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LOCAL INNOVATION AND INITIATIVE IN MANAGING BIODIVERSITY IN NORTHERN ETHIOPIA[1]

Fetien Abay, Mitiku Haile and Ann Waters-Bayer[2]

Keywords: *biodiversity, farmer innovation,* in situ *conservation, landraces*

Local management of biodiversity has received increasing attention as a way of spreading risks, conserving natural resources and enhancing food security in resource-poor farming systems. For poorer farmers on marginal lands, it increases their options to cope with variable environmental conditions and to exploit niches and micro-environments in their agro-ecosystems.

This paper discusses the dynamics of farmers' innovation and initiative in genetic resource management (GRM) in northern Ethiopia. A study was conducted in order to gain a better understanding of the diversity of farming systems in relation to natural environment and of farmer's related land-management and GRM practices and to identify sources of variability and biodiversity. This study formed part of an action-research programme to promote farmer innovation in land husbandry, and sought to identify farmers' initiatives, opportunities and limitations in improving their agro-ecosystems.

Both men and women farmers were identified who are deliberately domesticating wild plants to prevent their disappearance, introducing exotic species without the support of extension services and planting gardens with a wide variety of species for medicinal, cosmetic and household purposes. Some are experimenting with local grasses collected in the wild. Because of the obvious diversity observed in the widely planted prickly pear cactus (*Opuntia ficus indica*), a special case study was made of this. It was found that the farmers select primarily for prolific fruiting and big fruits. They select different types of plants based on their intended uses or gastronomic preferences. This has contributed to great genetic variability and stability. The natural hybridisation associated with ploidy of geographical isolation also appears to have played an important role in creating the existing diversity.

Farmers' knowledge of genetic resources and their traditional selection techniques have created a good germplasm base that, combined with scientists' knowledge and special breeding techniques, could lead to the identification and development of valuable cultivars that have a wide potential for use in semiarid areas, also beyond Tigray. The study led to scientists' appreciation of the astounding variations and transformations that indigenous people can produce in domesticated plants over the course of decades and centuries, as well as to the initiation of farmer-led participatory research on varietal selection.

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[2] The first and second authors are coordinator and former coordinator of the Ethiopian programme under ISWC-II; contact address: Mekelle University, POB 231, Mekelle, Tigray, Ethiopia (mekelle.university@telecom.net.et); the third author is external advisor to the programme; contact address: ETC Ecoculture, POB 64, NL-3830 AB Leusden, Netherlands (ann.waters-bayer@etcnl.nl).

AGRICULTURAL BIODIVERSITY AND THE LIVELIHOOD STRATEGIES OF THE VERY POOR IN RURAL BANGLADESH

Farida Akhter, UBINIG, Bangladesh

The fact that the poor people are dependent on uncultivated foods for their survival and livelihoods is well known in the villages of rural Bangladesh. But what is the nature of this dependence? Our study explores the use by the very poor of the food and plants they collect from the lands, water bodies and forests where they live. When we asked villagers "where are the poor", the answer was "chak", meaning in the cultivated fields of others or out on the roadsides. From the months of Bhadra to Kartik they are busy in the sugarcane fields harvesting for farmers. In the months of Agarhayan, Poush and Magh they are busy harvesting potatoes and preparing seedlings for the paddy fields of farmers. They may receive some money for this labor, which they will use to buy oil, salt, school expenses and debt repayment. But they will also take potatoes as partial payment and collect the straw which is no longer needed to cover the ground in the potato field and bring it home for fuel. They will pick the jute leaves in the farmers' field for food and collect the uncultivated leafy greens along the side of the rice field, some of which they will sell. They will sell eggs from their free-range chickens to buy rice and collect small fish in the water bodies for the daily meal. This is their livelihood. What is an appropriate response to the challenges of ensuring their access to these food sources? Agricultural development targeted on a few crops cannot adequately compensate the very poor for the losses in access to uncultivated food sources caused by farming practices such as the extensive use of pesticides and monocropping. Neither can they compensate for the erosion of the common property regimes and social rules that enable people to use these food sources. Analysis of the contributions of uncultivated foods to food security in Bangladesh suggests that the appropriate level for enhancing access to these foods sources is the community landscape, not the individual plant species, farm or backyard. Simply by promoting biodiversity-based farming systems and protecting village lands from pesticides and enclosure of common lands, an enormous resource in uncultivated foods is also ensured. Such a strategy can be called "cultivating the landscape", in contrast to more limited definitions of agriculture based on cultivated plants in cultivated fields. Improvements to agriculture should consequently be pursued in the context of a broader strategy to enhance the capacity of communities to create and maintain the conditions needed for biodiverse food systems. Ultimately, biodiversity is NOT cultivated, but rather nurtured in biodiverse agro-ecosystems.

THE CBUD PROGRAMME DOMESTICATION AND PRODUCT CHAIN DEVELOPMENT AS AN EFFECTIVE PROTOCOL FOR BIODIVERSITY UTILIZATION AND DEVELOPMENT TOWARDS CONSERVATION AND RURAL POVERTY REDUCTION IN GHANA

B. Amoako-Atta [1], E. O. A. Asibey [2], S. Ayeh [3] and W. de Boef [4], G. B. Bartels [5]

1,2,3,5. Centre for Biodiversity Utilisation and Development, CBUD/IRNR-KNUST P. O. Box UP 1106, Kumasi, Ghana, e-mail: bamoakoatta@hotmail.com

4. Biodiversity and Institutional Development Consultant: Bovenover 65, 6812 AT Arnheim, The Netherlands; e-mail: boef@cybercomm.nl

Indigenous biological food resources abound in Ghana. However, many of them are mainly recognised, sustained and utilised at the farmer/rural community level and are not part of main stream agriculture: their contribution to the nation's gross domestic product is very limited. The biological significance and the potential of these resources, commonly referred to as non-timber forest resources, have been generally recognised but they have not yet featured significantly on the national economic agenda, despite their importance within the context of in-situ on farm conservation. Until recently no dedicated institution existed in Ghana to address the specific issues related to these resources. In 1999, the Centre for Biodiversity Utilisation and Development (CBUD) was established within the Institute of Renewable Natural Resources (IRNR) of the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana. Within a short period of time this Dutch-funded programme has emerged as a Centre of Excellence with the mission to co-ordinate the process of identification of potential products of Ghana's biodiversity and to subsequently support and facilitate their production, processing and marketing. So far, CBUD has pursued this process of domestication and product chain development with five lesser-known food resources: snails, indigenous leafy vegetables, Tetrapleura tetraptera (a Mimosaceae known for its medicinal and food value, called 'Prekese'), grasscutter (Thryonomis swenderianus, a popular bushmeat) and Telfairia occidentalis, a Cucurbitaceae locally known as ‘Krobonko.’ This work involves sustained research efforts to accompany the domestication of wild biological resources on farms managed by farmers as CBUD partners. This basic production process is followed by a series of product chain development processes aimed at value addition. In all this, CBUD plays the role of facilitator; the execution of activities and the implementation of the programme itself is carried out by a host of partners ranging from farmers, NGOs, universities to local government and ministries. CBUD's aim is to utilise the country's biodiversity and to develop its products as a means to provide rural and in some cases urban people with a livelihood that is sustainable. Farmers and the other partners within the CBUD framework create the synergy of demand for these resources; this then enjoins other people to conserve and nurture the richness of biological resources that the country possesses. The experiences so far bear testimony to the validity of CBUD's philosophy and approach. Institutional arrangements already involve forty partner institutions across Ghana, and over 1,500 agricultural producers have taken up the production of the commodities promoted by the Centre throughout southern Ghana. The programme will soon expand to the northern half of the country.

BIOGAS: PRODUCTION OF METHANE GAS AND MANURE FROM DAIRY CATTLE / PALM OIL MILL WASTE AS A SOURCE OF FUEL AND FERTILIZER FOR AFRICAN FARMERS

RICHMOND ANTWI-BEDIAKO
Richmond Antwi-Bediako (president)
Rural Environmental Care Association
p.o.box 733
Tarkwa-Ghana.
West Africa
tel: 233-24-286927
e-mail: antwibed@alibaba.com

In Ghana and Africa as whole, most communities use wood as a source of fuel for domestic and commercial purposes with no alternative source of fuel. From report about 80% of African use wood as a source of fuel. This has led to the degradation of the forest, hence, resulting in significant dehydration water bodies and unpredictable rainfall pattern. Effective farming has thus been hindered.

Timber companies and local chain saw operators have been banned from revisiting the over exploitation of the forest. Reaforestation programs have embarked upon and are somehow yielding positive fruit.

To prevent or mitigate the negative environmental impact, an alternative fuel and fertiliser usage is required. This paper uses the research findings from a Project embarked upon by Rural Environmental Care Association, RECA, that is, The Generation of Methane Gas (for fuel) from Anaerobic Digestion of Agriculture waste (Animal waste and waste from Palm oil process plant). The digested effluent from the waste is used as manure.

The predominance or the availability of raw material will make this project a sure alternative source of fuel and fertiliser in Africa.

IN SITU CONSERVATION OF MILPA LANDRACES IN YUCATAN, MEXICO

Arias-Reyes L.M.,J. L. Chávez-Servia D.Williams and D. Jarvis.

For centuries Maya farmers have maintained a rich genetic diversity of maize, bean, squash and chili within their "milpa" or swidden agricultural system. The rural population in the Yucatan today is still highly dependent upon milpa crop production for self consumption. This diversity is decreasing due to government modernization programmes, population pressure, and environmental changes. Social-cultural, ethnobotanical, agronomic, genetic and ecological studies were implemented to understand the extent and distribution of the remaining diversity of these crops and the processes and reasons used to maintain this diversity in Yaxcaba, Yucatán. This included gaining an understanding of how farmers name and manage local landraces together with agromophological characterisation and isozyme markers, studies on gender and economic household activities, rural food processing and consumption characteristics, and bromatological analysis. Participatory breeding methods have also been used to reinforce *in situ* conservation on farm procedures including mass selection and limited back cross breeding systems in maize and recovering genetic diversity of traditional landraces like Nal-Tel seeds. Farmers classify landraces taking account morphology by growth cycle and grain colour, both of which are reflected in Mayan landrace names. Fifteen local varieties of maize were recorded, three landraces of squashes, sixth from beans and eight from chile. Farmer criteria is an important factor for conservation of landraces and adding value in any participatory breeding procedures.

DIVERSITY AND USE OF ECTOMYCORRHIZAL FUNGI IN WEST AFRICAN FORESTS

Amadou M. Bâ

Université des Antilles et de la Guyane, Faculté des Sciences Exactes et Naturelles, Laboratoire de Biologie et Physiologie Végétales, BP. 592, 97159 Pointe-à-Pitre, Guadeloupe, France

Key words: Tropical trees, Ectomycorrhizal fungi, Ectomycorrhizas, PCR-RFLP, Sequencing, Forest nurseries, Inoculation, Mycorrhizal dependency.

We examined the diversity of ectomycorrhizal fungi and ectomycorrhizas of *Caesalpinioideae, Euphorbiaceae* and *Dipterocarpaceae* specie trees growing in the tropical forests in West Africa. We collected 161 different sporocarps and 113 ectomycorrhizas under these tree species. The 3 most represented orders are Russulales (57 fungal species), Boletales (22 fungal species) and Agaricales (18 fungal species). Several fungi, especially in the genera *Russula* and *Lactarius*, were found to be undescribed species. For example, we discovered *Russula* sect. *Archaeineae* sp. nov and *Lactarius* sect. *Plinthogali* sp. nov fruiting under a grouping of ectomycorrhizal specie trees. The taxonomic position of these fungi was confirmed by the amplification and DNA sequencing of the ML5-ML6 region of the mitochondrial large subunit rDNA gene, using a database on basidiomycetes. We also identified the fungi from ectomycorrhizas by matching the ITS-RFLP patterns of the ectomycorrhizas with sporocarps, or by placing the unknown ectomycorrhizas in a phylogenetic tree constructed from a database on basidiomycetes. Our results support the hypothesis that sporocarp inventories only partly reflect the ectomycorrhizal species composition in west african forests.

20 mycelial cultures were isolated from sporocarps, ectomycorrhizas and sclerotia. Fungal inocula were produced on a mixture of vermiculite and peat moistened with a nutrient solution. These inocula were used for inoculation of seedlings growing in forest nurseries in West Africa. *Uapaca somon* showed the highest mycorrhizal dependency values, reaching a maximum of 85%, while the mycorrhizal dependency values of *Anthonotha macrophylla*, *Paramacrolobium coeruleum*, *Afzelia africana*, *Afzelia bella* and *Cryptosepalum tetraphyllum* were similar, reaching no more than 50%.

UNDERSTANDING GENETIC DIVERSITY AND FARMER NAMED VARIETIES IN TARO (*COLOCASIA ESCULENTA* L. SCHOTT), BARLEY (*HORLEUM VULGARE* L.) AND RICE (*ORYXA SATIVA* L.) IN THE MID AND HIGH HILLS OF NEPAL THROUGH ISOZYME AND MICROSATELLITE DNA ANALYSIS.

J. Bajracharya[1], D.K. Rijal[2], P.R. Tiwari[2], D.S. Shakya1, B.K. Baniya[1], K. A. Steele[3] and J. R. Witcombe[3], B.R. Sthapit[4], A.H.D. Brown[5], T. Hodgkin[6], and D.I. Jarvis[6].

