## PROJECT BRIEF

### A. COVER PAGE FORMAT

1. Identifiers:

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|---|---|
| Project Number: | Not yet assigned |
| Project Name: | Phase I and Phase II: Conservation and Use of Crop Genetic Diversity to Control Pests and Diseases in Support of Sustainable Agriculture |
| Duration: | Phase I 2 years<br>Phase II 3 years |
| Implementing Agency: | United Nations Environment Programme |
| Executing Agencies: | China: Yunnan Agricultural University, Kunming, Yunnan<br><br>Ecuador: Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Quito<br><br>Morocco: Institut Agronomique et Vétérinaire (IAV) Hassan II, Rabat<br><br>Uganda: National Agricultural Research Organisation, Entebbe<br><br>International Plant Genetic Resources Institute (IPGRI), Rome, Italy |
| Requesting Country or Countries: | China, Ecuador, Morocco, Uganda |
| Eligibility: | Countries participating in this project ratified the Convention on Biological Diversity on the following dates: China, 05 January 1993; Ecuador, 23 February 1993; Morocco, 21 August 1995; and Uganda, 08 September 1993 |
| GEF Focal Area(s): | Biodiversity |
| GEF Programming Framework: | OP 13: Conservation and Sustainable Use of Biological Diversity Important to Agriculture |

2. Summary:

The outcome of the project will be that resource-poor rural populations will benefit from reduced crop vulnerability to pest and disease attacks through increased use of genetic diversity on-farm. By providing farmers and NARS researchers with the tools and practices needed to manage local crop (intra-specific) genetic diversity, farmers' options to combat pest and disease on-farm will be expanded, food security will be increased, genetic diversity conserved, and ecosystem health

improved. The project will develop tools to determine when and where intra-specific crop diversity can be used to manage pest and disease pressures by integrating existing farmer knowledge, belief and practices with advances in the analysis of crop-pest/disease interactions. Unlike Integrated Pest Management (IPM) strategies, which have focused on using agronomic management techniques to modify environment around predominantly modern cultivars, this project is unique in that it concentrates on the management of the local crop cultivars themselves as the key resource, making use of the intra-specific diversity among cultivars maintained by farmers.

3. Costs and Financing (US$):

| | | | |
|---|---|---|---|
| **GEF:** | -Project Phase I | : | 2,249,900 |
| | -Project Phase II | : | 4,618,634 |
| | -PDF A | : | N/A |
| | -PDF B | : | 350,000 |
| | **Subtotal GEF** | : | **7,218,534** |
| **Co-financing:** | | | |
| | -Project | : | |
| | -Other International | | |
| | IPGRI | : | 1,080,000 in-kind |
| | | | 200,000 cash |
| | SDC | : | 750,000 cash |
| | Others | : | 846,624 in-kind |
| | | | 995,000 cash[1] |
| | -Governments (in-kind): | | |
| | China | : | 1,391,733 |
| | Ecuador | : | 601,680 |
| | Morocco | : | 867,605 |
| | Uganda | : | 513,904 |
| | -Governments (cash): | | |
| | China | : | 1,013,232 |
| | Ecuador | : | 43,800 |
| | Morocco | : | 143,050 |
| | Uganda | : | 25,000 |
| | -PDF A | : | *Not requested* |
| | -PDF B | : | 370,000 |
| | IPGRI | : | 90,000 in-kind |
| | | : | 25,000 cash |
| | Other International | : | 120,000 cash/in kind |
| | Governments | : | 135,000 cash/in-kind |
| | **Subtotal co-financing** | : | **8,841,628** |

[1] Discussions ongoing with donors (EU, Ford Foundation, BMZ,) for cash contributions

**Total Project Cost : 16,060,162**

4. Associated Financing (Million US $):

N/A

5. Operational Focal Point Endorsement:

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## List Of Acronyms And Abbreviations

| | |
|---|---|
| BARNESA | Banana Research Network for East and Southeast Africa |
| CAN | Andean Community of Nations |
| CBD | Convention on Biological Diversity |
| CBO | Community Biodiversity Organization |
| CIMMYT | International Maize and Wheat Improvement Centre |
| CITES | Convention on International Trade in Endangered of Wild Fauna and Flora |
| CSIRO | Commonwealth Scientific and Industrial Research organization |
| EAPGREN | Eastern Africa Plant Genetic Resources Network |
| ECOSALUD | Refers to focus on ecosystem and their impact of human health |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| FFS | Farmers Field School |
| FGD | Focus Group Discussion |
| GEF | Global Environment Facility |
| GIAHS | Globally Important Ingenious Agricultural Heritage Systems |
| GINC | Global Information Network on Chemicals |
| GM | Genetically Modified |
| GPA | Global Plan of Action |
| GTZ | Deutsche Gesellschaft für Technische Zusammenarbeit |
| IFPRI | International Food Policy Research Institute |
| INIAP | Instituto Nacional Autónomo de Investigaciones Agropecuarias |
| IPGRI | International Plant Genetic Resources Institute |
| IPM | Integrated Pest Management |
| IPPC | International Plant Protection Convention |
| IRRI | International Rice Research Institute |
| ISC | International Steering Committee |
| IUCN | World Conservation Union |
| IVA | Institut Agronomique et Vétérinaire |
| NARI | National Agriculture Research Institute |
| NARO | National Agricultural Research Organisation |
| NARS | National Agriculture Research System |
| NBSAP | National Biodiversity Strategy and Action Plan |
| NGO | Non-Governmental Organization |
| NRCAB | National Research Center for Agriculture Biodiversity |
| NSC | National Steering Committee |
| PAN | Pesticide Action Network |
| PGR | Plant Genetic Resources |
| PIC | Prior Informed Consent |
| PMU | Project Management Unit |
| SDC | Swiss Agency for Development and Cooperation |
| SANREM CRSP | Sustainable Agriculture and Natural Resource Management Collaborative Research Support Programme |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UPWARD | Users' Perspectives With Agricultural Research and Development |
| WSU | Washington State University |
| YAU | Yunnan Agricultural University |

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## B. PROJECT DESCRIPTION

### BACKGROUND AND CONTEXT (BASELINE COURSE OF ACTION)

1. In a period of less than a hundred years, the number of food crops that are cultivated today has dropped from an estimated 7000 species to 150. Crop diversity, both between (inter) and within (intra) species has given way to uni-variety cropping and to large scale, genetically homogenous, cropping for industrial purposes. As a result the genetic base has narrowed considerably.

2. The potential negative consequences of planting large areas to single uniform crop cultivars were recognised as early as the 1930s by agricultural scientists. When farmers sow cultivated varieties with uniform resistance to a pest or disease, the crops can become susceptible to attack by pathogens able to overcome the resistance and epidemics can result. The Irish potato famine is one of the most dramatic examples of genetic uniformity leading to devastating loss of the crop. Susceptibility of five major commercial cultivars of banana to the fungal disease black sigatoka resulted in Central America countries losing nearly 47% of their banana yield. Rice blast epidemics in Korea in the 1970s caused 30-40% yield losses.

3. Up to 30% of the world's annual harvest continues to be lost to pest and diseases, with developing countries experiencing the greatest devastation. The resulting economic and food resource costs are, to a significant extent, a consequence of the continuing evolution of new races of pests and pathogens that are able to overcome resistance genes introduced by modern breeding creating the phenomenon of boom and bust cycles. Breeding programs are in place to develop new varieties and to replace varieties that have lost their resistance. However, the maintenance cost of the current system is high. The International Center for Wheat and Maize (CIMMYT), based in Mexico, reportedly spent 35% of its budget in 1989 on 'maintenance research'. The inherent instability and thus risk for farmers and industry lead to a reliance on various generations of pesticides and more recently genetically modified (GM) crops.

4. Small-scale farmers in developing countries depend on genetic diversity to maintain sustainable production and meet their livelihood needs. Loss of genetic choices, reflected as loss of local crops or cultivars, diminishes farmers' capacities to cope with changes in pest and disease infestations, and leads to yield instability and loss.

5. Local cultivars are a primary source for the new resistant germplasm, providing about 39% of the resistant germplasm used in the breeding programmes of major crops such as maize and barley. Most if not all known resistance to arthropod pests and pathogens in crops are derived from accessions collected from farmers who traditionally grew them in genetically diverse systems. Even so, the development of new cultivars grown as monocultures continues to be central to modern agriculture. Most breeding programs use single genes to provide resistance across many types of environments. In single variety strategies, resistance to only few diseases can be incorporated leaving the crop susceptible to other diseases.

6. Genetic resistance continues to be part of the disease management strategy in traditional, genetically diverse systems. Maximum numbers of genes for disease resistance have been found in landraces in areas where host and pathogen had coevolved for a long period of time. In effect, *ex situ* seed collections of farmer landraces and varieties with landrace parentage are the source of virtually all genetic resistance in modern varieties.

7. In many regions of the world, farmers have local preferences for growing mixtures of cultivars, which they understand to provide resistance to local pests and diseases, and to enhance yield stability. However, the extent to which this is done and its effectiveness are not known. What is known is that farmers apply a variety of agronomic techniques, such as crop rotation and timed planting. Farmers also use high-yielding modern cultivars, shown to be resistant to pests and diseases, and pesticides. Integrated pest management (IPM) strategies, which have focused on using agronomic management techniques to modify environment around predominantly modern cultivars, have excluded the potential of using within-crop diversity, for example, through variety mixtures, multilines or the planned deployment of different varieties in the same production environment to minimize pest and disease pressures on-farm.

8. The main purpose of genetic mixtures (crop variety mixtures) for pest and disease management is to slow down pest and pathogen spread. The basic principle that enables varietal mixtures to reduce the severity of disease was stated by Wolfe in 1985: "*Host mixtures may restrict the spread of disease considerably relative to the mean of their components, provided the components differ in their susceptibility.*" This is considered to be the mixture effect.

9. A diverse genetic basis of resistance is beneficial for the farmer because it allows a more stable management of pest and disease pressure, than a monoculture allows. This is because when resistance in a monoculture breaks down the whole population succumbs, while in a genetically diverse field it is much less likely that different types of resistance will all break down in the same place for comparable pest or disease damage. The effectiveness of a given mixture to do so depends not only on the resistance available, but also on the nature and speed of the life cycles of the pathogens as well as their means of spread. Mixtures serve to decrease the spatial density of susceptible plants, provide a barrier effect by resistant plants that fill the space between susceptible components, and induced resistance by non-pathogenic spores such that normally pathogenic spores that land in the same area are prevented from infecting or are limited in their productivity.

10. Although the general mechanisms that contribute to the 'mixture effect' are now fairly well understood, there is inadequate information on the biological mechanisms that function in complex farmer (not simple researcher) managed intra-specific genetic diversity systems. Few studies are available to shed light on how farmers manage diverse genes in plant populations either to manage single constraints, or as complexes of pests and diseases. Surprisingly, few in depth studies are available on cultural methods that aid the use and longevity of genes. Local preferences exist for growing mixtures in part, because they provide resistance to local pests and diseases and enhance yield stability.

11. As people move around the globe with genetic resources, so does resistant and virulent germplasm. Resistance genes evolve in response to new pathogens and pest, as well as there being remnants of resistance from old diseases in other regions. This phenomenon has resulted in the occurrence of resistance outside the primary centre of diversity, such as the development of resistance to chocolate spot in faba bean (*Vicia faba*) in the South American Andes although the crops primary centre of diversity is the Fertile Crescent. This phenomenon creates the potential to find resistance diversity in countries of secondary centres of diversity not found in the primary diversity centres.

12. The six project target crops, rice (*Oryza sativa*), maize (*Zea mays*), barley (*Hordeum vulgare*), common bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), banana and plantain (*Musa* spp.), are major nutritional staples for large segments of the developing world and their yield stabilities are important factors in food security. The crops represent different breeding systems (cross-pollinated, partially outcrossing, self-pollinated, clonal), as differences between varieties would be expected to be less prominent in cross-pollinated crops than in self-pollinated ones. Banana and plantain, as a result of their sterility, have followed a clonal crop improvement strategy, with farmers doing most of the selection breeding. In addition, the life cycles of major pest and disease that affect these crops are well studied. Criteria for crop selection is listed in Annex H.

13. The four countries participating is this initiative, China, Ecuador, Morocco and Uganda, all contain areas of important crop genetic diversity for these crops, including different types of resistance to major pests and pathogens in their local crop cultivars maintained in traditional farming systems. Each of the four countries has at least two of their target crops in common with one of the other countries, linking diversity of primary centres of diversity to secondary centres of diversity.

14. Rice is the staple food for half the world population. Southwestern China along with Nepal, Bhutan, Assam, Myanmar, Laos and northern Thailand lies in the center of diversity and domestication of Asian cultivated rice (*Oryza sativa* L.). Rice blast is the most widespread and severe disease of rice. Host resistance in monocultures remains effective for only a few seasons. The development of severe epidemics on a regional scale is attributed to reliance on few high yielding varieties. In China, rice blast has caused losses of 91, 96 and 98% of total disease loss in 1974, 1978 and 1990, respectively. Fungicides are used extensively. Other major diseases like bacterial blight and tungro virus are also important and have caused epidemics in the 1980s in Asia.

15. Maize (*Zea may*s L.) along with rice and wheat is one of the three most important cereals in the world. Maize is grown throughout the temperate, subtropical and tropical environments, from highly favorable irrigated to highly variable rainfed mountain environments. It is believed to have been domesticated in Central America, Mexico/Guatemala from wild relatives that are still found in the region. It is probably the single most important new world crop and has contributed substantially to enable population growth in the rest of the world. The principal diseases of maize are a complex of what used to be called Helminthosporum Leaf blights; Southern Blight (*Helminthosporum maydis* (Syn. *Bipolaris maydis* (Nisik.) Schoemaker, *Drechslera maydis* (Nisk.) Subram. and Jain.) is one of the most important of these. The disease occurs worldwide. The fungus is responsible for causing the Southern blight epidemic on hybrid maize in the USA in the early seventies, causing severe financial losses. Maize has many

arthropod pests. One of the principal pests of maize is stem borer. It is a major arthropod pest of maize contributing to substantial yield loss.

16. Barley (*Hordeum vulgare*) is the fifth largest cultivated cereal crop in the world. It is grown as landraces in marginal, low-input, drought-stressed environments both for grain and straw. The crops domestication is believed to be the Fertile Crescent and Morocco. In China, Yunnan Province is the genetic diversity centre for barley. One of the major diseases of barley is powdery mildew, caused by the fungus *Erysiphe graminis* DC. f. sp. *hordei* Em Marchal (synamorph *Blumeria graminis* (DC.) Golovin ex Speer f. sp. *hordei*). It is a serious foliar disease that affects the crop in many major production regions around the world and it is of great economic importance. The primary loss from powdery mildew is reduced yield, which can reach up to 20% for Europe and up to 30% for North Africa, although average losses are smaller and about 10%. Powdery mildew on barley is considered as one of the most clearly characterized system of host-pathogen genetic interactions.

17. Common bean (*Phaseolus vulgaris* L.) is one of the world's most important grain legumes. It is endemic to Latin America forming three centers of domestication (Mesoamerica, the Andean highlands, and Chile). The crop is a historic and important protein source and a component in local diet, especially the poor. The crop is an integral part of the sustainability in traditional cropping systems of the highland areas of the Andes and Central America. Ecuador is in the Andean center of diversity of common bean. Varietal mixtures are common in the climbing type. Beans are often grown intercropped in non industrialized small holder systems due to better and more secure yields in lower input systems. The East African highlands have become a secondary center of diversity for common bean. In Uganda with some of the highest population densities in the world the crop is the most important protein source of people and provides 25% of the carbohydrates.

18. Faba Bean (*Vicia faba*) is an important old world food legume along with chickpea, peas and lentils. A near eastern center of origin has been postulated with four radii (1) to Europe (2) along the north African coast to Spain, (3) along the Nile to Ethiopia, and (4) from mesopotamia to China. Faba bean hosts many pathogens. Arthropod pests cause extensive damage in the field and during storage. The major diseases are Anthracnose (*Ascocyta fabae*) and chocolate spot (*Botrytis fabae*) which causes considerable damage. Moroccan faba bean populations have been used as sources for resistance to chocolate spot (*Botrytis*), with highly significant differences in resistance among local populations. China and Ecuador are secondary centers of diversity of the crop.

19. Bananas are one of the most important food crops in third world countries and are the staple food for millions of people. Eighty-seven percent of global production is produced by small scale farmers and consumed locally. Uganda is the leading consumer of bananas in the world particularly in the form of cooking types. The crop occupies 30-40% of all land under crops and produces more than 10 million tons of product. Uganda and the Great Lakes region of Africa is regarded as a secondary centre of diversity of *Musa spp*. The genetic uniformity and the inability to create new varieties makes the banana the most disease-vulnerable and therefore most heavily sprayed food crop in the world. Ecuador holds the top fourth position with respect to pesticide consumption due to high spray on bananas among other crops. The major biological constraints of banana in Uganda are Banana weevils, nematodes, black sigatoka, *Fusaruim* wilt, streak virus, bacterial wilt. *Fusarium* wilt, otherwise known as Panama disease, is regarded as a

major threat to commercial banana production. *Fusarium* is a soil borne pathogen infects the root and vascular systems of plants. Banana weevils also cause severe damage resulting in slower maturity and crop losses up to 60%. Farmers perceived banana weevils to be a major constraint and often attribute the visible damages caused by these diseases mentioned as well as nematodes.

**Threats and Barriers**

20. Local genetic diversity is increasingly under threat from national and international pressures to produce genetically homogenous, cropping for industrial purposes. An industrial global market is now cementing legal systems to protect intellectual property rights of the developers of the industrial germplasm. Local genetic diversity has been put further at risk to new and exotic pests and pathogens through increased trans-boundary movements of living organisms brought about from globalization of trade, and this is being exacerbated by climate change. No relevant genes may be available in local gene pools to provide protection to these new threats and lead to increased vulnerability of these genetically diverse systems.

21. Large areas are still planted to popular resistant cultivars, which facilitates rapid pathogen evolution and migration to overcome resistance, leading to the so-called "Boom and Bust" phenomenon in agriculture. This has caused the loss of local cultivars with different resistance properties and mechanisms, and ultimately, loss of genetic diversity in production systems.

22. Breeding programs rely heavily on *ex-situ* collection for new genes. Yet *ex situ* collections are snapshots frozen in time, away from the dynamic evolution of the crop and coevolution of pathogens. Farmer who maintain diversity are the custodians of relevant genes for pest and pathogen populations of the future, and less so the keepers of *ex situ* collections of seed that no longer is coevolving. Without the maintenance of viable economic systems that promote the maintenance and continuing evolution of a broad dynamic genetic pool, sustainability of not only 'traditional agriculture' but also industrial agriculture is at risk.

23. Pesticides consumption is increasing all over the world, leading to serious harmful impact on human and environmental health, including the associated crop biodiversity. China is one of the countries with largest amount of pesticide application in the world. The annual demand of pesticide active ingredients in China is up to 1 million tons and the annual spraying is 100 million tons in recent years. Ecuador holds the top fourth position with respect to pesticide consumption and imports high quantity of pesticides. The pesticide poisoning in Ecuador ranks as some of the highest in the world. An excessive pesticide application to control pest and diseases in potato have seriously affected natural enemies and appears to be the main reason for the high incidence of leaf miner in Ecuador.

24. Combating epidemics once they occur is costly to society both in terms of garnering the resources necessary to control them and compensating for the yield losses incurred. For developing countries and resource-poor farmers, compensation, in the form of crop insurance, is not economically viable. Pesticides are prohibitively expensive for poor farmers, and damage human health and ecosystem stability.

25. With financial resources for public sector research as a whole decreasing, and low levels of awareness of the potential contribution of intra-specific diversity to minimize pest and disease pressures on-farm, little public investment is made in understanding the potential of local crop diversity still existing in farmers' fields. The current number of trained personnel able to take

part in and lead the development of activities to support the conservation and use of local crop diversity to minimize pest and disease pressures on farm is also not sufficient.

26. Action that support and promote conservation of crop diversity on-farm is hampered due to lack of information regarding the value of these resources to manage biotic stress. Lack of coordination between agricultural developmental and environmental protection agencies, and to inadequate communication between local scientific and national level organizations and between governmental and non-governmental agencies has exacerbated the problem. Insufficient recognition of the communities who maintain crop germplasm *in situ* has led to the absence of systems for supporting such communities. Government agricultural policies often operate to discriminate against the maintainers of local cultivars, and benefit sharing protocols with local communities are limited.

**Baseline and System Boundaries**

27. Selected crops are the major food staples, and the basis for food security, for a high percentage of low income farmers. Each country contains areas of important crop genetic diversity, significant for the management of disease pressures, traditional farming communities that maintain the diversity, a national-level commitment to conserve crop resources and existing multi-stakeholder efforts upon which the project can build.

28. Evidence of high levels of intra-specific diversity in target crops has been documented in each of the four countries through genebank collections and earlier on farm projects (Annex I). Maize and bean landraces cover 90 percent of the Ecuador highlands. Landraces still cover a significant percentage of land area in remote indigenous areas in the southwestern provinces of China. Evidence of high levels of barley diversity come from on-farm surveys in Morocco, and accessions collected in southwestern China. On-farm studies in Uganda have shown that over 80 locally evolved highland banana cultivars still exist on-farm, and that commonly up to 22 cultivars can be found on any given farm.

29. Earlier on-farm conservation projects, both within and outside of project countries, have developed protocols that work with farmers, using participatory methods, to estimate the number of, and area covered by, different crop cultivars. These protocols include crop specific approaches to determine how consistent are the names and traits farmers use to distinguish their varieties with genetically identifiable units. These methods have been used to quantify the amount of genetic diversity maintained on-farm in Morocco for barley and faba bean, in Mexico for maize and common beans, in Nepal for rice and in Uganda for banana and plantain. However, these protocols have not been adapted to or applied to quantifying amounts of diversity in respect to resistance found on-farm

30. Evidence from all four countries indicates that local crop diversity in respect to pest and disease resistance exists for the target crops within each country. Local germplasm available in national *ex situ* collections continues to contribute to resistance breeding programmes in all four countries. Earlier screening of local varieties of target crops from *ex situ* collections for some of the project-targeted pests and diseases show in country resistance. In China, a total of 137 rice varieties were screened from genebank samples collected from different rice ecological regions in Yunnan Province. These included traditional and hybrid varieties, Indica and Japonica types,

glutinous and non-glutinous ones and upland rice varieties. The diversity of these rice varieties in Yunnan Province was analysis and partners looked for DNA markers related to rice blast disease resistance, to provide a molecular basis for rice disease resistance breeding and efficient utilization of local rice varieties. In Ecuador high levels of resistance for maize, especially to foliar diseases, have been found. In Morocco, local faba bean populations were screened for chocolate spot (*Botryis*) with high levels of resistance found in some local populations on-farm. In Uganda, resistance to *Fusarium* wilt and banana weevil has been found in local plantain populations.

