with NARS.

Optimal conditions for seed storage and plants propagation are available (e.g. regional nursery and regional gene bank) at ICRISAT-Sadore

Counterfactual:

Low economic profitability and risky lack of diversity in farmers production systems

Rural farmers and traders will miss the opportunities linked with the new development of markets with regard to traditional food plants.

Continuing chronic malnutrition amongst vulnerable groups

3B. Income increases from livestock

At least 100 million poor people in West and Central Africa rely on livestock for their livelihoods. Current estimates indicate that both the human and livestock populations are likely to continue to increase rapidly over the next few decades. As a result of this, as well as climatic changes, mixed crop-livestock and peri-urban production systems are going to become one of the dominant farming systems in the region. Rapid population growth, urbanization and economic growth are driving increasing demand for animal-based foods in the region. This dynamic offers significant opportunities for improving the livelihoods of poor people depending on livestock production. At the same time, it presents challenges for increasing livestock productivity to meet the demand while ensuring environmental sustainability, producing more feed/fodder for livestock, linking remote poor producers to markets, addressing the growing concerns of food quality/safety and ensuring appropriate policies and economic reforms.

Since crop-livestock systems are going to become a dominant farming system in the region in future, better integration of cropping and livestock activities will be a key element of a broad-based strategy for poverty reduction. Although crops and livestock are integrated to some extent in the farming systems in the region, there is a need to intensify their integration to increase productivity. This will require efficient nutrient flows within the system, better management of organic and inorganic fertilizers, optimal utilization of crop residues in ruminant production, improvement of the quality

and quantity of feed/fodder, and the development and introduction of improved food-feed crop varieties. The success of such productivity-increasing interventions is generally linked to market constraints. Thus, enhancing the participation of poor people in dynamic livestock value chains will be essential to providing them with increased incomes. In addition, policies will matter if accelerated growth in crop-livestock sector in the region is to occur.

Achieving the goal of increasing income for poor farmers through crop-livestock research will require adaptive and targeted research that addresses poor livelihood strategies, promotes better understanding of the drivers, processes and consequences of change in the farming systems, and responds to the rapidly changing global context. This will also require strategic and innovative partnership with NGOs, community based organizations, NARES, policy makers and the private sector. In terms of research activities in the region, to increase the income of the poor through livestock, there will be a need to focus on better understanding of livestock economies, access to market opportunities for poor livestock keepers, development and introduction of food-feed crops, genetic enhancement of the nutritive value of crop residues as animal feed, optimal utilization of crop residues, feeding strategies for improved animal production and natural resource management, practical preservation and processing methods for meat and milk to increase their market value and range, and public health risks associated with peri-urban livestock production and impacts on different social and gender groups.

Output 2015:

Food-feed crop varieties with improved nutritional traits acceptable to farmers made available to partners.

Farmer-friendly crop/livestock technologies that will increase income from livestock e.g. feeding strategies developed and made available to partners.

Outcomes:

Better integration of crop and livestock production systems by small holder farmers for sustainable natural resource management.

Better understanding of impediments to market access by smallholder farmers and strategies and action taken to eliminate them.

Potential Impact:

Increased yield in animal production in the region in terms of meat and milk.

Increase in income of poor smallholder farmers.

Regional research capacity enhanced for integrating animal and crop improvement.

Impact pathways:

Evaluation of nutritive value of promising food-feed crop varieties.

Participatory testing and demonstrations in target zones of crop/livestock intensification of range of promising food-feed crop varieties.

Development of improved feeding practices and crop residues management e.g conservation, improvement of feeding value.

Participatory testing and demonstrations of improved feeding strategies.

Economic evaluation of improved food-feed crop varieties and animal feeding strategies.

Predominant capability:

ICRISAT has several years of research experience in crop improvement in the region.

NARS rely heavily on ICRISAT for research on development of food-feed crop varieties.

Counterfactual:

Low adoption of improved food-feed crop varieties by farmers.

Unfavourable government policy regarding local and regional livestock trade.

System Priority 4. Poverty alleviation and sustainable management of water, land and forest resources

4A. Integrated land, water and forest management at landscape level

Background

Landscapes are to communities what farms are to individuals – they provide a familiar, recognizable physical setting for the execution of daily activities and mold significant portions of human lifespans. Yet the distribution of resources and diversity of interests that impinge on livelihoods are far more complex at the landscape level than at the farm level.