[1] **Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal e-mail:** jwala@unlimit.com
[2] **Local Initiatives for Biodiversity, Research and Development (LI-BIRD), P.O. Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: rblibird@mos.com.np**
[3] University of Wales, Gwynedd, Wales, and UK, e-mail: k.a.steele@bangor.ac; j.r.witcombe@bangor.ac
[4] International Plant Genetic Resources Institute, APO, Malaysia, e-mail: b.sthapit@cgiar.org
5 Division of Plant Industry, CSIRO, GPO Box 1600, Canberra, A.C.T. 2601 Australia, email: t.brown@pi.csiro.au
6 International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy d.Jarvis@cgiar.org

Genetic diversity of local farmer-named varieties of rice (*Oryza sativa* L.), barley (*Hordeum vulgare* L.) and taro (*Colocasia esculenta* L.) were assessed using germplasm collected in 1998-2000 from three agroecosystems in Nepal. Microsatellite DNA markers were used to evaluate rice landraces whereas isozyme analysis was used in barley and taro. In rice, a low level of polymorphism was revealed among farmer-named variety accessions with an average 0.40 polymorphic information content (PIC). The farmer-named varieties exhibited close relationships with little variation in landraces with same name maintained by different farmers. This suggests that landrace names adopted by farmers based on the phenotypic characteristics of panicle and grains are inconsistent indicators of genetic identity in high altitude areas where natural selection for low temperature is strong. Overall, these landrace accessions under study have little genetic variation suggesting that farmers' rice cultivars from Jumla be probably selected from locally common Jumle Marshi landrace. In Barley, isozyme data indicated the existence of diversity within and between populations of the four farmer-named varieties irrespective of the agroclimatic and altitudinal ranges. This variation could possibly be as a result of the farmers' management practices, particularly the different seed exchange systems. In taro the observed variation in isozyme profiles indicated the existence of genetic difference in farmer-named taro cultivars. Principal component analysis and UPGMA cluster analyses of these isozyme data sets provided the evidence that these cultivars possess considerable genetic variation and clustered the entire set of cultivars into two distinct groups irrespective to morphological classification.

SEED AND PLANTING MATERIAL FLOW SYSTEMS FOR BARLEY, FINGER MILLET, RICE, AND TARO IN THE TERAI, KASKI AND JUMLA DISTRICTS OF NEPAL

B.K. Baniya1, A. Subedi2, R.B. Rana2, R.K. Tiwari2 and P. Chaudhary1, R. B. Yadav1, S.K. Shrestha1 , P. R. D. M. Shakya1, S. P. Khatiwada1, B.R. Sthapit3, and D.I. Jarvis4

[1] Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal
[2] Local Initiatives for Biodiversity, Research and Development (LI-BIRD), P.O. Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: rblibird@mos.com.np
[3] International Plant Genetic Resources Institute, APO, Malaysia, e-mail: b.sthapit@cgiar.org
[4] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy d.Jarvis@cgiar.org

Formal and informal seed and planting materials supply systems of self-pollinated rice, finger millet, and clonal crop taro were studied in three ecosites of Nepal during 1999-2001 to understand the processes of seed flow, seed production, selection and storage system. A household survey (48-96) was conducted to document the indigenous knowledge about seed supply systems at each site for all crops. Informal seed supply was the only system in Jumla while in Kaski and Bara formal system also existed. Irrespective of crops, the main sources of seed included farmers' own saved seed (89-91%), seed from neighbours, and relatives. Exchange of germplasm was the main basis of fulfillment from other sources. All farmers obtained seed from their own village, while farmers do introduce materials occasionally from outside sources. Most of the farmers followed seed selection before or after crop harvest. Rice field selection and plant selection based on a fixed set of criteria was the common practice. Non lodging plants with more grain per panicle, bold grains, well-matured and uniform plants, long panicle, true to type, good looking grains, free from diseases and insects were the main seed selection criteria. All farmers from both sites stored rice seeds by local methods in the locally available containers. *Mor* is a special straw container to store rice seed freshly in Bara and *Mudkothi* also is a very common container there. *Dhara* is a special mud structure used to store rice seeds (any grain) in Jumla. Finger millet seed supply system was found mostly similar to that of rice seed system. Farmers used about double amount of seed than the needed. Ninety one percent farmers saved seed for their own use, however, many of them changed finger millet seeds lots or varieties regularly for their particular plot. Ears selection during harvest by set criteria for seed purpose was the common practice. Farmers stored finger millet seed carefully in small locally available containers and safe place and they tried their best to maintain the quality of seed during different steps of seed production. In contrast, diverse ways taro can be planted: cormels, corms with eyes, suckers and corm with small cormels. Taro planting materials management is totally informal and almost 89 percent farmers saved these materials for their use, replacing them mostly after 3 years. Farmers had fixed criteria of corms and cormels selection for planting purpose and focus more on disease free storage of planting materials done locally by using local materials methods. Taro is used for many purposes. It is a reliable commodity for regular income of local farmers and its importance will increase provided value is added. Understanding of seed system in various crops helps to develop conservation strategy.

FIELD STUDY OF TWO BARLEY LANDRACES OF JUMLA, NEPAL

BK Baniya[1], PR Tiwari[2], D Pandey[1], J Bajracharya[1], A Mudwari[1], BR Sthapit[3] and DI Jarvis[4]

[1] Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal. Email: issc_nepal2@wlink.com.np

[2] Local Initiatives for Biodiversity, Research and Development (LI-BIRD), PO Box No. 324, Pokhara, Nepal; e-mail: libird@mos.com.np

[3] International Plant Genetic Resources Institute, APO Regional Office, Malaysia; e-mail: b.sthapit@cgiar.org

[4] International Plant Genetic Resources Institute, Rome, Italy d.jarvis@cgiar.org

To study the agro-morphological variability of two common barley varieties of Jumla, *Lekali* and *Chawali*, data were collected *in situ* for four quantitative traits and six qualitative traits of each variety from 80 farmers' plots. High intra and inter varietal diversity was observed in quantitative traits and not much difference was found in qualitative traits was found less diverse than *Lekali* in both quantitative and qualitative traits. The distribution of average values of quantitative traits of the 80 populations of both varieties is erratic, which indicates need of further work in methodology of study. However, a isozyme analysis by Bajracharya and others (2001) of the two varieties showed that *Chawali* had more diversity in terms of number of alleles per locus, and percentage of polymorphic loci compared *to Lekali*. This might be due to the high environmental effect in the study, the seed systems of the varieties, or the different diversity measurements themselves. Due to its higher diversity of agronomic traits, *Lekali* may be more useful than *Chawali* in breeding programme in developing other improved varieties. There is need to study these populations in on-station conditions for additional traits and further molecular study to justify our conclusions.

Bajracharya, J, PR Tiwari, DM Shakya, BK Baniya, and BR Sthapit, 2001. Genetic variation in barley landraces (Hordeum vulgare L.), of Jumla ecosite revealed by isozyme analysis. In BR Sthapit, A Subedi, MP Upadhaya and BK Baniya, (eds.), Abstracts of a National Workshop on Strengthening the Scientific Basis of In Situ Conservation of Agricultural Biodiversity. 24-26 April 2001, Lumle, Nepal.

PARTICIPATORY INTERVENTIONS FOR ON FARM CONSERVATION OF MAIZE DIVERSITY IN THE CENTRAL VALLEYS OF OAXACA, MEXICO

Mauricio R. Bellon[1], José Alfonso Aguirre Gómez[2], Melinda Smale [1,3] Julien Berthaud [1,4] Irma Manuel Rosas [1] Ana María Solano [1] and Rafael Martinez [1]

1 International Maize and Wheat Improvement Center (CIMMYT)
2 Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Caudillo del Sur 121, Fracc. Bosques de la Alameda, Celaya, 38050, Guanajuato, Mexico.
3 International Plant Genetic Resources Institute, Rome, Italy.
4 Institut de Recherche pour le Développement (IRD), France.

ABSTRACT

The goal of this project is to determine whether it is possible to improve maize productivity while maintaining or enhancing genetic diversity. Maize productivity was broadly defined in terms of yield, stability, and other characteristics of interest to farmers. The project conducted and compared different participatory interventions with small-scale farmers in six communities in the Central Valleys of Oaxaca Mexico. Through the project, farmers gained access to the diversity of maize landraces present in the region, were trained in seed selection and management techniques, and learned principles to assist them in maintaining the characteristics of landraces they value. This project is divided into three components: 1) diagnosis, 2) interventions, and 3) impact assessment. The diagnosis included a collection of samples of landraces representative of the maize diversity present in this region; their agronomic evaluation in scientist-designed, but farmer-managed trials; a participatory exercise to identify a subset of landraces from those collected that were the most likely to be valuable to farmers; and a baseline survey. The interventions included access to the subset of landraces identified and training. The former through demonstration plots and field days, during which participants could purchase seed of any landrace of the subset that they wished. The latter through five training sessions, starting with a open discussion of their knowledge about maize reproduction and their perceptions of maize improvement. Additional sessions focused on teaching basic principles of maize reproduction, seed selection in the field and in the house (including hands-on exercises in the field), and seed and grain storage principles and techniques. The impact assessment component includes the baseline survey (described above) and the monitoring a sample of farmers who participated in each of the interventions. The monitoring consists of systematic interviews with this sample of farmers every year regarding their participation, their perceptions of the advantages and disadvantages of their participation, and collection of samples of the maize landraces purchased.

CONTRIBUTION OF HOME GARDENS TO *IN SITU* CONSERVATION OF PLANT GENETIC RESOURCES IN FARMING SYSTEMS IN GHANA

Dr. S.O. Bennett-Lartey[1] and Carol Markwei[2]

[1] Plant Genetic Resources Centre, P.O. Box 7, Bunso, Ghana
[2] Department of Botany, University of Ghana, Legon, Accra, Ghana

ABSTRACT

Home gardens are a long-established tradition in Ghana and occur in all agroecological zones. This study is a part of a global project to determine agrobiodiversity in home gardens at the species and infraspecific levels as well as the contribution of home gardens to the livelihood of the owners. Four agroecological zones were selected: the Moist Semi-Deciduous Zone, the Rainforest Zone, the Guinea Savanna Zone, and the Sudan Savanna Zone. In each zone at least one district and five towns/villages were randomly selected for in-depth study. Rapid appraisals, questionnaires, formal interviews and visual inspection of species were carried out in selected home gardens. Home gardens in Ghana were found to be multi-species, multi-storied and multi-purpose gardens which are sited close to the homestead and occurring to one side of it or partially surrounding it. In the moist semi-deciduous agro-ecological zone (MSZ), a total of 104 species belonging to 36 families were recorded. The Guinea Savanna Zone (GSZ) had 51 species in 29 families whilst the Sudan savanna zone (SSZ) recorded 40 species in 28 families. The use categories of species in the home gardens were as follows: cereals, legumes, root and tubers, fruit and nuts, oil crops, spices, medicinal plants, vegetables, hedging, ornamentals and shade trees. In the GSZ and SSZ 60% or more of families surveyed consumed the entire harvest from their home gardens whilst in the MSZ 49% consumed their entire produce, showing more commercialization of home garden products in the moist semi-deciduous zone with greater proximity to the capital city, Accra. In the GSZ and SSZ majority of home gardens (88.7% and 86.8% respectively) were owned by males whilst in the MSZ 57.7% of home gardens were owned by women, showing marked differences in gender dynamics between the North and the South-east of Ghana. The species of yams (*Dioscorea*) were as follows: *D. alata, D. bulbifera, D. cayenensis, D. dumetorum, D. esculenta, D. praehensilis,* and *D. rotundata.* In the GSZ 14 varieties of *D. rotundata* were recorded. There were two main plantain (*Musa*) varieties: False Horn and French Horn. There was further diversity within each variety, two for the French Horn and seven for the False Horn. The home gardens contained a great diversity of species and varieties which were rarely found elsewhere in the agroecosystem. Home gardens seem to provide refuge for these species and hence can be considered as conservation sites.

COMMERCIALISATION AS AN INCENTIVE AND THREAT FOR GNETUM SPP (ERU) IN CAMEROON1

Besong, M., Samalang, P. and Abia, C.
Institute of Agricultural Research for Development (IRAD)
Ekona Regional Research Centre, PMB 25 Buea, Cameroon

SUMMARY

Gnetum is the most exploited and commercialized vegetable in Cameroon (Besong, 1998). This forest vegetable plays a key role in the livelihoods of the people of Cameroon, particularly in that of the local communities. Gnetum, commonly referred to as Eru, is a threatened species in all areas of Cameroon where it grows. Gnetum is very important in terms of its social, cultural, medicinal, nutritional and, above all, economic values. Eru provides employment to many women and children who collect and sell it throughout the year. The leaves form part of the diet in almost all the social strata in Cameroon, particularly of people from Manyu Division. In addition, Eru is known to be high in protein (Schippers, 2000) and has a medicinal value. Large quantities are shipped to Nigeria for local consumption and for export to Europe and the USA.

INTRODUCTION

There are two species of Gnetum found in the forests of Cameroon. While Gnetum africanum has small leaves and is more available, and therefore more popular and widely consumed, Gnetum buchholzianum has larger leaves. The larger leaves make this Gnetum species easier to harvest, asking less time to shred and more easily fills a market bowl or dish with small number of leaves (Nkefor & Ndam, 2000).Gnetum is commercialized in different forms: leaves, shredded and as prepared food in the markets, workplaces, public schools and other places, according to the consumption habits of the buyers/consumers. Gnetum grows still wild in Cameroon (not cultivated). It is harvested by whosoever can afford to do so, particularly by those who live in the communities around the forests where Gnetum is found. Because of its economic importance and its very strong demand - particularly from neighbouring Nigeria and Gabon -, children and women from the Gnetum-growing communities harvest and sell Gnetum.

GNETUM COMMERCIALIZATION

Like other indigenous vegetables, Gnetum is commonly sold in bundles, and women are the major traders. A woman can harvest up to 100 bundles in a day. These are sold locally at 100 FCFA per bundle. This woman earns 10000 FCFA per day, which is higher than the defined average threshold for poverty in Cameroon (Cameroon Human Development Report, 1998).

SA'A is a community near Yaounde, the capital of Cameroon. SA'A and neighbouring villages are the source of most of the Gnetum that is exported through the coastal seaport of Idenau in the South West Province of Cameroon to Nigeria. Studies carried out by the Mount Cameroon Biodiversity Conservation Centre, showed that wholesalers go to SA'A and buy all the

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Gnetum harvested for 100-150 FCFA (0.15-0.22 USD) per bundle. Each bundle is estimated to weigh 1 kg. The Gnetum is packed and transported in buses and on their carriages to Idenau for export to Nigeria. It has been estimated that on average a bus carries between 1.7 tons to 2.5 tons of Gnetum. About 30 buses of Gnetum are going weekly to Idenau. Consequently Gnetum exported from the Idenau coastal port alone (to Nigeria), is calculated to generate an annual revenue of 1,060,800,000 - to 1,560,000,000 FCFA (1,500,000 - 2,200,000 USD).