31. The host-pest/pathogen systems selected are those which have well characterized cycles in the literature (Annex L). Pests/pathogens were selected to include coverage of different resistance gene systems (i.e. coverage of systems where resistance is controlled by both major and minor genes), transmission systems (seed-borne, soil-borne and air-borne diseases), and plant organ affected (e.g. leaf, stem, seeds, tubers, roots). The host-pest/pathogen systems selected will serve as important models for ease of replication and diffusion of project methodologies to areas outside the project's geographic scope. Criteria for selecting host-pest or host-pathogen systems, and for selecting project sites, are described in Annex H. Host-pest/pathogen systems and project sites are described in Annex I.

32. The four countries bring different expertise in developing practices and procedures to optimally use crop genetic diversity to minimize pest and disease damage. Partners from China have a wide experience in the use of varietal mixtures based on comprehensive analyses of the resistance background, agronomic character, economic value, local cultivation conditions and the planting habits of farmers. Results from the Yunnan Agricultural University work in using diversity to manage pest and disease by mixed planting of rice varieties to control blast and improve yield has convinced the Chinese Ministry of Agriculture and provincial agricultural departments to evaluate this technique in ten other provinces in China for possible large scale implementation. Partners from Morocco bring to the project the expertise in participatory screening of local crop germplasm, Ugandan partners have worked closely with farmer mixtures and percentages or ratios of different banana varieties in farmers' mixtures, and Ecuadorian partners have a long history of linking formal sector breeding practices with farmer breeding practices.

33. An agreed set of criteria among the countries has guided site selection. These criteria include environmental diversity, social cultural diversity of farming communities, intra-specific diversity of target crops, distribution of pest and pathogens, willingness of communities and local institutions to participate, local institutional capacity, and logistics for site access and are described more full in Annexes H and I.

34. Farmer field schools for farmer-to-farmer training in Integrated Pest Management (IPM) exist within the four countries. However, these schools have concentrated on understanding the agronomic practices that farmers use to manage pest and disease and have had made limited use of local crop genetic diversity in the schools. Little knowledge is available on how farmers make genetic choices, e.g., manage diverse genes in plant populations either to manage single constraints, or as complexes of pests and diseases to minimize crop loss.

35. Earlier projects in the on-farm management of Andean roots and tubers in Ecuador, on-farm management of durum wheat, barley, alfalfa and faba bean in Morocco, and on-farm

management of banana and plantains in Uganda have helped developed some participatory research capacity of Ecuadorian, Moroccan, and Ugandan scientists to work with farmers in the management of crop genetic diversity. The Ford Foundation has supported projects in southwestern China in ethnobotany and forest sociology, which have also developed capacity in participatory methodologies in China, though this capacity is not specifically directed towards supporting the management on crop genetic diversity.

36. Across the four countries there are 41 universities and institutions, both at national and local level, including technical schools, which can provide training to their respective partners at national level in the fields of: agronomy, crop protection, crop physiology, crop breeding and biotechnology, environmental sciences, extension techniques, documentation and communication, social sciences and economics. This information is based on preliminary surveys conducted during the national stakeholders meetings organised during PDF B phase of this project. A detailed list of these universities and institutions is provided in Annex E, the Public Involvement Plan, and in Annex O, Training and Capacity Building Strategy. These countries have good infrastructure and faculty for providing training in agricultural research and development. However, they lack trained manpower and training materials for specialised training courses in the field of plant genetic resources conservation and use and are not linked to community based organizations working with farmers.

37. This project aims to promote the conservation and sustainable use of crop genetic diversity in respect to resistance to pest and disease pressures. Conservation of the resource will support resource poor farmers' production and livelihood strategies and conserve valuable genetic materials globally important to plant breeders, researchers, and local populations who depend on them. The use of crop diversity to manage pest and disease pressures will reduce the need for the application of pesticides that destroy useful and beneficial insects and fungi in the agroecosystem and that also contaminate groundwater. Thus, additional global biodiversity benefits that will accrue through application of this approach will include conservation of insects, fungi, soil microorganisms, and aquatic biodiversity of adjacent ecosystems to the agricultural production system.

**Programming Context: National and International Policy and Action**

38. The importance of agricultural biodiversity conservation for sustainable food security has long been recognised by the Governments of China, Ecuador, Morocco and Uganda. Each of the four countries has developed their respective National Biodiversity Strategy and Action Plan (NBSAP), which include crop genetic diversity.

39. The partner countries have adopted a number of conservation and development plans related to plant genetic resources, agriculture, sustainable use of plant diversity, farmers' rights and benefit sharing mechanisms, pesticides reduction and Material Transfer Agreements. Laws and policy frameworks are continuing to be developed in each of these countries. Preliminary analysis and implication of these laws and policies, in the context of biodiversity conservation and sustainable food production, was carried out for each of these countries during the PDF B phase and are summarized in Annex F.

40. All four countries have signed and ratified the Convention on Biological Diversity (CBD). All countries ratified the Convention on International Trade in Endangered of Wild Fauna and Flora (CITES). All countries, except China, have also signed and ratified the International Treaty on Plant Genetic Resources for Food and Agriculture, which was adopted in the thirty-first FAO conference by unanimity. Ecuador and Morocco are also signatories to Global Crop Diversity Trust. The project supports objectives of Agenda 21 (1992), the Global Forum on Agricultural Research (1999), and the Global Plan of Action of FAO (1998).

41. In addition to the international treaties and policy guidelines, each country has also developed several domestic policies and laws addressing the need for agrobiodiversity conservation, access and benefit sharing, integrated pest management, biosafety and environmental protection:

- ***Access and Benefit-Sharing, Equity and Biodiversity:*** Morocco, Ecuador and Uganda have signed and ratified International Treaty on Plant genetic Resources for Food and Agriculture, which was adopted in the thirty-first FAO Conference by unanimity. Thereby, these countries are committed to conservation and sustainable use of plant genetic resources and the fair and equitable sharing of benefits derived from their use, including farmers' rights, which also includes the protection of traditional knowledge. As a signatory to this treaty, these countries are also committed the establishment of a transparent Multilateral System to facilitate access of plant genetic resources for selected species.

- ***Integrated Pest Management (IPM):*** As part of CBD, governments of all the four countries agreed to "increase food production in a sustainable way and enhance food security (Chapter 14 of Agenda 21). These Governments endorsed IPM, acknowledging its role in sustainable agriculture and rural development. IPM involves choosing a range of appropriate pest control techniques such as resistant varieties, natural predators, and cropping techniques. Annex N gives an overview of national and global IPM programmes and databases.

- ***Safe movement of germplasm and the Cartagena Protocol on Biosefety:*** All four countries are also committed to Article 19 of the Convention to develop protocols on biosafety, specially focusing on transboundary movement of any living modified organism resulting from modern biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity. In addition, Ecuador and Morocco has endorsed the "International Plant protection Convention (IPPC)" to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control.

- ***Pesticide control and environmental and human health*:** For the past two decade, the Pesticide Action Network (PAN) has worked to make voluntary codes and legally binding instruments more effective in reducing pesticide hazards. The International Code of Conduct on the Distribution and Use of Pesticides (FAO code) was adopted in 1985 and amended to include the principle of Prior Informed Consent (PIC) in 1989. China and Ecuador have signed the Rotterdam Convention establishing PIC in International Law. In addition, all four countries are participating in the *Global Information Network on Chemicals (GINC)*, a world information network for safe use of chemicals and provide information for better protection of workers, public health, and the environment

- ***Environmental Law Programme:*** All the four countries are members of the IUCN Environmental Law Programme to advance sustainability through the development of legal and policy concepts and instruments and through building the capacity of societies to develop and implement environmental law and policy, in furtherance of the IUCN Mission, in their respective countries.

42. Diversity of crops extends beyond national boundaries and cannot be adequately conserved by any single country. Regional networks and strategies have emerged as important ways that national programmes can collaborate to conserve and use crop genetic resources. Networks can also promote the safe exchange of material. Supporting regional networks is also one of six major institutional objectives of the International Plant Genetic Resources Institute (IPGRI). All the four countries are part of their respective regional PGR networks in addition to participating in other regional strategies and initiatives (Annex J).

43. A key component of the project will be the recommendation of diversity-rich practices to substitute pesticide use. Links have therefore been made not only of the agricultural sector, but also of the environmental sector for measurements of impact the project could have on environmental and human health. Links will enhance the project in the quantification of improved soil and water quality where diversity rich-practices have been implemented and sharing of information with biodiversity conservation projects concerned with associated biodiversity, i.e., pollinators, soil microorganisms.

44. China participates in the Regional Network for Conservation and Utilization of Plant Genetic Resources in East Asia, established to improve conservation and use of the region's plant genetic resources through information exchange and collaborative activities that are of common interest to member countries. China is a member of the Asian Rice Biotechnology Network, which was established at IRRI in 1993 to help national agricultural research systems institutes in Asia to apply biotechnology tools to improve rice production. China participates in International Network for Genetic Evaluation of Rice, which promotes the exchange of rice germplasm and information. China is also a member of Tropical Asian Maize Network, whose objective is to strengthen hybrid maize technology in the Asia-Pacific region through effective voluntary cooperation in product testing, germplasm exchange, information dissemination, consultation, training and periodic meetings and workshops.

45. Ecuador participates in three plant genetic resources networks: the Andean Plant Genetic Resources Network, the Amazonian Network on Plant Genetic Resources, and the Central American Network on Plant Genetic Resources, which aim to strengthen national capacities for plant genetic resource conservation through regional cooperative activities. Ecuador is a participant of the UNEP/GEF project on "Conservation of the Biodiversity of the Paramo in the Northern and Central Andes. Ecuador is a member of Andean Community of Nations (CAN) and has endorsed the CAN's Decision 391, which promotes the creation of Standard Regulations of Access to Plant Genetic Resources and Decision 345, which deals with intellectual property rights of plant varieties. Ecuador, along with other 11 other countries has signed the Declaration of Cancun and Declaration of Cusco – 2002 to recognise the importance of these mega-diversity countries for protection and conservation of diversity for global benefits. In addition, Ecuadorian partners are closely linked to two Andean initiatives; "Participatory research on Andean crops" and "Use of clean technologies for the banana production with small-scale

farmers" to be implemented through national agriculture research institutes (NARIs) of Venezuela, Ecuador, Peru and Bolivia."

46. Morocco is a member of The West Asia and North Africa Network on Plant Genetic Resources. Morocco leads the Faba Bean Research Network for the Maghreb supported by the EU for the development of methodologies and approaches for improving *Vicia faba* cultivars for resistance to major diseases and better adaptation to the Mediterranean conditions. Morocco is a member of the Mediterranean Network on Nitrogen Fixation and leads the grain legume component of the EU funding initiative on Modulation of plant-bacteria interactions to enhance tolerance to water deficit for grain legumes in the Mediterranean dry lands. Morocco has signed regional conventions for the protection of the Mediterranean against pollution and the protection of biological diversity, with the Middle East for the protection of the plants, and with the African continent on the natural resource and nature conservation and plant health.

47. Uganda is a member of the Eastern Africa Plant Genetic Resources Network (EAPGREN), which has a tripartite focus on capacity building, research and development of PGR support services. Uganda is also a member of the Banana Research Network for East and Southern Africa (BARNESA). Uganda is a member of the UNEP/GEF project on "Promoting Best Practices for Conservation and Sustainable Use of Biodiversity of Global Significance in Arid and Semi-Arid Zones" and the UNEP/GEF project on "Community-based Management of On-farm Plant Genetic Resources in Arid and Semi-arid Areas of Sub-Saharan Africa".

48. At the national level, the four countries have made appropriate linkages to existing projects and planned projects of country components of project within their countries:

- Project partners in China have developed close collaboration with the Ministry of Agriculture to implemented UNDP/GEF Comprehensive Agriculture Development and Biodiversity Conservation Programme. Linkages have been developed with Ford Foundation's program in Environment and Development, and the project will be working with Ford Foundation national partners from project in southwestern China in Sustainable Community Forest Management and Minority Culture and Natural Resources. The project complements the UNDP/GEF project on "Conservation and Sustainable Utilisation of Wild Relatives of Crops" which is concerned with protected areas wild relatives rice among other crops. Chinese partners have made links with the UNDP/GEF project on "Multi-agency and Local Participatory Cooperation in Biodiversity Conservation in Yunnan's Upland Ecosystem.

- Project partners in Ecuador have developed close links with the "Proyecto de Resistencia Duradera para la Zona Andina", which will provide a framework of knowledge and additional resistant material for farmers. Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), the project executing agency has also worked in close collaboration with the "ECOSALUD" (Refers to focus on ecosystem and their impact of human health) project to quantify the negative effects and assist farmers in the reduction of pesticide use through implementing of IPM programs. Ecuadorian partners have formed linkages with several national projects such as the recently funded by McKnight projects on, "Cover agriculture in the highland Andes", "Enabling Seed Systems: The biological foundation of food security in the Andes", and "Food security with Andean grain in Cotopaxi-Ecuador." Project partners have close links with FAO supported

Ecuador Farmers Field School (FFS), and with the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) in Ecuador, including a GTZ supported project to promote gender equity in policy makers in the region.

- The co-ordinating institute in Morocco, the Institut Agronomique et Vétérinaire Hassan II, Rabat is well-linked to the Moroccan National Research Institute, NGOs, and the Ministry of Agricultural and its extension service through the framework set up in the IPGRI supported global project on "Strengthening the Scientific Basis of *In Situ* Conservation On-farm". Moroccan partners are also linked to the UNDP-GEF supported project to promote the maintenance and better use of the data palm diversity present in North Africa. Project partners in Morocco are also providing information in the development of the UNDP/GEF project on "Conservation and Sustainable Management of Globally Important Ingenious Agricultural Heritage Systems (GIAHS)."

- Uganda project partners have made linkages with the Department of Soil Science, Faculty of Agriculture, Makerere University and the National Agricultural Research Organisation (NARO) through two of its research programmes - National Banana Research Programme and the National Plant Genetics Research Programme, and to two community based organisations – Bushenyi Banana and Plantain Farmers' Association and Masaka Banana Farmers' Association, who are currently participating in the regional project, "Utilisation of banana (*Musa* spp.)- based bio-diversity to improve livelihoods." Linkages have been made with Ugandan country component of UNEP-GEF project on "Conservation and sustainable management of below ground biodiversity" to collaborate on measurements of below-ground biological diversity to measure the impact of substituting diversity rich practices for pesticide.

49. The project builds on the experiences and capacity developed by the UNEP GEF supported UNU-led People Land management and Environmental Change (PLEC) programme. Participants of the PLEC programme actively contributed to stakeholder meetings in Uganda and China during the PDF-B phase of the project. During the last four years IPGRI has hosted two joint international meetings with PLEC partners to facilitate exchange of experiences in the field of agriculture biodiversity management on-farm, resulting in a IPGRI/PLEC/CBD collaborative book, currently in press, on the Management of Biodiversity and Agricultural Ecosystems.

50. The proposed project is consistent with the priorities of the GEF OP#13 "Conservation and sustainable use of biological diversity important to agriculture", and supports the objective "to promote the positive and mitigate the negative impacts of agriculture systems and practices on biological diversity in agro-ecosystems and their interface with other ecosystems; the conservation and sustainable use of genetic resources of actual and potential value for food and agriculture...".

51. The project directly supports all four objectives of the Convention on Biological Diversity (CBD) programme of work on agricultural biodiversity, adopted through decision V/5 at the fifth meeting of the Conference of the Parties of the CBD. More specifically, it relates directly to each of the four objectives of the CBD programme of work for agricultural biodiversity:

- *Objective 1:* Assessment of agricultural biodiversity. The project responds directly to Activity 1.2. "Promote and develop specific assessments of additional components of

agricultural biodiversity that provide ecological services", and Activity 1.3. "Carry out an assessment of the knowledge, innovations and practices of farmers and indigenous and local communities in sustaining agricultural biodiversity and agro-ecosystem services for and in support of food production and food security".

- *Objective 2:* Adaptive management. The proposed project responds directly to the CBD programme of work for agricultural biodiversity Activity 2.1 "to carry out a series of case-studies, in a range of environments and production systems, and in each region". It specifically addresses "(b) The role of genetic diversity in providing resilience, reducing vulnerability, and enhancing adaptability of production systems to changing environments and needs"; and "(f) Pest and disease control mechanisms, including the role of natural enemies and other organisms at field and landscape levels, host plant resistance, and implications for agro-ecosystem management".

- *Objective 3:* Capacity building. The proposed project responds directly to the CBD's programme of work for agricultural biodiversity Activity 3.1, "Promote enhanced capabilities to manage agricultural biodiversity by promoting partnerships among researchers, extension workers and farmers in research and development programmes for biological diversity conservation and sustainable use of biological diversity in agriculture…", Activity 3.2 "Enhance the capacity of indigenous and local communities for the development of strategies and methodologies for *in situ* conservation, sustainable use and management of agricultural biological diversity, building on indigenous knowledge systems", and Activity 3.3 "Provide opportunities for farmers and local communities, and other stakeholder groups, to participate in the development and implementation of national strategies, plans and programmes for agricultural biodiversity, through decentralised policies and plans, and local government structures."
- *Objective 4:* Mainstreaming. Project design incorporates diffusion of the resulting principles and approaches into all levels of decision-making, from the local farmer, farmer organisations and extension programmes, to national and global level policy fora. Under this objective, the project responds directly to the CBD's programme of work for agricultural biodiversity Activity 4.1 "Support the institutional framework and policy and planning mechanisms for the mainstreaming of agricultural biodiversity in agricultural strategies and action plans, and its integration into wider strategies and plans for biological diversity.

52. The project is consistent with Strategic Priorities Two and Four in Biodiversity for GEF Phase III. The project will: a) develop globally applicable and relevant criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pests and diseases in agroecosystems; b) demonstrate replicable best practices that determine how to optimally use crop genetic diversity to reduce pest and disease pressures; and; c) support the mainstreaming of agrobiodiversity conservation and sustainable use strategies beyond site-specific successes by effectively disseminating project tools, methodologies, practices and policies to stakeholders (farmers, community organisations, universities, government ministries) that are involved in sustainable use and conservation of agrobiodiversity. For policy makers and government officials, the results will support implementation of national policy that which supports the reduction of pesticide use and biodiversity conservation (Annex F).

RATIONALE AND OBJECTIVES (ALTERNATIVE)

53. This proposed intervention aims to provide a framework of tested management practices that can support use of genetic diversity to mitigate the effects of pests and pathogens. It will bring together farmer knowledge and experience with information from agricultural research work. On the basis of selected model studies on crop-pathogen systems throughout the world, it will develop the tools and capacities needed to determine what diversity-based approaches are desirable and how they should be deployed. It will identify techniques and approaches that can be replicated to areas and crops outside those selected for the project. It will help build the frameworks for sustainable partnerships between farmers, extension workers, national research institutes, government ministries and others. These frameworks will serve as models for other parts of the world.

54. The intervention complements and extends IPM strategies by using and managing local crop cultivars themselves as a key resource, making use of the intra-specific diversity among the cultivars maintained by farmers. For resource-poor farmers in developing countries, local crop diversity and its management may be one of the few resources and options available to combat pest and disease pressures and this will provide strong motivation for adoption and replication of this ecologically sound agricultural practice.

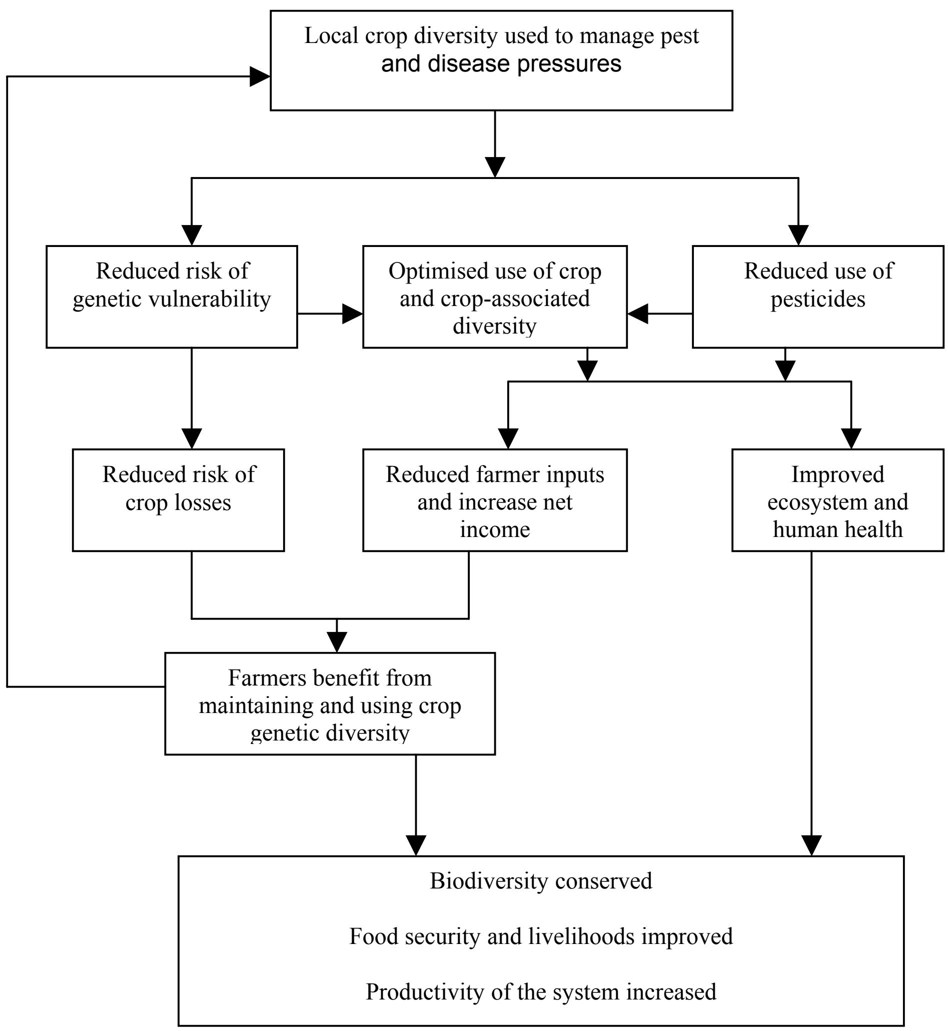
55. The project aims to increase the use of "diversity rich" solutions to manage pest and disease pressures for small and marginal farmers. They will be used by the farmers, community based organizations, development and extension workers, NGOs, NARS research scientists, breeders, environmental health workers and policy makers. Farmers will use the information and materials when the methods and materials reduce crop vulnerability to production and income losses. The approach will provide environmental health workers with an alternative to the unsafe pesticide use. Crop breeding programmes will be more effective through increased use of local resistant materials and new methods to reduce crop vulnerability.

