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AGRICULTURAL BIOLOGICAL DIVERSITY: REVIEW OF PHASE I OF THE PROGRAMME OF WORK AND ADOPTION OF A MULTI-YEAR WORK PROGRAMME

The ecosystem approach: towards its application to agricultural biodiversity

Note by the Executive Secretary

INTRODUCTION

1. At its fifth meeting, the Conference of Parties will consider new elements of a programme of work for agricultural biological diversity, as recommended by SBSTTA (recommendation V/9). The proposed programme of work has been developed in harmony with the ecosystem approach consistent with the description, principles and operational guidance as elaborated by SBSTTA (recommendation V/10).

2. The present document illustrates how the ecosystem approach, as developed under the Convention, can provide a framework for the conservation and sustainable use of agricultural biodiversity, consistent with programme element 2 of the proposed programme of work on agriculture, namely, "to identify management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on biodiversity, and enhance productivity and the capacity to sustain livelihoods, by expanding knowledge, understanding and awareness of the multiple goods and services provided by the different levels and functions of agricultural biodiversity."

3. Section I of the present note reviews the rationale for applying an ecosystem approach to agricultural biodiversity. Section II illustrates various aspects of the ecosystem approach by reference to the case of integrated pest management in Asian rice production systems. (This case-study is drawn from those compiled in document UNEP/CBD/COP/5/INF/10). Section III provides some provisional conclusions.

4. It is intended that the document will promote further elaboration of the use of the ecosystem approach in agricultural systems and stimulate the submission of further case-studies in line with the envisaged programme of work.

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A preliminary categorization of goods and services provided by agricultural biodiversity*

Goods and services	Examples	Nature of value	Contributions to livelihoods and benefits to other stakeholders	Major challenge for sustainability of use
Goods				
1: Products derived directly from biological resources hunted or gathered from managed systems through agriculture	Crop and livestock production, timber from plantation forestry, and fish from aquaculture	Direct use values (consumptive, some not traded in markets)	Basis of sustainable food production and livelihood systems, especially for traditional farmers. Basis of food industry	To ensure sustainability of the managed ecosystem itself (see item 4 below); To avoid negative externalities on other ecosystems
2: Products derived directly from biological resources hunted or gathered from natural or semi-natural systems	Most fish, wildlife, gathered wild foods and medicinal plants etc.	Direct use values (consumptive, much not traded in markets)	Significant contribution to nutrition and other livelihood needs of rural and per-urban vulnerable groups, and of traditional healers	To avoid over-exploitation of resources and damage to ecosystem integrity.
3: Products derived indirectly (i.e. from the information content) of collected genetic resources	Pharmaceutical derivatives and new plant varieties	Direct use value (current use) Option value (known material, not used currently) Exploration value (undiscovered sources)	Raw material for plant breeding and pharmaceutical production. Values largely appropriated by breeding and pharmaceutical companies, and by farmers in ‘industrial’ areas who use improved varieties	To ensure continued provision of genetic resources by incentives and fair and equitable sharing of benefits derived.
Services				
4: Essential processes to ensure continued functioning, resilience and productivity of ecosystems which provide the goods 1, 2 and 3	Nutrient cycling, pest and disease control, pollination	Indirect use values	Essential support to sustainable food production and livelihood systems for all types of farmers. Benefits largely appropriated at local level.	To maintain ecosystem integrity; to prevent pollution
5: Wider ecosystem functions	Watershed protection, carbon sequestration, habitat protection, climate stabilization	Indirect use values	Benefits of services appropriated at various levels, from local to global.	To maintain ecosystem integrity; to prevent pollution and habitat conversion. To internalize externalities.
6: Spiritual, cultural, and aesthetic functions.	Varieties valued for culinary properties; scenic and culturally important landscapes, sacred sites etc.	Direct use value (recreation), Indirect use value, Existence (non-use) value	Benefits of services appropriated at various levels, from local to global.	To prevent damage from excessive or inappropriate tourism; prevention of habitat conversion
7: Insurance against risk and uncertainty	Use of multiple species, breeds and varieties	Portfolio value Option and exploration values	Portfolio value appropriated at various levels, from local to global.	To maintain incentives for their use

* Agricultural biodiversity is used in the broad sense: biodiversity of relevance to food and agriculture (See SBSTTA recommendation V/9, annex, appendix, "The scope of agricultural biodiversity").