A study carried out in the local markets in Fako Division of Cameroon, shows that women are, as usual, the main sellers of Gnetum, mostly selling it in shredded form. These sellers buy from nearby markets and from middle-women who buy from the major collection/contractual points in the villages. Depending on the size of the market and also on the season, a middle-woman trading Gnetum buys between 15 to 20 bundles a day to shred for selling in the small/village market whereas the seller in the town/bigger market buys and sells 30 bundles of shredded Gnetum. One bundle of Gnetum is equivalent to 3 bowls/dishes with shredded leaves. The shredded Gnetum is sold at between 200 FCFA and 300 FCFA per bowl. Therefore, a seller of Gnetum in these markets can make 144.000frs CFA or more per month, during the wet season, and twice the amount during the dry season.

LINKAGE OF GNETUM TO USE AND CONSERVATION OF AGRO BIODIVERSITY.

As is clear from the market study, trade in Gnetum is very important in Cameroon. The study also showed that there is an increasing demand and supply of Gnetum. The increase in demand is the result of an increase in the population. In Cameroon the population is growing at a constant rate (2.83%, Cameroon Human Development Report, 1998), which has doubled the population over the last 20 years. Economically, Gnetum contributes to poverty alleviation. It provides employment and income for many, especially the vulnerable (women and children). Culturally, the leaves form part of the diets of almost all of the social strata in Central Africa and Nigeria. Gnetum is very nutritious. It is very rich in protein, minerals, and contains the eight essential amino acids. It can therefore be used to fight malnutrition. Gnetum has medicinal uses as well. In addition to treating enlarged spleen, sore throat, piles and high blood, it is used to treat nausea, arrow poison; to hasten maturation and to ease childbirth. The leaves are also used in the production of a commonly exported whisky to Nigeria (Mbah & Mih, 2001

One may wonder how the many uses of Gnetum can be linked to conservation of agrobiodiversity. Obviously, the Gnetum's resource base is threatened. With a constant source of supply and the fact that harvesting is a widely spread practice, occurs frequently and is destructive (through the cutting down of its shade cover and support base), Gnetum species risk to become extinct. Different from other forms of agrobiodiversity, i.e. crop varieties, wild and semi growing plants that are used for food and agriculture can be lost to overexploitation. With such loss, not only valuable genetic resources are lost, but also the livelihood security of people who are in a vulnerable position is directly affected. The irony of the situation is that these same people are the ones who harvest and commercialise the Gnetum produce, thereby undermining their own resource base. To counteract this risk of extinction the government of Cameroon has put in place a policy to control its harvesting through community forest management. Research Institutes, conservation projects, farmers, non-governmental organisations (NGOs), and community based organisations (CBOs) together are making increased efforts to conserve Gnetum (Ndam et al. 2001).

Cultivation of wild and semi-wild growing food plants is generallly considered a viable strategy for these resources. Shiembo in 1997 recommended vegetative propagation for Gnetum cultivation. Mount Cameroon Bio-diversity project has a genebank of the two Gnetum varieties, and has developed a simple and low-cost technology for propagation of Gnetum cuttings. A method for the sustainable harvesting of Gnetum is also been developed. Individual farmers and farmer groups have been trained to produce their own planting materials and adapt their harvesting techniques. Some farmers are already producing Gnetum in their farms. The National Institute of Agricultural Research for Development (IRAD) in collaboration with related institutions and farmers are testing the production of Gnetum in agroforestry systems. This particular production technology is recommended since Gnetum, apart from being shade tolerant, is a climber and therefore requires support.

RECOMMENDATION

Despite all the strong market forces and the many incentives that make Gnetum attractive and a successful vegetable in Cameroon the technologies for cultivated production are still experimental, while the demand for it continues to rise. Bulk production remains a problem. The production period of Gnetum and thereby the realisation of benefits take a long time. The threat on Gnetum's resource base is still there. Therefore our recommendations are three fold, all to be implemented through participatory/partnership approaches:

i) Research: conduct agronomic and economic trials, and establish germplasm and genebanks.
ii) Training: of a) technical staff (long and short-term training, b) other stakeholders (farmers, extensionists, researchers, conservationists and policy makers). They should be trained in the various aspects of conservation, including the cultivation of Gnetum (conservation by cultivation), market and post harvest issues
iii) Extension: introduce and adpapt on-station generated technologies to enhance adequate use and conservation of Gnetum as a means to preserve agrobiodiversity by all stakeholders.

Important constraints are, however, that there are many threatened wild and semi-wild growing plants in Africa that are used for food and agriculture, while resources are scarce.

Gnetum is a typical example in Cameroon. Therefore the challenges that can provide incentives for a sustainable use for Cameroun are:

- **for Government to make more farming land available.**
- **to domesticate through ex-situ cultivation.**
- **to conserve in-situ by creating many germplasm collections and gene banks.**
- **to match the production of Gnetum with the high population growth, a major investment is required for commercial farming.**
- **to explore other propagation methods like tissue culture**
- **to develop strategies to accelerate Gnetum production through seeds.**

<u>REFERENCES</u>

Besong M.T. 1998. Socio Economic Survey of Indigenous Vegetables in South West Cameroon. In opportunities and constraints in the subsistence production and marketing of indigenous vegetables in East and Central Africa. Edited by Rudy Shippers and Nicholas Fereday PP.16-21.

Besong, M.T. 1998. Production and Marketing of indigenous vegetables in the high rainfall zone of Cameroon. Abstract PP/DS 1-6, XXV International Horicultural Congress, Brussels.Mbah & Mih 2001. Conservation through cultivation: An appraisal of the Mt. Cameroon Project Initiative on Eru. University of Buea.

Ndam, N. Besong, M. Nkefor, J. and Samalang, P. 2001. Gnetum Africanum Germplasm conservation and on-farm cultivation in agroforestry systems. MCBCC Limbe.

Nkefor 2000. Germplasm management of Gnetum species. MCBCC, Limbe

Schipper, R., and Besong, M. 2001.Gnetum africanum, PROTA.Shiembo, P. 1997. Domestication of Gnetum SPP by vegetative propagation technicques. Workshop proceedings. African Indigenous Vegetables, Limbe, Cameroon

YDC 2000. Guide on how to grow 'Eru'. YDC extension series Nº 1, Limbe.

THE NGUNI: A CASE STUDY

J. Bester, L.E.Matjuda, J.M. Rust and H.J.Fourie
Animal Improvement Institute, Private Bag x2, Irene, 0062, South Africa.

ABSTRACT

The Nguni is a hardy breed uniquely adapted to the South African environment. Regarded as inferior in the past, it was decimated by government decree and its gene pool diluted through replacement and cross breeding with exotic stock. The recent recognition of its adaptive traits led to its evaluation and development as a beef breed in the commercial sector. Simultaneously, a mistaken perception of the breed's inferiority arose in the traditional sector, despite the fact that it was a low maintenance breed ideally suited to the low input farm systems of the communal farmer. This case study describes the breed and illustrates the potential of the Nguni as a beef breed. A project with the infrastructure required for reintroducing the Nguni breed was initiated in selected communities. In the past, projects for the introduction of exotic cattle breeds into the communal sector invariably failed. This project included support systems, programmes for the improvement of management, a development programme and a marketing system to facilitate the sale of animals at market related prices.

A total of thirty-five selected Nguni bulls were introduced into five communities in the Northern Province and six in the Eastern Cape Province. These communities had organised farmer groups that were willing to contribute a minimal amount towards the maintenance of the bulls. A further supply of 10 bulls/annum is available.

Problems encountered included a lack of qualified staff for the monitoring of the project and a collective lack of grazing, herd, reproductive and health management. Minimal infrastructure within the communal lands and a resultant lack of record keeping are further restraints. In addition, the land tenure system aggravates the situation, as individuals often have neither right of possession nor the right of prescription for its use.

The project is in its early stages and certain risks and assumptions were made at its inception. Amongst these are that the animals produced will be of market quality, that available resources can support the increased production and that there are no a major droughts or disease outbreaks. The success of the project also depends on the farmers themselves, as they will have to accept drastic changes to their current way of producing animals.

This project is designed to show that the development of the Nguni breed in South Africa supports the concept of conservation through utilisation in the traditional farming sector.

ON FARM CONSERVATION OF ALFALFA FARMER'S UNITS OF DIVERSITY (FUD) IN MOROCCO

A. Bouizgaren[1], A. Birouk[2], S. Kerfal[2], H. Hmama[2], and D. Jarvis[3]

[1] Institut National de la Recherches Agronomique (INRA), CRHPS Marrakech, MOROCCO, Tel. 212 44 447864 or 447882, Fax 212 44 435175, E-mail bouizgaren@hotmail.com

[2] Institut Agronomique et Vétérinaire Hassan II Dep. d'Agronomie et d'Amélioration des Plantes
B.P. 6202 Rabat, MOROCCO

[3] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy

ABSTRACT

Alfalfa is the principal cultivated forage crop in Morocco, covering 25% of the forage land. It was introduced in the north African oasis before 100 AD and is a unique forage crop used from the oasis areas of the desert valleys to the high atlas mountains. Local cultivars or landraces are predominantly used and are known by farmers by their biotic and abiotic tolerance (diseases, soil and water salinity, drought). The objective of the present study is to measure the amount of diversity in agromorphological traits among and within alfalfa landraces and to identify Farmer Units of Diversity or FUDs to design a better conservation method to guarantee the sustainability alfalfa diversity. To carry on the study, two sites were chosen according to the high number of alfalfa landraces: Rich, in the oasis area and Demnate in the Atlas Mountain area of Morocco. Collecting was conducted from farmers fields. One pod per plant was collected in order to increase samples diversity. Farmers were selected were seed producers who keep traditionally the identity of their landraces. In parallel to collection samples activity, socio-economic surveys were conducted with the objective to understand the local knowledge used by farmers to distinguish varieties and to understand farmers perceptions of seed management and seed flows. To evaluate the amount of diversity in agromorphological traits between and among alfalfa landraces, samples collected were installed in spaced planting trial (without competitions) in randomised complete bloc design at INRA Experimental Station. Morphological traits were measured plant by plant according to IPGRI's descriptor amended by farmers traits (from the surveys). To evaluate the agronomic potential value, the same landraces were installed in normal planting trials in two Experimental stations: Errachidia (60 km from Rich site) and Tassout (54 km from Demnate site). In the three trials two checks were used (modern varieties: Moapa and Trifecta). The agromorphological data was analysed among Rich landraces, Demnate landraces and checks using Factorial Function analysis and showed a significant discrimination between Rich origin, Demnate origin and cheeks. The two first Functions explain 100% of variability (62.2% and 37.8% respectively for the first and the second function). To evaluate the within origin diversity, for each site, in the first step, we used the Factorial Discriminant Analysis "with all variables" and pertinent variables were selected. In second step, we used Discriminant Canonic Functions with pertinent variables selected and determination of FUDs by k-Means clusters Analysis. Results showed that within Rich origin, four FUDs are identified and belong to different villages in the site. Each FUD belong to a seed producer partner and his neighboured farmers using the same FUD. The FUDs differ especially by their seed quality (which is related to seed storage conditions), forage winter quality, winter growth rate, steam size, and leaf area. These traits were consistent with traits used by farmers to distinguish their varieties. The analysis of agromorphological characterisation data within Demnate origin was consistent with three FUDs which belonged to different seed producers. The Demnate FUDs differed especially by seed quality, forage biomass, winter forage quality, plant height, leaflet area and leaf colour. Again,

these characters were consistent with farmers distinctive traits. To support the on-farm conservation of alfalfa different farmer's units of diversity should be conserved whether the FUDs are rare or common. The focus of conservation should be on the seed growers, who are maintaining the identity of their units of diversity. One recommendation is that for every identified farmer variety or farmer unity of diversity to work with a group of farmers neighbouring the main seed producer and support the development of small seed production units.

BIODIVERSITY IN AGROECOSYSTEMS: IMPORTANCE OF NON-CROP HABITATS

Boutin, C. (Canadian Wildlife Service, Environment Canada, Hull, Québec, Canada, K1A 0H3)
Bélanger, L. (Canadian Wildlife Service, Environment Canada, Sainte-Foy, Québec, Canada, G6V 3L8)

Almost 50% of the St.Lawrence/Great-Lakes lowlands (total 14.1 km^2) is devoted to agriculture. This is also the area where half the population of Canada lives. Consequently, the landscape is highly fragmented and non-crop habitats (woodlots, hedgerows, fencerows, small wetlands, old fields, etc.) have become increasingly rare and isolated. In addition, farming has intensified greatly during the last few decades, threatening further the quality of the remaining habitats interspersed among croplands. Yet little attention has been given to investigating the interface agriculture-urbanisation-wildlife and wildlife habitats in this region with a unique ecosystem, i.e., the mixed-wood forest. This paper will present first an overview of the landscape diversity and fragmentation, primarily of the St.Lawrence area, using satellite images and aerial photos. Second, the major changes in agriculture over several decades will be examined, from a dominance of dairy farming towards cash crop farming, and their impact in terms of the fragmentation process. We will also explore the most important causes related to agricultural activities that are responsible for the decline of non-crop habitats (quantity and quality), with particular emphasis on woodlots, hedgerows and wetlands. Finally, the importance of the different habitats as reservoir for plant species and other wildlife of conservation value will be demonstrated with several studies that were completed in the last decade in the study area. Some insight into conservation strategies that reconcile both the conservation of wildlife and its habitats with agronomic practices will be presented.

