Biodiversity Research for Sustainable Development: Can It Be Achieved?[1]

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ABSTRACT

Biodiversity is said to be the "heart of sustainable agricultural systems". Biodiversity research is envisioned to provide a better understanding of development issues so that better policy responses, management practices and actions will ultimately redound to a better quality of life for all, especially the poor. It is in this light that the Philippines-Netherlands Biodiversity Research Programme for Development is revisited and analyzed in this paper. This and other similar projects provide lessons for capacity development at the community, national, regional and international levels.

To proceed with its analysis, the paper fleshes out the framework of sustainable development, situating the role of biodiversity in determining the pathway of development. As shown, biodiversity, as an element of the natural resource base, and in concert with technology and sociocultural factors, will continue to be relevant in a rapidly changing and increasingly globalized world. It also presents the sustainable livelihood framework to illustrate that biodiversity alone, being only one component of natural capital, cannot alleviate poverty if nothing is done with the other capital assets.

One important lesson gleaned from the analysis of biodiversity research is that not all biodiversity is good. The key is to better understand the interactions between various levels and how these can be harnessed into positive interactions to produce a productive, stable and sustainable resource base. Another emerging lesson is that biodiversity can be conserved in agroecosystems if the poor resource users can be enabled to use it to improve their assets in the context of the sustainable livelihood framework. The effective management and conservation of agricultural biodiversity can be achieved through product value addition and link to market, germplasm enhancement, and participatory plant breeding, among others.

INTRODUCTION

Research in support of sustainable development is a major rationale of the Philippines -Netherlands Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. This program, which has been in-place for five years, will be analyzed in this paper in the context of this concern for sustainable development which was first enunciated during the United Nations Conference on Environment and Development (UNCED) Meeting in Rio de Janeiro in June 1992 and after the Bruntland Report was published in 1987. The world, during that historic meeting, was looking for an alternative development paradigm in the face of a widening gap between the rich and the poor, and the unabated destruction of the natural resource base resulting from a development process which was solely based on a top-down approach and a purely economic growth model.

During this same meeting, the Convention on Biological Diversity (CBD) was signed by 157 countries, thus signaling the historic commitment of the world community to conserve biological diversity, its sustainable use, and the equitable sharing of its benefits arising from its use. The CBD came into force in 1993.

Biodiversity, according to the United Nations Global Environmental Facility (GEF) is the "heart of sustainable agricultural systems." It is the "life insurance of life itself," according to Mc Neil and Shei (2002).

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What kind of biodiversity is most desirable for promoting sustainable development? Will all kinds of biodiversity, or diversity in general, promote sustainable development? Why?

Two Kinds of Biodiversity

There are two kinds of biodiversity. One kind is found in ecosystems uninfluenced by humans, which is very rare nowadays. Another kind—termed as agrobiodiversity and which is more prevalent—has been managed by humans to develop products useful to human society.

The first kind is a manifestation of the adaptive co-evolution between the natural biotic and abiotic elements of the ecosystem. The second kind is more of a manifestation of the co-evolution between natural and sociocultural subsystems (Conway 1984).

In the first case, biodiversity is expressed mainly as a result of the processes of natural selection and is, therefore, an element as well as a driving force that promotes the stability, productivity, and resiliency of ecosystems.

In contrast, in the second case, the biodiversity expressed or created is mainly the result of human perception, manipulation, and objectives. In many instances, biodiversity may not always lead to sustainability; for it to do so would depend on whether human society has the adequate and appropriate knowledge and experiences that would enable them to understand what this diversity is and how it can be effectively managed to attain sustainable development.

For example, many traditional agroecosystems, wherein indigenous knowledge systems and community practices have closely evolved with the natural system, have been able to maintain and enhance their agrobiodiversity, which, in turn, enabled them to produce their own needs as well as to regenerate the ecosystem (Xu et al. 1995; Long Chun-lin et al. 1995).

However, in agricultural systems designed solely to increase productivity, there are also many examples of the kinds of biodiversity which have proven to be unsustainable unless "propped" up with more and more inputs. Ultimately these systems start losing their capacity to regenerate, they pollute the environment, and eventually they have an adverse influence on human health and well-being (Sajise 2005).

PHILIPPINE-NETHERLANDS BIODIVERSITY RESEARCH PROGRAMME FOR DEVELOPMENT

The Background

Recently, the Science Council of the Consultative Group on International Agricultural Research (CGIAR), which comprises an informal group of donors providing funds for agricultural research supporting 15 International Agricultural Research Centers, presented to the group its research priority recommendations.

Consistent with its position, the Netherlands Government presented a critique which advocated that research should be for development and not just research and development. For those of us who have been associated with the Philippines-Netherlands Biodiversity Programme, the rationale of this position of the Dutch Government is readily comprehensible.

To start with, this five-year Philippines-Netherlands Biodiversity Research Programme for Development is anchored on three fundamental paradigms namely, (a) sustainable development, (b) biodiversity, and (c) research.

In 1994, the Netherlands Development Assistance Research Council or RAWOO came up with an advisory report on a "Medium-Term Perspective on Research for Development," which recommended that a long-term North-South research program on biodiversity and sustainable development be established. This recommendation was positively accepted by the Dutch Government in accordance with the spirit and provisions of UNCED and the CBD. RAWOO then launched a study to formulate the policy and design of the organizational framework for such a program.

In 1995, the Netherlands Government published its Strategic Action Plan for the Conservation of Biodiversity and two programmatic studies were undertaken: one conducted on biodiversity research in the Netherlands, and another biodiversity research in cooperation with developing countries. The requirements for biodiversity research with a developing country were specified, namely, the

preference for countries with which the Netherlands has long-standing relationships in development cooperation, the primacy of the research needs of developing countries, equal partnerships between the two partners, the linkage of development with science funding and funding from other international organizations, Southern partners with equal say on running the project, and the use of innovative and new approaches.

The research paradigm which served as an anchor for this program, was labeled as research for development. This diverged from the usual studies on purely researcher-conceived topics, referred to as research and development. Researchers who used the latter perspective believed that all studies were related or could be related to development, but they were not primarily concerned with the direct application of a study to development issues.