I. THE ECOSYSTEM APPROACH AND AGRICULTURAL BIODIVERSITY

5. Until recently, the focus in work on agricultural biodiversity has been on characterizing, conserving and improving useful species and genetic resources (i.e., varieties and breeds). Now, however, there is increasing realization of the importance of other components of agricultural biodiversity at the ecosystem level that are important in supporting agricultural production, and in providing a wider range of "ecosystem services". This broader focus is reflected in the proposed programme of work on agricultural biodiversity (SBSTTA recommendation V/9, annex). A preliminary categorization of the multiple goods and services provided by agricultural biodiversity in ecosystems is provided in the table on page 2 above.

6. Attention to the full range of goods and services provided by biological diversity in ecosystems is one of the features of the ecosystem approach being developed under the Convention. Application of the ecosystem approach also implies, inter alia, intersectoral cooperation, decentralization of management to the lowest level appropriate, equitable distribution of benefits, and the use of adaptive management policies that can deal with uncertainties and are modified in the light of experience and changing conditions. SBSTTA has developed a description of the ecosystem approach, twelve principles and five points of operational guidance for their application (SBSTTA recommendation V/10).

7. As defined in Article 2 of the Convention on Biological Diversity, an ecosystem consists of a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. In agricultural ecosystems a major part of the biota – that is the crops and livestock – are chosen and maintained by the farmer. Often they are exotic species. The farmer also influences the composition and activities of the associated biota (including herbivore, predator, symbiont and decomposer groups), and the structure and functioning of the landscape within which agricultural production systems are situated.

8. Agro-ecosystems can be considered at several levels or scales, for instance, a rhizosphere or phyllosphere, a field/crop/ herd/pond, a farming system, a land-use system or a watershed. These can be aggregated to form a hierarchy of agro-ecosystems, which themselves are nestled among natural ecosystems and human economies.

9. Often, agriculture represents a simplification of the ecosystem as compared to the natural one that it displaces. Nonetheless, there are usually substantial levels of biological diversity in agricultural ecosystems. In addition to the "planned components", i.e. the crops and livestock, many "associated components" of biological diversity in agro-ecosystems are essential for agricultural production itself. These components include those providing services such as soil-nutrient cycling, pest and disease modulation, and pollination of many crops.

10. Besides the services required to sustain agriculture itself, biodiversity in agricultural ecosystems has wider significance. Agricultural ecosystems constitute major parts of watersheds, they are often our main landscapes for recreation and tourism, and they harbour important biodiversity in their own right. In fact, in some regions, some elements of biodiversity now only exist in areas dominated by agriculture. Management of biodiversity in such areas is therefore an essential component of an overall approach to its conservation. There are a wide range of agricultural ecosystems, and it

is claimed that that, in some of them, biodiversity is comparable to levels in natural ecosystems.

11. The management of agricultural biodiversity has underpinned most civilizations for over 10,000 years. Domestication of crops and livestock, their wide geographical dissemination, and selection of more productive or better adapted types has led to the creation of large amount of genetic diversity for a select number of species. These components of agricultural biodiversity can be maintained only with human intervention. Over time, farmers have accumulated much knowledge and developed a wide range of useful management practices adapted to various production systems. For instance, the management of agricultural biodiversity in the cultivation of seed-crops is, of necessity, different from the cultivation of vegetables, root crops or trees. Management of semi-natural pastures and rangelands are different again. New opportunities for the management of agricultural biodiversity, as well as threats, are provided by modern technologies and the globalization of markets. In some cases these tend to favour further specialization and uniformity in agricultural systems; some services provided by on-farm agricultural biodiversity are replaced, to a partial extent, by external inputs such as fertilizers, pesticides and improved varieties. Frequently, inappropriate or excessive use of some inputs causes damage to biodiversity within agricultural ecosystems (thus compromising future productivity) and in other ecosystems. As illustrated by the case in section II below, alternative approaches which, instead, make use of agricultural biodiversity to provide these services can result in benefits for both productivity and biodiversity conservation.