Céline Boutin, PhD
Chercheuse scientifique / Research Scientist
Environnement Canada
Service canadien de la faune
Centre national de la recherche faunique
100 Boul. Gamelin
Hull, Québec, Canada K1A 0H3

MAINTAINING PLANT GENETIC DIVERSITY IN AGROECOSYSTEMS

A. H. D. Brown[1] and T. Hodgkin[2]

1 Centre for Plant Biodiversity Research, CSIRO Plant Industry, Canberra, Australia
2 IPGRI, 00157 Maccarese, Rome, Italy

Holistic approaches to agrobiodiversity conservation and development rightly stress an ecosystem perspective that integrates human community betterment. However, while aware of genetic erosion and species endangerment, such approaches could assume that developing the agroecosystem more sustainably will almost automatically stall the loss of genetic diversity and maintain underutilized species. Indeed, some ask why track genetic diversity at all. This question is especially pertinent, given the increasing power of modern molecular technology to reveal our genetic heritage at its most detailed level. This paper seeks to clarify the task of conserving plant genetic diversity and suggest how we might monitor progress towards better conservation outcomes. Strategies must address both species that are cropped or harvested, and wild species that occur in the ecosystem. In several cases the wild species deserving particular attention are evolutionary relatives of crop species. Recent data on single nucleotide polymorphisms emphasise the extent of diversity at the gene level, and great differences between species. An increasing number of new estimates and their patterns of variation among farms and of changes in time confront the manager, so that crucial indicators can easily be swamped. The nature of population divergence is a key characteristic encompassing issues ranging from the recognition and naming of landraces, to the focus of farmer's selection criteria. We conclude that one cannot manage plant genetic diversity as an amorphous, undifferentiated quantity that will take care of itself, but as contained in adaptively diverging poulations that should be the focus of concern.

DIVERSITY AND FUNCTIONAL ROLE OF SOIL MACROFAUNA COMUNITIES IN BRAZILIAN NO-TILLAGE AGROECOSYSTEMS

George G. Brown*[1], Amarildo Pasini[2], Norton Polo Benito[2], Adriana Maria de Aquino[3] and Maria Elizabeth Fernandes Correia[3]

[1] Embrapa Soja; [2]Universidade Estadual de Londrina; [3]Embrapa Agrobiologia

No-tillage agroecosystems now occupy >13 million hectares in Brazil, mostly in the southern region and more recently also in the Cerrado. Compared with natural ecosystems, agroecosystems tend to have lower biomass and diversity of soil-dwelling invertebrates, that are generally dominated by a few groups that often reach very high density and frequently become pests. The use of no-tillage as opposed to conventional tillage practices, especially when combined with crop rotations and cover crops, can enhance soil macrofauna populations and their contribution to soil function, leading to a more balanced community composition. The soil macrofauna, i.e., organisms easily visible that live in the soil or on its surface for at least some part of their life cycle, includes invertebrates considered both as pests and/or as beneficial to the soil environment and plant production. Ants, termites, earthworms, pot-worms, beetles, grubs, pill-bugs, true bugs, cicadas, snails, millipedes, centipedes, crickets, wasps, pseudo-scorpions, spiders and various insect (especially moth and fly) larvae all form part of the soil macrofauna community. They include saprophagic organisms that act as decomposers and mineralizers, root and shoot-feeding organisms that directly affect plant growth, predators and necrophages that feed on other organisms, geophagous bio-turbators that burrow through the soil leaving their excrements on or under its surface, social insects that create nests and congregate in large numbers, and omnivorous organisms, that feed on many different substrates. The first results on soil macrofauna communities in Brazilian no-tillage systems are just becoming available and confirm that the diversity of macrofauna groups in no-tillage is significantly higher than in conventional systems, and that crop rotations tend to enhance the positive effects (depending on the succession). Millipedes, earthworms, arachnids, insect larvae and beetles tend to be far more abundant in no-till systems, while enchytraeids, ants and sometimes termites tend to be more abundant in conventional-till systems. The number of large (up to 3cm wide, average 1.5-2cm; up to >1m deep, average 20-30cm) scarab beetle-grub holes can be up to 10 times greater in no-till than conventional-till systems, showing the importance of these organisms for soil porosity and infiltration, especially under heavy rain-showers. These preliminary results highlight the importance of these organisms in soil function, of agroecosystem management practices on their communities and the role of adequate decision-making, in achieving a more balanced soil fauna community composition, thus enhancing its potential benefits to soil fertility, crop production and sustainability.

*Presenter's address:
George G. Brown
Embrapa Soja
C.P. 231
Londrina, PR
86001-970, Brazil
browng@cnpso.embrapa.br

MANAGEMENT AND CONSERVATION OF BIODIVERSITY IN AGRICULTURE ECOSYSTEM IN SATPUDA MOUNTAIN REGION OF MAHARASHTRA STATE - INDIA.

Mr. LALITKUMAR P. CHAUDHARI,
VICE PRESIDENT, Institute for sustainable development & research ,
N-1-8, Narayan pujari nagar, WORLI, BOMBAY, 400018. INDIA.

India is a predominately an agricultural country. More than 80% of its population lives in villages and about 70% of them depends on the agriculture and forestry .Agriculture and forestry contributes about 40% to the Gross Domestic product .Therefore any significant transformation of the national economy and people cannot be conceived with out the transformation of both,the agriculture and forestry sector as the considerable forest region is falls under agriculture ecosystem. It is possible to achieve it through the application of science and technology for improvement of agriculture and forestry using biodiversity conservation and management in the local region.

Satpuda is a hilly/mountain region in the Maharashtra state located in central part of India which is now facing the problems of loss of biodiversity in past years either due to over use of natural resources or due to change in the environmental conditions .The loss of biodiversity in this area is affecting the traditional and also modern agriculture systems. There is also one major aspect of this loss of biodiversity, which is loss of the surrounding ecosystem .Due to loss of biodiversity, there are changes in the ecosystem causing adverse impact not only on the agriculture but also on the environment, depletion in natural resources etc . The NGOs in this region has taken a considerable efforts to conserve and manage the biodiversity in this region.The NGO forum is helping the farmers in understanding the role of biodiversity and ecosystem in agriculture, its importance and the methods for conserving and managing the same. This paper deals with the role of different aspects of biodiversity conservation such as agricultural and forest species, social forestry etc. in recent years. It also discusses the causes of the loss of biodiversity in this region, its effect on the socio-economic condition of the region and the past effort to conserve the biodiversity so as to avoid the environmental impacts.

The paper also discusses the role of NGOs and the local people in conserving and managing the agriculture biodiversity for their socio-economic development . It also emphasizes the need for extensive capacity building for assessment and conserving the agriculture biodiversity in the Satpuda mountain region using the public participation for maintaining the ecological and environmental balance in this region.

ENHANCING CONSERVATION AND USE OF AGROBIODIVERSITY ON-FARM THROUGH PUBLIC AWARENESS

P Chaudhary[1], DK Rijal[1], RB Rana[1], D Pandey[2], SP Khatiwada[2], D Gauchan[2], RB Yadav[2], MP Upadhyay[2], A Subedi[1], DI Jarvis 3 and BR Sthapit[4]

[1] Local Initiatives for Biodiversity, Research and Development (LI-BIRD), PO Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: libird@wlink.com.np

[2] Agricultural Botany Division, Nepal Agricultural Research Council, Nepal

[3] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy d.Jarvis@cgiar.org

[4] International Plant Genetic Resources Institute, APO, Malaysia, e-mail: b.sthapit@cgiar.org

Public awareness is an initial foundation for community sensitization and increased effective participation of farming communities in agro-biodiversity conservation on-farm. Different kinds of public awareness methods ranging from personal contact, group, participatory approach to mass media were used in the project. The methods have been found useful to bring about substantial positive changes in the attitude and behavior of community, contributing to the strengthening of *in situ* conservation of agro-biodiversity on-farm and their use. Farmers have started valuing their local crop diversities and importance of traditional seed supply network system has been reinforced. This paper intends to present few important public awareness methods applied in the project and their implication for change in community behaviour, with illustrations of indicators of awareness. Diversity fair, rural poetry journey, rural drama, folk song competition, and exchange visit were found a few successful methods of public awareness and community sensitization. The finding is based on the general observation and day to day interaction among local level staff, farmers and community-based organisations. Focus group discussions and individual interactions with other farmers were also employed to generate relevant information.

THE IMPACT OF RECOVERING THE *MESOAMERICAN MILPA* IN CENTRAL MEXICO

Chávez M., Ma. C., Arriaga J., Pérez E., Astier M., Chávez I., and Masera O.

ABSTRACT

Mexico is a mountainous country (75% of its territory), where agricultural production, carried out in 30 million ha, covers a wide range of systems. The highlands of Central Mexico (altitudes above 1800 m between 18º and 22º N) concentrate a large proportion of the population of the country and agricultural production in this area is characterised by smallholder *campesino* (peasant) agriculture. Agricultural policies and cultural conditions have determined agrodiversity.

Management of agrodiversity is reflected on landscape. In Central Mexico the variables that affect agrodiversity are physical (type of soil, weather conditions, stepness), and social ones (traditions, market, availability of labour, land tenure and *campesino*´s experiments).

The objective of this paper is to show the impact of recovering *mesoamerican milpa* in three indigenous communities of Central Mexico. The impact on organizational agrodiversity and landscape.

Agrodiversity research projects have been carried out in three indigenous communities in the mountains of Central Mexico. One objective of the projects is to recover the *mesoamerican milpa* through the establishment of demostration sites.

Campesinos are encouraged to recover the intercropping pattern in all of their fields. People have designed some strategies to use their local resources. For example, how much seed of certain specie has to be sown when (to obtain good yields and in some cases to get good price in the market), where to establish the crop and what cropping system to practice.

Some of the results are that *campesinos* harvest more products for family consumption, increase biodiversity, obtain products for the local market and intensify the use of their resources.

AGRICULTURAL DIVERSITY PRESERVED *IN SITU* BY SHIPIBO-CONIBO AND ASHANINCA GROUPS FROM AMAZONIAN PERUVIAN

Luis Collado-Panduro [1] Maria Arroyo-Jumpa [2], Jose Luis Chavez-Servia [3], and Alfredo Riesco-de la Vega [2]

[1] Universidad Nacional de la Selva – Tingo Maria (Peru)
[2] Consorcio para el Desarrollo Sostenible de Ucayali (CODESU) -- Peru
[3] International Plant Genetic Resources Institute (IPGRI-Americas) --

ABSTRACT

The amazon region is a zone with the highest genetic diversity in Peru, which is occupied by indigenous people belong to Shipibo-Conibo, Ashaninca, and mestizos farmer field groups. It was divided into three regions on base to economic activity, access to market (river or minor road) and indigenous communities who maintain the diversity of maize, beans, peanuts, chili pepper and cassava. The alluvial soil, replenished every year by floods, are highly fertile where the farmers have implemented different land forms in small areas; three located within the floodplain known as *barreal* or mudflat, *restinga* or natural levee, and *aguajal* or backswamp. A research was conducted with the objective of elucidate which diversity cultivated on farm and that agroecological, economic, social, cultural, and genetic aspect determine its conservation *in situ* by two ethnic groups from Amazon Peruvian. The basic unit in the village (100 to 1000 people) is made up by house sheltering nuclear families. The annual flood change affect to agricultural land-forms practiced by indigenous farmer. However the access to capital or capital sources, wage-labor opportunities, and transport change frequently affect directly to families which also continuously is changing their size, needs, preferences and obligations. Each change in any of these factors affect to household in its decisions on what and where to plant, and how modify the field manage, in some cases the families lost their crops due to floods. The diversity preserved by the Shipibo-Conibo, Ashaninca and mestizos groups have requested incorporate its own knowledge and experience according to landforms and crop cycle. In the *barreal* or *aguaral* are planted short-term crops as *Phaseolus* spp. landraces as “Huascaporoto”, “Frejol de Palo”, “Ucayalino”, “Pindayo”, “Vacapaleta” or peanuts landraces (*Arachis spp.*), “Rojo Masisea”. In fertile soils (*restingas*) maize (*Zea mays*) – Cuban yellow and Piricinco races –, cassava (*Manihot spp.*) Amarilla, Maria Bonita, Señorita, Morada, and “Añera”. Chili pepper indigenous preserved are “Charapita”, “Pucunoucho”, “Pico de Mono” and “Dulce”.(*Capsicum chinense* and *C. annuum*).

CROP DIVERSITY IN INDIGENOUS FARMING SYSTEMS OF AMAZONIA: THE ROLE AND DYNAMICS OF AGRICULTURAL PLANTING STOCK TRANSFERS AMONG TRADITIONAL FARMERS

Dr. Oliver T. Coomes
Associate Professor
Dept. of Geography
McGill University
805 Sherbrooke St. West
Montreal, PQ
Canada
H3A 2K6
E-mail: coomes@felix.geog.mcgill.ca

Recent studies of indigenous farming systems in Amazonia point to remarkable agrobiodiversity *in situ*, but overlook a key contributing factor – the availability and exchange of crop planting material (e.g., seeds, suckers, cuttings, etc.) among traditional farmers. This paper reports on research over the past five years on the nature and origins of crop diversity across and within traditional communities of river people (*ribereños*) in the Peruvian Amazon. Extensive networks of informal exchange in agricultural planting stock are identified that facilitate the regional/local re-distribution of plant germplasm, especially for vegetatively propagating cultivars, between upland ('source') areas and the seasonally inundated floodplains ('sinks'). Differential access to planting stock is found to be a key factor in the building and maintenance of agrobiodiversity among traditional communities, for subsistence security among lowland farmers, and for market specialization among farmers near urban centres in the upper Amazon. Findings point to the urgent need for a systematic assessment of the geographic and socio-cultural patterns of crop/varietal diversity in Amazonia with particular attention to the transmission of planting stock through informal networks in the basin. Implications are discussed for agrobiodiversity conservation and agricultural development in rural Amazonia.

TRADITIONAL PEASANT´S *IN SITU* CONSERVATION OF NATIVE POTATOES (*SOLANUM SPP*) IN RAGRACANCHA, HIGHLANDS OF HUANUCO, PERU.

Gisella S. Cruz
***In Situ* Project: Conservation of the native crops and its wild relatives. Programa de las Naciones Unidas para el Desarrollo. PNUD-IIAP- CCTA-IDMA Huánuco**
Jr. Piura 1071 Miraflores – Lima – Perú
Telef. (511-4460960)
E-mail: iiap@amauta.rcp.net.pe
gisellacruz@yahoo.com

Ragracancha (3250 – 4200 mosl.), a small micro watershed, has a great diversity of native potatoes with an important knowledge inherited by many generations ago, that permitted its conservation until now. Peasants have cultivated potatoes from more than seven hundred years, as an answer to the environmental diversity, which characterize the Andean Mountains.

Working with 19 families it was possible to register 277 different potato local names, related to tuber morphology (72%), origin (8 %), level of productivity (6%), legends (5 %), texture (3%), uses (3%) and flavor (3%). Traditional classification includes characters as color, flesh quality, altitude adaptation and, specially, the potential uses for nutrition. From a 99 tuber sample, 75 had high dry matter content and 24 had low dry matter content (aguachentas). A classification in 12 groups and 25 subgroups was proposed.