In 1997, a national workshop, which was organized by SEARCA and sponsored by the RAWOO, brought together researchers, policymakers, and representatives of user communities from all over the country. This workshop adhered to the new research paradigm which posited that the identification of research agenda and priorities for biodiversity for sustainable development should be based on a demand pull (i.e., driven by societal needs), wider stakeholder involvement, a trans-disciplinary nature, complementarity between local and global knowledge, employment of a systems approach to development issues, and a balanced North-South research partnership.

The Philippines-Netherlands Biodiversity Research Programme was born out of a common desire from both groups to design and implement a long-term North-South research program on biodiversity conservation for sustainable development (RAWOO 1997).

This joint research program aims to forge new relationships between the North and the South based on the principles of mutual trust and equal footing, more relevant research for sustainable development needs, and the participation in, and ownership of, the research by various stakeholders. It will presumably break new ground in establishing a new research paradigm for development especially in biodiversity conservation in a setting where poverty is common and which involves intercultural, interdisciplinary, multi-sectoral and participatory strategies.

This was also the reason for the choice of Mount Malindang in the Zamboanga Peninsula, Philippines as the area of study. The place is a biodiversity hot spot within the country where biodiversity threats abound which includes poverty. It is also the least studied area in terms of biodiversity.

The big challenge was in its implementation. Early on, there were already differences in perceptions between the Philippine and Dutch scientists, even on such basic matters as the identification of the research agenda, because of cultural differences. This type of research also required more defined and well-tested interdisciplinary approaches, which not many researchers from both sides were either familiar with or were willing to embrace.

The power of decision-making was also a critical process that needed a balanced representation of the key stakeholders in the research program. To achieve this balance, both sides would need more and more patience in undergoing leveling processes and mechanisms which would allow interdisciplinary research, and accommodate varied perceptions and contexts, and shared decision-making.

Experiences from other groups around the world implementing this kind of research show that it is a process of finding the balance between activities that generate scientific credibility and those that lead to technology uptake for development; balance between impacts on livelihood and on environmental protection; balance between opportunism and long-term strategic research; balance between those products relevant as global public good and locally relevant ones; and balance between North and South perceptions of scientists, each of whom brings his or her own "scientific and personal baggage" while at the same time undergoing a new learning process of how to work together.

My interest is to be able to revisit the experiences in the five-year implementation of this program in the light of its three fundamental paradigms in order to learn the lessons that would be relevant in the bid to expand its application to the regional level. The implications of these lessons will not only be relevant to our group but to a wider global scientific community and development practitioners. These will also find resonance in the global political agenda.

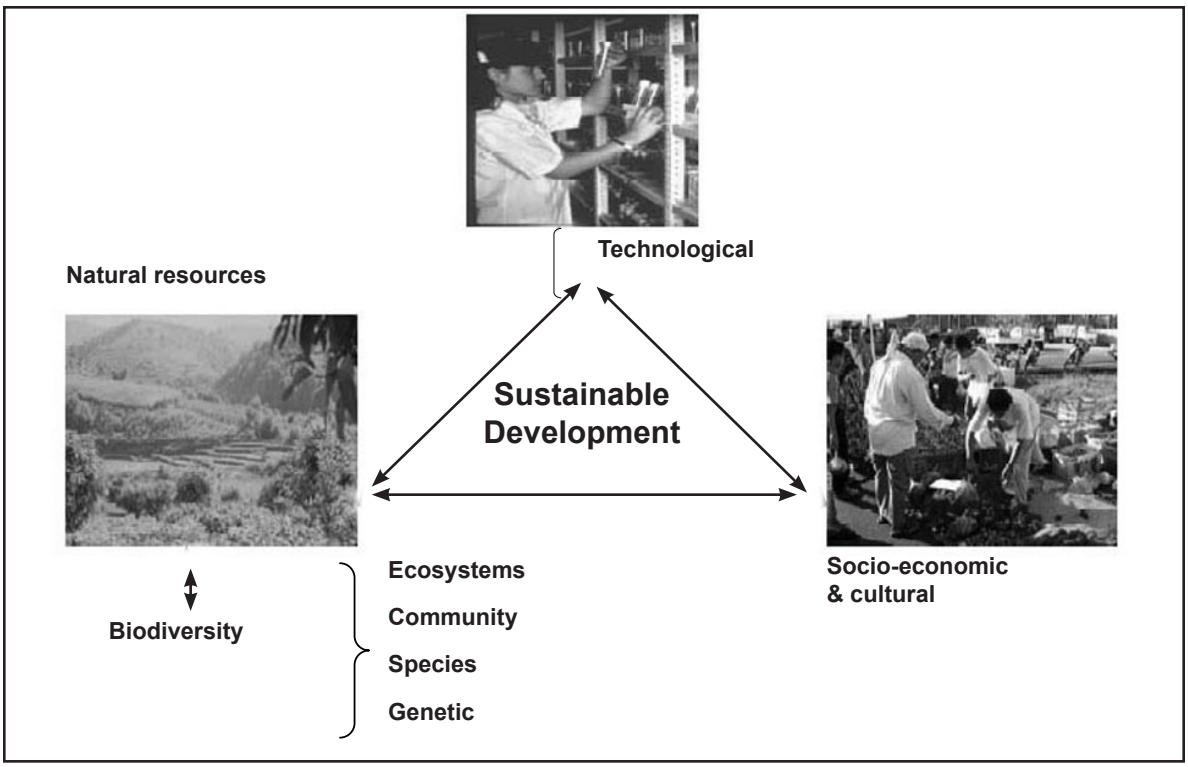

Fig. 1. Conceptual model of the relationship between plant genetic resources and sustainable development

The Frameworks

The basic framework for this joint research program on biodiversity for sustainable development was described in the original RAWOO document. Simply put, the research on biodiversity for development seeks to provide a better understanding of development issues, which will then provide better policy responses, management practices and actions, which will lead to improved livelihoods and better quality of life for the poor (RAWOO 1998).