12. Agriculture is the largest user of biodiversity and its components. Agriculture now extends to cover about one third of the land surface. (The extent of agriculture is here defined as areas where crop production or pasture accounts for 30 per cent or more of land.) Three quarters of the world’s population live in these areas. In fact, agriculture is by far the dominant land use in some regions, like western and central Europe, the eastern United States of America, much of south Asia, eastern China, the Indonesian island of Java, the Philippines, the Mekong Delta, parts of the Sahel and the East African highlands; parts of the Andes and eastern South America. Additionally, large areas of dry and sub-humid lands, including savannahs and grasslands, are used for extensive grazing.

13. Global food production will need to double over the next half-century to meet the projected increases in world food demand. This will require substantial increases in total production, which has to be achieved through sustainable intensification of existing agricultural lands and/or expansion of agriculture into other areas. Both scenarios have potential impacts for biodiversity. The productive management of agricultural biodiversity will be key to meeting future food needs while also maintaining or enhancing the other goods and services provided by agricultural ecosystems.

14. Farmers are, de facto, ecosystem managers. As such, there is an opportunity to engage them to improve management of agricultural ecosystems so as to reduce negative externalities, as well as to increase productivity. As discussed at the Norway/United Nations Conference on the Ecosystem Approach for the Sustainable Use of Biological Diversity, held in Trondheim in September, 1999, there is a need for a programme of work to integrate "ecosystem approaches" into everyday management. Everyday management is practised by people who work at many scales, from individual fishers, farmers, or forest harvesters through communities, non-governmental organizations,

district governments, nations, private corporations, large eco-regions, and global organizations. As noted at the Trondheim meeting, there are already significant cases of success that could provide major inputs into the programme.

15. In section II, one such case is presented. It illustrates the application of the ecosystem approach to the tropical rice production system in Asia. Rice is the world's major crop in terms of the number of people it feeds. It is the main crop of Asian farming households, which constitute one third of the world's population. These small farmers continue to be a major component of Asian economic development. Furthermore, since rice farming accounts for more pesticide use than any other crop (and 80 per cent of this is used in Asia), there is great potential for reduction in pesticide use through alternative pest management strategies. The case shows that these small-scale farmers are dependent on the conservation of agricultural biodiversity for their well-being. As managers of the rice ecosystem, they are also custodians of an important part of the earth's biodiversity.

II. THE RICE IPM CASE-STUDY

A. Description of the case

16. Integrated pest management (IPM) has been promoted in Asia by many national governments and non-governmental organizations, and supported by the Food and Agriculture Organization of the United Nations (FAO) through its inter-country programmes for community IPM. The programme was initiated first in Indonesia in 1989 as a response to problems caused by intensification of rice production and, particularly, through the inappropriate use of pesticides to control brown plant hopper and other pests. At that time, national rice production was severely threatened and pesticide subsidies were costing the Indonesian Government more than US$ 100 million per year. Additionally, there were major health and environmental problems and damage to agricultural biodiversity caused by excessive pesticide use.

17. The main tool of the IPM programme is the "farmer field school", a form of community-based non-formal adult education. The farmer field school comprises season-long education and training activities where a group of around 25 farmers meet regularly (usually for one morning each week) in the field to learn about the rice ecosystem through self-discovery and experimentation, based on a firm understanding of ecological principles. Farmers monitor the progress of their crop, and examine the distribution of insect pests, their natural enemies and other components of biological diversity. Each week, based on their observations, they carry out, as a group, an "agro-ecosystem analysis" as a basis for their crop management decisions. This approach has empowered farmers to become better managers of their crops, and thereby to improve production whilst substantially reducing pesticide inputs.