56. Local crop genetic diversity will be maintained as it becomes clear that it contributes to sustainable production and farmers' livelihoods. Tools and practices will be provided that can be used to support farmers around the world to conserve local crop diversity which, through its use, can minimize pest and disease damage. Practices will include diversity rich options to substitute pesticide use. IPM strategies will be complemented and extended globally to include the use of local crop cultivar diversity as an important resource. Ultimately, these results will support biodiversity conservation, improve ecosystem health and increase food security.

57. National partners selected crops, pests and diseases to cover a range of systems and circumstance so that the methodologies developed could be replicated and applied to other systems. The project crops, rice (*Oryza sativa*), maize (*Zea mays*), barley (*Hordeum vulgare*), common bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), banana and plantain (*Musa spp),* cover a range of breeding systems (inbreeding, outcrossing, partical outcrossing, and clonal) and farmer management systems (managed as populations versus managed as single plants). Pest and pathogens cover those that are determined by major and minor genes (one gene or a complex of genes provide resistance), seed-borne, soil-borne and air-borne diseases, and pathogens or pests affecting different plant organs (aerial and roots). All four countries, China, Ecuador, Morocco

and Uganda, contain areas of important crop genetic diversity for these crops, including different types of resistance to major pests and pathogens in their local crop cultivars maintained in traditional farming systems. The countries have at least two target crops in common with another partner country, linking diversity of primary centres of diversity to secondary centres of diversity, in-country initiatives exist upon which the project can build, and each country's demonstrated commitment to conservation of agrobiodiversity. Details of crop, pest, disease and sites, together with their selection criteria are listed in Annexes H and I.

58. The fundamental approach for achieving the goal of this project is illustrated in the following flow chart.



59. The development objective of the project is to conserve crop genetic diversity in ways that increase food security and improve ecosystem health. This will be shown through local and indigenous communities' increased and more reliable food supply through the use of crop genetic diversity to minimize crop loss, and through diversity-rich practices used to replace pesticide use. The immediate objective of the project is to enhance conservation and use of crop genetic diversity by farmers, farmer communities, and local and national institutions to minimize pest and disease damage on-farm. Measurement of project progress and achievement of the project's immediate objective will be based on the land acreage that will contribute to the conservation and sustainable use of crop genetic diversity in respect to minimizing pest and disease damage (at least 356,000 ha of land) and the number of departments of agriculture and the environment and local and national institutions in each country that have incorporated crop genetic diversity-rich practices to minimize pest and disease pressures into their development plans.

60. The project has three anticipated outcomes:

*Outcome 1:* Rural populations in the project sites benefit from reduced crop vulnerability to pest and disease attacks.

*Outcome 2:* Increased genetic diversity of target crops in respect to pest and disease management

*Outcome 3*: Increased capacity and leadership abilities of farmers, local communities, and other stakeholders to make diversity-rich decisions in respect to pest and disease management.

Measurement of progress and achievement of these outcomes will be based on seven impact indicators:

i. Food insecurity is reduced for 10% of the families in 31 local and indigenous communities.
ii. Crop yields are increased by 10% from reduced crop losses from disease and pest damage for at least 20% of the farms (equivalent to 52,600 ha) in project sites.
iii. Diversity-rich practices replace pesticide use to minimize crop damage for 15% of project site regions (equivalent to 106,900 ha).
iv. Diversity for resistance is increased by 10% on 30% of farmer fields in the project sites (equivalent to 78,900 ha).
v. Use of crop genetic diversity to manage pest and disease pressures occurs on 20% of the farms (equivalent to 142,600 ha) in the project site regions in four countries.
vi. At least 20% of the farmers of the project site regions (equivalent to 6,200 families) implement diversity-rich methods developed in the project to increase use of crop genetic diversity to manage pest and disease pressures on-farm.
vii. At least two male and female farmer representatives in each site have participated in national committees or decision making fora for planning and evaluation of diversity-rich methods to manage pest and diseases.

Specific Activities for Phase I, together with Milestones, and Objectively Verifiable Indicators for Phase I are listed in Annex B1: Phase I: Objectively Verifiable Indicators and Milestones.

61. Economic impact will also be measured using methods and tools tested and made available by year four of the project to estimate the value of crop genetic diversity in reducing yield losses, and in mitigating product quality losses from pest and diseases (see Annex B, Output 1, Objectively Verifiable Indicator 1.3).

62. Global benefits of the project are: (1) the conservation of globally significant crop genetic diversity in respect to resistance to pests and diseases, (2) the conservation of associated biodiversity due to decreased pesticide use, and (3) the development of practices that use local crop genetic diversity to manage pest and diseases that can be applied both within and outside the four project countries.

63. Domestic benefits include: (1) increased availability and use of "diversity rich" low cost solutions to manage pest and disease pressures for small and marginal farmers, (2) capacity to make decisions by the farmers, community based organizations, development and extension workers, NGOs, NARS research scientists, breeders, environmental health workers and policy makers on when and where local crop genetic diversity will be useful to minimize pest and disease pressures, (3) increased and more reliable food supply for local and indigenous communities through the use of crop genetic diversity to minimize crop loss, and (4) increased land area contributing to the sustainable use of crop genetic resources. The approach will provide environmental health workers with an alternative to the unsafe pesticide use. Crop breeding programmes will be more effective by increased use of local resistant materials and new methods to reduce crop vulnerability and the development of benefit sharing protocols with farming communities.

## PROJECT ACTIVITIES/COMPONENTS AND EXPECTED RESULTS

64. During the PDF-B phase, project components were tested, assumptions analyzed, and stakeholder groups identified. The resulting analyses have guided the implementation of the project intervention, which comprises four components: (1) Criteria and Tools; (2) Practices and Procedures; (3) Capacity and Leadership; and (4) Mainstreaming and Replication. These four components led to the formulation of four project outputs. All four project outputs contribute to the achievement of each of the three project outcomes and are therefore listed together after the project outcomes in the project logical framework (Annex B). The project intervention will develop criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pests and diseases by integrating existing farmer knowledge, belief and practices with advances in the analysis of crop/pest and disease interactions. Practices and procedures that determine how to optimally use crop genetic diversity to reduce pest and disease pressures will be made available. The capacity and leadership of farmers and other stakeholders to use local crop genetic diversity to manage pest and pathogen pressures will be enhanced. Best practices will be supported, mainstreamed and replicated.

The complete list of indicators per output can be found in Annex B.

### Criteria and tools

*Output 1: Criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting damage caused by pests and diseases*

65. While it is known that crop genetic diversity can be used to reduce pest and disease pressures, it is also known that this approach is not appropriate in all circumstances. Criteria will be developed to determine when and where diversity can play or is playing a key role in managing pest and disease pressures. These criteria will form the basis for tools and decision-making procedures for farmers and development workers to enable the appropriate adoption of "diversity-rich strategies" to manage pests and diseases.

66. National partners are jointly developing global participatory diagnostic protocols which will standardize research protocols. A draft protocol for participatory diagnosis for (i) farmers' beliefs and practices and (ii) field and laboratory assessment was begun during the PDF B phase based on outputs of the initial planning workshop in Spoleto, Italy before the PDF-B phase as well as subsequent global workshops on participatory planning and diagnostic tools and is found in Annex G. Decisions were made on types of information to come from focus groups discussions (FGD), individual surveys, secondary sources, and technical assessment (field and laboratory) for the target crops, pests and pathogens. In each site there will be a minimum of five FGD sessions, one each for a) older farmers, b) male farmers, c) women farmers, d) community leaders and e) extensionists. Individual surveys will be disaggregated by gender.

67. Technical assessment will include characterization of hosts, pests, pathogens and surrounding abiotic environments. For maize, faba bean and common bean, care will be taken to collect large enough seed samples to allow for the screening for diversity within a sample, and to note all descriptive information by farmers. For plantain, plants will be mapped within populations/sites based on morphological and resistance traits. Initial standards for experimental design and sampling by crop will be decided upon by project partners during the first six months of the project.

68. The protocols go much further than providing guidance to produce descriptions of host-pest/pathogen systems on-farm. These protocols are being refined for development of a six step decision making tool. The steps are listed below that will enable the determination of when the use of crop genetic diversity on-farm would be an appropriate option to minimize crop loss due to pest and diseases. Each step includes assessments of farmers beliefs and practices and measured data. Components and guiding questions for methodology development for each step are detailed in Annex G.

*Step 1*. Are pest and diseases viewed both by farmers and scientists as a significant factor limiting production? If so –

*Step 2*. Does intra-specific diversity with respect to pests and diseases exist within project sites and if not, whether other sources of intra-specific diversity with respect to pest and diseases exist from earlier collections or from similar agroecosystems within the country? And/or –

*Step 3*. Does diversity with respect to pest and diseases exist but is not accessed or optimally used by the farming communities? If so --

*Step 4*. Is there diversity in virulence and aggressiveness of pathogens and/or diversity in biotypes in the case of pests?

*Step 5*. Are, and if so how are, pest and diseases moving in and out of the project sites, including the role of the local seed/propagation material systems?

*Step 6*. What "genetic choices" do farmers make, including using or discarding new and old genotypes, selecting criteria for hosts that are resistant, and managing mixtures to minimize crop loss due to pest and diseases?

69. Step 1 is used to ensure that before investment in resources for project implementation, is in areas where specific pest and disease problems are identified as being of major issue to farmers.

70. Step 2 includes quantification of the amount and type of diversity of local crop varieties on farm not only for identifying resistant varieties, but also for understanding the potential tradeoffs among resistant and non resistant varieties in terms of production and quality traits preferred by local communities. Participatory protocols, developed through earlier projects in Morocco (barley and durum wheat), Mexico (maize and common beans), Nepal (rice) and Uganda (banana and plantain), that exist to determine whether the same named varieties from within and among different regions are genetically the same, will be modified for participatory determination of to what extent variety names and traits used by farmers to describe these varieties, can be used to identify amounts of diversity in respect to resistance found on-farm.

71. Resistance may exist in project sites or in earlier collections from project sites, or similar agroecosystems with in the target countries, that is not being optimally used on-farm. Farmers may be using varieties for other purposes not associated with minimizing pest and diseases, or they may not be able to access materials that they know are resistant. In Step 3, barriers and constraints, including social, economic and knowledge barriers to diversity access will be examined.

72. Step 4 includes surveys of pathogen variation (e.g., screening samples of isolates against a range of crop genotypes), and pest biotypes. Measurements will be made on insect pests and pathogens of importance and the time of their occurrence; varieties will be surveyed *in situ* for infestation levels at the appropriate times. Step 4 includes gaining an understanding of farmer classification systems for pests and pathogens. Perceptions by farmers of pests and diseases variation, including whether farmers perceive that varieties are becoming more susceptible over time or more susceptible when planted in different plots or environments, and whether pesticides have become less affected will help provide insights to the reasoning behind pest and disease management practices and the management of genetic diversity. A detail quarantine strategy will be worked out in each country for each host - pest or pathogen system as part of the research protocols. Particular care that both field and glasshouse or lab experiments do not introduce aliena biotypes or pathotypes.

73. Step 5 is concerned with the mechanisms that are responsible for movement and transmission of pest and diseases within and among communities, and thus requires an understanding of the mechanisms and components of local seed systems. Identifying which persons or groups are involved in movement of seeds and other propagating material, and their

awareness of pest and disease transmission mechanism will be key for mainstreaming and replicating practices involved with seed and clonal cleaning discussed later in this document.

74. Step 6 leads the decision maker into an understanding of farmer management practices which use crop genetic diversity. Do farmers use mixtures; how are the mixtures arranged? Do farmers select for resistance: do they choose particular varieties because they have known resistant traits, do they select particular plants within a variety to have a more resistant population, do they plant particular parts of their fields for seeds to be used the next generation? Answers to these questions will guide the development or practices and procedures that enhance the use of genetic diversity to minimize pest and disease pressures.

75. In addition, econometric methods will be developed to test the effects of crop genetic diversity on expected crop yields and yield variability as well as the probability of crop failure, given levels of pesticides applied. The estimated, stochastic production function can then be used to simulate the pesticide-crop genetic diversity relationship to investigate the degree of substitutability of crop genetic diversity for pesticides. The production function requires data on yields, pesticide application, and levels of all other production inputs (e.g. labor and management, land, animal traction, fertilizer). Since substantial differences between farmer conditions and trial conditions are typical, the function will be applied to data generated in researcher-managed trials and recorded with farmers. Indicators on the role of crop production and losses in household vulnerability (food insecurity and income instability) will also be developed and applied with participatory research tools.

76. In order to provide scientific backstopping to project activities, a database for a national as well as an international roster of experts has been developed and will be continued during the project duration. This database will be made available on the project website, where project partners will be looking for assistance at national and international levels.

**Practice and Procedures**

*Output 2: Practices and procedures that determine how to optimally use crop genetic diversity to reduce pest and disease pressures.*

77. Scientists and farmers will together test and implement approaches to use within-crop diversity in different production situations to reduce pest and disease pressures. Practices and procedures for effectively and efficiently using crop genetic diversity as a response to pest and disease pressures will then be developed. Determining the effectiveness of the different diversity deployment strategies for the different crop/pathogen interactions will allow the identification of general criteria for adopting a diversity-based approach. Generally applicable criteria, guidelines and decision-making tools will be developed. These criteria will be used to identify new systems and sites to reduce genetic vulnerability to pest and disease pressures through the use of genetic diversity management.

78. Traditional local varieties often possess substantially more diversity than found in modern cultivars. They may also provide different kinds of resistance than those found in modern cultivars. Farmers may already be using this diversity in the form of mixtures or diverse local cultivars. In addition, procedures may be used to increase the number of varieties, to vary variety mixtures to include cultivars with more diversity. Multi-lines may also be used, and resistant

varieties may be inter-planted with other varieties to break disease spread. Practices and procedures to be tested can be grouped into four categories:

(1) Identifying and replicating farmer knowledge and practices in on-going systems where intra-specific diversity is being used to manage pest and disease pressures and promote good practices.
(2) Conducting experiments using intra-specific diversity that show the effect of diversity on controlling pest and disease incidence;
(3) Linking national breeding and farmer selection practices to manage pest and disease pressures experience; and
(4) Conducting simulation modelling to look at how patterns of intra-specific diversity distribution and population sizes might affect pest and disease incidence over space and time.

79. One of the strengths of farmer genetic diversity is that is has been used as a very flexible tool to adapt available germplasm to often highly variable conditions. Farmers' mixtures are developed to site-specific disease and pest pressures, soils, slope, temperature humidity, and fertility. Thereafter a variety is added to the established mixture of a specific field as a proportion determined by the farmer. If mixtures were not managed they would soon dominated by one or two varieties. In areas where farmers have long established themselves and have finely tuned mixtures new germplasm is much welcomed, but first tested separately in the various fields to see if and where best the varieties perform. Activities will examine existing methods of managing mixtures to determine if similar pratices can be replicated to other sites.

80. The project will test whether single varieties grown pure could outperform such tuned mixtures over the wide range of environments in non-favored and often hilly or mountainous regions. A complicating factor in evaluating new germplasm is the correct use of controls to evaluate new varieties. Given that by nature farmer mixtures are highly locally tuned for performance, not just any local landrace or mixture can act as a fair control in selection and yield trials.

81. Based on experience from the Chinese partners, varietal mixtures will be developed based on a comprehensive analysis of the resistance background, agronomic character, economic value, local cultivation conditions and the planting habits of farmers. In their previous work the Chinese partners used modern resistant varieties to "protect" more susceptible local varieties in mixtures. For this project they will be challenged in the use of local mixtures, and resistance found in local germplasm in indigenous areas where local diversity still exists to minimize pest and disease pressures.

82. There are a number of areas where the formal breeding sector might usefully make additional contributions to maintenance of local crop genetic diversity. The project will include an evaluation of past and present use of crop diversity by national breeding programmes to manage pest and diseases. Comparisons will be made among selection criteria and methods of formal breeders and farmers. Options will be explored for strengthening supplies of important local cultivars by national gene banks.

83. Breeding will focus on increasing desirable characteristics in local resistant varieties, and increasing the resistance of local varieties preferred by farmers. Participatory processes will be used to develop and test these materials locally.

84. Simulation modelling, as proposed in the project activities, will help for testing over space and time the impact these different practices could have on the sustainability of crop yield stability.

85. These practices and procedures will be tested and validated at project sites, in farmers' fields. The different range of diversity-rich practices and options will be compared to determine appropriate spatial and temporal scales to manage pests and diseases. This will include providing different mixtures of local germplasm from project site materials and earlier collected materials (including from *ex situ* collections) from project sites and similar agroecosystems, and promoting interchange of resistant materials among farming communities from the same sites as well as between sites. Quarantine issues are of extreme importance. Protocols will be developed for exchange of resistance plant materials within and among countries, however, aliena biotypes or pathotypes will remain within their country of origin.

**Enhanced Capacity and Leadership**

*Output 3: Enhanced capacity of farmers and other stakeholders to use local crop genetic diversity to manage pest and pathogen pressures.*

86. The project is driven by a clear appreciation by all project partners of the central role of the farmer in managing crop genetic diversity and of the importance of adopting working practices that are fully participatory and start from a desire to reflect farmers' needs and concerns in diversity management. Experience of working on the management of agricultural biodiversity has demonstrated that not only do participants need the capacity to employ those activities relevant to their specific work or role, but also they must be able to rely on strong working relationships with other stakeholder groups. These working relationships will be developed through training in participatory approaches and team building among farmers, farmers' organisations, NGOs, local and national research and educational institutes, government ministries, and international institutes.

87. Different knowledge of women and men, and the importance to ensure equitable benefits from the project outputs requires not only that information be disaggregated by gender but that training and management opportunities be equitably distributed. In response to this, activities in the Logical Framework (Annex B) include not only enhancing farmer's leadership ability to take decisions concerning the management of pest and diseases but also actively ensuring women's participation in technical and university training programmes and decision making fora. Farmers and farmer groups will be targeted for capacity-building to manage their production systems with diversity rich options to manage pests and diseases. This includes training in biological sciences, diversity assessment, and seed management for pest and diseases. The seed activities of local farm organisations will be strengthened to integrate pest and disease considerations.

88. Community biodiversity management approaches used in this project will facilitate the development of strong ownership of the conservation and development activities by local communities and by local and national researchers, development workers, and policy makers.

This will result in nationally supported initiatives, where communities will be prepared to develop their own work plan and generate their own resources and information systems to guide the activities.

89. The capacity of local institutions to sustain project activities will be enhanced through training and inputs to local extension, NGOs, middle and technical schools and local colleges. Teachers at primary schools will also be involved in the process through training which could improve understanding at community level. Capacity will be built in research institutes to analyse local crop diversity in respect to pests and pathogens. Capacity will also be build to apply new econometric methods and tools in assessing the value of crop genetic diversity, and manage the information. The project will build capacity to analyse national and international legal and economic policies related to project objectives.

90. A National Research Center for Agriculture Biodiversity (NRCAB) will be established and operative at the Yunnan Agricultural University (YAU), Kunming, China. This center will focus on three key areas: agricultural biodiversity and pest and disease control; agricultural biodiversity and its conservation and use; and crop modeling, technology development and extension activities for agriculture biodiversity to enhance sustainable economic development. During PDF B phase, it has been agreed that this center will provide training at global level for use of crop diversity to manage pests and diseases problems in traditional farming systems, using both local and high yielding varieties.

91. During PDF B, opportunities were explored for linking higher degree programmes supported by co-funding (M.Sc. and Ph.D.). During the full project "sandwich" Ph.D. programmes will be designed between Washington State University (WSU), Oregon State University (OSU) and Cornell with the Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco, and Makarere University, Kampala, Uganda. Washington State University is taking the lead in providing a collaborative arrangement among the three US universities. A sandwich Ph.D. programme is also being designed between University of Kassel, Germany and universities in Ecuador. Students who enter the sandwich programmes will complete their course work in the US or a European university and return to their respective countries to complete their research work at the project sites. A feature of the programmes is the student's thesis research, which will focus on major research questions of the project logframe. Another important dimension of the sandwich programmes will be the appointment of qualified respective national university faculty as adjunct faculty in relevant departments at WSU and the appointment of qualified WSU faculty as adjunct at the respective national universities.

92. Training needs were identified through a consultative process during national planning meetings, where representatives of all major project stakeholders participated in each country. Based on strengths and weaknesses, a training strategy was developed for each country and the training needs were listed. Details of the training and capacity building needs are described in Annex O, Training and Capacity Building Strategy.

**Mainstreaming and Replication**

*Output 4: Actions that support adoption of genetic diversity rich methods for limiting damage caused by pests and diseases.*

93. Sustainable application of benefits derived from the project will require integration of the knowledge gained into all levels of agricultural and environmental practices and development. Mainstreaming will move the project beyond site-specific successes to strategies for diffusing beneficial techniques into practices and policies from community to global levels. It is this process that ultimately allows replication of project results, and adds significant global value to the project investments.

94. The four national executing institutions are primary institutions in their respective countries for mainstreaming project results. The Yunnan Agricultural University close collaboration with the Chinese Ministry of Agriculture has resulted in the expansion of mixed planting of rice varieties to manage pest and diseases to ten other provinces in China. The Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Ecuador has more than 40 years of research and extension activities in the country and has contributed significantly for pests and diseases problem management in potato and agrobiodiversity management of local roots and tubers at national level in partnership with several international organizations. The Morocco Ministries of Agricultural and the Environment jointly awarded the Institut Agronomique et Vétérinaire (IAV) Hassan II, Rabat, Morocco in 2004 the National FAO World Food Award for its work in improving food security through the use of crop genetic resource in Morocco. The National Agricultural Research Organisation, Entebbe, Uganda is the overall government institution in charge of all agricultural research and has contributed significantly for client-oriented agricultural research and dissemination for small-holders farmers and mainstreaming fight against cassava mosaic disease epidemic in Uganda.