However, as we know today, sustainable development is a complex, multi-dimensional, and highly contextual state or condition; in general, it adheres to the basic principle of utilizing the natural resource base such that the ability of this natural resource base to provide current and future goods and services useful to human society is not impaired. It is a type of development which is economically viable, environmentally appropriate, and socially acceptable.

Conceptually, sustainable development can be represented in Figure 1. This framework illustrates that sustainable development will result from the interactions of three major and interacting elements: (a) technology; (b) natural resource base; and (c) socioeconomic elements. To attain sustainable development, these three major elements must work in a symbiotic and complementary manner so that the goods and services generated by the interactions of technology and the resource base which are needed by human society are produced sustainably.

For example, technologies that must be developed or used to utilize the natural resource base must not only be economically viable but also be environmentally-friendly. In the same manner, socioeconomic factors, including institutional processes and arrangements, promote the development of technology(ies) that will optimally utilize the natural resource base while at the same time protect its regenerative capacity. If one major element will not complement the other, sustainable development cannot be attained in a particular context. These contexts will vary given the particular state or condition of any or a combination of these three factors in a particular setting (Sajise 2002).

Sustainable development would also mean that members of human society should have secure access to quality food for a healthy and productive life, which means having the ability and capacity to grow and/or purchase food as needed. It also means that people should not be overly preoccupied with the matter of staples such as wheat, rice, potatoes, and cassava but must also be concerned with incomes, markets, and natural resources. This definition again clearly illustrates that food security emanates from a sustainable resource base consisting of plants, animals, and microbial organisms interacting with and within the environment.

HOW DOES BIODIVERSITY RELATE TO SUSTAINABLE DEVELOPMENT?

Biodiversity is another term which was transformed from an esoteric ecological beginning to become a modern-day element of international treaties and conventions, notably the CBD. Its transformation came at a time when human society, while experiencing the many benefits coming from myriads of living organisms from various ecosystems, began to realize that many of these ecosystems were rapidly being destroyed and that this basic source of life itself was also rapidly being eroded.

To some, the term is aligned with the idea of conserving the unique flora and fauna of ecosystems under threat, which are considered as legacy to human society. To others, especially the poor, biodiversity refers to the assortment of living organisms serving as food, medicine, and shelter to both humans and other living organisms, and providing the ecosystem with the services and other uses that human society needs to survive and develop now and in the future. Those with the technology can transform biodiversity into big business! Biodiversity obviously has different meanings and values at various levels (local versus global), and among various stakeholders (policymakers versus local resource users versus the scientific community).

It is, therefore, not unusual that decisions on biodiversity management, including those based on science, can be value-laden. The legitimacy of stakeholder claims will always be subject to debate, with power dynamics likely to be a major factor in making decisions on the access to, use, and benefit-sharing of biodiversity (Vermeulen 2004).

Biodiversity is an element of the natural resource base, which is a component of the ecosystem and landscape. As part and attribute of the ecosystem, biodiversity, particularly that of plants, serves as the primary producer that provides the energy that is used and channeled to different components of the ecosystem, interacts with other components of the ecosystem, and becomes a major determinant of the ecosystem's structure and its functions. These interactions determine the productivity, stability, and sustainability of ecosystems including functions such as reproduction and regeneration, nutrient and water cycling, biotic stability, and others.

Kenmore (2004) stated that biodiversity has three broad dimensions: ecosystem functions or services, which are the most important; poverty alleviation, especially in the most marginalized communities in the least endowed regions; and global framework categories. The value of biodiversity can also be classified into three categories: direct-use values, which accrue from the benefits of a wider range of raw materials; indirect-use values, which are normally associated with environmental use services; and non-use values, which consist primarily of options to use biological resources either in the present or in the future.

In the sustainability framework discussed earlier, biodiversity is a key feature or element of the natural resource base which, when it interacts with the technology and socioeconomic dimensions, determines the pathway of development. If the existing technological, socioeconomic and institutional processes erode biodiversity and its functional elements as a component of the natural resource base, the resulting development process will not be sustainable in the long run. However, if biodiversity is well-managed such that its structure and functional relations are kept intact, then a more sustainable pathway for economic development could likely be attained.

For example, in the ecosystem services that are primarily influenced by biodiversity, the important role of pollinators is increasingly being realized. The total annual value added to our agricultural production through these beneficial biological agents of biodiversity amounts to US$40B. The role of the natural enemies of crop pests in pest management is also quite significant

and is estimated at US$100-200B annually in the US, while natural nitrogen fixation is US$50B (Constanza et al. 1997).

Sourcing High-quality Food

This biodiversity is the same source of high-quality food needed to meet the protein and vitamin requirements of very poor people, especially those who are victims of natural and socially-induced calamities. For example, in the Pacific, a local variety of banana known as "karat" has been recently found to contain high levels of provitamin A carotenoids, which are protective against Vitamin A deficiency and can also confer some protection against chronic diseases including certain cancers, heart disease and diabetes (Engelberger et al. 2003).

In China, several varieties and landraces of buckwheat are known not only for their food value but also for their medicinal uses, particularly in reducing high levels of blood sugar and cholesterol. These are just some examples of unique biodiversity for nutriceuticals other than the better-known pharmaceutical products derived from biodiversity, which is the base of a multi-billion US dollar industry.

These direct values of biodiversity itself have brought about the controversial issue of Intellectual Property Rights (IPR) between the biodiversity-rich developing countries and the technology-strong developed countries. The issue is a clear example of the interactions between the elements of natural resource base, technology, and socioeconomic elements in our framework.

SUSTAINABLE LIVELIHOOD FRAMEWORK AND SUSTAINABLE DEVELOPMENT

While we have indicated, in a general way, the role of biodiversity in sustainable or non-sustainable development in the above two frameworks earlier discussed, we have not yet been able to link biodiversity and poverty to answer the question: why is it that in biodiversity-rich situations, people are poor? To shed light on this, we need another framework—the sustainable livelihood framework.