Landscapes harbor a range of competing, often conflicting processes that affect ecological sustainability, livelihood security, resource productivity and social well-being. This intricacy is exacerbated in poverty-stricken areas of semi-arid West Africa characterized by heterogeneous agro-ecosystems, disparate endowments, and where local and external forces like population growth, climate variability and the global economy result in a scarcity of land, water, forest and other resources.

Challenges

Embracing this complexity at the level of agricultural and environmental process scales demands trans-disciplinary research that i) fully integrates genetic and natural resource management (IGNRM) approaches, ii) incorporates the latest advances in information technology and simulation modelling, and iii) promotes participatory approaches to reduce the cost of investigations and speed up the uptake of appropriate technology and policy options.

Landscape level studies, initiated by ICRISAT in Niger in the 1990s, have now expanded into other WCA countries. A number of established ICRISAT benchmark sites cover a range of contrasting agro-ecologies from sparsely vegetated desert margins to the typically Sahelian, extensive millet/livestock systems, and further South into intensifying areas of the Sudanian cotton/sorghum belt and the sub-humid maize growing regions of the northern Guinean zone. The long-term management of this network of benchmark landscape units, and its junction with historical village-level studies are pivotal activities to provide the foundation for up- and out-scaling results at national and regional levels.

Strategic activities

Important research and development targets pursued by ICRISAT at the landscape level include:

The development of predictive, spatially distributed models for tradeoffs analysis and decision support. A realistic assessment of solutions available to farmer communities requires the abandonment of compartmentalized, disciplinary investigations for holistic approaches that embrace the largest breadth of challenges faced by these communities. Such a shift calls for a new modeling paradigm driven by careful simplification and interfacing of existing thematic (plant physiology, soil physics, social/behavioral, econometric, etc.) modules inside spatially explicit frameworks. ICRISAT works with leading partners on agricultural landscape modeling, including pioneer studies on the use of ensemble data assimilation for a more realistic understanding of the probabilistic nature of risk and decision-making at multiple time scales.

The elaboration of monitoring and evaluation protocols for ecosystem services. There is a potential for the development of environmental services by farmer communities in Sudano-Sahelian West Africa, as evidenced by the growing regional interest of international NGOs targeting emerging global funding mechanisms. One such example is carbon sequestration in biomass and soils through improved agroforestry and land management (notably: water harvesting) practices. New very high resolution sensors can monitor tree biomass accretion (e.g. *Acacia Senegal* for Gum Arabic production), the distribution of crops and soil/water conservation practices (e.g. contour ridge tillage for enhanced crop growth), and therefore have potential for verifying farmer compliance in future contracts.

The popularization of baseline land use/land cover (LU/LC) change studies. Nowadays high resolution satellite time series provide decadal snapshots of land surface conditions in West Africa back into the 1960s. Direct application of simple, validated classification methodologies can document LU/LC trajectories and assess the magnitude of these critical drivers of systems productivity and sustainability, such as the encroachment process of cropland onto natural vegetation and marginal lands. Capacity in the use of satellite data needs to be strengthened in NARS, and there is a need of awareness-raising amongst a wider range of scientific disciplines.

The exploration of landscape genetics approaches. At the interface of molecular population genetics and landscape ecology, this emerging field aims to study the interactions between landscape features and micro-evolutionary processes, such as gene flow, genetic drift and selection. It provides a unique opportunity to exploit ICRISAT's longstanding expertise on genetic resources to investigate, for example, the environmental risks associated with the introduction of Genetically Modified Crops in selected agro-ecologies, against their potential benefits for poor farmers food and livelihood security.