The peasant’s main concern however is the tuber’s use, so they differentiate them in four main groups: to be fried, to be fermented (‘tocosh’), to be used as dry potatoes and also to be transformed in dehydrates potatoes (‘chuño’) using the night low temperature. Therefore, the 63% of the families we worked with (N=19) have more than eighty different morphotypes of native potatoes.

The most important traditional techniques of production are: the different varieties mixed sowing, the sectorial fallow system, the organic fertilization (‘guaneo’, ‘estercoleo’, ‘ushpa’) and the ‘chiwi’ sowing.

It is necessary to emphasize the importance of the women role considering them as a fertility symbol. In this way, women are dedicated to select the tubers before sowing, to put them into the soil and to select them at the harvest. They know better the characteristics of the native potatoes varieties and have the greater knowledge about their diverse nutritional uses.

Nevertheless, there are problems on cultural and genetic erosion, probably caused by the absence of knowledge about the nutritional value of the native crops, the introduction of food products from the big cities, the lost of the youth’s interest in the conservation and the low prices paid for this kind of crops. It is badly needed in the region to value our richness in agrobiodiversity and traditional knowledge, and suggest new policies and educational programs in this issue.

MANAGING BIODIVERSITY IN CROPPING SYSTEMS: THE CASE OF SYMBIOTIC AND NON-SYMBIOTIC MICROBES AND THEIR ASSOCIATED HOST PLANTS

Felix D. Dakora
Botany Department, University of Cape Town
Private Bag, Rondebosch 7701, South Africa
Telephone: 27-21 650 2964
Fax: 27-21-650 4041
e-mail: <dakora@botzoo.uct.ac.za>

ABSTRACT

Microbes are a major component of biodiversity in cropping systems, and can increase grain yields through their mutualistic and symbiotic interactions with host plants, or reduce crop productivity via their pathogenic effects on plant growth. Mixed intercropping of legumes, cereals, tuber crops and vegetables, which is the mainstay of traditional agriculture in the tropics, allows for greater exploitation of symbiotic microbes and/or better control of microbial pathogens for higher yields. While farmers have historically exploited N_2 fixation in legumes for increased grain yields via the practice of crop rotation, other benefits of biodiversity in cropping systems have remained unknown in crop production. In addition to N_2 fixation, rhizobia (species of soil bacteria belonging to *Rhizobium, Bradyrhizobium, Allorhizobium, Sinorhizobium* and *Mesorhizobium*) produce chemical molecules that promote plant growth. These bacterial metabolites include phytohormones, lipo-chito-oligossacharide Nod factors, lumichrome, riboflavin and H_2 molecules that collectively or individually affect biodiversity in the cropping system. Nod factors, for example, stimulate seed germination, promote plant growth and increase grain yields in legume and non-legume crops. Recent field reports show that these increases in yields is due to increased photosythesynthetic rates in a wide range of crop species including corn, rice, common bean, canola, apple and grape plants. Lumichrome also stimulates plant growth and increases biomass in corn, sorghum, soybean and cowpea under glasshouse conditions, thus suggesting that its release into cropping systems can potentially enhance growth and possibly yields of plant biodiversity in the ecosystem. H_2 gas, which is a byproduct of N_2 fixation by rhizobia in symbiotic legumes, is also known to stimulate biomass accumulation in soybean, wheat, barley, and canola, as well as increase tillering, head number and grain yields of field-grown wheat and barley. Recent evidence also shows that rhizobia occur as natural endophytes of non-legume plants such as rice, corn, wheat and canola. Eventhough they do not fix N_2 in these hosts, they are able to significantly promote rice grain yields with optimal N fertilization. Additionally, rhizobia can suppress soil pathogen populations, and thus contribute to plant health in natural and agricultural ecosystems. The legume itself releases phenolics that suppress pathogens, solubilize nutrients, and promote growth of mutualistic microbes, in addition to forming nodule symbioses with rhizobia. Phytosiderophores and organic acids exuded by the host plant further enhance mineral nutrition in the cultural system. The biodiversity components of a cropping system, which includes cereals, vegetables and legume species, also emit green leaf volatiles as defense signals against insect attack. In so doing, some components of the biodiversity help control insect pests in mixed plant cultures. This paper provides new insights into how management of microbial biodiversity and the associated host plants can enhance productivity in natural and agricultural ecosystems.

THE CULTIVATED YAMS (DIOSCOREA CAYENENSIS / DIOSCOREA ROTUNDATA COMPLEX) AND THEIR WILD RELATIVES IN BENIN REPUBLIC : DIVERSITY, EVOLUTIONARY DYNAMIC AND IN SITU CONSERVATION.

A. Dansi[1,2], H. Adoukonou [1,2], K. Moutaïrou[3], O. Daïnou[1] & P. Sessou[3]

[1] *Genetic Laboratory, National university of Benin, FAST, BP 526 Cotonou, Republic of Benin*
[2] Crop, Aromatic and Medicinal plant biodiversity Research and Development Institute (IRDCAM): 071 BP 28, Cotonou, Republic of Benin
[3] Biochemistry and cellular Biology Department, FAST, BP 526 Cotonou, Republic of Benin

ABSTRACT

Yam (*Dioscorea sp.)* occupy in Benin Republic, a pre-eminent position as food crops, next only to cereals and grain legumes. Among the diverse species cultivated, *D. cayenensis / D. rotundata* complex remains the most important, the most preferred and widely planted. In order to assess the diversity of the landraces maintained by farmers, to understand how farmers manage that diversity and to document the indigenous knowledge related to the diverse varieties, 70 villages distributed in 18 districts of 13 ethnic zones were surveyed. The number of varieties produced per village (10 to 45) and per farmer (2 to 12) is function of the ethnic zones. An important polymorphism of varietal name (about 300 in total) is observed; each village seems to have its series of vernacular (generic or specific) names. Origin, morphological traits, agronomic characteristics, cooking qualities, market value and medicinal proprieties are the criteria used by farmers for distinguishing and naming landraces. In the different production zones, factors influencing farmers varieties choice and the level of the diversity maintained are either social, cultural, economic, abiotic (edaphic, precipitation regimes) or biotic (pests and diseases). Using both morphological and isozyme analysis, 560 landraces accessions collected along with the surveys were characterised and classified into 26 cultivar groups, 90 morphotypes and 227 clones. Based on the geographical distribution of the clones, two centres of diversity were identified. The disappearance of some varieties (genetic erosion) has been reported. To overcome this erosion mainly due to biotic and economic factors and to broaden the existing genetic diversity, new genotypes are acquired by farmers through introductions from bordering countries or created through the domestication process. The domestication process consists of bringing into cultivation selected individuals which go through intense vegetative multiplication and selection procedure (over a lengthy but variable period of time) that induce morphological and biochemical change in the plant mainly at the tuber level. Selection criteria used by farmers during the domestication process are related to morphological traits, cooking qualities, agronomic characteristics and yield component. Surveys data coupled with morphological and isozyme analysis of 68 newly domesticated yams have shown that tubers collected in the bush and used in the domestication process are either from wild related species (*D. abyssinica, D. praehensilis, D. burkilliana*), weedy forms (diverse hybrids) or from existing landraces that turned to wild. The dynamic co-evolution between wild and cultivated forms hence point up has lead to the conclusion that in term of conservation, cultivated forms can not be separated from the wild ones. Yam species richness and density comparison of six of the national natural reserves allowed the selection of Ouémé-Supérieur and Ouénou-Bonou savannah zones in the north and Toui-Kilibo forest zone in the centre as genetic reserve for *in situ* conservation of natural populations of wild yam species. Complementary studies needed for the sustainable conservation of the genetic diversity of this crop and its wild relatives in the ecosystems where they have been generated are exposed.

COMMUNITY DIVERSITY FAIR: AN EFFECTIVE WAY FOR UNDERSTANDING OF LOCAL DIVERSITY MANAGEMENT

Nguyen Ngoc De[1] and Vo Minh Hai[2]

[1] Site coordinator, In situ conservation project, Mekong Delta Farming Systems Research and Development Institute, Cantho University, Vietnam

[2] Field staff, In situ conservation project, Mekong Delta Farming Systems Research and Development Institute, Cantho University, Vietnam

ABSTRACT

A community diversity fair was conducted in Dai An village, Tra Cu district, Tra Vinh Province of the Mekong Delta, Vietnam to raise farmers' awareness of local plant genetics resources. This included raising awareness of the importance and role genetic resources in crop improvement and sustainable agricultural development and promoting an understanding of genetic diversity at community level. The fair was organized with two major activities: (1) the display of all materials collected by group members with full description of the main identification characteristics of each variety and (2) the farmer groups' contest on farmers' knowledge about local genetic resources, farmers' perception on the importance of local crop diversity, genetic erosion and its reasons and farmers' viewpoints on conservation and development needs. The information from community diversity fair revealed the number of varieties of each major crop being grown by individual farmers. Farmers could easily identify and recognize well the major characteristics of local varieties. In addition, they explained how to grow and conserve them in local conditions. Results showed that is was more difficult for farmers to explain or know the origin of the different varieties; knowledge was commonly about the year the variety was first planted, but the first grower(s)or the source person on the variety was commonly unknown. Farmers' knowledge on crop diversity and the necessity of crop diversity conservation and development were clearly acknowledged by most farmers. Genetic erosion and its reasons were also recognized by local farmers. Through diversity fair, all genetic materials displayed were collected for *ex situ* conservation, seed multiplication of favorable varieties, and exchange with other communities to increase local diversity. Diversity fairs were shown to be more effective that village surveys for data collection of crop diversity in the community. Results also indicated that precision of information was positively correlated with the level of farmers' participation.

THE POTENTIAL CONTRIBUTION OF BIODIVERSITY IN FOOD SECURITY AND POVERTY REDUCTION IN WEST AFRICA: ADOPTION OF IMPROVED VARIETIES OF FOOD CROPS BY SMALL FARMERS

Mrs. IGUE DJINADOU Alice

ABSTRACT

Biodiversity can play a critical role in ensuring food security and substantial incomes for small farmers in West Africa. Intercropping and the use of different plant species have sustained food demand for decades, but with increasing population and stagnant food production the per capita food production has been decreasing in most of the West African countries. The consequences of decreasing per capita food production are seasonal food insecurity, child malnutrition and rampant poverty. The chief constraints to increase in food production are high risks of crop failure linked to fluctuating rainfalls with drought pockets, pest and diseases and the wide spread use of low yielding local cultivars. Biodiversity would contribute to the decrease of farm risk and hence food security and poverty reduction through the diffusion and adoption of improved food crop varieties by small farmers. Among the food crop varities to be widely diffused and adopted by small farmers are early maturing and drought escape cereal and leguminous varities, pest and disease tolerant and resistant varieties which may decrease crop losses, high yielding cereal and leguminous varieties which can increase food production and leguminous species used in agroforestry systems aimed to sustain and increase the soil fertility. The diffusion of high quality seeds and pest resistant varieties can also increase the market value of crops and hence generate more incomes for farmers. The contribution of biodiversity through the development, diffusion and adoption of cereal and leguminous varieties will require a motivationg policy and institutional environment which includes access to reliable input and output markets and mainly seed supply, a sound and participatory coordination between research, extension and farmers. The committment of government, NGOs, private business, farmers and other stakeholders will be an incentive for a sustained contribution of biodiversity to food security and poverty reduction in West Africa.

WHAT DO WE NEED TO CONSERVE IN AGRICULTURAL LANDSCAPES AND WHAT IS POSSIBLE? CONSERVATION FARMING IN BIODIVERSITY HOTSPOTS IN SOUTH AFRICA

John Donaldson
National Botanical Institute, Cape Town, South Africa

South Africa contains a remarkable richness of plant and animal species. Although the country comprises less than 0.8% of the total land area of the world, it contains ca. 8% of the worlds vascular flora, as well as between 2% and 7% of the world's amphibian, reptile, bird and mammal species. Poorly known groups such as insects and fungi are probably equally rich in species.

Despite a reserve network that covers ca. 6% of the land area, a significant proportion of South Africa's biological diversity (especially plants and invertebrates) exists only outside reserves, mainly in agricultural landscapes. Managing biodiversity in agricultural landscapes is therefore critical for the conservation of biodiversity and the GEF has funded a study focusing on four biodiversity hotspots in this region. Our studies examine patterns of biodiversity in relation to current and historical landuse, we evaluate the processes that impact on elements of biodiversity and we predict the probability of extinction under different scenarios, we identify key ecosystem services and how they are related to biodiversity (including carbon sequestration), we put an economic value on biodiversity and ecosystem services, and we examine the sociological context in which novel ideas for managing biodiversity will spread through farming communities. The data that are emerging from this study show that even farmers who are ecologically aware often cannot implement practices that conserve a wide range of biodiversity because of economic constraints. It is therefore important to determine which elements of biodiversity should be conserved in agricultural landscapes and to identify economically viable farming practices that will contribute significantly to biodiversity conservation.

ON-FARM MANAGEMENT AND CONSERVATION OF CROP GENETIC DIVERSITY *IN SITU* BY WOMEN IN BURKINA FASO."