Biodiversity on the ground or in the water or in a landscape is primarily determined by those who manage and use them - fisherfolks for fisheries, farmers for farms, and so on. If we use the sustainable livelihood framework, this will help us analyze and comprehend why and how people do what they do with the natural resource base. This is because user groups will primarily have the objective of engaging in activities, including conservation and use of genetic resources, to obtain outputs for sustainable livelihood—whether it is for income, for food security, or for cultural, aesthetic, and environmental values.

The sustainable livelihood framework is based on the premise that user groups and their households have five capital assets, which they can use for various livelihood outcomes (Figure 2). These are their human, financial, physical, social, and natural assets. Human capital refers to the skills, knowledge and information, ability to work, health, and others. Natural capital consists of land, water, livestock, wildlife, biodiversity, environment, air, and others. Physical capital may consist of transport, shelter,

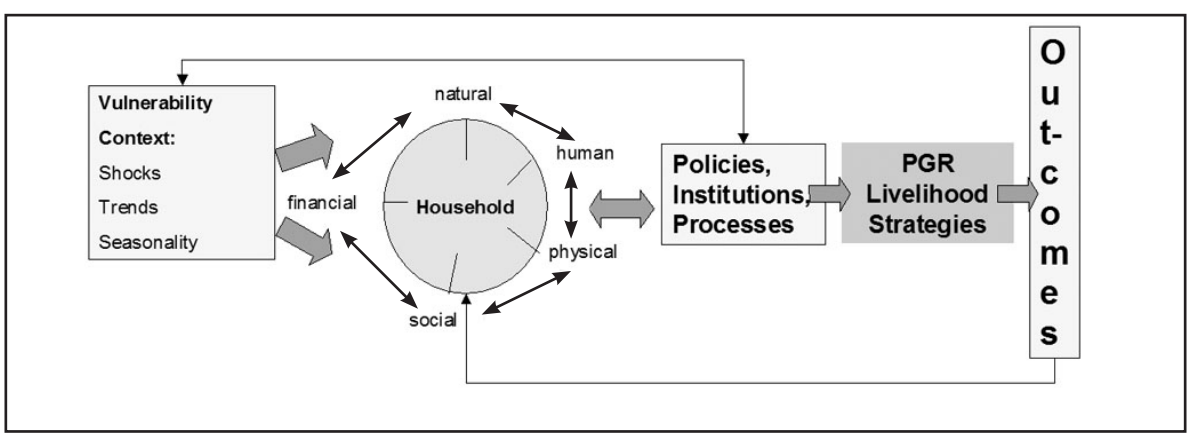

Fig. 2. Sustainable Livelihood Framework (Department for International Development, UK, 1999)

energy, communication and other infrastructures, and technology.

Financial capital consists of savings, credit, remittances, and pensions, among others. Social capital refers to social networks, group, trust, access to wider institutions, ability to demand, and others. These assets and their uses are also affected by vulnerability elements and by processes, institutions, and policies. Examples of vulnerability factors that prevail in the environment in which people exist are population pressure, natural calamities, economic forces, social conflicts, new pests and diseases, fluctuations in market prices, and others. Other factors influencing these assets and their use are the legal systems and judicial rules, property rights, political systems, civil society, trade barriers, cultural norms and values, informal networks, formal institutions in the farm household and community, and others.

Given the level of the five capital assets and their interactions, and in the context of existing processes, institutions, and policies, the farm household or community will choose the "best" livelihood option primarily in the use of these assets including biodiversity, to attain certain livelihood outcomes. These outcomes, in turn, affect and feed back into the building up of the assets and the level of vulnerability of these assets. The whole cycle is repeated in a cyclical feedback loop.

This second framework brings down to a lower and operational level the previous two others, which are more general, on the role of biodiversity for sustainable livelihood which can directly relate to sustainable development. This framework clearly illustrates that biodiversity alone, which is only one component of the natural capital, cannot alleviate poverty if nothing is done with the other capital assets. Working together the other capital assets can allow the biodiversity asset of the natural capital to promote a livelihood activity that will improve human welfare.

THE FRAMEWORKS AT VARIOUS LEVELS AND CONTEXTS

The Philippine-Netherlands research for development program approaches need to be participatory, multi-stakeholder, poverty- and people-oriented, institution-based, demand-driven, and problem-oriented. Indeed, the program can break new ground if its outcomes are proven to be more effective not only in addressing the goal of biodiversity conservation but also in responding to the needs of the poor. The lessons it can generate can be very important in the context of the local, national, regional, and global context vis-à-vis platforms and commitments.

In the context of the Philippines, locally, it should be able to provide the answer to the question of how we can conserve biodiversity while at the same time responding to the need for poverty alleviation and environmental protection. At the national level, the answer to this basic question can provide a valuable guidepost in the formulation of national policies and programs in response to the country's commitment to the goals of sustainable development and the Millennium Development Goals (MDG).

The MDG, formally established through the UN's Millennium Declaration in 2002, addresses the issues of poverty and sustainable development through its goals of: eradicating extreme poverty and hunger, achieving universal primary education, promoting gender equality and empowering women, reducing child mortality, improving maternal health, combating HIV/AIDS, malaria and other diseases, ensuring environmental sustainability, and developing global partnerships for development.

The role of biodiversity in ensuring that these targets are successfully achieved is well-recognized. Biodiversity should be mainstreamed not only in MDG 7 but also across other MDGs since the realization of these goals will directly or indirectly impact on the status and use of biodiversity itself. Figure 3 illustrates this principle.

At the regional level, the lessons learned can be picked up and applied in similar cases and contexts for the same end of fulfilling a country's commitment, first to its own people and then to the international community.