95. Successful experiences and comparisons of diversity rich options to others (e.g., agronomic practices, chemical use) will be documented and published in different media forms, farm field visits will be organised for policy makers and the press, and cross site visits will be organised for farmers. Field visits will illustrate the benefit of specific technologies and operations on demonstration plots, such as seed cleaning and treatment effects on seed quality, production practices, and results of participatory selection.

96. Seed supply systems are often one of the most vulnerable components of diversity management at local level. Strong seed supply systems enable farmers to maintain a high level of crop genetic diversity over time, despite losses of seed stock, bottlenecks, and other regular or unanticipated losses of crops genetic diversity. Activities within the project are aimed at developing and/or strengthening local systems that enhance seed security, through promoting the control of seedborne or clonal material diseases is a priority, and includes the role that might be played in enhancing the capacity of farmers to deal with post-harvest pests.

97. Collaboration between agricultural extension services and local NGOs will be promoted to increase access of locally-adapted farmer seeds across villages and regions with similar agroecosystems. Diversity fairs, site demonstration plots of selected *ex situ* collections and promotion of seed interchanges through local nodal farmers will be used. Inclusion of local crop diversity and techniques on seed cleaning of local crop cultivars, other methods of seed quality improvement and use of diversity in pest and disease management will be mainstreamed into agricultural extension, NGO development packages, and educational curricula. National breeding strategies will be adapted to include farmers' knowledge and materials in breeding programme.

98. An economics methodology will be developed to estimate the effects of these diversity rich practices of crop genetic diversity management on expected yield losses, yield variability, and downside risk, or the probability of crop failure. These effects, when valued by relevant prices, constitute the insurance value of crop genetic diversity. In cases where pests and diseases affect product quality, the value of crop genetic diversity in mitigating quality differentials will also be measured. The extent to which crop genetic diversity is an effective substitute for pesticides in reducing yield losses will be assessed. If it does substitute for pesticides, three types of benefits result. First, farmers save cash outlays in terms of input costs. Second, the deleterious effects of unsafe pesticide use on human health are avoided. Third, environmental externalities, such as the risk of losses to other species and aquatic diversity, are reduced. Where feasible in the project timeframe, methods will be developed to estimate the ecosystem support value of crop genetic diversity.

99. Part of participatory research involves making sure that data are of some use to the communities from which they are being elicited and returning these data in a user-friendly format. Data collected through on-farm research, such as compilations of diversity resistance of local crop varieties, will be useful to communities for use in community information systems. These include community-based registers or records, kept in a paper or electronic format by community members, of all landraces in a community, including information on their custodians, agroecological characteristics or adaptive traits, and cultural use. Posters or displays in vernacular languages will be used to present written information. Cultural knowledge such as folk songs highlighting the importance of local crop diversity and pest and disease management can be published and disseminated to communities in vernacular languages. Other public awareness strategies, such as Diversity Fairs and Diversity Theatre, can be utilized to share information with a wide audience and have the advantage of reaching beyond the literate population. As always with participatory work, community members will be involved in deciding the most useful strategies for sharing the information generated through such collaborative research.

100. Workshops will be organised at the province and county levels of each site designed to feedback results generated to a multi-stakeholder group. Workshops will be attended by highest level representatives of all the provincial and local authorities under different ministries (Interior Affairs, Agriculture, Environment, Economy and Finance, Education), NGOs, farmers directly involved in the project and farmers from all over the Province, representatives of staff from provincial schools and universities, and newspapers and radio commandeers. Meetings will be organized in local languages and include presentations and discussion of messages related to the conservation strategy based on generated data, exhibitions of variety samples and related technologies developed by the project, farmers' and professional (NGOs, development) view of the proposed strategy.

101. Policy briefs and extension manuals will be developed demonstrating economic value of use of crop diversity, curricula for local schools, modified extension packages on the use of diversity, and benefit sharing mechanism, all will promote the public awareness for sustainable use of crop diversity on farm and policy support to national programme and donor concern for sustainability of the project over space and time.

102. Through the regional networks described under Programme Context, the project will see that the outcomes are shared with the respective network member countries through active

participation and linking project activities. The project will also support regional meetings, where the respective network members countries will be supported for their participation.

103. Analyses will be carried out of legal and economic policies related to project objectives, including an analysis of potential barriers to adoption of the best practice demonstrated in the project and the development of benefit sharing protocols for the use of local resistant materials. The aim is to build recognition amongst institutions and in policy fora that the project methodologies provide an effective and efficient approach to managing pest and disease pressures.

## RISKS AND SUSTAINABILITY

104. The project carries with it a number of assumptions (detailed in the project logical framework, Annex B) and associated risks. These assumptions can be classified into five areas: (i) that host resistance exists or is available within the project countries; (ii) that higher levels of diversity will not create super-races of pathogens (iii) that decision-makers and farmers are cooperative and open to the adoption of diversity rich approaches, (iv) that a stable and favourable political environment exists and policy makers and partners are committed, and (v) that a representative, collaborative and efficient project management structure is operative.

105. The main purpose of genetic mixtures for disease management is to slow down pathogen and pest spread. Thus, genetic diversity is not by itself a guarantee for protection against pathogens. It depends on whether the available diversity contains the right genes for resistance to protect a crop or population. For example, genetic diversity in the North American chestnut did not save it from devastation when the chest blight fungus (*Cryphonectria parasitica*) was introduced with chestnut germplasm from China. The species in North America had never been exposed to the pathogen. The chestnut population, although diverse, had no resistance genes to this pathogen. In about two decades chestnut forests were exterminated.

106. Achievement of the project outcomes is based on availability of suitable crop genetic resources in respect to managing pests and diseases. The four countries selected are rich in diversity of local crops, both on farm and *in situ*, and in diversity in traditional farming systems, thereby giving an indication of possible availability of suitable genetic materials for the project activities. Site identification is based on participatory field survey for both landrace diversity and virulence in pathogenicity during participatory field survey undertaken in each country during the PDF B phase of the project.

107. Some authors have warned that host populations that have genotypes differing in resistance to different sets of pathotypes could allow diverse pathogen populations to build up, and the potential of new super-race pathotypes to arise by single-step mutation, or recombination. Field evidence does not support this. A diverse genetic basis of resistance is beneficial for the farmer because it allows a more stable management of disease pressure than a monoculture allows. Local preferences exist for growing mixtures in part because they provide resistance to local pests and diseases and enhance yield stability. Field evidence instead supports farmer confidence in mixtures. Fields devastated by disease are rare for mixtures, yet not so for single variety sowings. The time-tested nature of mixed sowings as well as farmers' confidence in the use of genetic mixtures suggests that super-races do not develop in genetically diverse systems.

Thus, both on-farm observation and empirical evidence point to traditional genetically diverse systems selecting for stability and low aggressiveness of pathogens rather than super-races and instability.

108. Technical capacity across all levels of stakeholders is an important assumption for achieving project outcomes. During the PDF B phase of the project, a critical analysis was carried out regarding the strength and weakness of the project partners, both at national and project site levels, and including farmers, farming communities, local institutions and NGOs. Based on the outcomes of these discussions, a Training and Capacity Building Strategy (Annex O), was developed which includes not only traditional training needs but also the building of leadership capacity for farmers.

109. Sustainability of formal training programmes and facilities after project completion is ensured through the establishment of permanent "sandwich" degree programmes, which substantially reduce costs for students to obtain higher degrees in US universities. The establishment, through support by the Chinese government of the National Research Center for Agriculture Biodiversity (NRCAB) at the Yunnan Agricultural University, ensures that this training center will continue to be funded after project completion.

110. The project assumes national programme commitment to integrating the use of local landraces into their development and conservation strategies for genetic resources; and the national programme commitment to working with farmers and linking NGOs. During national planning meetings, special emphasis was given on the participation of farmer representation, NGOs, and local institutions, including public schools and local research centres to bridge the gaps between government and non-government stakeholders at local and national levels in each country.

111. Sustainability of the project will be achieved when farmers and communities are able to benefit from the use of diversity rich approaches. This includes benefits from reduced crop loss to pest and disease damage and reduced expenditures for agricultural inputs such as pesticides. The project has been designed with the farmer at the centre and of the importance of adopting working practices that are fully participatory and that reflect farmers' needs and concerns in diversity management so that diversity rich practices developed are appropriate.

112. Benefit sharing also includes that the custodians of the world's genetic diversity for food security benefit from the public good they are providing. Efforts for international level benefit sharing are often oriented in favour of national governments and do not necessarily fully take account of the interest of the farmers and communities maintaining the materials. A clear approach to benefit sharing is central to this project. Initial analysis of national related policies and laws for biodiversity protection and its conservation in the four countries during the PDF- B phase indicates that the building blocks of a suitable policy environment are available. The project will be developing benefit sharing means such that the goods and services from crop diversity benefit the stakeholders responsible for their production and management.

113. In view of the global nature of the project, where project partners are based in different political and/or geographical regions, the project relies on a strong management structure that supports cooperation between and among regions and countries, as well as between and among national and local level agencies. Project management also relies on the representative

partnerships that comprise stakeholders at all levels, including farmers, community organisations, scientific institutes and government agencies. Based on national and international stakeholder meetings during the planning phase, and on the experience of the international and national executing agencies in project management of earlier on-farm management projects, a project management structure has been designed and agreed upon at global and national levels that will ensure collaboration, representative partnerships and team efforts.

### STAKEHOLDER PARTICIPATION AND IMPLEMENTATION ARRANGEMENTS

114. The main stakeholders involved are: farmers, farmer organizations, women motivators within the farming communities, community based organizations (CBOs), NGOs, agricultural extension workers, natural and social science researchers from universities and agricultural research institutes, and government ministries of agriculture and the environment. Farmers are the direct beneficiaries and implementers of the use of crop genetic diversity, and their participation is crucial to the project. Farmers' organizations and local NGOs will be providing local support by representing and mobilising local communities. Their capacities will be used to strengthen and implement activities related to public awareness, information relating to pest and disease problems and use of crop genetic diversity to overcome these pest and disease problems. Researchers, community-based organizations and farmers will work together with the ministries or Departments of Agriculture and Environment extension systems, to increase the awareness of agricultural extension workers in the importance of local landraces for pest and disease management, and to include local crop diversity as another option along with standard agricultural development packages.

115. Stakeholders were identified through consultation and are based on multi-institutional and multi-disciplinary approach at national and local project site level. Stakeholder groups will vary from country to country, based on each country national organization for research, education and development activities. However, by and large, the stakeholder group will include Ministries and agencies dealing with issues of agriculture, environment, education, extension and rural development, communication and information management, crop improvement, production and protection; central and provincial universities and schools; and premier national agricultural institutions. In addition to these governmental agencies, farmer associations to address concern relating to agro-biodiversity conservation, NGOs involved in the conservation and sustainable use of crop diversity, agricultural development and farmers education through participatory approach, key farmers with knowledge and awareness for biodiversity conservation and other local community groups have also been involved for project implementation activities at the grass roots level.

116. During the national planning meetings in each country, stakeholders, including individual farmers from the identified sites, researchers, extension and development workers, educators, NGOs, and government policy makers contributed to the development of procedures and criteria for: site selection, strategy for public participation; identifying roles and responsibilities for each of the key stakeholders; identifying capacity strengthening and needs assessment; related projects and baseline estimation; project implementation and coordination plan. Stakeholders during these national planning meetings also contributed to the finalization of global and respective national logical frameworks and work plans; systems for monitoring and evaluation at national level; and identification of co-financing for the project, both in-kind and in-cash.

117. A detailed national project management and implementation structure and its linkage with the global coordination were discussed for each country during PDF B phase. The project management and implement structure is based on each countries' national policies and organizational set up. These implementation and execution arrangements are designed for effective coordination of project activities at national as well as at project sites. The details of the public involvement plan for each country are described in Annex E. A common agreement was reached among partners for the Project Management Unit across all the four countries. The Project management Unit will have a National Project Director (contribution from the national executing agency), a National Project Manager (to be hired by the project) a national Programme Assistant (to be hired by the project), and Technical or Thematic Advisors.

118. The country partners discussed the need for various committees at national and site levels for better coordination of project activities during PDF B phase. The various committees proposed are: a National Steering Committee, a Site Coordination Committee, National Teams of Technical or Thematic Experts, and Site Teams. During the PDF-B Phase, the National Coordinator along with national focal team members visited each of the identified project sites to meet with leading local government officials, researchers, extension workers, media persons, key farmers and staff from local universities, schools, NGOs and community based organizations. This has facilitated the definition of the structure and role of Site Teams and National Site Coordination Committee for project implementation and their reporting to the National Steering Committee. Detailed roles and responsibilities are presented in Annex E.

119. IPGRI will serve as the executive agency at the global level. It will oversee the Global Project Management Unit (PMU), located at its headquarters in Rome. The Global PMU will be under the overall management of IPGRI's Agricultural Biodiversity and Ecosystem Project Coordinator who will act as Global Project Director. The Global PMU will include a Global Project Manager, Programme Assistant, and Technical Advisors. The PMU will establish reporting guidelines for all partners and ensure that they submit quality reports meeting reporting schedule; prepare biannual progress and quarterly financial and annual summary progress reports for UNEP and carry out a programme of regular visits to project sites to supervise activities and to address concerns relating to implementation problem.

120. An International Steering Committee (ISC) will be established. Membership will include representation from each of the Project Management Units at national level (National Project Director), IPGRI (executing agency, Global Project Director), representatives from international partners (FAO; SDC, University of Kassel, Germany, Washington State University) and a UNEP/GEF representative. ISC responsibilities include: reviewing biannual progress and quarterly financial reports and annual summary progress reports, providing policy guidance to the project, assisting the PMUs in developing linkages with other related projects, and overall guidance for the project implementation. The ISC will be meeting once a year.

121. A team of Technical and/or Thematic Advisors will be established at international and national levels. Members of the team will support technical aspects of the project included, plant population genetics, pathology, entomology, ecology, anthropology, sociology, economics, participatory approaches, law and policy. Several international institutions have already made in-kind commitments to participate as technical advisors, these include: CSIRO, Washington State University, Oregon State University, Cornel University, the University of Kassel, IRRI, IFPRI,

UPWARD, and FAO. Details are listed in Annex E. In addition, an international and national rosters of experts has been established organized by discipline of potential expertise that can be called upon during project implementation (Annex K).

122. National Steering Committees (NSCs) will be established and have responsibility for approval of project planning and monitoring at national level; review of biannual progress and quarterly financial reports and annual summary reports; advice to the PMU on implementation problems at national level and suggest ions for suitable modifications to the subsequent work plan. The NSC will include representation from the Ministry of Agriculture, the Ministry of the Environment (or a representative of the GEF Focal point), the national executing agency, including the National Project Director, representation from local institutions, representation from NGOs, representation from farmers organization and/or farmers. The National Project Manager will act as secretary to this committee. The NSC will meet once a year and at least two months before the ISC meeting each year.

123. In order to share cross-site experiences and to coordinate activities across sites, national partners proposed to have a Site Coordination Committee. The members of the Site Coordination Committee will be site coordinators together with National Project Manager. The National Coordination Committee will be responsible for developing the annual work plan and budget; preparing quarterly progress reports and annual summary report; and linking Site Teams within country to ensure that lessons learned are shared among the sites and with national and global level operation. The National Site Coordination Committee will hold two meetings each year.

124. The composition of Site Teams and their roles were discussed by each country's national partners, and one such Site Team will be established for each site (China: 6, Ecuador: 6, Morocco: 5, and Uganda: 4). The Site Teams will consists of Site Manager, local thematic contact people, farmers, NGOs, and development and extension staff. The agreed responsibilities of the Site Team will include developing, together with the Site Coordination Committee, six-monthly work plan; implementing project activities on site, ensuring feed back from farmers, building relationship between farmers and national teams, organizing farmers' training and cross site visits. The Site Teams will be meeting quarterly.

125. During the PDF B phase, each country has assigned a project executive agency and each of these institutes will coordinate activities among stakeholder groups in their respective countries and are as under:

- China: Yunnan Agricultural University, Kunming, Yunnan
- Ecuador: Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Quito
- Morocco: Institut Agronomique et Vétérinaire (IAV) Hassan II , Rabat
- Uganda: National Agricultural Research Organisation, Entebbe

INCREMENTAL COSTS AND PROJECT FINANCING

## Incremental Cost Analysis

126. Baseline, incremental, and component costs are provided in the tables that follow. They reflect the baseline and increments costs and activities described in Annex A.

**Table 1: Baseline, Alternative and Incremental Costs in US$**

| | Partner | Baseline | Alternative | Increment |
|---|---|---|---|---|
| **Outcome 1** | China | 445,000 | 1,427,224 | 982,224 |
| | Ecuador | 183,000 | 820,775 | 637,775 |
| | Morocco | 258,375 | 815,968 | 557,593 |
| | Uganda | 294,200 | 887,618 | 593,418 |
| **Total** | | ***1,180,575*** | ***3,951,585*** | ***2,771,010*** |
| **Outcome 2** | China | 620,000 | 1,688,312 | 1,068,312 |
| | Ecuador | 297,400 | 737,380 | 439,980 |
| | Morocco | 383,315 | 1,006,193 | 622,878 |
| | Uganda | 207,000 | 627,389 | 420,389 |
| **Total** | | ***1,507,715*** | ***4,059,274*** | ***2,551,559*** |
| **Outcome 3** | China | 863,069 | 2,635,442 | 1,772,373 |
| | Ecuador | 381,200 | 958,230 | 577,030 |
| | Morocco | 255,479 | 879,183 | 623,704 |
| | Uganda | 194,900 | 914,468 | 719,568 |
| **Total** | | ***1,694,648*** | ***5,387,323*** | ***3,692,675*** |
| **Outcome 4** | China | 520,000 | 1,428,750 | 908,750 |
| | Ecuador | 173,800 | 782,195 | 608,395 |
| | Morocco | 202,831 | 889,381 | 686,550 |
| | Uganda | **137,100** | 617,371 | 480,271 |
| **Total** | | ***1,033,731*** | ***3,717,697*** | ***2,683,966*** |
| **Project Management** | China | 0 | 610,386 | 610,386 |
| | Ecuador | 0 | 372,000 | 372,000 |
| | Morocco | 0 | 469,291 | 469,291 |
| | Uganda | 0 | 369,275 | 369,275 |
| | Global | 0 | 1,820,000 | 1,820,000 |
| **Total** | | ***0*** | ***3,640,952*** | ***3,640,952*** |
| **GRAND TOTAL** | | **5,416,669** | **20,756,831** | **15,340,162** |

**Table 2: Component financing in US$**

| Component | Partner | Increment | Co-funding | | | | Requested from GEF |
|---|---|---|---|---|---|---|---|
| | | | Governments | | International | | |
| | | | In-kind | Cash | In-kind | Cash | |
| **Outcome 1** | China | 982,224 | 149,253 | 86,152 | 100,000 | 150,000 | 496,819 |
| | Ecuador | 637,775 | 128,875 | 3,000 | 110,000 | 210,000 | 185,900 |
| | Morocco | 557,593 | 124,790 | 23,874 | 138,641 | 110,000 | 160,288 |
| | Uganda | 593,418 | 100,494 | 5,000 | 148,640 | 120,000 | 219,284 |
| | **Total** | ***2,771,010*** | ***503,412*** | ***118,026*** | ***497,281*** | ***590,000*** | ***1,062,291*** |
| **Outcome 2** | China | 1,068,312 | 426,353 | 106,778 | 30,000 | 60,000 | 445,181 |
| | Ecuador | 439,980 | 125,080 | 20,800 | 20,000 | 170,000 | 104,100 |
| | Morocco | 622,878 | 205,109 | 32,864 | 30,000 | 30,000 | 324,905 |
| | Uganda | 420,389 | 93,347 | 5,000 | 20,000 | 70,000 | 232,042 |
| | **Total** | **2,551,559** | ***849,889*** | ***165,442*** | ***100,000*** | ***330,000*** | ***1,106,228*** |
| **Outcome 3** | China | 1,772,373 | 465,685 | 732,122 | 40,000 | 120,000 | 414,566 |
| | Ecuador | 577,030 | 132,330 | 10,000 | 72,500 | 225,000 | 137,200 |
| | Morocco | 623,704 | 118,773 | 15,988 | 135,921 | 25,000 | 328,022 |
| | Uganda | 719,568 | 163,433 | 5,000 | 135,922 | 25,000 | 390,213 |
| | **Total** | ***3,692,675*** | ***880,221*** | ***763,110*** | ***384,343*** | ***395,000*** | ***1,270,001*** |
| **Outcome 4** | China | 908,750 | 248,842 | 57,057 | 65,000 | 175,000 | 362,851 |
| | Ecuador | 608,395 | 135,395 | 10,000 | 60,000 | 125,000 | 278,000 |
| | Morocco | 686,550 | 210,951 | 53,015 | 60,000 | 75,000 | 287,584 |
| | Uganda | 480,271 | 85,155 | 5,000 | 50,000 | 105,000 | 235,116 |
| | **Total** | ***2,683,966*** | ***680,343*** | ***125,072*** | ***235,000*** | ***480,000*** | ***1,163,551*** |
| **Project Management** | China | 610,386 | 101,600 | 31,123 | 0 | 0 | 477,663 |
| | Ecuador | 372,000 | 80,000 | 0 | 0 | 100,000 | 192,000 |
| | Morocco | 469,291 | 207,982 | 17,309 | 0 | 0 | 244,000 |
| | Uganda | 369,275 | 71,475 | 5,000 | 0 | 0 | 292,800 |
| | Global | 1,820,000 | 0 | 0 | 710,000 | 50,000 | 1,060,000 |
| | **Total** | ***3,640,952*** | ***461,057*** | ***53,432*** | ***710,000*** | ***150,000*** | ***2,266,463*** |
| | | | | | | | |
| **GRAND TOTAL** | | **15,340,162** | **3,374,922** | **1,225,082** | **1,926,624** | **1,945,000** | **6,868,534** |