Outputs and outcomes

Outputs to 2010:

At least one leading mechanistic model adapted for spatial simulation of African sorghum/millet phenology and biomass partitioning and made available to partners, along with updated genotype databases (30 landraces and hybrids) and simplified framework for upscaling varietal performance to larger recommendation domains

One predictive toolset based on assimilation of in-situ measurements and satellite observations with models made available to partners for evaluating options for soil C sequestration at both farm and cropping system scales, including the role of livestock on C and nutrient balances

At least one stochastic assimilation method extended to incorporate expected advances in seasonal regional climate forecasting and made available to partners; subsequent augmentation of farmer decision portfolios assessed

Capacity building measures associated with the previous three bullet points

Outcome by 2015:

Advanced encapsulation of specialist knowledge (plant physiology) into spatially distributed agricultural models well underway at the landscape and aggregate levels and models being employed by partners

Paradigmatic shift from deterministic to stochastic research in partner NARS research approaches

Potential impact:

Improvement of plant improvement efficiency

Impact pathway:

Monitoring of partner breeding program for changes in research approach

ICRISAT's predominant capability:

ICRISAT's strategic position at the nexus of genetic and natural resource management research (IGNRM) including diversified and active collaborations with leading modeling networks and teams (e.g. ICASA, APSRU, CIRAD/INRA)

ICRISAT's longstanding experience of grass-root constraints allows for a bottom-up appraisal of advanced geospatial modeling technologies as powerful tools in service of the resolution of concrete farmer problems, and not objects of research in themselves

Counterfactual:

Slower progress towards the integration of specialty knowledge (notably: genotype x environment interactions) into spatially explicit models

Deepening closure problem in research undertakings between advanced and developing countries

4B. Sustainable agro-ecological intensification in low and high potential environments

Inherent poor soil fertility and drought constitute major constraints to agricultural production in West and Central Africa. There is a potential of combining organic inputs from leguminous trees and inorganic fertilizers including local phosphate rocks, compound and nitrogenous fertilizers to enhance soil fertility and improve productivity. Numerous studies have shown that applying fertilizer with a phosphorus component is economically profitable in years of both low and high rainfall in the low potential areas, particularly on the sandy soils which are deficient in phosphorus. There are more opportunities to intensify and diversify agriculture in the higher potential areas in the Sudanian zones. Higher value crops can offer possibilities to increase productivity and environmental sustainability. Adapted leguminous crops, trees and livestock will enable the diversification and improvement of the farming systems.

The fertilizer micro-dosing technology, which consists of the application of small quantities of fertilizers in the hills of plants, is an innovation that is applicable in both low and high potential areas. This strategic application of fertilizer enhances fertilizer use efficiency and improves productivity, thereby enabling intensification of agriculture and increases in productivity. Efforts will be made to work closely with farmers' organizations, NGOs and the private sector to scale-up and scale-out this technology using farmer field schools, on-farm demonstration trials and modern tools such as GIS and modeling.

Leguminous crops are relatively low-P tolerant crops which are able to utilize symbiotically fixed air N_2 as a nitrogen source. These unique characteristics are favorable to the poor soils in the Sahelian region, where nitrogen and phosphorus are the most limiting nutrients. Leguminous crops should therefore be integrated into cropping systems on the basis of their capacity for nitrogen fixation and P acquisition. Technologies will be tailored to improve the efficiency of use of available resources.

Improvement of the traditional crop-livestock system is also an important research target, because livestock are efficient miners of precious nutrients from fallow lands. It is very important to elucidate the role of organic matter in the sustainability of soils for the development of sustainable technologies for soil fertility and crop production.

The variability of WCA biophysical and socio-economic conditions demands strategic partnership with an agro-ecological as well as a national focus. The marked latitudinal gradient in rainfall is a major environmental determinant of the availability of natural resources. The similarity of environmental constraints and opportunities within each agro-ecological zone results in the need of cooperation within each zone that reaches across national boundaries.

Outputs 2010:

Fertilizer micro-dosing technology widely disseminated in Burkina Faso, Mali, Niger and Senegal for increased crop productivity

The role and function of organic matter in sandy soils elucidated and published

Technical options for more efficient and sustainable application of organic matter, such as plant residues and/or cattle manure on sandy soils developed and promoted

Promising and efficient soil, water and nutrient management technologies evaluated and promoted in WCA

Outcomes 2015:

NARES partners' capabilities to formulate and implement research-for-impact through collaborative activities and training shows positive enhancement.

Scaling up methods used by NARES partners, NGOs and development agencies to widely disseminate improved fertilizer management technologies in WCA

Potential impacts:

Crop intensification and yields increased and incomes of rural households increased

Degraded lands in Burkina Faso, Mali, Niger and Senegal rehabilitated and put back to intensive cropping as regional exemplars.