18. To date over one million Indonesian rice farmers have graduated from farmer field schools, over 400,000 in Viet Nam, and over 170,000 in the Philippines. The programme has been extended to several other Asian countries, and now, through the Global IPM Facility (sponsored by FAO, the United Nations Development Programme, the United Nations Environment Programme, and the World Bank), to many countries in Africa and elsewhere. It has also been extended to other crops such as vegetables, maize and cotton.

19.The benefits of individual farmer field schools are scaled up through the training of trainers, and farmer-to-farmer learning. The impact at community level is extended and sustained through "community IPM clubs" formed by the farmer field school graduates themselves after the formal programmes have ended. In many countries, support through local government and extension services also guarantees the sustainability of the approach. The programme has also had major policy impacts at national level. These include, for example, reduced subsidies for pesticides in Indonesia, and the introduction of taxes in India.

20.The farmer field school approach is also being used to promote, for example, integrated plant nutrient systems and other aspects of crop management which can facilitate sustainable intensification. Indeed the success in IPM has resulted largely through better overall crop management. In Bangladesh, CARE-International, a non-governmental organization, has used the approach in their "NOPEST" and "INTERFISH" projects to promote rice-fish culture with vegetable planting on the dikes. In the Philippines, non-governmental organizations such as CONSERVE (in Mindanao) and SEARICE (in Bohol, Visayas) have used farmer field schools to improve the management and use of crop genetic resources, through farmer selection of off-types, participatory varietal selection of introduced varieties, and also true participatory plant breeding by selection from segregating populations. IPM can thus be regarded as an entry point to a wider approach of integrated crop management based on ecological principles.

B. Analysis of the case

The farmer field school approach to IPM in the context of the 12 principles of the ecosystem approach

21.The farmer field school approach to IPM is consistent with the principles of the ecosystem approach through the adoption of a "whole system" approach to the control of a management problem within agreed limits. The philosophy and policy guidance of the twelve principles (SBSTTA recommendation V/10, annex), are here applied and interpreted in the rice case-study.

22.As embodied in principle 1, the objectives of management of land, water and living resources are a matter of societal choice. Farmer field schools and follow up activities at the community level can facilitate the expression of societal choice. They also facilitate decentralization of management to the lowest appropriate level (principle 2), which may be, depending on the issue, the individual farm plot, or the community at village level. In this respect, consideration of the effects on adjacent ecosystems (principle 3) is also important both in terms of effects of actions on natural enemies of insect pests and their food sources and the wider effects of pesticides. Thus management takes place at the appropriate scale (principle 7).

23.One of the main principles of the farmer field school approach to IPM is to "conserve natural enemies" and other aspects of ecosystem functioning (principle 5), including, for example, those dependent on levels of organic matter, and wider landscape effects, and to manage ecosystems within the limits of their functioning (principle 6). An understanding of the population dynamics of insect pests and their natural enemies is an illustration of the recognition of varying temporal scales and lag effects (principle 8). The approach of learning through doing promoted by the farmer field schools equips the farmers to adapt to, and effect change (principle 9). Scientific principles and experimental methods that are taught through the farmer field schools allow farmers to capitalize on their local knowledge and experience (principle 11). The approach draws upon a wide range of disciplines from the natural and socio-economic sciences (principle 12).

24.Given that the main purpose of rice growing is to produce a product, it follows that the rice agro-ecosystem is managed in an economic context (principle 4). Further to this, the IPM case has provided examples of the reduction of market distortions (such as the removal of subsidies for pesticides and other input); the aligning of incentives to promote biodiversity (including both the provision of awards and recognition to those participating in the national IPM programmes, and monetary incentives such as taxes on the use of pesticides. The latter can also contribute towards the internalization of costs and benefits. The rice system is a highly managed, highly productive ecosystem. At the same time, this productivity is reliant on the conservation and management of biological diversity within the rice agro-ecosystem. A proper recognition of this fact is promoted by the farmer field schools, which strive for a balance between conservation and sustainable use (principle 10).