**Table 2a: PHASE I: Component Financing in US $**

| Components | Partner | PHASE I: Increment | Co-funding: PHASE I: Government In-kind | Co-funding: PHASE I: Government Cash | Co-funding: PHASE I: International In-kind | Co-funding: PHASE I: International Cash | PHASE I: Requested from GEF |
|---|---|---|---|---|---|---|---|
| **Component 1** | China | 785,779 | 119,402 | 68,922 | 80,000 | 120,000 | 397,455 |
| | Ecuador | 510,220 | 103,100 | 2,400 | 88,000 | 168,000 | 148,720 |
| | Morocco | 446,074 | 99,832 | 19,099 | 110,913 | 88,000 | 128,230 |
| | Uganda | 474,734 | 80,395 | 4,000 | 118,912 | 96,000 | 175,427 |
| | ***Total*** | ***2,216,808*** | ***402,730*** | ***94,421*** | ***397,825*** | ***472,000*** | ***849,833*** |
| **Component 2** | China | 213,662 | 85,271 | 21,356 | 6,000 | 12,000 | 89,036 |
| | Ecuador | 87,996 | 25,016 | 4,160 | 4,000 | 34,000 | 20,820 |
| | Morocco | 124,576 | 41,022 | 6,573 | 6,000 | 6,000 | 64,981 |
| | Uganda | 84,078 | 18,669 | 1,000 | 4,000 | 14,000 | 46,408 |
| | ***Total*** | ***510,312*** | ***169,978*** | ***33,088*** | ***20,000*** | ***66,000*** | ***221,246*** |
| **Component 3** | China | 681,311 | 186,274 | 292,849 | 16,000 | 48,000 | 138,189 |
| | Ecuador | 221,665 | 52,932 | 4,000 | 29,000 | 90,000 | 45,733 |
| | Morocco | 227,613 | 47,509 | 6,395 | 54,368 | 10,000 | 109,341 |
| | Uganda | 261,813 | 65,373 | 2,000 | 54,369 | 10,000 | 130,071 |
| | ***Total*** | ***1,392,403*** | ***352,088*** | ***305,244*** | ***153,737*** | ***158,000*** | ***423,334*** |
| **Component 4** | China | 0 | 0 | 0 | 0 | 0 | 0 |
| | Ecuador | 0 | 0 | 0 | 0 | 0 | 0 |
| | Morocco | 0 | 0 | 0 | 0 | 0 | 0 |
| | Uganda | 0 | 0 | 0 | 0 | 0 | 0 |
| | ***Total*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| **Component 5** Project Management | China | 212,310 | 40,640 | 12,449 | 0 | 0 | 159,221 |
| | Ecuador | 136,000 | 32,000 | 0 | 0 | 40,000 | 64,000 |
| | Morocco | 171,450 | 83,193 | 6,924 | 0 | 0 | 81,333 |
| | Uganda | 128,190 | 28,590 | 2,000 | 0 | 0 | 97,600 |
| | Global | 657,333 | 0 | 0 | 284,000 | 20,000 | 353,333 |
| | ***Total*** | ***1,305,283*** | ***184,423*** | ***21,373*** | ***284,000*** | ***60,000*** | ***755,488*** |
| **PHASE I** | **TOTAL** | **5,424,806** | **1,109,219** | **454,126** | **855,562** | **756,000** | **2,249,900** |

**Table 2b**: **PHASE II: Component Financing in US $**

| Components | Partner | PHASE II: Increment | Co-funding: PHASE II: Government In-kind | Co-funding: PHASE II: Government Cash | Co-funding: PHASE II: International In-kind | Co-funding: PHASE II: International Cash | PHASE II: Requested from GEF |
|---|---|---|---|---|---|---|---|
| **Component 1** | China | 196,445 | 29,851 | 17,230 | 20,000 | 30,000 | 99,364 |
| | Ecuador | 127,555 | 25,775 | 600 | 22,000 | 42,000 | 37,180 |
| | Morocco | 111,519 | 24,958 | 4,775 | 27,728 | 22,000 | 32,058 |
| | Uganda | 118,684 | 20,099 | 1,000 | 29,728 | 24,000 | 43,857 |
| | ***Total*** | ***554,202*** | ***100,682*** | ***23,605*** | ***99,456*** | ***118,000*** | ***212,458*** |
| | | | | | | | |
| **Component 2** | China | 854,650 | 341,082 | 85,422 | 24,000 | 48,000 | 356,145 |
| | Ecuador | 351,984 | 100,064 | 16,640 | 16,000 | 136,000 | 83,280 |
| | Morocco | 498,302 | 164,087 | 26,291 | 24,000 | 24,000 | 259,924 |
| | Uganda | 336,311 | 74,678 | 4,000 | 16,000 | 56,000 | 185,634 |
| | ***Total*** | ***2,041,247*** | ***679,911*** | ***132,354*** | ***80,000*** | ***264,000*** | ***884,982*** |
| | | | | | | | |
| **Component 3** | China | 1,091,062 | 279,411 | 439,273 | 24,000 | 72,000 | 276,377 |
| | Ecuador | 355,365 | 79,398 | 6,000 | 43,500 | 135,000 | 91,467 |
| | Morocco | 396,091 | 71,264 | 9,593 | 81,553 | 15,000 | 218,681 |
| | Uganda | 457,755 | 98,060 | 3,000 | 81,553 | 15,000 | 260,142 |
| | ***Total*** | ***2,300,272*** | ***528,133*** | ***457,866*** | ***230,606*** | ***237,000*** | ***846,667*** |
| | | | | | | | |
| **Component 4** | China | 908,750 | 248,842 | 57,057 | 65,000 | 175,000 | 362,851 |
| | Ecuador | 608,395 | 135,395 | 10,000 | 60,000 | 125,000 | 278,000 |
| | Morocco | 686,550 | 210,951 | 53,015 | 60,000 | 75,000 | 287,584 |
| | Uganda | 480,271 | 85,155 | 5,000 | 50,000 | 105,000 | 235,116 |
| | ***Total*** | ***2,683,966*** | ***680,343*** | ***125,072*** | ***235,000*** | ***480,000*** | ***1,163,551*** |
| | | | | | | | |
| **Component 5** Project Management | China | 398,076 | 60,960 | 18,674 | 0 | 0 | 318,442 |
| | Ecuador | 236,000 | 48,000 | 0 | 0 | 60,000 | 128,000 |
| | Morocco | 297,841 | 124,789 | 10,385 | 0 | 0 | 162,667 |
| | Uganda | 241,085 | 42,885 | 3,000 | 0 | 0 | 195,200 |
| | Global | 1,162,667 | 0 | 0 | 426,000 | 30,000 | 706,667 |
| | ***Total*** | ***2,335,669*** | ***276,634*** | ***32,059*** | ***426,000*** | ***90,000*** | ***1,510,975*** |
| | | | | | | | |
| **PHASE II** | **TOTAL** | **9,915,356** | **2,265,703** | **770,956** | **1,071,062** | **1,189,000** | **4,618,634** |

MONITORING, EVALUATION AND DISSEMINATION

127. The monitoring and evaluation plan (M&E Plan) maps the approach for measuring and verifying that activities and outcomes described in the project logframe and timeline are being met. The M&E Plan follows UNEP guidelines and incorporates UNEP monitoring activities. The full M&E Plan and Tracking Tools are found in Annexes P and Q, respectively.

128. There are four entities with roles to play in the M&E process:

- UNEP will receive from the PMU quarterly progress and financial reports. UNEP will also serve as a member of the International Steering Committee (ISC), make field visits to assess progress and problems (as needed and agreed with the PMU and ISC), and organize independent evaluators for mid-term and final evaluations.
- The PMU will develop a reporting structure for all project partners and ensure that reporting is timely and complete. It will develop all reports for UNEP, and carry out regular site visits with particular attention to sites experiencing difficulties or delays.
- The ISC will review all reports, advise the PMU on resolving difficulties and increasing efficiency, and monitor progress on the capacity-building component.
- The NSCs will review all national reports and offer policy guidance where needed. They will play a key role in facilitating linkages, both in their respective countries and between countries, and will report on both successes and difficulties within the monitoring process.

129. Project monitoring will be carried out at two levels. The first is the execution performance, which monitors efficiency of project management and supervision. Execution performance tracks both programmatic progress and financial accountability. With support from the PMU, UNEP will carry out this level of monitoring. The second is monitoring of project outputs and milestones. This process examines technical execution of the project. It is based on the indicators and means of verifying them that are documented in the project logframe, and on the implementation timeframe set out in the timeline (PB) and the M&E Plan (Annex P). Biannual progress reports will include assessment of all outputs that were to be completed within that specific timeframe. Outputs not completed within the planned timeframe will be noted, the reason for delay assessed, and anticipated date of completion cited for tracking purposes.

130. The Global Project Manager will be responsible for developing biannual progress and quarterly financial reports, with inputs from national management units. These reports will be important monitoring tools, as they will be carefully tracked by both the NSCs and the ISC. These bodies will be responsible for assessing successes, ensuring that effective approaches are replicated to the extent possible, and that difficulties are addressed. When problems arise, members of the NSCs and ISC are expected to help craft solutions and follow the result of their execution.

131. Participation of all stakeholders is fundamental to this project. Stakeholder participation in the M&E process is also essential to ensure their continued ownership in the project activities. As important is the knowledge the diverse group of stakeholders brings to the process of monitoring and evaluation; they are often best positioned to understand the reasons behind successes and failures. Farmers and other stakeholders will therefore be included on the evaluation team and will be involved in internal project evaluation and annual reviews of project

performance. Mid-term and final evaluation will be conducted by independent evaluators contracted by UNEP.

## ANNEX A – INCREMENTAL COST

### BROAD DEVELOPMENT GOALS

Host resistance breeding and pesticide use are the most common strategies to protect crops against pest and disease pressures. In most cases, however, these responses provide only temporary solutions. Most breeding programs use single genes to provide resistance across many types of environment. The large areas in which popular resistant cultivars are then planted facilitate rapid pathogen evolution and migration to overcome resistance. This has led to the so-called "Boom and Bust" phenomenon in agriculture. One consequence of the development and spread of new resistant cultivars can be the loss of local cultivars with different resistance properties and mechanisms, and, ultimately, loss of genetic diversity in production systems.

This proposed intervention aims to integrate and applying existing knowledge to provide a framework of tested management practices that can support use of genetic diversity to mitigate the effects of pests and pathogens. It will bring together farmer knowledge and experience with information from agricultural research work. On the basis of selected model studies on crop-pathogen systems throughout the world, it will develop the tools and capacities needed to determine what diversity-based approaches are desirable and how they should be deployed. It will identify techniques and approaches that can be replicated to areas and crops outside those selected for the project. It will help build the frameworks for sustainable partnerships between farmers, extension workers, national research institutes, government ministries and others, frameworks that will serve as models for other parts of the world. The intervention complements and extends IPM strategies by using and managing local crop cultivars themselves as a key resource, making use of the intra-specific diversity among the cultivars maintained by farmers. The approach will provide environmental health workers with an alternative to unsafe pesticide use. Crop breeding programmes will be more effective by increased use of local resistant materials and new methods to reduce crop vulnerability.

Global benefits of the project are:

1. Conservation of globally significant crop genetic diversity in respect to resistance to pests and diseases
2. Conservation of associated biodiversity due to decreased pesticide use, and
3. Development of practices that use local crop genetic diversity to manage pest and diseases that can be applied both within and outside the four project countries

Domestic Benefits of the project are:

1. Increased availability and use of "diversity rich" low cost solutions to manage pest and disease pressures for small and marginal farmers,
2. Enhanced capacity to make decisions by farmers and other stakeholders on when and where local crop genetic diversity will be useful to minimize pest and disease pressures,
3. Increased and more reliable food supply for local and indigenous communities through the use of crop genetic diversity to minimize crop loss,
4. Increased land area contributing to the sustainable use of crop genetic resources,
5. Alternatives to unsafe pesticide use for environmental health workers.
6. More effective crop breeding programmes through increased use of local resistant materials and new methods to reduce crop vulnerability
7. Benefit sharing protocols with farming communities.

## BASELINE

Each country contains areas of important crop genetic diversity significant for the management of disease pressures, traditional farming communities that maintain the diversity, a national-level commitment to conserve crop resources and existing multi-stakeholder efforts upon which the project can build. Earlier projects have developed protocols, which work with farmers, using participatory methods, to estimate the number of, and area covered by, different crop cultivars. These protocols, however, have not been applied to quantifying amounts of diversity in respect to resistance found on-farm. The host-pest/pathogen systems selected are those which have well characterized cycles in the literature. All host-pest/pathogen systems selected will serve as important models for ease of replication and diffusion of project methodologies to areas outside the project's geographic scope. The four countries bring different expertise in developing practices and procedures to optimally use crop genetic diversity to minimize pest and disease damage. An agreed set of criteria among the countries has guided site selection. These criteria include environmental diversity, social cultural diversity of farming communities, intra-specific diversity of target crops, distribution of pest and pathogens, willingness of communities and local institutions to participate, local institutional capacity, and logistics for site access.

These countries have good infrastructure and faculty for providing training in agricultural research and development. However, they lack trained manpower and training materials for specialised training courses in the field of plant genetic resources conservation and use and are not linked to community-based organizations working with farmers.

Each country also has its own national coordination mechanism for undertaking various activities relating to plant genetic resources conservation, both *ex situ* and *in situ*. These national programmes have well established national coordination mechanisms for plant genetic resources related activities and also participate in regional sub-regional PGR networks, to share and gain from each others experience in the region. The partner countries have adopted a number of conservation and development plans related to plant genetic resources, agriculture, sustainable use of plant diversity, farmers' rights and benefit sharing mechanisms, pesticides reduction, Material Transfer Agreement. Each country has also developed several domestic policies and laws addressing the need for agrobiodiversity conservation, access and benefit sharing, agricultural biodiversity and food security, integrated pest management, biosafety and environmental protection.

The project components were designed to address the overall project baseline assumptions:

1. Lack of criteria and tools to determine when and where intra-specific crop genetic diversity can be used to minimize pest and disease pressures on-farm.
2. Lack of tested and available practices to use within-crop diversity in different production systems to minimize pest and disease pressures.
3. Insufficient capacity and leadership abilities at local, regional and national levels to optimally use crop genetic diversity to minimize pest and disease pressures.
4. Insufficient awareness of the benefits of using local crop diversity and lack of national benefit sharing protocols with local communities.

## Criteria and Tools

Evidence of high levels of intra-specific diversity in target crops has been documented in each of the four countries through genebank collections and earlier on farm projects. Maize and bean landraces cover 90 percent of the Ecuador highlands. Landraces still cover a significant percentage of land area in remote indigenous areas in the southwestern provinces of China. Evidence of high levels of barley diversity come from on-farm surveys in Morocco, and accessions collected in southwestern China. On-farm studies in Uganda have shown that over 80 locally evolved highland banana cultivars continue to exist on-farm, and that commonly up to 22 cultivars can be found on any given farm.

Substantial theoretical advances exist in the biological and epidemiological knowledge of the function of intra-specific genetic diversity. Still, the understanding of long-term host-pathogen interactions is inadequate. The role of the farmer in these interactions is even less known. The few studies that are available provide only localized insight. Most problematic is the lack of a standardized methodology to enable easy comparisons between diagnostic information on farmers' perceptions and practices and technical assessment through field and laboratory experiments. A further constraint has been that the understanding of farmer management of genetic diversity for pest and disease management is limited to a few cropping systems.

Participatory tools exist to aid in on-farm research and development, but these tools are not adapted for understanding farmers' perception on the pest and disease problem, nor are they linked to standard technical methods of assessing the availability of host (crop variety) resistance available in the existing farming system. Little is known of farmers' understanding regarding virulence and aggressiveness of pathogen diversity, and the movement and transmission mechanisms of diseases, nor have these on-farm systems been well studied in the field or in laboratories. Protocols that provide guidance for the production of host-pest/pathogen systems on-farm are inadequate. Moreover, protocols do not exist that can provide decision making tools for farmers and other stakeholders based on assessments of farmers' beliefs and practices combined with laboratory and field measured data.

The baseline cost for this project component is estimated to be $ 1,180,575. These costs comprise the related on going work in each of the four countries such as: developing participatory tools for better understanding of farmers knowledge; collecting, screening and evaluation of national and international germplasm collections against different pest and diseases reactions, both by curators of genebank and plant breeders for the respective crops and their conservation cost; scientific and field studies in progress to understand host-pest interaction and existing diversity for virulence and aggressiveness of pathogens and biotypes for pests. The estimated cost cover the real cash spent by the national government and by other donors; the in-kind contribution of national partners in terms of staff time salary and other facilities made available for these project activities, including any publication costs for developing extension packages and scientific publications.

## Practices and Procedures

The four countries bring different expertise in developing practices and procedures to optimally use crop genetic diversity to minimize pest and disease damage. Partners from China have a

wide experience in the use of varietal mixtures based on a comprehensive analysis of the resistance background, agronomic character, economic value, local cultivation conditions and the planting habits of farmers. Results from the Yunnan Agricultural University work in using diversity to manage pests and disease by mixed planting of rice varieties to control blast and improve yield has convinced the Chinese Ministry of Agriculture and provincial agricultural departments to evaluate this technique in ten other provinces in China for possible large scale implementation. Partners from Morocco bring to the project the expertise in screening local crop germplasm, Ugandan partners have worked closely with farmer mixtures and percentages or ratios of different banana varieties in farmers' mixtures, and Ecuadorian partners have a long history of linking formal sector breeding practices with farmer breeding practices.

Actions that support technology transfer and farmers' education are available in each of the four countries. Farmer field schools for farmer-to-farmer training in integrated pest management (IPM) exist. However, these schools have concentrated on understanding the agronomic practices that farmers use to manage pest and disease and have made limited use of local crop genetic diversity in the schools. Little knowledge is available on how farmers make genetic choices to manage pest and disease pressures, e.g., how farmers manage diverse genes in plant populations in order to control single constraints or complexes of pests and diseases to minimize crop loss.

The baseline cost for this project component is estimated to be $ 1,507,715. These estimates are based on on-going project related activities which include: national crop improvement programmes with focus on resistance breeding; understanding genetic of resistance mechanisms for the target crops; on-going scientific research to use crop genetic diversity to control pest and disease problems; economic aspects of comparing different approaches for pest and disease management at national level; physiological crop modeling and pest and pathogen infestation; Early warning system for spread of pests and diseases over space and time; and scientific research for integrated pest management. The cost includes the cash by national governments and other donors within country for staff time salaries, cost of equipment and chemicals and also for field and lab experimentation.

**Capacity and Leadership**

The project is driven by a clear appreciation by all project partners of the central role of the farmer in managing crop genetic diversity and of the importance of adopting working practices that are fully participatory and start from a desire to reflect farmers' needs and concerns in diversity management. Experience of working on the management of agricultural biodiversity has demonstrated that not only do participants need the capacity to employ those activities relevant to their specific work or role, but also they must be able to rely on strong working relationships with other stakeholder groups. These working relationships need to be developed and enhanced among the four countries through training in participatory approaches and team building among farmers, farmers' organisations, NGOs, local and national research and educational institutes, government ministries, and international institutes.

Across the four countries there are 41 universities and institutions, both at national and local level, including technical schools, which can provide training to their respective partners at national level in the field of: agronomy, crop protection, crop physiology, crop breeding and biotechnology, environmental sciences, extension techniques, documentation and

communication, social sciences and economics. This information is based on preliminary surveys conducted during the national stakeholders meetings organised during the PDF B phase of this project. These countries have good infrastructure and faculty for providing training in agricultural research and development. However, they lack trained manpower and training materials for specialised training courses in the field of plant genetic resources conservation and use and are not linked to community based organizations working with farmers.

The baseline cost for this project component is estimated to be $ 1,694,648. The cost is based on personnel, logistic arrangements for conducting training and development and printing of training materials in each of the four countries. The various training and capacity building programmes considered for these estimates includes: participatory and rural appraisal; crop breeding for resistance; genetics of host-pest interaction; team building; IPM and Farmers Field Schools; agricultural extension training activities. This also includes the amount being spent for teaching and research for degree studies at the national and regional universities as well as the amount spent by the local institutions, including NGOs, for training of farmers and extension workers for related activities.

**Mainstreaming and Replication**

Successful experiences using agronomic practices, resistant varieties and application of chemicals to minimize pest and diseases on farm are well documented and published in different media by the national partners. However, these experiences lack the component of using intra-specific diversity and information on trade-offs of diversity rich approaches compared to other approaches Seed cleaning techniques other methods of seed quality exist within agricultural extension and NGO development packages but have not included intra-specific diversity as an option.

Education sectors contain curriculum on biodiversity, agronomy and plant breeding, but lack information on the value and use of local crop genetic diversity in support of sustainable management. Methods are available for ensuring that data are of some use to the communities from which they are being elicited and returning these data in a user-friendly format.

Methods for upscaling best practices, such as diversity fairs, site demonstration plots, and the promotion of seed interchanges through local nodal farmers are known but not mainstreamed into national extension and development systems. National breeding strategies include local materials from *ex situ* collections, but farmer's knowledge and local on-farm materials are not mainstreamed.

Economics methodologies exist for calculating income instability due to yield losses, but have not focused on yield variability and downside risk, or the probability of crop failure, nor have these methods included estimates of public good value for the conservation of resistant crop genetic diversity for future use, or the impact on environmental externalities, such as the risk of losses to other species and aquatic diversity. Methods are lacking to estimate the ecosystem support value of crop genetic diversity.

Each country has also developed several domestic policies and laws addressing the need for agricultural biodiversity conservation, access and benefit sharing, agricultural biodiversity and food security, integrated pest management, biosafety and environmental protection. All the four

countries are part of their respective regional plant genetic resources networks in addition to participating in other regional strategies and initiatives. A key component of the project will be the recommendation of diversity rich practices to substitute pesticide use. Links have therefore been made not only to the agricultural sector, but also to the environmental sector for measurements of impact the project could have on environmental and human health.

The baseline cost for this project component is estimated to be $ 1,033,731 and these costs are based on spending by each of the four countries on related project activities such as: public appreciation and awareness of the use and conservation of agrobiodiversity; developing legislation and policy guidelines for conservation and use of agrobiodiversity; promotion of scientific research, including the high yielding resistance varieties, to farmers and farming communities; spending on promotion of farmers diversity fair and field demonstration for PPB, PVS and for high yielding resistant varieties. This also includes the cost of printing and distribution of public awareness materials.

## GLOBAL ENVIRONMENT OBJECTIVES

This project will conserve and promote the sustainable use of crop genetic diversity with respect to resistance to pest and disease pressures. Conservation of the resource will support resource-poor farmers' production and livelihood strategies and conserve valuable genetic materials globally important to plant breeders, researchers, and local populations who depend on them. The use of crop diversity to manage pest and disease pressures will reduce the need for the application of pesticides that destroy useful and beneficial insects and fungi in the agroecosystem and that also contaminate groundwater. Thus, additional global biodiversity benefits that will accrue through application of this approach will include conservation of insects, fungi, soil microorganisms, and aquatic biodiversity of adjacent ecosystems to the agricultural production system.