Potential Impact pathway:

Identify weakness and demerits of indigenous organic management of sandy soils

Develop a model of integrated organic matter dynamics in sandy soils

Identify indigenous and introduced plant/crop genetic resources to improve the fertility of sandy soils

Implementation of proposed technical options on farm trials to confirm the efficient utilization of organic matter for crop production in sandy soils

Predominant capability:

Highly trained and experienced inter and multi-disciplinary research teams from ICRISAT and collaborating institutes based at ICRISAT such as JIRCAS, ILRI and ICRAF, supplemented by post graduate students and Post Doctoral fellows all involved in Integrated Genetic and Natural Resource Management (IGNRM)Research operating in ICRISAT's high quality research and laboratory facilities and dedicated to the production of regionally functional IPGs give the institution predominant capability over its potential regional substitutes

Counterfactual:

If ICRISAT ceases its NRM work in the Semi-Arid Tropics of WCA, there will be further degradation of already degraded lands which will lead to decreased and unstable yields and loss of biodiversity. NARES will revert back to location specific NRM studies which cannot be scaled-up or scaled-out to wider agro-ecological zones in the SAT of WCA. Farmers' incomes will continue to decrease and there will be substantial food insecurity.

4a: Strategies for conservation, restoration and sustainable use of degraded agro-ecosystems, developed and implemented in the desert margins of SSA

Sustainable use and rural development activities cover agricultural, pastoral; agro-forestry and forest, land uses. A couple of initiatives are planned to identify and re-popularise sustainable indigenous land use practices (Zimbabwe, Senegal). A number of activities are planned to help communities improve their management of soil and water resources, retain soil fertility, avoid soil erosion, and make best use of water resources (Zimbabwe, Burkina Faso, Senegal, Niger). The DMP will take the latest lessons from the field, indigenous knowledge and scientific research from across the region to update and rationalise approaches to water and soil management at project sites. Rural development initiatives are planned to help local communities build the capacity to organise themselves into collectives and co-operatives, increase their levels of productivity and add value to farm gate prices (Kenya, Burkina Faso). Finally there are a number of baseline activities to rehabilitate pastoral areas, encourage natural regeneration of over-used species, and to re-afforest degraded areas, and stabilise sand dunes (Burkina Faso, Senegal, Niger). The DMP will build on the foundations laid by the community development and rehabilitation activities, building on the broad base of experience.

The output will introduce pre-identified sustainable land use practices with similar or increased potential for profit over those practiced in the baseline. The GEF will finance all barrier removal costs of introducing these technologies; community training in approaches; community extension advice; community capacity building and institutional strengthening to support adoption of new practices. All factors of land use production including land, labour, equipment, and agricultural inputs will be co financed. For habitat and ecosystem rehabilitation activities the GEF will fund the costs additional to least cost practices expected under the baseline, such as pasture improvement with non-native monocultures.

Outputs by 2009:

100,000 ha under improved management for biodiversity conservation;
100,000 ha of degraded lands rehabilitated;
Increased carbon sequestered on 150,000 ha of improved lands;

Outcomes:

Crop, tree and livestock system integration promoted for agro-diversity, commercialization and health Water and nutrient use enhancing techniques developed and integrated into sustainable systems

Potential impact:

Rural households and the agribusiness sector adopt improved agricultural technologies and income generation activities

Counterfactual:

More degraded lands in the fragile environments of the desert margins of SSA leading to missed income generation opportunities and more poverty

4d: Sustainable agro-ecological intensification in low- and high-potential areas

Alternative livelihood systems tested and promoted in the desert margins of SSA
Initiatives are planned at project sites to encourage the development of (as opposed to the modification of) new rural enterprise and livelihood ventures. Both Kenya and Burkina Faso are planning to promote alternative rural enterprise, by making rural credit available to seed new ventures, and provide renewable sources of energy for rural initiatives, and provide business development support for new enterprises. In Senegal activities are planned to newly domesticate wild fruit, for commercialisation.
As with Output 2 the GEF will finance all barrier removal costs of fostering alternative livelihoods; including community training in the technical and business aspects of proposed alternative livelihoods; on-going community extension advice; community capacity building and institutional strengthening for cooperatives, collectives and existing micro-credit schemes to support adoption of alternative livelihoods. All factors of land use production including land, labour, equipment, and agricultural inputs will be co-financed.