Bernadette Dossou[1], Didier Balma[2], Mahamadou Sawadogo[2], Devra Jarvis[3]

[1] IPGRI West and Central Africa c/o IITA/Benin Research Station, 08 BP 0932 Cotonou, Benin
[2] Institute de L'Environnement et Recherches Agricoles (INERA) 01 BP 476, Ouagadougou, Burkina Faso
[3] IPGRI, Via dei Tre Denari, 472/a, 00057 Maccarese (Fiumicino) Rome, Italy

ABSTRACT

Gender differences in on-farm management and conservation of crop genetic resources *in situ* was evaluated in Burkina Faso. 109 women and 48 men (Mossi, Bixa, Samo, Peuhl) from four villages (Médéga, Ouahigouya,Gourga, Pobè Mengao) were surveyed through individual and focus group interviews. Surveys were complemented through direct observations of activities in fields, granaries, markets, and places for processing. The women contribute to *in situ* conservation of crop diversity at various stages and levels of on-farm management and decision-making. In all villages, more than 70% of the women's time was devoted to on farm activities. In addition, 30 to 45% of ploughing, 95% of seeding, 40% of the weeding, 45% of the transportation of the harvest, 90% of the husking and 80% of the work for storing crop is performed by women. In some regions, according to their age and social rank, women intervene equally in the selection, distribution, exchange and storage of crop varieties in the village and neighbouring areas. Women are the main actors in the processing of grain to other food and fodder products as more than 95% of the harvest is processed by women. Retail marketing of local varieties was found to be done almost entirely by women while wholesale marketing was conducted by both by men and women. Women interviewed we well informed on the use of local materials to ensure healthy storage of grains. Women, especially Bixa people of Médéga, were found to play an important role in deciding on the selection of varieties to be planted for sorghum, pearl millet, ground nut and cowpea. For okra, considered a "female crop", women are entirely responsible for the selection, maintenance, and exchange of varieties. In contrasts for frafra potato (Solensteum sp.) seeds are selected by men exclusively. The management of crop diversity on-farm by women of Burkina Faso is also governed by social-cultural and traditional demands. Women may be restricted from seed management during menstration or seed selection maybe performed only by older women. Understanding who is responsible for the different activities involved in the management of crop diversity on-farm allows targeted support to the appropriate gender and age group.

THE IMPORTANCE OF THE MACROTERMES GENUS (ISOPTERA : MACROTERMITINAE) FOR TROPICAL AGRICULTURE OF SEMI-ARID REGION : THE POINT OF VIEW OF NORTH-CAMEROON'S FARMERS

Duboisset A., Garnier-Sillam, E. & Seignobos, C.
Université Paris XII LBSE
av Gal de Gaulle
94010 Créteil
Tel. : (33) 01 45 17 14 64
Fax (33) 01 45 17 19 99
Mail : duboisset@univ-paris12.fr

ABSTRACT

Contradictory results deal with the importance of the mound build by Macrotermes for tropical agriculture. Agronomic studies present this genus as a major tropical pest for maize, yams and sugar cane crops. On the contrary, pedological and ecological studies emphasize on their significant role on the regulation of ecosystem processes and on the establishment of soil fertility status. This work aims at studying the farmer's point of view and the agricultural practices concerning the nest of Macrotermes. In the Fali region of the North-Cameroon, farmers cultivate systematically the peripheral zone of the mound with maize or sorghum crops associated with okra (Hibiscus esculentus) and cucurbitaceae, even if the mound is located on groundnuts, rice or coton field. The production of cereal obtained around each mound reaches 18.5 kg grain maize or 51.6 kg grain sorghum on a 46.8 m2 peripheral fertile zone (n= 197 mounds). Although this zone concern 3.5 % of all the cultivated area, its yield represents 18-20 % of the total cereal production (n= 28 farmers). Farmers protect these mounds and prefer to cultivate around it rather than use as a soil amendment or destroy and level it. The fertility of these mounds is therefore used to reduce agricultural risk and provide a stock of cereal with a minimum time consuming labor. These results clearly emphasizes on the need to investigate traditional knowledge and practices in order to improve the managment of soil fauna in tropical farming system.

THE PLIGHT OF THE BEE, IN SOUTH AFRICAN SEMI-DESERTS

Connal Eardley
Agricultural Research Council-Plant Protection Research Institute, Private Bag X134, Pretoria, 0001, Pretoria, South Africa. vrehcde@plant5.agric.za

ABSTRACT

South Africa's semi-deserts are renown for their floral diversity, which is amongst the greatest per unit area in the world. Consequently they are priority conservation areas. Much of these semi-arid regions are pastoral agricultural land, and grazing pressure has impacted on the vegetation. The change caused by early stock farming was not documented, but since 1936 floral surveys have been conducted and the results published. The predominant pasture in these areas comprises indigenous insect pollinated plants, and bees are among the most important pollinators. However, they are comparably poorly known and knowledge of their host plant specificity is scant. Agriculture is known to affect bee abundance and diversity, and the changes are still not being documented. In disturbed areas bees with a wide range of host plants are common, and those that visit only a few closely related plant species are largely absent. It appears unlikely that plants and bees with narrow pollinator-host plant requirements will re-colonize areas from which they have been lost. Therefore, the South African semi-deserts should be managed to conserve the regions biodiversity. But without an appreciation for pollination as an essential ecosystem services and basic research on pollinator biodiversity, the world riches ecosystems will be lost, and this without knowledge of what was lost.

LINKAGES BETWEEN BIODIVERSITY AND POVERTY: A CONCEPT PAPER

Eltighani M. Elamin and El Hag H. Abu elgasim

Conservation of biodiversity takes place largely in landscapes that are managed for farming and pastoralism. Biodiversity provides not only food and income but also raw materials for clothing, shelter, and medicines. Biodiversity also breeds new varieties of agricultural crops and animals. In addition, it performs other services such as maintenance of soil fertility and biota, and soil and water conservation. All of these biodiversity provisions are essential to human survival.

Rural people use and manage biodiversity in developing their livelihoods. Through generations of innovation and experimentation, they have nurtured diversity of plants and animals, either wild or domesticated, and accumulated rich knowledge on biodiversity management. The process of learning, experimentation and innovation continues throughout the developing world. Much has been written on loss of managed biodiversity under threats from commercial and intensified production. But only limited work has been done on how farm households mange their resources so as to sustain and enhance them. To develop practices and system for sustaining managed biodiversity in Sudan, this research work has been motivated by a threefold primary objective.

1) What are the principal mechanisms (frameworks) within which farmers select and or manage biodiversity at all levels, agro-ecosystems, species and genetic diversity.
2) What are key factors that make some biodiversity-rich farming practices profitable and productive in a market economy? Can these practices sustain food security in the future?
3) What are the challenges those efforts to sustain farmers' management of biodiversity will have to meet, nationally and internationally?

In order to grasp firmly these objectives the current paper has critically examined the functional relationships between the states of biodiversity as related to poverty and its consequences. More specifically, this research paper examines two operational arguments (hypotheses) working on opposite direction. The first hypothesis states that "areas with rich biodiversity supports better livelihood and hence low poverty levels". The second hypothesis states the opposite that "areas with low biodiversity are originally areas with high poverty". The second hypothesis therefore, attributes the deterioration on biodiversity to the socioeconomic behaviors of basically poor farm households, perhaps have been subjected to market economy effects. These two arguments can be stated mathematically as follows:

$$POV = f\,(BVD, \text{other socioeconomics}) \text{ first hypothesis} \qquad (1)$$
$$BDV = f\,(POV, \text{Other socioeconomics}) \text{ second hypothesis} \qquad (2)$$

POV represents a set of poverty indices and BDV a number of biodiversity variables. These two equations are estimated, each as single equation, using Hechman method, because of the discrete variables involved. The two equations are also estimated as growth trends in biodiversity and poverty indices, using a log linear specification on discrete variables. Other socioeconomic continuous variables are also added to the right hand-side terms of each equation. The indices of poverty are the depth and severity variables while those of biodiversity include 1) Range and pasture, 2) Livestock, 3) Forestry, and 4) Agricultural biodiversity, and 5) Biotechnology and biosafety.

The P-alpha measures are used to estimate the indexes of depth and severity of poverty using data from inter and intra household surveys designed and conducted by the author for CARE_INT in Sudan, during the period 1994-2000, in Kordofan region. Indices of biodiversity are imputed from the Sudan Country Study on Biodiversity carried out by the UNDP in 2000. This research study is carried out in Kordofan region, with an official estimate of more than 90% of population is below the poverty line. Its anticipated results are to determine the biodiversity linkages to poverty and accordingly advise in designing poverty alleviation programmes based on biodiversity dimensions for inherently agrarian communities whose livelihoods are totally dependent on farming.

GENETIC EROSION QUANTIFICATION IN ULLUCUS (*ULLUCUS TUBEROSUS* CALDAS), OCA (*OXALIS TUBEROSA* MOL.) AND MASHUA (*TROPAEOLUM TUBEROSUM* R.&P.) IN AGROECOSYSTEMS OF THE PROVINCES OF CAÑAR, CHIMBORAZO AND TUNGURAHUA – ECUADOR

César Tapia B.; Agronomist; M.Sc.♣
Jaime Estrella E.; Agronomist; Ph.D. ♣

ABSTRACT

An alarming loss of genetic variability of three Andean tubers (*Ullucus tuberosus,* ullucus; *Oxalis tuberosa*, oca; and, *Tropaeolum tuberosum,* mashua) has been observed during the last decades due to many factors such us the introduction of new varieties, droughts, changes in food habits, encroaching agriculture, deforestation and the migration from rural to urban areas. Thus, a pilot study was carried out to determine levels and rates of genetic erosion in these Andean crops by means of both morphological and molecular characterisations of these species, as well as a socioeconomical survey in highland communities from the provinces of Cañar, Chimborazo and Tungurahua (Ecuador).

The present study included a field and laboratory stage. For the field stage, tubers from the three species were collected and identified with the code *CEG* (=cuantificación erosión genética). The resulting germplasm was comparatively analysed with *ex situ* conserved accessions (coded *ECU*) since 1978 by the National Department of Plant Genetic Resources and Biotechnology (DENAREF, the national germplasm bank); to this purpose, the descriptors tuber main colour, secondary colour and tuber shape were recorded. All available information included in the *ECUCOL* passport database and the *Catalogue of Genetic Resources of Andean Root and Tuber Crops* (Tapia *et al*., 1996) was also used. Furthermore, information of a total of 64 socio-economical questionnaires (30 in Cañar, 24 in Chimborazo and 10 in Tunguraha) was compiled and analysed so as to confirm (or reject) the occurrence of genetic erosion in the three tuberous species.

For statistical analysis of the socio-economic survey four parameters were taken into account: farmers no longer cultivating the species, reasons for abandoning the crop, morphotypes no longer cultivated and morphotypes that have been recently lost at the collecting localities compared with those described in the *ECUCOL* passport database.

Ullucus showed an average loss of variability of 37,6%. Regarding provinces, Cañar exhibited the highest level of genetic erosion with an average value of 45,5%. Oca accounted an average of 33,3%, being Tungurahua the province reaching the highest level of erosion (47,7%). An average value of 46,5% loss of variability was determined for mashua, with Cañar as the province revealing the highest percentage (61,1%).

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♣ Authors. **Contact address:** Departamento Nacional de Recursos Fitogenéticos y Biotecnología (DENAREF) del INIAP (Instituto Nacional Autónomo de Investigaciones Agropecuarias). *Santa Catalina* Experimental Station. Panamericana Sur km 14, Quito - Ecuador. P.O. Box 17-01-340. Telephone/fax: (593 2) 2 693359. E-mail: denaref@ecnet.ec. Internet: www.denaref.org.

The laboratory stage used the RAPD technique (Randomly Amplified Polymorphic DNA) to compare *ECU* and *CEG* accessions on the basis of molecular polymorphisms revealing genetic relationships between *on-farm* conserved materials and *ex situ* accessions from the germplasm bank. DNAs from the three species under study were amplified with primers of arbitrary sequence; of these, seven, 10 and 12 primers rendered polymorphic products for ullucus, oca and mashua, respectively. All DNA amplifications generated consistently a larger number of RAPD polymorphic fragments in the *CEG* accessions (compared to *ECU* materials) of the three species. Therefore, new RAPD alleles have been generated in the genomes under study (possibly due to nucleotide substitution, deletions, insertions, inversions, etc.) in the period of time elapsed between the original collecting and the one carried for this study (~20 years), discarding the occurrence of partial mismatching and PCR artifacts such as "ghost" bands.

The binary matrices obtained after molecular survey of the three species were phenetically analysed using both Neighbour-Joining (NJ) and UPGMA techniques with Jaccard's coefficient. In addition, a phylogenetic approach (parsimony) was used, taking into account time elapsed. These three methodologies rendered dendrograms which classified *ECU* and *CEG* accessions of each crop as closely related, "semi"– related or distant genetically.

For final interpretation of the laboratory data, attention was focused on the results and dendrograms generated by the NJ technique since it considers analysis of genetic relatedness with different mutation rates along the plant genome (time elapsed). In this framework, ullucus showed seven accessions (i.e. morphotypes) which have undergone genetic erosion (25%, out of a total of 28 *ECU* materials), seven accessions with no genetic erosion occurrence and 14 accessions which have undergone germplasm flow (i.e. man-made dispersal from one community to another). Oca showed 11 accessions which have undergone erosion (45,8% out of a total of 24 *ECU* accessions) and 13 accessions with germplasm flow. Mashua exhibited 10 cases of genetic erosion (43,4% out of 24 accessions studied), whereas two accessions displayed no erosion and two cases were recorded as germplasm flow.

In terms of species, mashua reached the highest levels of genetic erosion: 45% average value for both field and laboratory stages. On the other hand, Cañar is the province with the highest loss of variability for the three species with an average of 46,4% taking into account data from the socio-economical survey, morphological characterisation and the *ECUCOL* data base.

Finally, detection of a larger number of RAPD fragments on all *on farm*- conserved materials (= *CEG* accessions) in comparison with *ex situ* materials (= *ECU* accessions) confirms the nature of *in situ* conservation, i. e. a complementary methodology to *ex situ* techniques which allows continuation of evolutionary processes, natural and man-made selection, thus creating and enhancing genetic diversity in agroecosystems.

HUMAN AND ENVIRONMENTAL FACTORS AFFECTING THE COMPOSITION OF AGROBIODIVERSITY IN CUBAN HOME GARDENS

Z. Fundora Mayor, L. Castineiras, T. Shagarodsky, V. Moreno, O. Barrios, L. Fernandez & R. Cristobal
Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt" (INIFAT). Calle 1, esquina a 2, Stgo. De las Vegas, Boyeros, Cuba. CP: 17200.