The project will increase the use of "diversity rich" solutions to manage pest and disease pressures for small and marginal farmers. They will be used by the farmers, community based organizations, development and extension workers, NGOs, NARS research scientists, breeders, environmental health workers and policy makers. Farmers will use the information and materials when the methods and materials are seen to reduce crop vulnerability to production and income losses. The approach will provide environmental health workers with an alternative to unsafe pesticide use. Crop breeding programmes will be more effective through increased use of local genetic diversity and new methods to reduce crop vulnerability.

Local crop genetic diversity will be maintained as it will contribute to sustainable production and farmers' livelihood. Tools and practices will be provided that can be used to support farmers around the world to conserve local crop diversity through its use to minimize pest and disease damage. Practices will include diversity rich options to substitute pesticide use. IPM strategies will be complemented and extended globally to include the use of local crop cultivar diversity as an important resource. Ultimately, these results will support biodiversity conservation, improve ecosystem health and increase food security.

GEF ALTERNATIVE

At project completion, diversity for resistance to pest and disease will be increased on farm. Local and indigenous communities will show increased and more reliable food security through the use of crop genetic diversity to minimize crop loss, and diversity rich practices will reduce pesticide use. Tools and practices will be available to support farmers around the world to conserve local crop diversity through its use to minimize pest and disease damage. Benefit sharing protocols will ensure that the goods and services from crop diversity benefit the stakeholders responsible for their production and management.

**Criteria and Tools**

Criteria will be developed to determine when and where diversity can play or is playing a key role in managing pest and disease pressures. These criteria will form the basis for tools and decision-making procedures for farmers and development workers to enable the appropriate adoption of "diversity rich strategies" to manage pests and diseases.

National partners will continue the joint development and testing of diagnostic protocols begun during the PDF-B phase. These protocols will aid farmers and researchers to determine (1) whether pest and diseases are viewed both by farmers and scientists as a significant factor limiting production; (2) whether intra-specific diversity with respect to pest and diseases exists within project sites and if not, whether other sources of intra-specific diversity with respect to pest and diseases exist from earlier collections or from similar agroecosystems within the country; (3) whether diversity with respect to pest and diseases exists but is not accessed or optimally used by the farming communities; (4) whether in the case of diseases there is diversity in virulence and aggressiveness of pathogens or diversity in biotypes for pest; (5) whether and how pest and diseases are moving in and out of the project sites, including the local seed systems; and (6) how farmers make "genetic choices" on using or discarding new and old genotypes, including their selection criteria for hosts that are resistant.

A detailed quarantine strategy will be worked out in each country for each host - pest or pathogen system as part of the research protocols. Particular care will be taken that both field and glasshouse or lab experiments do not introduce alien biotypes or pathotypes. Partners will also be developing econometric methods to test the effects of crop genetic diversity on expected crop yields, yield variability and the probability of crop failure, given levels of pesticides applied.

The incremental cost of this project component is estimated to be US$2,771,010 of which national government will provide co-financing of US$503,412 (in-kind) and US$118,026 (cash) to cover salaries of their staff participation and use of laboratory and operational facilities for undertaking activities as indicated for Output 1 of the project logframe and includes: refinement of protocol for participatory diagnosis of farmers beliefs and practices and field and laboratory assessment; undertaking field surveys and collecting of samples of host and pathogen diversity; and providing all logistic arrangements for undertaking these surveys and laboratory experimentations. Co-financing from others is estimated at US$497,281 in-kind, of which IPGRI will contribute US$180,000, and US$590,000 cash, of which IPGRI will contribute US$50,000, and SDC will contribute US$340,000 to IPGRI to implement this component. GEF funds of US$1,062,291 will be used to assist the development of protocols for participatory diagnosis

through conducting focus group discussions, farmer surveys, technical assessment through field and laboratory trials, and for the development and testing of econometric methods to test the effect of these methods using crop diversity to minimize pest and disease pressures.

**Practices and Procedures**

Farmers and researchers will together test and implement approaches to use within-crop diversity in different production situations to reduce pest and disease pressures. Practices and procedures for effectively and efficiently using crop genetic diversity as a response to pest and disease pressures will then be developed. Determining the effectiveness of the different diversity deployment strategies for the different crop/pathogen interactions will allow the general criteria to be identified on the prerequisites for adopting a diversity-based approach. Generally applicable criteria, guidelines and decision-making tools will be developed. These criteria will be used to identify new systems and sites to reduce genetic vulnerability to pest and disease pressures through the use of genetic diversity management.

Practices and procedures to be tested can be grouped into four categories: (1) identifying and upscaling farmer knowledge and practices in on-going systems where intra-specific diversity is being used to manage pest and disease pressures and promote good practices; (2) conducting experiments using intra-specific diversity that show the effect of diversity on controlling pest and disease incidence; (3) linking national breeding and farmer selection practices to manage pest and disease pressures; and (4) conducting simulation modeling to look at how patterns of intra-specific diversity distribution and population sizes might affect pest and disease incidence over space and time. These practices and procedures will be tested and validated at project sites, in farmers' fields. Quarantine issues are of extreme importance. Protocols will be developed for exchange of resistance plant materials within and among countries. However, alien biotypes or pathotypes will remain within their country of origin.

The incremental cost of this project component is estimated to be US$2,551,559. Countries partners agreed to contribute US$849,889 (in-kind) and US$165,442 (cash) for this component of the project. This will include: contribution for personnel for the staff time; laboratory space and available lab equipments; part of chemicals and glassware uses cost; and to provide all logistic arrangements for undertaking field experimentation. Co-financing by international partners is estimated at US$100,000 in kind, of which IPGRI will provide US$50,000, and US$330,000 in cash, of which IPGRI will contribute US$70,000, and SDC will contribute US$60,000 to IPGRI to provide scientific backstopping, supervising PhD students, monitoring of project progress and publication of scientific articles. The GEF funds of US$1,106,228 will be used for testing different practices and procedures developed.

**Capacity-building**

Working synergies will be enhanced through training in participatory approaches and team building among farmers, farmers' organizations, NGOs, local and national research and educational institutes, government ministries, and international institutes. Training will include enhancing farmer's leadership ability to take decisions concerning the management of pest and diseases. Capacity building will take into account the different knowledge of women and men,

and the importance to ensure equitable benefits from the project. Activities will include actively supporting women's participation in technical and university training programmes and decision making fora. Farmers and farmer groups will be targeted for capacity-building to manage their production systems with diversity rich options to manage pests and diseases, including training in biological sciences, diversity assessment, and seed management for pest and diseases. The seed activities of local farm organizations will be strengthened to integrate pest and disease considerations.

The capacity of local institutions to sustain project activities will be enhanced through training and inputs to local extension, NGOs, middle and technical schools and local colleges. Teachers at primary schools will also be involved in the process through training which could improve understanding at community level. Capacity will be built in research institutes to analyze local crop diversity in respect to pests and pathogens. Capacity will also be built to apply new econometric methods and tools in assessing the value of crop genetic diversity, and manage the information. The project will build capacity to analyze national and international legal and economic policies related to project objectives.

A National Research Center for Agriculture Biodiversity (NRCAB) will be established and operative at the Yunnan Agricultural University (YAU), Kunming, China. This center will focus on three key areas: agriculture biodiversity and pest and disease control; agriculture biodiversity and its conservation and use; and crop modeling, technology development and extension activities to for agriculture biodiversity to enhance sustainable economic development. During PDF B phase, it has been agreed that this center will provide training at global level for use of crop diversity to manage pests and diseases problems in traditional farming systems, using both local and high yielding varieties.

"Sandwich" Ph.D. programmes will be designed between Washington State University, Oregon State University and Cornell with the Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco, and Makarere University, Kampala Uganda. Washington State University is taking the lead in providing a collaborative arrangement among the three US universities. A sandwich Ph.D. programme is also being designed between University of Kassel, Germany and universities in Ecuador. Students who enter the sandwich programmes will complete their course work in a US or European university and return to their respective countries to complete their research work at the project sites. A feature of the programmes is the student's thesis research, which will focus on major research questions of the project logical framework. Another important dimension of the sandwich programmes will be the appointment of qualified respective national university faculty as adjunct faculty in relevant departments at WSU and the appointment of qualified WSU faculty as adjunct at the respective national universities.

The incremental cost of this project component is estimated to be US$3,692,675. Of this the countries will provide US$880,221 (in-kind) and US$763,110 (cash). National funds include support from the Chinese government for the establishment of National Research Center for Agriculture Biodiversity. Funds also include staff time of national experts for conducting various training courses and to provide training room facilities and logistic arrangements, including subsidized accommodations and catering for the participants, wherever possible. International co-funding will include the support "sandwich" programmes with US and European universities, resource persons, training courses and training materials. Total international co-funding in kind is estimated at US$384,343, of which IPGRI will provide US$50,000, and US$395,000 cash, of

which SDC will provide US$100,000 to IPGRI for implementation of this component. GEF funds of US$1,270,001 will be used to cover capacity building for farmers and local communities, local institutions, and national research institutes and for training for use of intra-specific diversity to manage pest and disease problem.

## Mainstreaming and Replication

Sustainable application of benefits derived from the project will require integration of the knowledge gained into all levels of agricultural and environmental practices and development. Mainstreaming will move the project beyond site-specific successes to strategies for replicating beneficial techniques into practices and policies from community to global levels. It is this process that ultimately allows replication of project results and adds significant global value to the project investments.

The four national executing institutions are primary institutions in their respective countries for mainstreaming project results. The Yunnan Agricultural University has expanded the mixed planting of rice varieties to manage pest and diseases to ten other provinces in China. The Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Ecuador has more than 40 years of research and extension activities in the country. The Institut Agronomique et Vétérinaire (IAV) Hassan II, Rabat, Morocco was awarded the 2004 National FAO World Food Award from the Ministries of Agriculture and the Environment for its work in improving food security through the use of crop genetic resource in Morocco. The National Agricultural Research Organisation, Uganda is the overall government institution in charge of all agricultural research.

Successful experiences and comparisons of diversity rich options to others (e.g., agronomic practices, chemical use) will be documented and published in different media forms, farm field visits will be organised for policy makers and the press, and cross site visits will be organised for farmers. Field visits will illustrate the benefit of specific technologies and operations on demonstration plots, such as seed cleaning and treatment effects on seed quality, production practices, and results of participatory selection. Workshops will be organised at the province and county levels of each site designed to feedback results generated to a multi-stakeholder group. Workshops will be attended by highest level representatives of all the provincial and local authorities under different ministries (interior affairs, agriculture, environment, economy and finance, education), NGO's, farmers directly involved in the project and farmers from all over the Province, representatives of staff from provincial schools and universities, and newspapers and radio commandeers. Meetings will be organized in local languages and include presentations and discussion of messages related to the conservation strategy based on generated data, exhibitions of variety samples and related technologies developed by the project, farmers' and professional (NGOs, development) view of the proposed strategy.

Analyses will be carried out of legal and economic policies related to project objectives, including an analysis of potential barriers to adoption of the best practice demonstrated in the project and the development of benefit sharing protocols for the use of local resistant materials identified. The aim is to build recognition amongst institutions and in policy fora that the project methodologies provide an effective and efficient approach to managing pest and disease pressures. Through the regional networks described under the Programme Context Section of the Project Brief, the project will ensure that the outcomes are shared with the respective network

member countries through active participation and linking project activities. The project will also support regional meetings, where the respective network member countries will be supported for their participation.

The incremental cost for this project component is estimated to be US$2,683,966. The contribution for the national governments is estimated at US$680,343 in-kind and US$125,072 cash for providing support for the promotion of project outcomes at both policy and grass roots levels. The national contribution will also be used for providing support for field demonstration and local media facilities for broadcasting and modifying the existing extension packages and for the development of school curriculum of local institutions. International co-funding is estimated at US$235,000 in kind, of which IPGRI will contribute US$90,000, and US$480,000 cash, of which IPGRI will contribute US$30,000, and SDC will contribute US$250,000 to IPGRI to this component to provide backstopping for revising national policies and laws, publishing project outcomes into publications and newsletters and making available information to its web site for wider circulation. The GEF contribution of US$1,163,551 will be used for documentation of successful experiences from the project and their publication; developing and disseminating public awareness materials for conservation of crop diversity and protection of environment, translation of publication, developing cost effective design of policies for pest and disease management.

**Project Management**

The incremental cost of project management component is estimated to be US$3,640,952. The funds requested from GEF of $2,266,463 for project management of which US$1,060,000 will meet costs of full time global project manager, full time global program assistant, direct administration charges, global coordinator's travel, International Steering Committee's work, support of technical advisors to participate in global planning meetings, internal monitoring, including field visits. IPGRI will contribute US$710,000 in-kind and US$50,000 cash to support staff time of the Global Project Director and scientific and administrative staff based at its headquarters and regional offices for scientific and administrative backstopping, office space and supplies. The remaining US$1,206,463 requested from GEF will cover costs for National Project Management Units, which include a full time National Project Manager for each country, full time national admin/finance assistants, direct administration charges, national coordinator's travels, National Steering Committee's work, National Site Committees and Site Teams meetings, cost for Site Coordinators and office equipment. Costs of National Project Directors are covered by national in-kind and cash contributions. Country contributions also include funds to cover cost for the office maintenance of PMUs. Total contribution of the countries for this component is US$461,057 in kind, and US$53,432 in cash.

**COSTS**

The incremental costs and benefits of the proposed project are summarized in the following incremental cost matrix. Baseline expenditures amount to US$5,416,669, while the alternative has been estimated at US$20,756,831. The incremental cost of the project, US$15,340,162, is required to achieve the project's global environmental objectives of which the amount US$6,868,534 is requested from GEF. This amounts to 33.1% of the total costs of the alternative. The remaining amount US$8,471,628, 55.2% of the "Full Project" total incremental cost, will

come from the national and international partners and other donors. The figure includes in-kind and cash contributions.

TABLE 1: COSTS AND INCREMENTAL ANALYSIS

| | Baseline (B) | Alternative (A) | Increment (A-B) |
|---|---|---|---|
| **Global Benefits** | • No systematic efforts to conserve crop genetic diversity through its use in production system for pest and disease management.<br>• Lack of knowledge to exploit the natural resistance that resulted from the co-evolution of pest and host-species.<br>• Pesticides used to control pest and diseases are polluting groundwater, affect human health, and decreasing beneficial insects and fungi diversity<br>• 30% of the world annual harvest is lost to pest and disease, with developing countries experiencing the great devastation<br><br>Baseline $ 5,416,699 | • Conservation of globally significant crop genetic diversity in respect to resistance to pest and diseases<br>• Conservation of associated biodiversity due to decreased pesticide use<br>• Development of practices that use local crop genetic diversity to minimize pest and disease pressures that are replicable within and outside the four project countries.<br>• Increased availability of "diversity rich" solutions to manage pest and disease pressures for small and marginal farmers,<br><br>Alternative $ 20,756,831 | Increment $ 15,340,162 |
| **Domestic Benefits** | • Knowledge on the use of existing varieties to manage disease and pest incomplete and lacks information on the farmer's central role;<br>• Host resistance breeding and pesticide use are the most common strategies to protect crops against pest and disease pressures proving only temporary solutions.<br>• Most breeding programs use single genes to provide resistance across many types of environment.<br>• Large areas in which popular resistant cultivars are planted facilitate rapid pathogen evolution and migration to overcome resistance. | • Farmers provided with low-cost options for pest and disease management.<br>• Increased and more reliable food supply for local and indigenous communities through the use of crop genetic diversity to minimize crop loss<br>• Capacity to make decisions by the farmers, development and extension workers, NGOs, NARS research scientists, and policy makers on when and where local crop genetic diversity will be useful to minimize pest and disease pressures<br>• Crop breeding programmes more effective by increased use of local resistant materials and new methods to reduce crop vulnerability<br>• Environmental health workers provided with an alternative to unsafe pesticide used | |

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| | | • Benefit sharing protocols developed with farming communities | |
| **Component 1: Criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pests and diseases** | • Knowledge of how pest and disease systems function<br>• Limited characterization of local crop diversity of target crops<br>• Lack of information to characterize hosts, pests, pathogens and surrounding abiotic environment in the production system<br>• Lack of decision making procedures for farmers and development workers for use of local crop diversity for disease and pest management<br>• Lack of information on local crop cultivar resistance to pest and pathogen pressure | • Criteria, guidelines and decision making tools for use of local crop diversity to pest and disease management developed<br>• Genetic basis of resistance in local crop cultivars better understood and identified<br>• Distribution patterns of the pathogen and of variation in pathogen virulence for the target crops better understood<br>• Farmers concerns and appreciation of pest and diseases understood and used in decision making<br>• Protocols for participatory assessment combined with laboratory and field analysis to determine when and where genetic diversity can be recommended to minimize pest and disease pressures on-farm<br>• A set of tools to estimate the economic value of crop genetic diversity in reducing yield and quality losses, and yield variability | China: 982,224<br>Ecuador: 637,775<br>Morocco: 557,593<br>Uganda: 593,418<br><br>Total: 2,771,010<br>Co-finance: 1,708,719<br>Cost to GEF: 1,062,291 |
| | China: 445,000<br>Ecuador: 183,000<br>Morocco: 258,375<br>Uganda: 294,200<br><br>Total: 1,180,575 | China: 1,427,224<br>Ecuador: 820,775<br>Morocco: 815,968<br>Uganda: 887,618<br><br>Total: 3,951,585 | |

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| **Component 2: Practices and procedures that determine how to optimally use crop genetic diversity to reduce pest and disease pressure** | • No systematic information available to implement different ways of using within crop diversity in different production situations to reduce pest and disease pressures<br>• Lack of tested diversity rich methods to manage pest and diseases | • Synthesis of farmers experiences on using crop genetic diversity to minimize pest and diease pressures<br>• Increased number of different landraces with different resistance available to farmers<br>• Desirable characters bred into resistant varieties<br>• Increased number of varieties which are now more resistance through breeding or mixture planting<br>• Diversity rich methods to manage pest and disease pressures tested and made available for different spatial scales | China: 1,068,312<br>Ecuador: 439,980<br>Morocco: 622,878<br>Uganda: 420,389<br><br>Total: 2,551,559<br>Co-finance: 1,445,331<br>Cost to GEF: 1,106,228 |
| | China: 620,000<br>Ecuador: 297,400<br>Morocco: 383,315<br>Uganda: 207,000<br><br>Total: 1,507,715 | China: 1,688,312<br>Ecuador: 737,380<br>Morocco: 1,006,193<br>Uganda: 627,389<br><br>Total: 4,059,274 | |
| **Component 3: Enhanced capacity of farmers and others to use local crop genetic diversity to manage pest and pathogen pressures** | • Training to assess distribution and diversity for resistance, collecting and conservation techniques, data documentation, socio-economic issues and other areas related to conservation, and sustainable management of agrobiodiversity not available<br>• Training for farmers, local communities, and policy makers not available | • Farmer associations established to support the use of local crop genetic diversity to minimize pest and disease damage<br>• Male and female farmers have increased leadership capacity and participate in national decision making fora<br>• International training center established and operative;<br>• Stakeholders trained in areas of expertise needed for their role in project implementation;<br>• Participatory research programmes established or enhanced to supporting agrobiodiversity conservation. | China: 1,772,373<br>Ecuador: 577,030<br>Morocco: 623,704<br>Uganda: 719,568<br><br>Total: 3,692,675<br>Co-finance: 2,422,674<br>Cost to GEF: 1,270,001 |

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|---|---|---|---|
| | China: 863,069<br>Ecuador: 381,200<br>Morocco: 255,479<br>Uganda: 194,900<br><br>Total: 1,694,648 | China: 2,635,442<br>Ecuador: 958,230<br>Morocco: 879,183<br>Uganda: 914,468<br><br>Total: 5,387,323 | |
| **Component 4: Action that support adoption of genetic diversity rich methods for limiting damage caused by pests and diseases** | • Extension and development systems and packages exist in countries but with minimal use of local crop genetic diversity and farmer knowledge<br>• Seed cleaning techniques exist but not applied to local materials<br>• Education sectors contain curriculum on biodiversity but lack inclusion of information on the value of agricultural biodiversity<br>• International and domestic policies and laws exist related to biodiversity conservation and pesticide use<br>• Partner countries are part of regional networks and strategies | • Agricultural extension packages include diversity rich options to manage pest and disease pressures<br>• Policy briefs and extension manuals developed that demonstrate the economic value of using these options in practical terms, for policymakers and farmers in year five<br>• Breeding, pathology, and entomology programmes in the country include the use of intraspecific diversity to manage pest and diseases in year four<br>• Information exchange and mainstreaming of practices through national, regional and local conferences and workshops on diversity and pest and disease management<br>• National education sectors have available materials on the use of diversity rich methods to manage pest and diseases for inclusion in curriculum<br>• Recommendations on the establishment or improvement of benefit sharing protocols are submitted to policy makers by year five<br>• Agreements for benefit sharing mechanisms among farmer communities and national programmes developed and adopted in each country by year five | China: 908,750<br>Ecuador: 608,395<br>Morocco: 686,550<br>Uganda: 480,271<br><br>Total: 2,683,966<br>Co-finance: 1,520,415<br>Cost to GEF: 1,163,551 |

| | | | |
|---|---|---|---|
| | China: 520,000<br>Ecuador: 173,800<br>Morocco: 202,831<br>Uganda: 137,100<br><br>Total: 1,033,731 | China: 1,428,750<br>Ecuador: 782,195<br>Morocco: 889,381<br>Uganda: 617,371<br><br>Total: 3,717,697 | |
| **Project Management** | | Effective national and global collaboration to produce project outputs with required standards of monitoring, evaluation and active participation of stakeholders in project activities at national and global levels.<br><br>China: 610,386<br>Ecuador: 372,000<br>Morocco: 469,291<br>Uganda: 369,275<br>Global: 1,820,000<br><br>Total: 3,640,952 | China: 610,386<br>Ecuador: 372,000<br>Morocco: 469,291<br>Uganda: 369,275<br>Global: 1,820,000<br><br>Total: 3,640,952<br>Co-finance: 1,374,489<br>Cost to GEF: 2,266,463 |

## ANNEX B- LOGICAL FRAMEWOK AND WORK PLAN

| Project Planning Matrix (PPM) | Project title: "Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture" | Phase I:<br><br>Date: | ANNEX B |
|---|---|---|---|

| Objectives and Outcomes[1] | Objectively Verifiable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| ***Development Objective***:<br><br>Conserve crop diversity in ways that increase food security and improve ecosystem health | • 10% of the families from 31 local and indigenous communities show increased and more reliable food supply through the use of crop genetic diversity to minimize crop loss.<br>• Diversity rich practices replace pesticide use in 31 local and indigenous communities. | • Project and survey reports that include quantification of reduced crop loss and cost savings from reduced pesticide use. | • Stable and favourable political environment and policy makers' and partners' commitments |
| ***Immediate objective***:<br><br>Enhanced use of crop genetic diversity by farmers, farmer communities, and local and national institutions to minimize pest and disease damage on-farm | • At least 356,000 ha of land contribute to the conservation and sustainable use of crop genetic diversity in respect to minimizing pest and disease damage.<br>• At least 2 departments of agriculture and the environment in each country have incorporated crop genetic diversity rich practices to minimize pest and disease pressures into their extension plans. | • Extension packages including instructions with diversity rich options.<br>• Project publications, reports and agricultural census data<br>• Participant lists of workshops and meetings, project reports | • Host resistance exists or available in project countries<br>• Financial support is available<br>• Decision makers are open to the adoption of diversity rich approaches |
| ***Outcome 1:***<br>Rural populations in the project sites benefit from reduced crop vulnerability to pest and disease attacks | • Food insecurity is reduced for 10% of the families in 31 local and indigenous communities.<br>• Crop yields are increased by 10% from reduced crop losses from disease and pest damage for at least 20% (equivalent to 52,600 ha) of the farms in project sites.<br>• Diversity rich practices replace pesticide use to minimize crop damage for 15% of project site regions (equivalent to 106,900 ha). | • Project reports including analysis of farmer interviews | • Host resistance exists or available in project countries<br>• Farmers are open to the adoption of diversity rich approaches |
| ***Outcome 2:***<br>Increased genetic diversity on farm in respect to pest and disease management | • Diversity for resistance is increased by 10% on 30% of farmer fields in the project sites (equivalent to 78,900 ha).<br>• Use of crop genetic diversity to manage pest and disease pressures occurs on 20% of the farms (equivalent to 6142,600 | • Survey reports on number of different landraces with different resistance, breeding desirable characters into resistant varieties; | • Host resistance exists or available in project countries |

[1] All four project outputs contribute to the achievement of each of the three project outcomes and are therefore listed together after the project outcomes.