Outputs by 2009:

200,000 farm families with increased income from sustainable livelihood options.

Outcomes:

Crop, tree and livestock system integration promoted for agro-diversity, commercialization and health Water and nutrient use enhancing techniques developed and integrated into sustainable systems

Potential impact:

Rural households and the agribusiness sector adopt improved agricultural technologies and income generation activities

Counterfactual:

200,000 farm families missing opportunity to increase their income from the development and adoption of sustainable livelihood options developed by the project

System Non-Priority. Knowledge management and sharing

Background

Knowledge Management, originally a collection of primarily information sharing processes in the corporate sector, has evolved in the last ten years to become a component of development action and research. The recent initiatives of well known development investors such as the DFID, the SDC or the IDRC/Bellanet to promote knowledge management in development-oriented organizations indicate its emergence as a lever in generating impact. (It is more appropriately termed "knowledge management and sharing" in this context). An earlier CG-wide (2001-02) initiative, the Organizational Change Program, emphasized the importance of knowledge sharing processes in enhancing organizational effectiveness. In line with the system-wide effort in ICT and knowledge management, ICRISAT has developed its own brand and has built up a core of network services, library support, partner-oriented training programs and well-organized communication systems over the last five years, ICRISAT has further developed a pilot initiative (called VASAT) for knowledge sharing with partners and stakeholders, with the overall aim of improving food security and drought preparedness at the level of a community. The KMS strategic action framework is meant to support the Institute's effort to build new partnerships for enhanced development impact, expressed in MDG 8.

Role of ICT as a mediator in knowledge management and sharing

While knowledge sharing as a process has always been an integral part of a development research organization, incorporation of contemporary ICT adds value to its effectiveness. A number of standard information sharing processes have been transformed through the use of ICT, through significant increases in speed and volume. New technology developments enable rapid communication of results. More importantly, new collaborative opportunities in knowledge creation and sharing, as exemplified by the global Wikipedia (www.wikipedia.org), have emerged. Web-based content distribution technologies such as "Blogs" have created unprecedented advantages for experts engaged knowledge creation. All these technologies now enable "capture" of both formal as well as tacit knowledge of an individual expert to make it available to a larger community that can take suitable advantage. Our goal is to make an expert's knowledge available to any needy partner or stakeholder anytime, anywhere through virtualising presence. ICT is thus an essential component of KMS.

New developments among NARS partners

Increased information intensity in agricultural production and distribution and marketing has created new challenges for NARES partners. Non-linear onset of climate change-related phenomena were evident throughout the year 2005, and floods have resulted in major damages in regions which had been in the grip of severe drought for almost half of a decade. The potential spread of new hybrids, even GMOs, and the increases in internationalization of commodity markets have also led to increasing pressure on NARES partners to develop rapid responses which are knowledge-intensive. The preparedness levels in relation to disasters have to be higher at the level of a community, which is an information and knowledge-intensive process. The need for revamping public sector extension has been voiced in many regions, while policy makers have started to emphasize the need to change the character of agricultural education to make it easy for practicing farmers to access instructional delivery systems. The NARES partners (including new ones such as the field-based NGO's or the minor corporate sector) are looking for a new paradigm in knowledge sharing with an increasingly large number of farmers and other rural inhabitants.

Global interest in ICT4D and open access systems

In recent years, the ICT4D movement has made significant advances in Asia and Latin America while a blend of satellite digital radio and the community radio is fast emerging as a choice for development communication in the Sub Saharan Africa. The two-part WSIS organized by the UN has generated new global partnerships who aim to utilize the power of digital technologies to achieve the MDG's. On a parallel track, the science community has taken the lead in making research results available to peers and to the informed public through a different distribution model called the Open Access, fortified by the practice of reserving only limited nights. Several of the Open Access journals (e.g. PLOS-Biology, www.plos.org) have reached extraordinary impact levels within three years, and major development investors and research promoters are increasingly seen preferring OA methods for peer review and dissemination.