The International Platforms

At the global level, biodiversity, especially agrobiodiversity, has shrunk. Studies indicate that less than 20 species of plants and only 14 domesticated species of animals today contribute to over 90% of our global food supply. However, it does not mean that other species are not important. These "lesser" species interact to allow a healthy

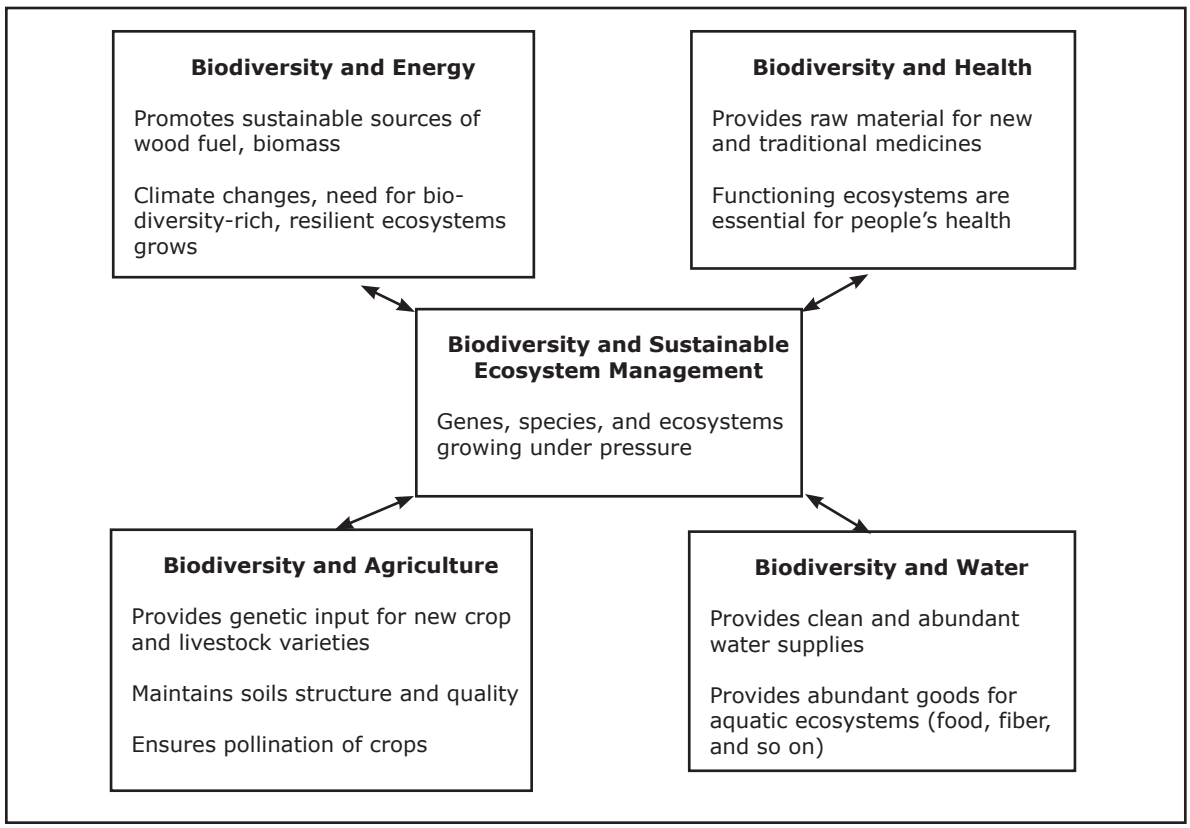

Fig. 3. Examples of the critical role of biodiversity and sustainable ecosystem management under the UN Water-Energy-Health-Biodiversity (WEHAB) priority areas (Pisupati and Warner, 2003)

and functioning ecosystem.

Sadly, the focus on "important species" has led to the neglect of the role of other living organisms or components of biodiversity which make the productivity of these valuable species more sustainable. Because of this, most of the farming communities or agroecosystem management methodologies today require short-term palliatives such as the use of chemicals or even genetically modified organisms (i.e., those with genes that make them tolerant to certain herbicides or have the insecticidal property within their bodies to prevent insect damage).

To bring about sustainable development, the integrity of the natural resource base must be ensured; the basic understanding and management of its biodiversity component must be generated; and the elements of this biodiversity must be collected, conserved, characterized, evaluated, exchanged, and used in a sustainable manner to make possible long-term human survival and prosperity. It is a race against time and there are many contentious issues related to this basic principle, which arise from the many international agreements and platforms, which have recently been put in place by the global community.

As a basic principle and supported by strong evidence, there is a need for free exchange of biodiversity materials among countries of the world to promote food security. In previous years, there has been so much interdependence among countries in plant genetic materials to bring about an agricultural economy for increasing Gross Domestic Product (GDP) and enhancing food security. The platform which made this possible was the FAO International Undertaking which espouses the tenet that plant genetic resources are a common heritage of humankind. This is also founded on the fact that plant diversity or biodiversity in general does not recognize national boundaries. There had been wide distribution of the most important food crops and there is interdependence among countries with regard to genetic resources.

However, with the rapid development of molecular tools for isolating and incorporating genes that provide specific and desirable traits to

crops and animals, two phenomena that gained strength were the rapid trade globalization and commercialization of plants and animal products, and the growing consciousness for IPRs supported by international platforms such as the World Trade Organization (WTO), International Union for the Protection of New Varieties of Plants (UPOV) and others. The latter was also welcomed by those who were involved in the production of new varieties and breeds as it provided a form of incentive for innovation and was a good sink for business investments. It has also brought some political controversy between the biodiversity-rich South and the technology-strong North, raising issues of biopiracy, among others.

Envisioned to be the answer to these issues, the CBD came into being. The CBD conferred sovereign rights to countries over the biodiversity within their boundaries, and adhered to the principle that these biodiversities can only be collected, exchanged, and used with prior informed consent and when there is equitable sharing of benefits.

Under this regime, the much-needed exchanges of important plant genetic resources, especially of the most important food crops, slowed down, which evoked the global community's concern for food and nutritional security. To arrest this slow exchange, the FAO International Undertaking was renegotiated to come up with an equally legally binding instrument and platform that was consistent with the CBD but would support the needed facilitated exchanges of plant genetic materials of the most important food crops for human society. This gave birth to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

This Treaty essentially facilitates a multilateral system of exchanges of the most important food crops of humankind today, including those in the collections of the CGIAR Centers, which are under a trusteeship agreement with FAO. It is consistent with the CBD because the placement of these crops into this multilateral system of facilitated access and benefit requires prior informed consent of Contracting Parties. Further, portions of the benefits generated from the exchanged materials—once these go beyond research and are commercialized—go to the funding scheme of the Treaty. There is also a Global Crop Diversity Trust, which was established to fund the Treaty by funding in perpetuity the security of the most important ex situ collections of the most important food crops included in the Treaty.