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|---|---|---|---|
| | ha) in the project sites in four countries. | and number of varieties which are now more resistant through breeding or mixture planting. | |
| ***Outcome 3:***<br>Increased capacity and leadership abilities of farmers and local communities to make diversity rich decisions in respect to pest and disease management | • At least 20% of the farmers of the project site regions (equivalent to 6,200) implement diversity rich methods developed in the project to increase use of crop genetic diversity to manage pest and disease pressures on-farm.<br>• At least two male and female farmer representatives in each site have participated in national committees or decision making fora for planning and evaluation of diversity rich methods to manage pest and diseases. | • Participant lists of national meetings | • Decision makers and farmers are open to the adoption of diversity rich approaches<br>• A favourable political environment exist that supports farmers participation in national forum |

| **Project Planning Matrix (PPM)** | **Project title: "Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture"** | **Phase I:**<br><br>**Date:** | **ANNEX B** |
|---|---|---|---|

| **Outputs** | **Objectively Verifiable Indicators** | **Means of Verification** | **Important Assumptions** |
|---|---|---|---|
| ***Outputs:***<br><br>*1. Criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pests and diseases* | • Guidelines for Farmers Group Discussion to understand farmers' knowledge, practices, problems and needs for using diversity to control pests and diseases developed, published and used by year two.<br>• Protocols for participatory assessment combined with laboratory and field analysis to determine when and where genetic diversity of the four target crops can be recommended to manage pest and diseases published and made available to concerned stakeholders by year three.<br>• A set of methods and tools to estimate the value of crop genetic diversity in reducing yield losses, yield variability, and in mitigating product quality losses from pests and diseases tested and made available by year four in each country. | • Guidelines and protocols<br>• Scientific publications<br>• Training materials for farmers, extension workers and research groups<br>• Periodic project progress reports<br>• Donors reports | *In order to achieve output 1*<br><br>• Farmers on-site are cooperative<br>• Farmers have understanding and awareness about use of crop diversity |
| *2. Practices and procedures that determine how to optimally use crop genetic diversity to reduce pest and disease pressure* | • At least one diversity rich practice or option developed for each of the four target crops, which synthesizes project experiences and provides guidance to farmers on using diversity rich options to manage pest and disease by year four.<br>• A set of recommendations that provide guidance about substituting diversity rich practices for pesticide use produced in each country and submitted to agricultural and environmental development sectors by year five. | • Technical reports of field trials of diversity rich options<br>• Published manual<br>• Report and papers from concerned partners<br>• Community feedback and project documents | *In order to achieve output 2*<br><br>• Decision makers are open to adoption of *in situ* conservation approaches to manage pest and disease damaget |
| *3. Enhanced capacity of farmers and other stakeholders to use local crop genetic diversity to manage pest and pathogen pressures* | • At least one farmer associations is established or enhanced per site in each country to support the use of crop genetic diversity to manage and pest and disease pressures by year four.<br>• At least two male and female farmer representatives in each site have participated in national committees/ decision making fora for planning and evaluation of diversity rich methods to manage pest and diseases by year five.<br>• At least four researchers with Partner teams have in-house expertise on all disciplines to enable project outputs in the country | • Progress reports<br>• National reports and publications<br>• Training course evaluation and reports<br>• Training database<br>• Training manuals, lecture notes and presentations<br>• Increase farmers' knowledge | *To achieve output 3*<br>• Commitment of the project partners is ensured<br>• Farmers are receptive |

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| | by year four of the project.<br>• Site Coordination Committees are established in each county and operating to coordinating and link intra-site, thematic and multidisciplinary activities within each country by the end of year one.<br>• At least two researches in each country with expertise on participatory approaches in respect to pest and disease management available in each country by year two.<br>• At least one participatory research training programme developed at the provincial level in each country by year three.<br>• An International Agrobiodiversity Training Centre is operative in China which includes a training curriculum on agrobiodiversity management for pest and disease pressures by year three.<br>• At least two International Ph.D. sandwich programmes are set up with universities from the partner countries by year four. | about pests and disease management (site visits and interview with farmers)<br>• Increase use of crop diversity on-farm (Site visits and community biodiversity registers) | |
| *4. Actions that support the adoption of genetic diversity rich methods for limiting damage caused by pests and diseases.* | • Agricultural extension packages include diversity rich options to manage pest and disease pressures in year five in each country.<br>• Policy briefs and extension manuals developed that demonstrate the economic value of using these options in practical terms, for policymakers and farmers in year five.<br>• Breeding, pathology, and entomology programmes in the country include the use of intraspecific diversity to manage pest and diseases in year four.<br>• Four national and three regional conferences on diversity and pest and disease management organized by year five.<br>• National education sectors have available materials on the use of diversity rich methods to manage pest and diseases for inclusion in curriculum in each country in year five.<br>• At least two recommendations on the establishment or improvement of benefit sharing protocols are submitted to policy makers by year five.<br>• At least two agreements for benefit sharing mechanisms among farmer communities and national programmes developed and adopted in each country by year five. | • National curricula<br>• Course outlines<br>• Diversity rich options used in farmers' field<br>• Extension service packages<br>• Policy guidelines | *To achieve output 4*<br><br>• Decision makers are open to adoption of *in situ* conservation approach through use for pest and disease management |

**PLAN OF ACTIVITIES FOR THE PERIOD 1 FEBRUARY 2006 – 1 JANUARY 2011**

| **Activities and time table by Output** | **Project: "Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture"** | | |
|---|---|---|---|
| ***Component 1. Criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pest and disease***<br><br>***Research questions:***<br>• *Host Diversity -- Among and within traditional crop cultivars, what genetic variation for resistance exists against the pathogen populations harboured?*<br>• *Biotype Diversity -- How does the population structure of pathogens vary across systems and in space?* | Planning period: | Schedule established: | ANNEX B |

| Activities<br>Sub-activities | Timeframe<br>Years | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **1.1 Develop participatory criteria and tools to determine whether pest and or disease are a key limiting factor to production in farmers' systems** | | | | | |
| 1.1.1 Global and national workshops on participatory diagnostic approaches and data analysis | | | | | |
| 1.1.2 Global and national workshops to standardize assessment methods for pest, pathogen and environmental interactions | | | | | |
| 1.1.3 Determine farmers' concerns and appreciation of pest and diseases in their crops | | | | | |
| 1.1.4 Determine farmers' perceptions on the controllability of the pest or disease under different environmental conditions | | | | | |
| 1.1.5 Determine site characteristics (environmental, social, economic, levels of poverty) which influence the effect of pest and disease pressures | | | | | |
| **1.2 Determine whether intraspecific diversity with respect to resistance exists within the site** | | | | | |
| 1.2.1 Assess the amount and distribution of crop genetic diversity (landraces) in target sites | | | | | |
| 1.2.2 Collect and analyze farmers' knowledge/descriptions of host diversity with respect to pest and diseases at different degrees, stages and environmental conditions | | | | | |
| 1.2.3 Conduct experiments for identification of resistance response in landraces - including intra-populations reactions to different pest and diseases | | | | | |
| 1.2.4 Develop criteria and tools to determine whether the pest and/or disease problem is related to lack of crop diversity with respect to resistance on-farm or to other factors | | | | | |
| **1.3 Identify other sources of intraspecific diversity with respect to resistance from earlier collections from the site or from similar agroecological environments (*ex situ* collections, other sites with similar environments)** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 1.3.1 Look for *ex situ* characterization data and farmer knowledge on disease and pest response from earlier collections of landraces from the sites of similar environments to project sites | | | | | |
| 1.3.2 Conduct experiments for identification of resistance response in landraces | | | | | |
| **1.4 Develop criteria and tools to determine whether diversity, with respect to pest and/or disease control, exist but is not accessed and/or not optimally used** | | | | | |
| 1.4.1 Determine whether farmers are using available intra-specific diversity to manage pest and diseases | | | | | |
| 1.4.2 Determine how farmers access intra-specific materials, and information on the materials, to manage pest and disease pressures | | | | | |
| 1.4.3 Identify constraints to optimal access and use of intra-specific diversity to manage pest and diseases (e.g., farmers are not aware that host resistance exists, mixtures not used that would reduce pest and disease pressures, problems in access to existent material) | | | | | |
| **1.5 Develop criteria and tools to determine whether there is diversity in virulence and aggressiveness of pathogens and biotype diversity for pests** | | | | | |
| 1.5.1 Determine farmers' knowledge and perceptions on pathogen variation and pest population dynamics | | | | | |
| 1.5.2 Determine pathogen variation (e.g. collection, screening, and conservation of samples of isolates against a range of host genotypes) | | | | | |
| 1.5.3 Standardize methods for resistance and virulence screening for specific host-pest/pathogen systems | | | | | |
| 1.5.4 Standardize methods for determining population dynamics of pest for specific host pest systems | | | | | |
| **1.6. Determine the movement and transmission mechanisms of pest and diseases within and among the sites** | | | | | |
| 1.6.1 Determine farmers' knowledge and perceptions on movement/transmission mechanisms of pest and pathogens and their management to reduce transmission (including seed systems and access to resistance hosts) | | | | | |
| 1.6.2 Identify key persons responsible and pathways for the movement of seeds/genetic planting material inside and outside the village and their knowledge of disease and pests | | | | | |
| 1.6.3 Quantify the transmission of the disease and pest through the movement of the material and through other mechanisms (including host range) | | | | | |

| **Activities and time table** | **Project: “Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture”** | | |
|---|---|---|---|
| ***Component 2. Practices and procedures that determine how to optimally use crop genetic diversity to reduce pest and disease pressures***<br><br>***Research Question:***<br>• *Diversity and field resistance -- Does the resistance diversity present in a crop actually reduce pest and disease pressure and vulnerability, at least in the short-term?* | Planning period: | Schedule established: | ANNEX B |

| Activities<br>Sub-activities | Timeframe<br>Years | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **2.1 Identify and compile farmer knowledge and practices in on-going systems where intra-specific diversity is being used to manage pest and disease pressures and promote good practices** | | | | | |
| **2.2 Conduct experiments using intra-specific diversity that show the effect of diversity on controlling pest and disease incidence** | | | | | |
| **2.3 Evaluate past and present use of crop diversity by national breeding programmes to manage pest and disease pressures** | | | | | |
| **2.4 Conduct simulation modelling to look at how patterns of intra-specific diversity distribution and population sizes might affect pest and disease incidence over space and time** | | | | | |
| **2.5 Compare the range of diversity rich practices and options to determine appropriate spatial and temporal scales to manage pest and diseases pressures** | | | | | |
| **2.6 Provide sets of options for farmers, farmer organizations, NGOs and extension works of diversity rich solutions to pest and disease management in project sites** | | | | | |
| 2.6.1 Provide different mixtures of local germplasm from project site materials and earlier collected materials (*ex situ* collections) from project sites and similar agroecosystems | | | | | |
| 2.6.2 Promote interchange resistance materials between farming communities from the same sites as well as between sites | | | | | |

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| **Activities and time table** | **Project: "Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture"** | | |
| ***Components 3. Enhanced capacity of farmers and others to use local crop genetic diversity to manage pest and disease pressures*** | Planning period: | Schedule established: | ANNEX B |

| Activities<br>Sub-activities | Timeframe<br>Years | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **3.1 Team building of farmers, field technicians, researcher, policymakers at regional and local level and education institutions (strengthen the ability to work in a group in a participatory manner)** | | | | | |
| 3.1.1 Training in participatory approaches and team building for all the stakeholders mentioned above | | | | | |
| 3.1.2 Promote information interchange among different stakeholders through local networks | | | | | |
| **3.2 Provide opportunities to increase gender equity in project management and participation project activities and training opportunities** | | | | | |
| **3.3 Identify key farmers (male and female) and farmer groups who use intra-specific crop diversity to manage their production systems and support these farmers with diversity rich options to manage pests and diseases** | | | | | |
| 3.3.1 Facilitate the definition of criteria to identify key farmers | | | | | |
| 3.3.2 Organize training programmes for identified key farmers and facilitate farmers to train other farmers | | | | | |
| 3.3.3 Organize cross site visits | | | | | |
| **3.4 Reinforce the local farmer organizations in seed activities related to pest and disease management** | | | | | |
| 3.4.1 Seed cleaning, management and marketing | | | | | |
| 3.4.2 Support local seed system networks | | | | | |
| **3.5 Empower male and female farmers and other stakeholders to determine when diversity rich choices are appropriate for their circumstances** | | | | | |
| 3.5.1 Enhance farmers' knowledge to strength their decision-making on use of diversity choices to manage pest and disease pressure | | | | | |
| 3.5.2 Enhance the leadership ability of farmers to take decisions concerned with the management of pest and diseases (including participatory approaches for confidence building) | | | | | |

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| **3.6 Identify and promote local methods for farmers to efficiently use crop diversity information** | | | | | |
| 3.6.1 Link with on-going national and/or informal (NGO) literacy promotion programmes to enhance farmer's ability to manage crop diversity information | | | | | |
| **3.7 Build local institutional capacities to sustain project activities through training and inputs to local extension, NGOs, CBOs, local research stations, middle and technical schools and local colleges** | | | | | |
| 3.7.1 Formulate and implement appropriate training programmes for each partner | | | | | |
| 3.7.2 Support and complement local educational initiatives already in operation (e.g. school curriculum) to include diversity rich solutions to manage pest and diseases | | | | | |
| **3.8 Enhance capacity of research institutes to analyze local crop diversity with respect to pest and disease resistance through training and facilities** | | | | | |
| 3.8.1 Support national needs to implement project activities through for short, medium and long term training plans in phytopathology, entomology, plant population genetics, ethnobotany, economics and participatory approaches | | | | | |
| 3.8.2 Interchange of experts visits among country partners | | | | | |
| 3.8.3 Organization of thematic network meetings by crop and by discipline | | | | | |
| 3.8.4 Design “sandwich” programmes and courses among universities | | | | | |
| **3.9 Develop the understanding of national and international legal and economic policies related to use of local crop diversity to manage pest and disease pressures** | | | | | |
| 3.9.1 Develop strategy for information and germplasm exchange and testing based on national and international treaty and agreements | | | | | |
| **3.10 Set up an international network of persons from national, regional and global levels to compile and feed back information on using intraspecific diversity to manage pest and disease pressures** | | | | | |

| Activities and time table | Project: “Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture” | | |
|---|---|---|---|
| ***Component 4. Actions that support adoption of genetic diversity rich methods for limiting damage caused by pest and diseases*** | Planning period: | Schedule established: | ANNEX B |

| Activities<br>Sub-activities | Timeframe<br>Years | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **4.1 Document successful experiences from the project output of interdisciplinary work and of farmers’ participatory research on use of diversity to manage pest and disease and recognition of such team efforts (prizes, awards, etc.)** | | | | | |
| 4.1.1 Publish and disseminate information from the project case studies in different media forms (journals, newspapers, videos, radio, web pages, etc.) showing the benefits/gains from using of local crop diversity to manage pest and disease pressures | | | | | |
| 4.1.1 Organize and participate in national, regional and global scientific exchange meetings (including participation in other appropriate regional and international meetings in agrobiodiversity management, phytopathology and entomology not organized by the project) | | | | | |
| **4.2 Promote public appreciation and awareness of the use of agrobiodiversity to minimize pest and disease pressures for farmers, extension and education programs, and policy makers** | | | | | |
| 4.2.1 Organize field visits for policy makers and the press | | | | | |
| 4.2.2 Organize cross site visits for farmers | | | | | |
| **4.3 Develop mechanisms to disseminate information and materials to farmers and communities on previously collected (*ex situ*) and/or characterized/evaluated germplasm from farmers’ sites and similar agroecosystems** | | | | | |
| **4.4 Compare diversity rich approaches to other options (e.g., agronomic practices, chemical use)** | | | | | |
| 4.4.1 Examine cost effectiveness of approaches and estimate economic benefits of using diversity rich approaches | | | | | |
| **4.5 Promote collaboration with agricultural extension services and local NGOs to increase access of locally adapted farmer seeds across villages and regions with similar agroecosystems.** | | | | | |
| 4.5.1 Promote seed interchange through diversity fairs | | | | | |
| 4.5.2 Promote seed interchange through on site demonstration plots of selected *ex situ* collections | | | | | |
| 4.5.3 Promote seed interchange through local nodal farmer(s) on site – informal seed exchange system | | | | | |

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| **4.6 Mainstream the inclusion of local crop diversity and techniques on seed cleaning of local crop cultivars and other methods of seed quality improvement into agricultural extension and NGO development packages** | | | | | |
| **4.7 Adapt the national breeding strategy to include farmers' knowledge with local materials in breeding programmes** | | | | | |
| 4.7.1 Compare conventional breeding strategies with the farmers' strategies to minimize pest and disease pressures | | | | | |
| 4.7.2 Adopt the use of local resistant material together with farmers' knowledge in national breeding programmes | | | | | |
| 4.7.3 Develop or expand participatory selection and participatory breeding (PPB, PVS) to include the use of local resistant materials and farmers' knowledge | | | | | |
| **4.8 Work with education sectors to supply materials on the use of local crop diversity to manage pest and disease pressures to integrate into the national curriculum** | | | | | |
| 4.8.1 Review existing materials, identify areas where materials could be included, and supply information for inclusion of materials | | | | | |
| **4.9 Provide information for cost effective design of policies to support the maintenance of diversity on farm** | | | | | |
| **4.10 Develop protocols for benefit sharing of genetic material and new methods of diversity management** | | | | | |

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| **Activities and time table** | **Project: "Conservation and Use of Crop Genetic Diversity to Control Pests and Disease in Support of Sustainable Agriculture"** | | |
| ***Component 5: Project Management*** | Planning period: | Schedule established: | ANNEX B |

| Activities<br>Sub-activities | Timeframe<br>Years | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **5.3 Arrangements for overall project administration and implementation infrastructure** | | | | | |
| 5.1.1 Hire global project manager and assistant | | | | | |
| 5.1.2 Hire project personnel in partner countries | | | | | |
| 5.1.3 Establish and equip national project offices | | | | | |
| 5.1.4 Establish the Site Coordination Committees in each partner country | | | | | |
| 5.1.5 Establish and equip site committees at each site | | | | | |
| **5.2 Establish and operate project reporting and accounting system** | | | | | |
| **5.3 Prepare work plans for project personnel in partner countries** | | | | | |
| **5.4 International Steering Committee Meetings** | | | | | |
| **5.5 National Steering Committee Meetings** | | | | | |
| **5.6 Site Committee Meetings** | | | | | |
| **5.7 Site Coordination Committee meetings** | | | | | |
| 5.7.1 Annual work plan workshops | | | | | |
| 5.7.2 Annual project implementation review meetings | | | | | |
| **5.8 Project monitoring and evaluation** | | | | | |

## ANNEX B1: PHASE I - OBJECTIVELY VERIFIABLE INDICATORS AND MILESTONES (YEARS 1 AND 2 OF PROJECT IMPLEMENTATION)

| Components and Cost to GEF for Phase I | Objectively Verifiable Indicators (from Annex B: Logical Framework and Work Plan) | Percent Completion in Phase I | Logframe Activity Numbers | Phase I Milestones (from Annex P: Monitoring, Progress Reporting, and Evaluation Plan) |
|---|---|---|---|---|
| ***Component 1:***<br><br>*Criteria and tools to determine when and where intra-specific genetic diversity can provide an effective management approach for limiting crop damage caused by pests and diseases* | • Guidelines for Farmers Group Discussion to understand farmers' knowledge, practices, problems and needs for using diversity to control pests and diseases developed, published and used by year two. | **100% completed** | 1.1.1-1.1.5<br><br>1.2.1-1.2.3<br><br>1.3.1-1.3.2<br><br>1.4.1-1.4.3<br><br>1.5.1-1.5.2<br><br>1.6.1-1.6.2 | **M** Global workshop on participatory diagnostic approach and data analysis for developing Farmers Group Discussion (FGD) and participatory assessment combined with laboratory and field assessment organized by *Month 6 Year 1*<br>**M** National workshops in each of the four countries to refine and finalize the FGD and participatory assessment, based on target crops and local situations, by *Month 10 Year 1*<br>**M** Field survey for gathering site specific baseline information relating to amount of crop diversity, use of pesticides, site environment, social and economic aspects of the farmers and farming communities, undertaken by *Month 10 Year 1*<br>**M** Survey information compiled and analyses to understand farmers belief regarding the concept of crop diversity and using the diversity to manage pest and diseases problem in their farming system by *Month 12 Year 1*<br>**M** Survey information compiled and analyzed to determine whether intraspecific diversity with respect to resistance exists within the site and to identify other sources of diversity to be used by *Month 4 Year 2*<br>**M** Guidelines information for Farmers Group Discussion to understand farmers' knowledge, practices, problems and needs for using diversity to control pests and diseases gathered and compiled from each of the four countries for publication by *Month 10 Year 2* |
| | • Protocols for participatory assessment combined with laboratory and field analysis to determine when and where genetic diversity of the four target crops can be recommended to manage pest and diseases published and made available to concerned stakeholders by year three. | **100% completed** | | |
| ***Cost to GEF Phase I:***<br><br>China: 397,455<br>Ecuador: 148,720<br>Morocco: 128,230<br>Uganda: 175,427<br><br>Total: 849,832 | • A set of methods and tools to estimate the value of crop genetic diversity in reducing yield losses, yield variability, and in mitigating product quality losses from pests and diseases tested and made available by year four in each country. | 50% completed | | |
| ***Component 2:***<br><br>*Practices and procedures that determine how to* | • At least one diversity rich practice or option developed for each of the four target crops, which synthesizes project experiences and provides guidance to farmers on using diversity rich options to manage pest and disease by year four. | 10% completed | 2.1<br><br>2.3 | **M** Status of national crop improvement system for developing resistant varieties, its extension and associated problem and challenges fully understood and documented in each of the four countries by *Month 8 Year 2* |