<u>The farmer field school approach to IPM in the context of the five points of operational guidance of the ecosystem approach</u>

25. The ecosystem approach, as further elaborated by SBSTTA, includes five points of operational guidance. These are:

(a) Focus on the functional relationships and processes within ecosystem;

(b) Promote the fair and equitable access to the benefits derived from the functions of biological diversity in ecosystems and from the use of its components;

(c)Use adaptive management practices;

(d) Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate;

(d)Ensure intersectoral cooperation.

In the following paragraphs, the farmer field school approach to IPM is presented in relation to these five points.

26.<u>Functional relationships and processes within ecosystem</u>. It is well known that insects, spiders and other arthropods often act as natural enemies of crop pests. Research on the rice fields in Java, has also shown that other components of arthropod diversity are important in this respect. Without alternative food sources populations of natural enemies would be directly dependent on the plant pest, which in turn is directly dependent on the rice plant for food. Such a linear system would be expected to give rise to seasonal oscillations in populations at the various trophic levels. In the Javanese rice fields, however, ‘neutral’ arthropods, mostly detritivores and plankton-feeders such as midges and mosquitoes, provide an alternative source of food for the natural enemies of rice plant pests, thus stabilizing the populations of the natural enemies. Furthermore, the detritivores are dependent on high levels of organic matter in the paddies which provides the food source for an array of micro-organisms (bacteria and phtytoplankton) and zooplantkton. This emphasizes the importance of soil organic matter levels as a source of food for insects which offer an alternative food source for the natural enemies of plant insect pests, thereby stabilizing natural enemy populations even in the absence of the plant pest and/or its host plant.

27. Further stability is provided by spatial and temporal heterogeneity at the landscape level. In central Java, for example, the landscape is made up of a patchwork of small to intermediate sized plots of paddy rice (each between 10 and 100 hectares), planted at differing times throughout the year, with only a short fallow period, and interspersed with patches or lines of trees and shrubs. Rice is planted, weeded and harvested by hand. Water buffalo and plough are used to prepare the paddies. This pattern must be similar to how rice has been grown for most of its 3,000-year history on the island. There is evidence that landscape pattern (as compared to more uniform rice environments as in western Java for instance), contributes to the control of pests in the tropical rice ecosystem by denying pests refuge from natural enemies in space or time. Asynchronous planting of rice and the patches of uncultivated land mean that there are always alternative food supplies for natural enemies.

28.<u>The functions of biological diversity in ecosystems and benefits derived</u>. The Asia rice-farming system provided a number of goods and services from which the farmers and others derive benefits. The main product of the farming system is, obviously, rice. Other crops such as soybean, maize or vegetable may be grown as a third-season crops after the second rice crop or on the dikes. In some systems, fish may also be cultivated in the paddies. In fact in some areas, such as Bangladesh, fish may provide as much as 70 per cent of dietary protein. Harvested wild plants and fish may also be important in some situations. Control or moderation of pests of the rice plant is an important service to the rice agro-ecosystem that is provided by the diversity of insects, spiders and their various food sources and natural enemies. Accumulated evidence shows that the tropical rice agro-ecosystem can be fully homeostatic with regard to pest control. Insecticides are therefore not usually needed in these systems translating into various benefits for the farmer: lower costs, increased yield, and reduced health and environmental damage. As outlined above, the populations of the generalist natural enemies of pests is maintained by alternative food sources, which, in turn rely on organic matter in the paddies, and, in some cases on spatial and temporal heterogeneity at the landscape level. Sustainable management of the rice agro-ecosystem also allow for the protection of watersheds, provision of clean water, wildlife refuges and provides a pleasant cultural landscape.