Situating the Philippine-Netherlands Project in the Context of International Platforms

What is the significance of these international platforms to this project that we are going to discuss?

First, the signatory countries to the CBD, the Treaty, the UPOV, and other international treaties impinging on the sustainable conservation and use of biodiversity can learn lessons from the Philippine-Netherlands biodiversity project and other similar projects implemented in similar contexts. These lessons focus on how to effectively link biodiversity with poverty alleviation and environmental protection, and how biodiversity can be supported by the appropriate policy environment. There will also be lessons in how to bring about capacity development at all levels: community, national, regional, and international.

Almost all countries in the region have formulated or are in the process of formulating and putting in place their national biodiversity plans and programs. The lessons learned from this type of project can be very important for these countries and can be adapted to support their national biodiversity plans. These lessons can pertain to a wide range of areas such as institutional arrangements, policy, the conduct of research for development, the most effective collaboration mechanisms and approaches between the North and South scientific communities, the most effective unit for managing biodiversity, effective interdisciplinary methodologies, identifying the most useful participatory approaches and methodologies, community empowerment, and many more.

Second, these international platforms provide an avenue by which we can navigate the "tight rope" between promoting exclusive rights over some benefits gained from biodiversity versus granting more "communal rights" for some biodiversity materials to support humankind's basic rights to food, health, and good environment. How do we provide an appropriate mix of IPR arrangements that would allow countries to effectively walk through this "tight rope"?

SEARCA, as a regional organization has the mandate to provide the platform for these lessons to be embedded in its capacity-building activities. These activities include short-term training modules that consolidate lessons generated by this project as well as other similar projects in the region. The Dutch institutions, other national institutions, and NGOs involved in the process can do the same.

For academic partner institutions, there are many lessons that can be incorporated in the course contents of the social, biological, and natural resource disciplines being offered in these institutions. These can also be transformed into policy initiatives. The best indicator of accomplishment will be if the local government units (LGUs) and the local communities themselves will be able to make full use of these lessons learned. A prerequisite for this process, however, is to document, analyze, and transform these lessons into formats that will be useful for various clients.

Some of these lessons can be transposed on a region-wide scale through a comparative analysis of the methodologies and the participatory approaches used, and the development of effective and sustainable intervention strategies. These will require the generation of a set of guidelines on how to implement this kind of research for development, the kind of institutional arrangements needed, and how the results can be transformed into appropriate policy at all levels.

There is another important area which will be quite relevant at the regional level – impact. If this research for development is the more appropriate approach, what are its impacts and what differences has it made, as opposed to the ordinary way of doing research? What are the criteria for impact that we can use at the community, landscape, local government, national, regional, and international levels? A big challenge, however, for researchers and managers is how to identify, right from the very beginning, what are the outputs versus the outcomes, and consequently the impacts from this research program.

Some Lessons Learned

As we go through the accomplishments of the program, many of us in the scientific community can revisit basic scientific hypotheses on biodiversity and on sustainable development as well as basic research approaches and philosophy.

Not everything about biodiversity is good. The key is to better understand what kinds of interactions take place between various levels of biodiversity—between the biotic and abiotic elements—and how these can be harnessed into positive interactions to produce a productive, stable, and sustainable resource base in the face of a burgeoning human population and increasing globalization.

Another emerging lesson from other researches around the world today along the same concern is that biodiversity can only be conserved in agroecosystems if the poor resource users can be assisted to use it as a tool to improve their assets in the context of the sustainable livelihood framework. The effective management and conservation of agricultural biodiversity on the farm will enable farmers to link this biodiversity to their needs for sustainable livelihood outcomes such as increased income, food security, health and general well-being on several levels, including spiritual well-being. These can be achieved through the following, among others:

- product value addition and link to market;
- germplasm enhancement; and
- participatory plant breeding.

The author's experience with coconut on-farm conservation in 24 communities in eight countries in Asia yielded the following observations summarized in Figure 4 which, when viewed within the context of a sustainable livelihood framework, demonstrate the link between coconut diversity and livelihood of farmers and farming communities (Sajise 2005):

1. The adoption of livelihoods associated with coconut diversity was facilitated by the synergistic combination of the following interventions: farmers' training for processing of high-value coconut products such as handicrafts from coconut shell, doormats from coconut fiber, coconut candy and other delicacies such as "buko pie," and coconut virgin oil (enhancement of human capital) combined with the provision of simple