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| *optimally use crop genetic diversity to reduce pest and disease pressure*<br><br>***Cost to GEF Phase I:***<br><br>China: 89,036<br>Ecuador: 20,820<br>Morocco: 64,981<br>Uganda: 46,408<br><br>Total: 221,245 | • A set of recommendations that provide guidance about substituting diversity rich practices for pesticide use produced in each country and submitted to agricultural and environmental development sectors by year five. | 10% completed | | |
| ***Component 3:***<br><br>*Enhanced capacity of farmers and other stakeholders to use local crop genetic diversity to manage pest and pathogen pressures*<br><br>***Cost to GEF Phase I:***<br><br>China: 138,189<br>Ecuador: 45,733<br>Morocco: 109,341<br>Uganda: 130,o71<br><br>Total: 423,334 | • At least one farmer associations is established or enhanced per site in each country to support the use of crop genetic diversity to manage and pest and disease pressures by year four. | 20% completed | 3.1.1-3.1.2<br><br>3.3.1-3.3.3<br><br>3.7.1<br><br>3.8.1-3.8.3<br><br>3.10 | **M** Team building and participatory training workshops in each of the four countries organised by Month 8 Year 2<br>**M** Key farmers, both male and female, identified and were trained at each site in each of the four country for their active participation in the project by Month 10 Year 1<br>**M** Necessary training facilities at national and site level provided to all four countries by *Month 5 Year 2* |
| | • At least two male and female farmer representatives in each site have participated in national committees/ decision making fora for planning and evaluation of diversity rich methods to manage pest and diseases by year five. | 0% | | |
| | • At least four researchers with Partner teams have in-house expertise on all disciplines to enable project outputs in the country by year four of the project. | 20% completed | | |
| | • Site Coordination Committees are established in each county and operating to coordinating and link intra-site, thematic and multidisciplinary activities within each country by the end of year one. | **100% completed** | | |
| | • At least two researches in each country with expertise on participatory approaches in respect to pest and disease management available in each country by year two. | **100% completed** | | |

| | | | | |
|---|---|---|---|---|
| | • At least one participatory research training programme developed at the provincial level in each country by year three. | 20% completed | | |
| | • An International Agrobiodiversity Training Centre is operative in China which includes a training curriculum on agrobiodiversity management for pest and disease pressures by year three. | **100% completed** | | |
| ***Component 4:***<br><br>*Actions that support the adoption of genetic diversity rich methods for limiting damage caused by pests and diseases.*<br><br>***Cost to GEF Phase I:***<br><br>Total: 0 | Agricultural extension packages include diversity rich options to manage pest and disease pressures in year five in each country. | 0% | | All activities in Phase II (Activities begin year 3 of project implementation) |
| | | | | |
| | • Policy briefs and extension manuals developed that demonstrate the economic value of using these options in practical terms, for policymakers and farmers in year five. | | | |
| | • Breeding, pathology, and entomology programmes in the country include the use of intraspecific diversity to manage pest and diseases in year four. | | | |
| | • Four national and three regional conferences on diversity and pest and disease management organized by year five. | | | |
| | • National education sectors have available materials on the use of diversity rich methods to manage pest and diseases for inclusion in curriculum in each country in year five. | | | |
| | • At least two recommendations on the establishment or improvement of benefit sharing protocols are submitted to policy makers by year five. | | | |

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| | • At least two agreements for benefit sharing mechanisms among farmer communities and national programmes developed and adopted in each country by year five. | | | |
| ***Component 5:***<br><br>*Project Management*<br><br>***Cost to GEF Phase I:***<br><br>China: 159,221<br>Ecuador: 64,000<br>Morocco: 81,333<br>Uganda: 97,600<br>Global: 353,333<br><br>Total: 755,488 | • Project management | 20% | 5.1-5.8 | Years 1 and 2 of project management |
| ***Cost to GEF Phase I:***<br><br>***Grand Total:* 2,249,900** | | | | |

ANNEX C - STAP ROSTER TECHNICAL REVIEW

# "CONSERVATION AND USE OF CROP GENETIC DIVERSITY TO CONTROL PESTS AND DISEASES IN SUPPORT OF SUSTAINABLE AGRICULTURE"

**Norman C. Ellstrand**
**Professor of Genetics**
**University of California at Riverside**

***Key issues***

- ***Scientific and technical soundness of the project***

Overall, the project has a high level of scientific and technical soundness. The keystone to the project is the general observation that very low genetic diversity in crops is highly correlated with vulnerability to epidemics of pests – both disease organisms and other organisms such as insects that devastate yields. The same observation has been made for wild populations that have low genetic diversity. Those observations have been largely backed up with experimental and theoretical work that has demonstrated that genetic mixtures generally have higher mean yields (or fitness, in the case of wild populations) than genetically uniform stands. The authors of the proposal, however, correctly note that not all genetic diversity should necessarily lead to sustainability of crop yields, but rather genetic diversity for resistance to pests. They note that a general feature of traditional agriculture is that farmers frequently manage the genetic diversity of their crops in such a way that genetic diversity with regard to resistance is frequently maintained or augmented, resulting in sustainable yields.

The goal of the proposal is to study how genetic diversity for resistance is managed and maintained such that the best practices can be identified and introduced to resource-poor rural populations to increase yields and sustainability. With this information, farmers should be able to grow crops more sustainability without resorting to pesticides, thereby having economic and environmental benefits as well.

The crops and countries have been well chosen. In particular, the six crops represent globally important species that provide food in multiple continents. Therefore, their general biology, agricultural biology, and pest biology have been extremely well-studied. At the same time, the six are a diverse assemblage representing three different plant families – two grains, two pulses, and a fleshy fruit – and the three types of plant reproductive systems – selfing, outcrossing, and clonal reproduction. The crop pests under study represent microorganisms, pest insects, and nematodes. The four target countries represent three different continents and four different biogeographical zones. And while they are all developing nations, the central locus for research at each is a significant research institution.

The research has two important components: ethnobotanical and ecological/genetic. The ethnobotanical component involves measuring farmers' beliefs and practices. The ecological/genetic component involves measuring biological and abiotic parameters at the field sites.

Nonetheless, I have a set of questions regarding the research. The details of how genetic diversity will be measured and described are not clear. Furthermore, it is not clear how either

set of data will be statistically analyzed. Both straightforward comparisons of controls to experiments will be necessary; some multivariate analysis is probably necessary as well. Also, I note that there is an explicit plan for monitoring, but it is not clear to me that the project has an internal adaptive protocol if unanticipated data or other problems appear that require a re-evaluation of the project's planned pathway. Finally, given year-to-year environmental variation that impacts yields, is a single year of data collection sufficient to create a baseline for future comparison? Regarding these questions, it is disconcerting to read on pages G-42 and G-43 that protocols for technical assessment of the crops have not yet been developed.

♦ ***Global environmental benefits and/or drawbacks of the project***

If it is shown that genetic diversity for resistance of crop pests can be manipulated to significantly reduce food insecurity – and that it is general over sites, crops, countries, and pests, application of the information gleaned in this project has tremendous potential for global environmental benefits because genetic manipulation would serve as an alternative to pesticides. The adoption of this methodology by farmers, large and small, would reduce pesticide use and pesticide exposure to farmers and non-pest organisms in the surrounding environment. Secondary environmental benefits would include (1) reduced need to transport pesticides, reducing burning of fossil fuels, and (2) reduced exposure to residual pesticides by the human and animal consumers of the crops. If the methodology is indeed general, the substitution of genetic manipulation for pesticide use could be applied anywhere globally with the above benefits.

One potential drawback is that the principal of managing crops for an *optimal level of genetic diversity with respect to pest resistance* might easily be misunderstood as managing crops for a *maximum amount of general genetic diversity*. Conservation geneticists who work on wild populations have already come to realize that introducing genetic diversity to populations for its own sake may have disastrous consequences. I am confident that the authors of this proposal recognize that but should be on guard that their results are not misunderstood.

♦ ***Global environmental benefits for the biodiversity important to agriculture***

If the methodology is indeed general, genetic manipulation of crops for diversity with regard to pest resistance has immediate benefits for the biodiversity important to agriculture. First and foremost, it is recognized that genetic diversity itself is an important component of the biodiversity important to agriculture. *Ex situ* conservation of genetic diversity has been critical for crop improvement in the last century, including improvement in areas other than pest resistance. Efforts towards *in situ* conservation of genetic diversity have been uneven at best. The management of genetic diversity at the farm level has the immediate benefit of tremendously augmenting the diversity held in *ex situ* collections (it should be noted, however, that *in situ* conservation does not replace *ex situ* collections). That *in situ* diversity is likely a valuable resource for future crop improvement for crop resistance in other regions of the world and for other purposes as well. Maintenance of such a large base of germplasm serves as a *global* resource of food security via the opportunity for enhanced germplasm exchange among countries because of the greater pool of genotypes available.

Secondly, reduced pesticide use stops the pesticide-based deaths of non-target beneficial organisms. For example, these include soil species that interfere with populations of soil-borne pest species as well as insects that effect pollination or prey upon insect pests.

Therefore, application of the new methodology is expected to increase beneficial species diversity in agroecosystems wherever applied.

- ***How the project fits within the context of the goals of GEF, as well as its operational strategies, Operational Programme 13 on Conservation and Sustainable Use of Biological Diversity Important to Agriculture, Strategic Objectives for Biodiversity focal area, GEF Council guidance and the provisions of the relevant conventions, particularly the Convention on Biological Diversity (CBD) and approved by Conference of Parties (COP) work programme for Agrobiodiversity.***

As a plan to increase, manage, and sustainably maintain biodiversity, the project fits the goals and operational strategies of the GEF very well. It matches the priorities of GEF OP 13 in that it directly addresses the objective "… to promote the positive and mitigate the negative impacts of agriculture systems and practices on biological diversity in agro-ecosystems and their interface with other ecosystems; the conservation and sustainable use of genetic resources of actual and potential value for food and agriculture … ". Likewise, the project directly addresses the four objectives of the Convention on Biological Diversity program of work on agricultural biodiversity in that it (1) assesses biological diversity – both in terms of measuring genetic diversity and assesses farmer knowledge; (2) builds an adaptive management scheme from case studies (a) by studying the goal of genetic diversity in providing resilience, reducing susceptibility to pests, and enhancing adaptability through the *in situ* management of local germplasm and (b) by studying pest and disease control mechanisms, (3) builds capacity by the cycle of knowledge and information among farmers, extension workers, and scientists as the same time directly linking them to a framework of national and international programs for agricultural biodiversity, and (4) creates a mainstreaming effect driven by the immediate benefits of the research. In the same way, the project supports the goals of the other programs listed above.

- ***Rationale for the project's global approach***

As noted above, the rationale for the project's global approach is clear. The four partner countries represent as diverse a set of environmental sites as possible, a key for testing for global generality. Likewise, if global generality is demonstrated by the project, then because of the immediate and diverse benefits of crop genetic diversity management as an alternative to pesticides (listed above and below), it is likely that the diversity-promoting methodology developed will be globally adopted, with adaptation to local crops, pests, and conditions.

- ***Replicability of the project (added value for the global environment beyond the project itself)***

If the methodologies developed by the project are found to be generally successful for the crops, pests, sites, and countries involved, then the project is inherently replicable because it should "sell itself", mainstreaming into other regions motivated by the anticipated benefits accrued that have been described above.

- ***Sustainbility of the project in terms of environmental, socio-economic and financial sustainability***

Currently, the global trend has been to increased local genetic uniformity of crops. It is well-accepted that the temporary gains in yields are accompanied by occasional disastrous

outbreaks of pests. While pesticides can offer relief from pests, pests eventually evolve resistance, leading to even worse outbreaks. Clearly, the current trend is not sustainable.

If management of genetic diversity for optimization of food security proves to be globally general, the project should be inherently environmental, socio-economic, and financial sustainable. It will be environmentally stable because the higher levels of biodiversity that will be generated (both intra-specific and inter-specific) are already known to be correlated with community and ecosystem stability and resilience. The use of fewer pesticides will also contribute to environmental sustainability. Socio-economic sustainability should also be enhanced as the iterative cycle of exchange of information between farmers, scientists, and other project participants increases and stabilizes crop yields for the farmers who adopt the refined methodology that emerges. As the project becomes increasingly successful, its own financial sustainability should be assured as other regions seek to adopt the new methodology.

***Secondary issues***

♦ ***Linkages between biodiversity and other focal areas.***

The project involves direct and straightforward linkage of genetic biodiversity to a number of other GEF focal areas. In particular, the reduced use of pesticides accrued as a benefit of increasing and maintaining crop genetic diversity related to pest resistance will result in reduced runoff of pollutants into international waters, reduced land degradation by pesticide accumulation, and the overall reduced use and accumulation of persistent organic pollutants.

♦ ***Linkages to other programmes and action plans at regional or sub-regional levels.***

The four partner countries have strong multiple links to other relevant programs. All are participants in regional plant genetic resources networks and other programs for the improvement of agriculture, and the development of rural communities (including a number of existing UNEP-GEF projects). These are extensively detailed in the proposal brief and the Annexes of the proposal.

♦ ***Other beneficial or damaging environmental effects***

None that I can think of.

♦ ***Degree of involvement of stakeholders in the project***

The proposed project has an impressive array of appropriate stakeholders. At the local level, the direct stakeholders, the farmers, are directly involved in conveying data. Local scientists are directly interacting with the farmers. All of the appropriate stakeholders at a series of higher levels appear to be listed for each of the countries involved – academic, NGO, governmental and other public institutions – representing all aspects of agriculture, agricultural science, environmental science, and the communities of people directly involved. I could not identify any group of obvious stakeholders that were overlooked.

♦ ***Capacity-building aspects***

As designed, the project inherently builds capacity because its execution depends on training of the participants and by the requisite establishment of collaborative frameworks from the local through the national to the international levels. In particular, farmers and farmer groups will receive substantial training because they represent the sites of the management of genetic diversity for pest control. At the same time, it is farmers' knowledge and skills that will be accumulated by the scientists involved in the project so that the farmers will be training local scientists as much as the scientists are training the farmers. This iterative cycle of training provides an opportunity to break down barriers and build lasting partnerships. Also, I note that the major academic institutions involved in the project will serve as sites for "sandwich" Ph.D. programs.

♦ ***Innovativeness***

The proposed project is exceptionally innovative. While germplasm scientists have cried for decades for the need for farmers to be involved in *in situ* conservation, they have often felt that farmers would accrue no benefit from doing that. On the other hand, crop ecological geneticists have recognized the benefit of genetic diversity in raising and sustaining wild plant fitness and crop yields, but with little opportunity to use that information. The proposed project seeks to merge the first goal with the recognized benefits posited by the second goal. When reading this proposal, it seems like a "no-brainer" but it is clearly not obvious because the need for *in situ* conservation and the benefits of genetic mixtures have been well-known for at least thirty years. This is a bold and innovative application of plant population genetics.

## Annex C1 - Response to STAP Review

We would like to thank the Reviewer for his comments noting the high level of scientific and technical soundness of the proposal, the impressive array of stakeholders, and the inherent capacity building component based on the project's collaborative partnerships. We also appreciate the Reviewer's agreement on the appropriateness of the crops, pest and disease systems, countries, and lead institutions selected for the proposal, and his statement that "the proposed project is exceptionally innovative." We have listed responses below to the reviewer's set of questions regarding the project.

♦ ***Scientific and technical soundness of the project***

***Reviewer comment****:*
*1. The details of how genetic diversity will be measured and described are not clear.*

**Response:**
We agree with the reviewer on the need to have a sound strategy for the measurement of genetic diversity on-farm. These methodologies were not specifically stated in the project brief, as extensive in-house experience and documentation is available at IPGRI and its national and international partners on the assessment of the amount and distribution of diversity in farmers' fields *(e.g., Jarvis, DI, L Myer, H Kelmick, L Guarino, M Smale, AHD Brown, M Sadiki, B Sthapit, and T Hodgkin. 2000. "A Training Guide to In Situ Conservation On-farm. Version I." International Plant Genetic Resources Institute, Rome, Italy*). This expertise is mentioned in Paragraph 29 of the Project Brief where we discuss the fact that protocols have been developed to determine how consistent are the names and traits that farmers use to distinguish their varieties, with genetically identifiable units.

In this project, diversity will be measured at agromorphological, biochemical and molecular levels using international standards and protocols developed through earlier projects in Nepal, Morocco, Uganda and Mexico. CSIRO (one of the international partners) has been working with IPGRI and its national partners over the last nine years to develop capacity in national programmes in the assessment of the amount of distribution of diversity maintained over time on farmers fields. The three US universities (Washington State University, Oregon State University and Cornell) also have extensive expertise on traditional diversity assessment methods. This capacity and inputs of the project national and international partners are listed in the Annex E: The Public Involvement Plans.

***Reviewer comment****:*
*2. There is an explicit plan for monitoring, but it is not clear to me that the project has an internal adaptive protocol if unanticipated data or other problems appear that require a re-evaluation of the project's planned pathway.*

**Response:**
An internal adaptive protocol is part of the project implementation plan. As the project progresses, protocols for data collection will be re-evaluated and refined. This is part of the protocol development procedure mentioned in Annex G, and shown on page G-22 for the participatory diagnostic component, but will also be applied to the other components of the project.

***Reviewer comment**:*
*3. Given year-to-year environmental variation that impacts yields, is a single year of data collection sufficient to create a baseline for future comparison?*

**Response:**
Although a single year of data constitutes the primary baseline, data exist from previous years in related sites in all four countries, and within specific project sites in Morocco and Uganda through earlier projects. Previous year data will provide some measure of year-to-year variation. Certainly, the project plans to have yearly sampling, which will provide additional information on year-to-year variation. The amount of yearly data collected will be based on an analysis of the baseline information collected during the first year of the project. This will be more clearly spelled out when the national work plans are developed.

***Reviewer comment**:*
*4. Regarding these questions, it is disconcerting to read on pages G-42 and G-43 that protocols for technical assessment of the crops have not yet been developed.*

**Response:**
We realize from reading this comment of the reviewer that the statements on pages G-42 and G-43 are misleading, and the word "development" should not have been used. In fact, technical assessment methods of host-pest/pathogen systems do exist for all systems proposed in the project. As noted in paragraph 31 of the Project Brief, the crop-host/pathogen systems are well characterized. Descriptions of host-pest/pathogen systems are described in Annex L. What is currently lacking is a finalized standardization by crops across the countries on the experimental design, minimum sampling sizes and precise procedures appropriate for specific sites. A working meeting (as noted in Activity 1.1.2) is planned in the first six months of the project, to standaradize technical assessment protocols across the countries, so as to meet comparative objectives of producing globally applicable protocols.

- ***Global environmental benefits and/or drawbacks of the project***

***Reviewer comment**:*
*5. One potential drawback is that the principal of managing crops for an <u>optimal</u> level of genetic diversity with respect to pest resistance might easily be misunderstood as managing crops for a <u>maximum</u> amount of general genetic diversity.*

**Response:**
We are glad that the reviewer has drawn attention to this point. We are also concerned that the project is not misinterpreted as promoting maximum amounts of diversity, which could be detrimental to farmers' livelihoods. The project does not assume that maximum diversity is the best solution, but will identify when and where diversity, and the optimal levels of this diversity, could be used to minimize pest and disease pressures. For this reason, as stated in the Project Brief Summary, and within the title of Output 1 of the Project Brief, the project proposes to develop tools to determine when and where intra-specific crop diversity <u>can</u> provide and effective management approach. Output 2 also notes that the project seeks to develop and promote: "Practices and Procedures that determine how to <u>optimally</u> use crop genetic diversity."

- ***Global environmental benefits for the biodiversity important to agriculture:***

***Reviewer comment****:*
*6. The management of genetic diversity at the farm level has the immediate benefit of tremendously augmenting the diversity held in ex situ collections (it should be noted, however, that in situ conservation* *<u>does not replace</u>* *ex situ collections).*

**Response:**
We are in agreement with the reviewer's comment that *in situ* conservation does not replace *ex situ* collections. Identification of other sources of intraspecific diversity from earlier *ex situ* collections from project sites or similar agroecological environments is a part of Activity 1.3 (Annex B). Activity 4.3 is designed to develop mechanisms to disseminate information and materials to farmers and communities on previously collected (*ex situ*) materials. In addition, the project is also concerned with developing protocols for the conservation of sample isolates as mentioned in Activity 1.5.2.

***Reviewer comment****:*
*7. Reduced pesticide use stops the pesticide-based deaths of non-target beneficial organisms. For example, these include soil species that interfere with populations of soil-borne pest species as well as insects that effect pollination or prey upon insect pests.*

**Response:**
We thank the reviewer for pointing out the importance of this project in not only conserving crop genetic diversity on-farm, but also on the potential global benefit it will have on the conservation of associated biodiversity.

- ***Rationale for the project's global approach***

***Reviewer comment****:*
*9. The rationale for the project's global approach is clear. The four partner countries represent as diverse a set of environmental sites as possible, a key for testing for global generality.*

**Response:**
As noted by the reviewer, and also in paragraphs 11, 12, and 13 of the Project Brief, the global approach proposed in this project will allow the promotion of methodologies that can be globally adopted with adaptation to local crops, pests, and conditions.

## ANNEX D - LETTERS OF ENDORSEMENT