29.The main direct beneficiaries of the improved IPM practices are the farmers themselves, their families and communities. Benefits are in the form of lower costs, increased yield, and reduced health and environmental damage. Benefits also accrue at the national level in terms of increased food security, reduced pesticide pollution and other forms of environmental damage; and no need to provide for alternative means of support to rice production through subsidies of pesticides for example. Global benefits accrue from the conservation of representative agricultural, natural and cultural landscapes and associated biodiversity, and reduced damage to off-farm biodiversity.

30.<u>Adaptive management practices</u>. Ecosystem processes and functions are complex and variable. As our knowledge base is usually incomplete it follows that proactive ecosystem management should involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. This model is applied in the farmer field schools approach where the emphasis is on the application of ecological principles to actual cases, and learning through observation and experimentation. Management of the rice ecosystem thus builds on its results as it progresses, based on the results of the agro-ecosystem analyses carried out as part of the farmer field schools.

31.Scale of management and decentralization. Agriculture necessarily involves farmers as managers of the agro-ecosystem. Nevertheless many models of agricultural development are based on the application of technological packages that are developed in research institutes and which have little regard for externalities beyond the main producer. Coupled with increasing power of the buyers and sellers of agricultural produce, this can lead to a dis-empowerment of the farmer as decision maker. The farmer field schools facilitate application of an ecological approach to agricultural intensification, using adaptive management that requires that the main responsibility for ecosystem management is returned to the farmer and the community.

32.The IPM case-study illustrates that ecosystems need to be managed at multiple scales. Very positive results can be obtained by focusing on pest management at the level of the individual plot, within a farm field. For example, outbreaks of brown plant hopper on rice can be reduced substantially on a single plot by the conservation of natural enemies, even when insecticides (which kill natural enemies) are applied to the surrounding plots. Nevertheless, more complete control is obtained when wider landscape effects are also taken into consideration.

33.Intersectoral cooperation. Management of natural resources, according to the ecosystem approach, calls for increased intersectoral communication and cooperation at a range of levels (government ministries, management agencies, etc.). Experience with IPM shows that the success of local actions can be enhanced through supporting policy measures such as: (a) promotion of IPM as a national policy, as in Indonesia; (b) changes in incentive measures such as the removal of subsidies for pesticides, and/or the application of taxes on pesticides; and (c) regulatory measures, such as the banning of particularly harmful pesticides. Potentially, markets for pesticide-free food products could also play a role.

34.In summary, through the discussion of the 12 principles and five points of operational guidance as they relate to the philosophy and application of IPM using farmer field schools, it is well demonstrated that the wider consideration of the ecosystem approach in agriculture can lead to substantial benefits both for the sustainable use and conservation of biodiversity and for the individual ecosystem managers who practice it.

III. SOME PROVISIONAL CONCLUSIONS

35.The case-study highlights the importance of agricultural biodiversity in high-production systems, even those, such as tropical irrigated rice, that are based on monoculture, often using a single variety. In this case crop diversity is low but associated biodiversity is high and critical to ecosystem functioning. Additionally, diversity at landscape level is important.

36.The case-study illustrates the usefulness of practical examples. While the successful implementation of IPM programmes at national level requires a supporting policy environment, policy change is more easily obtained once facts on the ground are demonstrated. Mobilization of farming communities, through approaches such as farmer field schools, can help create the political will needed for policy change.

37. Agricultural ecosystems are designed to produce certain goods (such as food, feed and fibre). Increasingly it is being recognized that agricultural ecosystems also provide other services (for example recreational areas and clean water). Thus, the management of agricultural biodiversity may provide useful examples that illustrate application of the ecosystem approach. Adaptive management of biodiversity in agricultural ecosystems constitutes a massive experimental base with the potential to provide lessons for the application of the ecosystem approach to some other ecosystems. Moreover, people are generally more knowledgeable of the value of agricultural ecosystems, and hence more amenable to understanding principles demonstrated by it.

38. In conclusion, application of the ecosystem approach to the management of agricultural biodiversity has the potential to reconcile the needs for increased food production, with the continued provision of other goods and services derived from agricultural biodiversity, and also to contribute to the conservation of biodiversity in agricultural ecosystems.

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