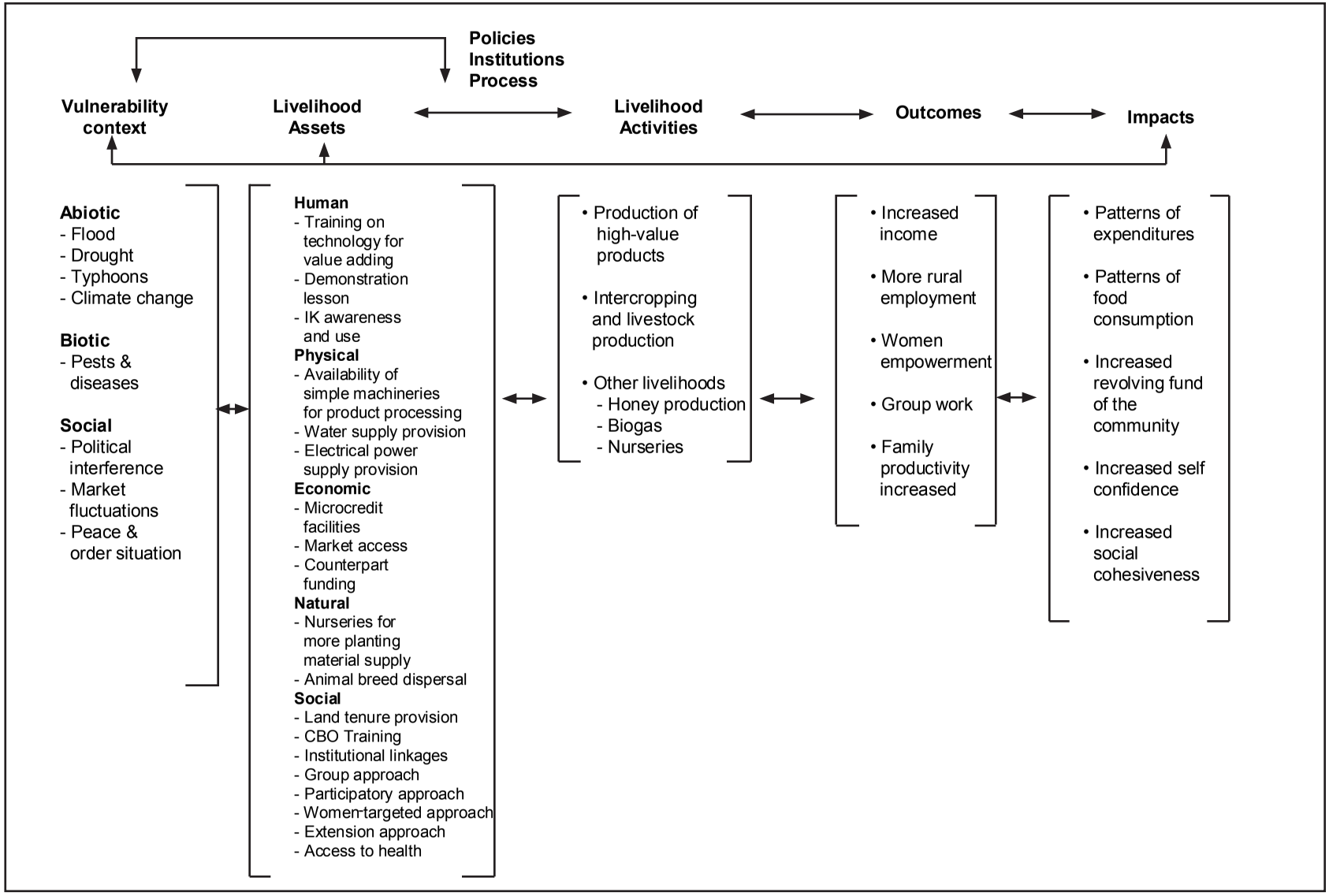

Fig. 4. Livelihood and coconut plant genetic resources relationship (Sajise 2005)

Table 1. Process of on-farm conservation of agricultural biodiversity and set of good practices for implementing community-based on-farm management in Nepal

Step	Objectives of practices in various steps	Practices tested	References
1	Develop understanding of local context and local agrobiodiversity (Building Human Capital)	Rapid biodiversity assessment Four-cell analysis method Social seed network Baseline survey	Rana et al. 2000 Subedi et al. 2003 Rana 2004 Rana et al. 2005
2	Sensitize farming communities and key stakeholders (Building Human Capital)	Village workshop Meetings with key stakeholders Rural poetry journey Rural drama *Teej geet* competition Song/poetry/essay/ printing competition Diversity fairs Exchange visit Rural radio Traveling seminar National workshop	Sthapit et al. 1999ab Rijal et al. 2000 Chaudhary et al. 2003 Rijal et al. 2003 Sthapit et al. 2003 Baral et al. 2005
3	Improve access of materials and knowledge (Building Human Capital and Natural Asset)	Diversity fairs Diversity blocks Diversity kits Promoting nodal farmers Community seed bank	Sthapit 1999a Rijal et al. 2000 Sthapit et al. 2003 Rijal et al. 2003 Shrestha et al. 2005
4	Locate, characterize, and evaluate useful diversity (Building Natural Asset)	Diversity fairs Diversity blocks Diversity kits On-farm characterization Intensive data plot Community biodiversity register	Sthapit et al. 1999 Rijal et al. 2000 Sinapit et al. 2003 Rana et al. 2003 Rijal et al. 2003ab Subedi et al. 2005
5	Manage community biodiversity information systems for empowering and monitoring local biodiversity (Building Human and Social Capital)	Community biodiversity register (CBR) Inventory/Catalogue Stamps Community biodiversity management (CBM)	Rijal et al. 2003 Subedi et al. 2005a Joshi et al. 2005 Subedi et al. 2005b
6	Develop options for adding social, economic, and environmental benefits to community (Build Economic, Physical, Human, and National Asset)	Value addition program Participatory variety selection Participatory plant breeding Landrace enhancement Community seed production	Sthapit and Jarvis 1999 Sthapit et al. 2001 Sthapit et al. 2003 Joshi et al. 2000 Rijal et al. 2000 Gyawali et al. 2005abc
7	Influence policy (Building Human, Natural, Social, and Financial Capitals)	Traveling seminar Diversity fairs Community biodiversity register Variety release of PPB and landrace enhancement Workshop/meetings/visits	Gauchan et al. 2003 Gauchan et al. 2004 Upadhyaya et al. 2005

Table 1. (Continued).

Step	Objectives of practices in various steps	Practices tested	References
8	Exit strategy and sustainability (Building Social, Financial, and Economic Assets)	Community biodiversity management Micro-credit Linkages with other agencies	Sthapit and Eyzaguirre 2005 Subedi et al. 2005

processing machineries (enhancement of physical asset), and micro-credit and access to market (enhancement of financial capital).

This synergy in enhancing and deploying these three capital assets for livelihood enabled the farmers to develop high-value products. This, in turn, enhanced their income, generated more rural employment, empowered women's groups, and enhanced family productivity (Figure 4). The increased income will translate into new patterns of expenditures, food consumption, and levels of self-confidence and family cohesiveness. These impacts have not been adequately studied in the project.

Table 1 also summarizes the required interventions in the five capitals in the on-farm conservation site in Nepal which resulted in the adoption of livelihood strategies which promote local crop diversity with corresponding sustainable livelihood outcomes and impacts (Subedi et al. 2005).