ICRISAT's comparative advantage

The main asset is the accumulated knowledge from ICRISAT research. The people, the ICRISAT experts, with their tacit as well as formal knowledge constitute the key resource in the process of knowledge sharing. Over the last five years, ICRISAT has stabilized an advanced network management service, along side a library service that has gradually moved into an electronic mode. By 2004, every country office of ICRISAT has an "always-on" type of connectivity, and a compact, efficient group of human resources have been created for managing digital information services. Over the same period, the training programs have been moved to a new level, supporting about 250 graduate learners through the year on an average. An advanced learning and content management system is in place, and partners such as the Commonwealth of Learning (www.col.org) have assessed ICRISAT as highly capable in developing new instructional delivery systems. ICRISAT led the trial project across the CGIAR in the use of video conferencing, and has developed advanced capability in the use of this technology for peer-to-peer and for extension communication. A diverse range of new partners have been linked into our KMS programs, such as corporate organizations such as Microsoft and Sun Micro. Joint technology development is under way with many of them. We will also seek out new partners that previously may have been presumed to be unlinked to agriculture such as the telecom industry. We have assets in terms of people, knowledge (formal as well as tacit), technology and partnerships.

Outputs and outcomes to 2009-2015

Outputs by 2009:

Development of an architecture and building an infrastructure for advanced research informatics which will include

- web-based information services to enable instant publishing (eg GT-BT-Bioinfo, LIMS; GT-CI-genebank, varietal information; GT-AE-GIS, soil and meteorological data, MPI-VLS).
- Mainstreaming support systems to take advantage of tacit knowledge (based on Media Wiki and Blogs).
- Comprehensive and secure network services delivered to staff (intranet) and partners (extranet) based on unique ID authentication anywhere in the world

Building a pilot educational materials grid to support post-secondary extension learning:

- A learning objects repository on SAT production and livelihoods with about 150,000 objects developed and linked to CG-Wide OLR.
- Developing a seamless delivery method combining the web, digital satellite radio, and community radio in 3 locations in SSA.
- Develop video conferencing as a routine method of transaction between the three regional hubs and two SSA-based country offices.
- Develop an arrangement whereby ICRISAT-based experts are able to interact with NARES partners seeking knowledge using satellite-based video conferencing (20 locations in South Asia).

Virtual SAT library with about 100,000 entries, accessible anywhere, anytime and is linked to the CGIAR Virtual Library program:

- An e-print repository and an OA-science publication access system developed with 5000 entries.

By 2015:

ICRISAT emerges as a META-University supporting new agricultural learning/ instruction delivery processes on a mass-scale:

- web-based as well as video-interactive learning
- ICRISAT and the FAO provide the backbone services in terms of global standards in content design
- ICRISAT web site turns into semantic web portal for highly customized information and instruction delivery, anchoring about 25 institutional sites relevant to SAT.

Every ICRISAT faculty is a global knowledge entrepreneur with a readily available array of online tools and techniques, and can virtually be an institution herself.

Outcomes:

NARES partners design new extension-engagement processes based on ICRISAT KMS approaches.

Agricultural universities develop new paradigms in customizable mass education for enhanced food security and livelihoods using ICRISAT exemplars.

Users of ICRISAT Knowledge in the public domain provide significant new contributions of viable revenue for ICRISAT.

Potential impact:

The totality of ICRISAT's research has a large potential for good development impact. The rate and coverage by which this good knowledge is received by primary and secondary users is dependent upon the strength of supporting extension and communication agencies. The ICRISAT Knowledge Management and Sharing program has the potential to make this process, faster and more effective and is thus a vital tool in ensuring ICRISAT's IPG bring the development for which the research is intended.

Impact pathway:

Examination of the adoption by partners of modern and effective methods of mass communication for the purposes of capacity building and agricultural extension

Predominant capability:

ICRISAT is internationally recognized as a leader in ICT4D innovations and new learning/content management/approaches. With appropriate right ideas and basic resources, ICRISAT sees no evident competition in customizable agricultural information delivery on a mass scale that would undermine our predominant capability

Counterfactual:

The NARES need for developing a new farmer-engagement and mass education paradigm is real as well as pressing. There is a risk presently of the efforts of the current actors addressing this issue to do so in a piece-meal fashion which is likely to be less effective than if a large-scale coordinated effort is allowed to function. ICRISAT has strengths in playing such a unifying role for a large-scale effort which would otherwise be lost.

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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