ABSTRACT

There are several factors that influence the composition of the species and infraspecific diversity in Cuban home gardens, or "conucos." Aspects such as culture, climate, socio-economic status and politics are the main influences on the diversity present in home gardens. Among the most important aspects are human actions and decisions. Conucos were surveyed in the three major geographic regions of Cuba. In all regions the coexistence of wild species and weeds have been noted growing together with the cultivated varieties, as in the case of *Capsicum frutescens*. In many cases the wild or weedy varieties are at first "tolerated" and then, if found useful, "managed" to a certain degree. It can be seen that approximately 50% of the species and/or cultivars originate outside the home gardens. Interviews conducted with farmers confirm the ample exchange of genetic materials between the gardens and its surroundings. The most frequent source of germplasm is from close family and neighbours, and to a lesser extent from the formal sector (Ministry of Agriculture or scientific institutions). Once the reproductive material has obtained, the farmers show great interest in reproducing their own seed (in approximately 80% of the cases). The remainder correspond to those types which self-seed (weeds), or which are useful wild species, or which must be bought because seed can not be reproduced in our country, such as cabbage (*Brassica oleracea*) or beetroot (*Beta vulgaris*). Climatic factors, such as prolonged droughts, hurricanes and strong winds, can prevent flowering and destroy crop populations. Topographic factors such as altitude negatively influence the number of fruit species managed by farmers (r=-0.51), due to the presence of mists at high elevations. Altitude, however, has a positive effect on roots and tubers (r=0.45), medicinal species (r=0.37), grains (r=0.35) and seasonings (r=0.41) due to the high rainfall that occurs in those home gardens. No defined tendency was observed in the total number of species in relation to altitude. Home garden owners with the high levels of education tend to cultivated a greater number of species, suggesting that the farmer are capable of perceiving greater benefit through managing a greater number of species. Cuban farmers easily adopt new technologies and new species or varieties. There is also a positive tendency in the relationship between increased time dedicated to home garden care and the total number of managed species; increased labor also tends to increase the number of categories of use. Pests and diseases sometimes cause farmers to change the composition of the managed diversity, especially when they are causing serious crop damage. One example is the case of *Thrips palmi*, which attacks a wide range of species that are of importance to the households. Finally, agrarian and environmental policies can affect the dynamics of the Cuban "conuco", either by promoting or constraining the presence of wide diversity in the home garden. Despite policies that have not favored crop genetic diversity in field crops, diversity in Cuban home gardens remains quite stable over time, because they are essential to the livelihood of the owners.

A PARTICIPATORY MARKETING SYSTEM RESEARCH APPROACH TO ANALYSING MARKET BASED INCENTIVES AND DISINCENTIVES: A CASE OF RICE, BARA (TERAI), NEPAL

D. Gauchan[1], P. Chaudhary[1], B. Sthapit[2], MP Upadhaya[1], M. Smale[3], D. Jarvis[3]

[1] In-Situ Conservation of Agrobiodiveristy On-farm Project, NARC/LIBIRD, Nepal
[2] International Plant Genetic Resource Institute (IPGRI), Asia-Pacific, Region
[3] International Plant Genetic Resource Institute (IPGRI), Rome, Italy

Key words: Market disincentives, Landraces, On-farm conservation

ABSTRACT

Market based incentives and disincentives often provide strong influence on farmers' choice and use of cultivar diversity. This study aims to describe and analyse market based incentives and disincentives based on the data and information from a case study on rice landraces marketing carried out in the centre of rice diversity, Bara, central plains (Terai) Nepal. The framework includes a participatory and system approach to marketing research employing market channel, market price and market margin analysis. The analysis aims to highlight how farmers' variety choice and traders' marketing decisions are influenced by market signals in the form of market-based incentives and disincentives. The findings show that market provides incentives and disincentives for the rice products through price signals, market margins, and market channels. Except traditional Basmati (aromatic high quality) rice, most of the landraces are traded in small-scale informal markets channels. Market provides negative signals to most of the landraces in the form of market price, market margin, and market demand. Seed and product markets for landraces are not well developed. Landraces as a whole face strong disincentive from market due to production and market incentives available for MVs and flow of cheaper rice from across open border (India). The study suggests specific production and market incentives for landrace products and inputs (e.g. seed) through action programs on market linkages and value addition. Future research is needed in combination with non-market based measures (e.g. technical and policy incentives) over time for better understanding of landraces production and marketing decisions.

MECHANISMS FOR ON-FARM BIODIVERSITY MANAGEMENT: A PERSPECTIVE FROM ON-FARM WOODY-PLANTS MANAGEMENT PRACTICE IN A NEPALI VILLAGE

Krishna H Gautam

Farm landscapes in Nepal demonstrate the integration of crop, livestock and trees. Woody plants are managed for products such as fodder, compost, timber, fuelwood, implements, medicine, and many other consumable and marketable products. Farmers also understand the protective role of woody plants in their farm. As such practice has been a established culture, the farmers hold rich knowledge of plant crop interaction, and maintain biodiversity in the level that promotes the production of agricultural ecosystems. Farmers are innovative, and the agricultural ecosystems are changing to sustain and enhance their livelihood.

The study investigates the components of agricultural ecosystems in a village in Nepal. Changes in the woody plants in farms between 1992 and 2001 are analysed. It is demonstrated how farmers promoted woody-plant biodiversity in agricultural ecosystems. Based upon farmers' knowledge and understanding, factors associated with the different levels of biodiversity in the farms are explored. Challenges on the sustainability of farmer's management of on-farm biodiversity are discussed, and potential approaches of promoting biodiversity in agricultural ecosystems are sketched.

USE OF BIOCHEMICAL MARKERS FOR GENETIC DIVERSITY AND DETERMINING QTLS IN *VIGNA MUNGO* GERMPLASM

Abdul Ghafoor and Muhammad Ishtiaq
Plant Genetic Resources Institute (PGRI), National Agricultural Research Centre (NARC), Islamabad, Pakistan.
Email: ghafoor59@hotmail.com

Key words: cluster analysis, genetic diversity, PCA, seed proteins, gel electrophoresis

ABSTRACT

One hundred and eleven genotypes of blackgram from diverse origin were evaluated for agronomic traits for 2 years to determine the extent of genetic diversity. Seed proteins were analyzed using Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE) through vertical slab type unit. High genetic variance was observed for days to flowering, days to maturity, number of branches/plant, number of pods/plant, biomass/plant, grain yield/plant and harvest index, whereas low genetic variance was observed for pod length, seeds/pod and 100-seed weight during both the years. On the basis of SDS-PAGE, a low level of inter-collection diversity was observed and no clear differentiation on the basis of origin or source was observed. The genotypes in one cluster with similar agronomic characters were not necessarily belonging to the same source or origin. The indifferent clustering pattern of germplasm collected from Pakistan might be due to exchange of germplasm between the neighbouring regions, and perhaps with same ancestors. Clustering of advanced breeding lines and approved variety in one group revealed that only a portion of genetic diversity has been exploited for blackgram improvement, and it is suggested to broaden the genetic base of cultivated blackgram involving diverse parents in breeding programme. Screening analysis for marker bands to QTLs revealed significance in determining QTLs in blackgram through SDS-PAGE markers. The factors affecting quantitative traits may occur as individual genes or gene clusters scattered throughout the genome, therefore, quantitative trait were expected differently at several loci. Variation in seven quantitative traits out of ten was significantly associated with 9 protein peptides, however, the actual number of QTL might be fewer because several of these traits were correlated. Variation at protein peptides in the vicinity of QTL in blackgram may be an indication of genetic variation potentially available to breeding programmes. Expansion of genetic base for blackgram breeding might be accomplished by systematic use of germplasm that differ from common banding pattern and known to be associated with variation in quantitative traits.

STRATEGIES AND TOOLS FOR CONSERVATION OF LIVESTOCK GENETIC RESOURCES

J.P. Gibson[1] and J.E.O. Rege[2]

[1] International Livestock Research Institute, P.O. Box 30709, Nairobi, Kenya
[2] International Livestock Research Institute, PO Box 5689, Addis Ababa, Ethiopia

Most livestock are believed to have originated from very few, often a single domestication event per species, from which large-scale radiation, genetic change and adaptation has occurred. Natural and artificial selection has created enormous genetic diversity among breeds, with examples of adaptation to extreme and fluctuating environments, resistance to many of the most important livestock diseases, and highly developed and specialised production capacity. Most wild ancestors are extinct, and where surviving, do so in limited numbers and/or geographical range with limited genetic diversity. Thus, in contrast to many agricultural plant species, most or all genetic diversity in livestock resides within and between existing domesticated stocks. While most of the more than 5000 breeds of livestock remain very poorly characterised, it is estimated that two breeds per week are lost through extinction. Ex situ cryopreservation methods are not available for most livestock species, and will rarely be practical even where technically feasible. *In situ* conservation through utilization, and ensuring that AnGRs remain functioning parts of the production system, seems the most practical solution for widespread conservation of diversity. Community based approaches seem essential for sustainable *in-situ* programs, and open nucleus breeding schemes provide a practical model for genetic improvement. It is likely, however, that there will also be need for *in situ* and *ex situ* conservation without immediate utilisation. Conservation decisions will involve difficult choices with important long-term consequences, and will thus need to be based on reliable information and frameworks for objective decision making. Considerable, but still inadequate effort is underway to characterise livestock at the phenotypic and molecular genetic levels, and to document their production environments, uses and status. Research is also underway to evaluate methods of valuing livestock breeds and for developing frameworks for decision making based on information on phenotype, value, molecular diversity, status and cost of conservation. It is hoped that such information and tools will enhance both the quality of conservation decisions and the amount of conservation activity.

COMMUNITY BASED PROMOTION OF RURAL POULTRY DIVERSITY AND UTILISATION IN MALAWI

T.N.P. Gondwe[1,2], C.B.A. Wollny[1,2], M.G.G. Chagunda[1], A.C.L. Safalaoh[1] and F.C. Chilera[1]

1 Department of Animal Science, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi.
2 Institute of Crop and Animal Production in the Tropics, University of Göttingen, Kellnerweg 6, 37077 Göttingen, Germany.
E-mail: tgondwe@gwdg.de

Key words: rural poultry, community-based management, Malawi

ABSTRACT

In Malawi rural poultry constitutes over 80 % of total poultry population and is raised and utilised by about 80 % of human population primarily based in rural areas and occupied by subsistence agriculture. Different poultry species are raised, mostly indigenous to the locality except in chickens where traces of Black Australorp breed are identified. Most of the species are known by vernacular names that describe their phenotype. Some phenotypes need attention to rescue them from becoming extinct. Despite their importance, rural poultry has received little attention by policy makers. Several constraints such as poor management, poor housing and feeding systems, Newcastle disease outbreaks, predation, and mating systems were identified in earlier studies.

A community based project on improving and sustaining food self-sufficiency through promoting integration, multiplication and intensified utilisation of diversity of rural poultry has been initiated in villages of Mkwinda and Mitundu Extension Planning Areas (EPA), Lilongwe Agricultural Development Division. These villages surround Bunda College of Agriculture. The project aims to operate through open nucleus breeding centres established in rural communities and managed by a committee of farmers. The farmers and other community-based stakeholders are fully participating in all aspects and all decisions are made by the community committees. Two breeding and multiplication centres are established, one from each EPA, with an additional set up at Bunda College to conduct complementary trials. Breeding farmers from within the community will multiply and distribute breed stock to other farmers. Different species and strains of poultry (chickens, pigeons and ducks) will be raised and performance evaluated at the centres. The above average performing birds will be selected as breeding stock for farmers. Distribution will be through the traditional stock sharing systems. The project plans technical interventions such as Newcastle disease vaccination, feed supplementation and early weaning. Village committees and breeders will be getting trained on rural poultry management to sustain the program afterwards.

The project is in its early implementation phase and aims at increasing flock sizes and flock integration among rural households; improved productivity through selection and evaluation; reduced mortality; and improved nutritional, social and economic contribution of poultry biodiversity to rural human communities. These include malnourished children, the aged and female- headed households, thus contributing to food security and managing poultry genetic resources.

Introduction

Malawi is a landlocked country located in Southern Africa lying along coordinates 8 20 S, 32 36 E. Malawi is above South Africa, bordered by Mozambique to the South, South East and South West, Tanzania to the North and North East, and Zambia to the West. The country has a total area of approximately 118, 000 sq km, of which, one third is. Arable land constitutes about 34 %; other land being permanent pastures, forests and woodlands, estates and public land. Total land boundary is about 2900 km.

Malawi has about 86 % of its 9.8 million human population living in rural areas and these are mainly occupied with smallholder subsistence farming (NSO, 2000). The majority are resource poor, with over 60 % being food insecure (NEC, 1999). These farmers grow different crops and are the custodian of more than 80 % of total national livestock population (GoM, 1998). From a study of 323 farm households, annual per capita income could be as low as 74 US$ (1 US$ = MK27.00) equivalent (Gondwe et al. 1999) mainly derived from crop production. Most of income spending (78 %) is on food (NSO, 2000).

Poultry is the most dominant species and more than 80 % of the national poultry population is kept in the rural areas. Chickens constitute the majority (83 %) followed by pigeons (14 %) and ducks (2 %). Most of these are indigenous except in chickens where traces of Black Australorp (BA) breed can be found. These BA chickens were introduced through a cross breeding program that has existed for over 40 years in an attempt to improve the local chicken (GoM, 1998). In most households, women and children are caretakers of traditional poultry kept on free-range extensive system, just as is the case for most African countries (Dessie and Ogle, 1996, Kitalyi, 1997; Agang et al., 2000).

Per capita animal protein consumption in Malawi has declined from 6.3 kg in 1996 to 5.26 in 1998 (GoM, 1999). Both situations are far below average consumption for Africa (12.0 kg and for developing countries (27.8 kg). These contribute to maternal mortality and to over 50 % of children in rural areas to be malnourished (NEC, 1999). Poultry in rural areas could play a role to contribute to nutritional status of human being in this arena. This would exploit their fast reproductive rates, ability to be raised even under limited land spacing per household and their capability to be taken care of by relatively inactive labour force (old, children) in households. Their small-frame make poultry good starters to those farmers without any (mostly poorest) unlike-large framed species such as cattle (Dolberg, 2001).

The Government attempted to improve local chicken production through crossbreeding with an exotic dual - purpose breed Black Australorp (BA). The program seems to be failing generally due to technical constraints, complexity of farming systems and the different uses farmers attach to their indigenous poultry, which the cross breeding program was missing. The BA seems not to adapt well to the harsh village-scavenging environment. Against this background, efforts were taken to initiate studies and improvement programs in rural poultry considering the existing diversity, the role of poultry to the society, and the prevailing farming systems. The paper presents the community-based project aiming to contribute to food self-sufficiency among smallholder farmers through promoting and improving poultry species in an integrated system without changing the cultural and farming system.