2. At the community level, these livelihood activities can be effectively and sustainably implemented with the help of group activities. Labor and job allocations can be shared by members of the community-based organizations (CBO) and supported by community-generated revolving fund. These strategies enhance social and financial assets. The revolving fund can only be managed well if appropriate training is given to the officers and members of the CBO to develop their management and leadership skills as well as attitudes.

   This forms part of the social capital build up in the sustainable livelihood framework. The economic values, both short- and long-term, will improve income and human welfare as well as enhance environmental functions. However, based on the results of a participatory assessment of the project, coconut genetic resources were enhanced through the planting of different coconut varieties, which provided the raw materials for various marketable coconut products. Increasing coconut diversity also helped provide a buffer for farming households against risks associated with income fluctuations and food security.

   The summary matrix table (Table 1) can also be transformed into a sustainable livelihood framework where interventions are directed towards enhancing the five capitals. The same lessons are apparent: adoption of appropriate on-farm conservation activities can be understood through interventions which involve the synergistic buildup of the required livelihood assets.

3. The Philippine-Netherlands Biodiversity programme itself is at the cross road of a set of paradigms on how to conduct a kind of research which directly applies to issues in development as well as how to bring about an effective research collaboration between cultures and disciplines, to the paradigm of sustainable development as well as the paradigm on how to link biodiversity with poverty alleviation and environmental protection. In such a crucial crossroad, the findings from this research which has run its course for slightly over five years is important not only locally but also nationally, regionally, and globally. The answer to the original question of whether this type of research for development can be achieved is generally a yes, but we must have more examples that can demonstrate this strongly. What it will need is the attitude and commitment from researchers and development workers to make this happen as we are running out of time in the race between the need of an increasing population against a rapidly deteriorating support system which is leading

humankind to a pathway of unprecedented difficulties.

4. Biodiversity, especially agrobiodiversity, in its broader meaning and as an important element of the natural resource base and in concert with technology and socio-cultural factors, will continue to be a determining element of sustainable development. It has gained increased attention especially in our rapidly changing and increasingly globalized world where human society needs more of everything - more food, more clothing, more shelter, more medicine, more clean air, and more clean water. Our basic understanding of biodiversity especially in terms of interrelationships between the key biological, physical, and socio-cultural elements which shape it must be improved so that we can manage it properly for obtaining its direct and indirect services on a sustainable basis. We are hoping that this research for development approach can effectively uncover these relationships so that we can apply it across the country, as well as in the region and globally, to help in the attainment of the MDG that the global community has committed itself to attain.

REFERENCES

Constanza, R d' Arge, R. De Groot, F.S. Grano, M. Hannon, K. Limbos, S. Name, R. V. Neill, J. Paruello, R. Raskin, P. Sulton, and M. Van der Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature,* 387:254-260.

Conway, G. R. 1984. "What is an agroecosystem and why is it worthy of study?" In A. Terry Rambo and Percy E. Sajise, eds., *An introduction to human ecology research in agriculture systems in Southeast Asia*. University of the Philippines at Los Banos, Laguna, Philippines. pp. 25-38.

Development for International Development. 1999. Sustainable Livelihood Guidance Sheet. U.K, January, 1999.

Engelberger, L., W. Aalsbersberg, P. Ravi, E. Bonnin, G. Mrks, M. Fitzgerald, and J. Elymore. 2003. Cultivars of Micronesia banana, taro and other food: Newly recognized sources of Pro Vitamin A carotenoids. *J. Food Anal,* 16:219-236.

Kenmore, P. 2004. Biodiversity better understood now. The Hindu. http://www.hinduonet.com/2004/storied/2004092202991300

Long Chun-Lin, L. Yanhui, Wang Jieru, W. Kanglin, and Pei Shengji. 1995. Plant diversity in Swidden agroecosystem: A case study of the Jinno Community of Xishuangbanna. In Pei Shengji and Percy Sajise, eds., *Regional study on biodiversity: Concepts, frameworks and methods*. Yunnan Science and Technology Press, PROC. pp. 53-72.

McNeill, C. and P. Shei. 2002. A framework for action on biodiversity and ecosystem management. WEHAP Working Group, WSSD.

Pisupati, B. and E. Warner. 2003. Biodiversity and the millennium development goals. IUCN Biodiveristy Program. Asia, pp. 40.

RAWOO. 1997. Building bridges in research for development. pp. 36.

RAWOO. 1998. Framework for a Philippine-Dutch Programme of biodiversity research for development. Publication No. 17. pp. 50.

Sajise, P.E. 2002. Plant genetic resources for food security and sustainable development. Paper presented during the Conference on "Competitive Food Production: New Challenges," UPM, Malaysia in conjunction with the celebration of its 70th Anniversary.

Sajise, P.E. 2005. Biological diversity for sustainable development: What it is and what it is not. Keynote paper presented at the Regional Symposium on Environment and Natural Resources II, 22-23 March, 2005, Pan Pacific Hotel, Kuala Lumpur, Malaysia.

Subedi, A., P. Chaudhary, B. Baniya, RB Rana, MP Upadhyay, and PK Shrestha. 2005. Community biodiversity management (CBM): Lessons learnt from in situ conservation project. In Sthapit, BR, PK Shrestha, MP Upadhyay, and D. Jarvis, eds., *Scientific basis of in situ conservation of agricultural biodiversity on farm in Nepal: Demonstrating benefits for people.* IPGRI, Rome, Italy.

Xu Jianchu, P. Shengji, and Chen Sayang. 1995. From subsistence to market-oriented systems and the impacts of agroecosystem biodiversity: The Case of the Hani (Akha) swidden cultivation in Mengson, Southwest China. In Pei Shengji and Percy Sajise, eds., *Regional study on biodiversity: Concepts, frameworks and methods*. Yunnan Science and Technology Press, Yunnan, PROC. pp. 73-88.

Vermuelen, S. 2004. Biodiversity planning: Why and how should local opinion matter? *Gatekeeper* Series No. 115. pp. 22.