Project research area and background studies

The project has been initiated in Lilongwe Agricultural Development Division (LADD), specifically in villages of Mkwinda and Mitundu Extension Planning Areas (EPAs). These are villages that surround Bunda College of Agriculture. In these villages, researchers have had earlier studies on evaluation of poultry biodiversity, on-farm and on-station species characterisation and flock monitoring (Gondwe et al., 1999). A catalogue of local names for poultry in *Chichewa* (local language) was established (Table 1). Most of the names were descriptive, based on phenotype such as feather plumage, legs, tail feathers, head, other features or simply colour.

Monitoring studies determined prevalence of different types of poultry within species in the area (Table 2). From these, it was noted that phenotypes *Kansilanga* (freezled), *Tsumba* and *Kameta* (Naked neck) were relatively few in flocks. Black Australorp breed trace was Phenotypically identified but constituting an insignificant proportion of total chicken population. On the other hand, *Simboti* (dwarf) and *Kachibudu* were missing among flocks. These phenotypes need care to prevent them from extinction. Ducks had few *Kawangi* while phenotypic diversity distribution was equal in pigeons. The prevalence of pigeons and ducks in relation to chicken was still low and need to improve. The same trend is being observed from current monitoring results.

Table 1. Catalogue of local names of poultry in Chichewa.

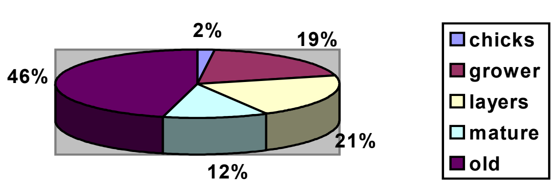
Species	Name	Phenotypic description	Basis for the name
Chicken	Kachibudu	Without tail feathers	Physical appearance
	Kameta	Naked neck	
	Masapa	Feathers on legs	
	Kambwata / Simboti	Dwarf with short legs	
	Kansilanga	Frizzled (with rough feathers)	
	Tsumba	Feather hill on head	
	Kawangi	Black with white spots resembling a predator for chicks called Kawando (Guinea fowl type)	Colour
	Chiphulutsa	Grayish like ash	
	India	Came from India (Exotic)	Origin
	Mikolongwe	Bought from Veterinary centers (BAs)	
Ducks	Yoyera	White in colour	Colour
	Yakuda	Black in colour	
	Kawangi	Like a predator for chicks	
Pigeons	Boli	Black with white strips around neck (Zebra type)	Colour
	Nyemba	Bears colour of beans	
	Kaphulusa	Grayish like ash	
	Chimwendomphako	Big size with feathers on legs	Physical appearance

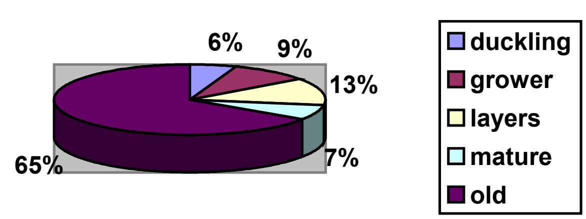
Source: Gondwe et al. (1999)

Distribution of flocks by age groups was in favour of old birds (over 52 weeks) in chickens and ducks and growers (20 - 30 weeks) in pigeons. This showed that farmers keep their breeding birds for a long time. Chicks and ducklings of less than 10 weeks of age were least in proportion despite high hatching rates (> 50 %). This suggests high mortality rates resulting from diseases, predators and unfavourable weather conditions. Chicks and ducklings belong to the age-group that is prone to deaths and needs care. Their survival would contribute to usable outputs and replacement stock. Simple husbandry interventions and regular vaccination against important diseases would reverse the trend in proportions within flocks as reported elsewhere (Huque et al., 1999; Mopate and Lony, 1999; Dolberg, 2001). In pigeons the low number of squabs arise from the fact that this is the group that is mostly consumed (Gondwe et al., 2000a). Growers, mature and old pigeons are used for breeding. Inbreeding within flocks is probably occurring due to inadequate and non - formalised cockerel exchange system, long time use of parent stock and lack of record keeping.

Table 2. Flock structure and distribution of different types of poultry in Mkwinda EPA, LADD.

Species / Type	Type	Percent of population
Chickens	Chiphulutsa	13.4
	Kameta	0.3
	Kansilanga	0.3
	Kawangi	12.2
	Mikolongwe (BA)	0.6
	Tsumba	0.2
	Yakuda	40.4
	Yofira	16.4
	Yoyela	16.2
Pigeons	Boli	27.1
	Chimwendomphako	15.0
	Chiphulutsa	16.4
	Kapambwe	7.9
	Mpheta	11.4
	Nyemba	7.1
	Yoyela	15.0
Ducks	Kawangi	5.4
	Yakuda	63.6
	Yoyela	31.0

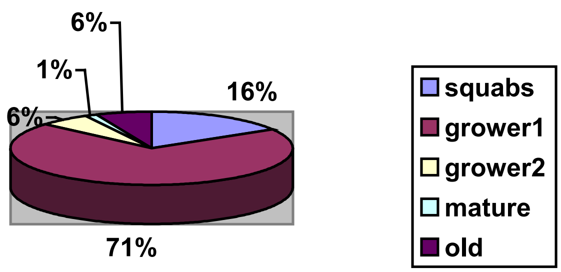




Age group distribution: Chicks, ducklings and squabs (1 - 10 weeks); Grower (1) (>10<=20 weeks); Grower (2)/ layers (>20 <=30 weeks); Mature (>30<=52 weeks); old (>52 weeks).

Figure 1. Flock distribution by age groups for chickens (above left), ducks (above right) and pigeons (below) in Mkwinda EPA.

The major constraints to poultry production were Newcastle disease (NCD) outbreaks in chickens in the months of September to December every year; predators in pigeons, chickens and ducks; poor housing and prolonged weaning periods in chickens and ducks. There is also haphazard sharing of breed stock among relatives, friends and others, more within the village (70 – 90 % of farmers, n = 323) than between villages (Gondwe et al. 2000b).



Approach to the community based project

This project is designed to promote breeding of diversity of poultry species in the rural areas while at the same time putting necessary intervention measures to identified constraints. Unlike other projects related to poultry, such as the Bangladesh (Jansen, 2000) and Egyptian Models (Kolstand and Abdou, 2000), the current project concentrates on indigenous poultry species of chickens, pigeons and ducks. The goal is to improve productivity of meat and egg production and sustain diversification within flocks utilising the existing free-range system. All management decisions are taken and implemented by the community and accompanying research is based on full farmer participation.

Breeding and performance testing

There are two breeding centres established in the Chatenga and Chinungu villages of Mkwinda and Mitundu EPAs, respectively. These sites were identified upon agreement by traditional chiefs that surround the areas, in prior consultation with Government Extension Officers from the EPAs. Clubs were formed to run the centres and the activities of the project. These include assisting in construction of traditional poultry houses, working out logistics and administration of vaccines through a contributory system and later running the stock distribution and sharing system from the breeding centres. The breeding centres are therefore, under full control of the rural people through the club committee. An additional centre was already established at Bunda College to provide facilities for complementary on-station research.

By July 2001, about 50 adult chickens and 10 pairs of pigeons were stocked at each of the village breeding centres. Stocking of ducks was delayed due to scarcity. These birds were purchased from different villages outside the working community area. The target is to have up to 100 adult chickens and 50 pairs of pigeons at the centres. Number of ducks will depend on availability. These form the base population for multiplication and improvement. Each bird was individually identified through numbered wing or leg bands. All birds will be raised under traditional free-ranging system. Supplementation will be done using traditional maize bran. The birds will be under performance evaluation for meat, egg production, hatchability, mothering ability and adaptation. Young cocks will be evaluated for growth traits up to the point they start crawling (reproductive maturity, at 20 weeks) and top 10 to 25 % will be recommended for breeding purposes and distributed to farmers. Selection (initially based on phenotypic performance) will be based on an index that will be established in due course, taking into account different traits of use at village level. The hens will be evaluated for egg production, hatchability, mothering ability, among other traits.

In addition to breeding centres, some farmers with high flock diversity have been selected to be breeders and fertile egg producers. Currently there are 12 farmers selected in consultation with field extension staff of the EPAs from Mkwinda EPA. These will have their birds individually tagged and subjected to evaluation as at the breeding centres. There will be sharing of breed stock with the breeding centres and fellow farmers.

The set-up of a basic breeding program following the concept of an open nucleus breeding system for rural poultry is outlined in Figure 2. Production farmers will obtain superior breed stock from breeder farmers and from the breeding centres. Breeder farmers will obtain phenotypically top young evaluated cockerels from the breeding centres. On the other hand, there will be cockerel exchange among breeding centres and breeder farmers in form of a six months cockerel cycle to reduce chances of inbreeding.

Farmers who will be interested to have their birds tested will bring six weeks old cocks to the breeding centres of choice where they will be evaluated for growth up to 20 weeks of age. Depending on the performance birds will be recommended for use in breeding or for consumption.

Immediate benefits to farmers were control of Newcastle disease through vaccinations that started at breeding centres and had spinning off effects to breeder farmers and other farmers in different villages. Vaccination program started in May and by July, 37 villages had their birds vaccinated with proper record of dates for next vaccination. This fulfilled the concept to have the main disease prevented by strategic vaccination prior (from May to July) to period of outbreak. Vaccination programs will continue, three times a year, the last one being in December. This will be facilitated by field workers from EPAs but coordinated by the Committee of the club. Vaccines will be shared at cost recovery through monetary and egg contribution to a revolving fund run by the committee. Chickens reproduce more during the same period of NCD outbreak, probably due to availability of supplements. The control of NCD will contribute to survival of chicks and old ones, leading to increased flock sizes and reversing the trend shown in Figure 1. The increased flock sizes will contribute to more usable inputs, some of which can go to markets and generate some cash apart from increasing animal protein consumption.

Early weaning will be encouraged in chickens to increase laying cycle. The hens will be forced to abandon their chicks at the sixth week to induce laying. Promotion of supplementation and protection of chicks from day and night predators is planned.

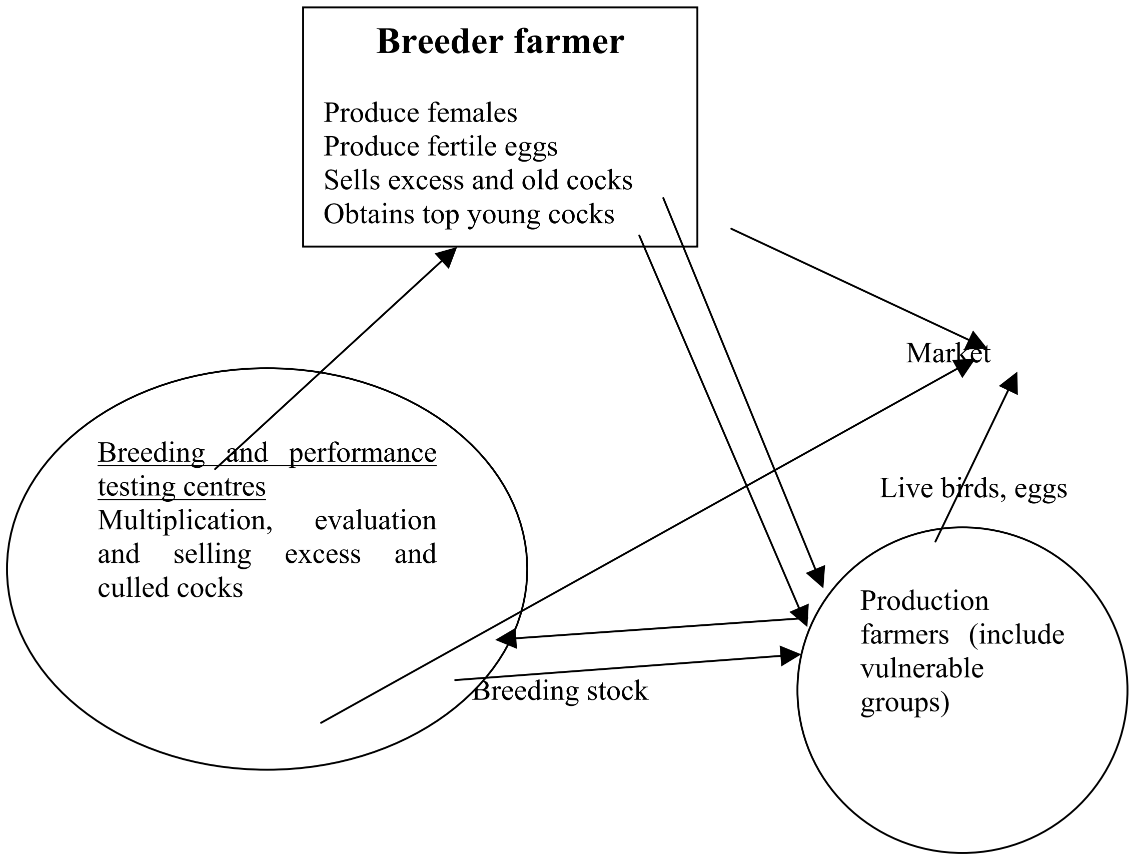


Figure 2. Interaction between farmers, breeders and evaluation centres in the villages.

Research component

In direct collaboration with the community farmers the project conducts research to characterise indigenous poultry aiming to develop applicable technologies and interventions. On-farm monitoring study is in progress where flock census is taking place. Information obtained from every household in Mkwinda and Mitundu EPA include:

- flock dynamic (distribution by age, type and sex over time)
- growth
- egg production and related traits
- mortality and its causes
- socio-cultural factors and effects
- contribution of different poultry species to human diets and income generation
- testing of interventions

These census studies are on regular interval and will also provide immediate evaluation of the project by monitoring changes in poultry population and proportions.

A meat preference and acceptability test trial with farmers has taken place in Chatenga. Meat from chickens, ducks and pigeons was evaluated at two different age groups. Initial studies indicated that farmers prefer chicken meat to other species (Gondwe, 1994; Lwesya, 1998; Gondwe et al., 1999) but this observation seemed to be skewed due to chickens being more prevalent than others. Meat preference study wanted to test this hypothesis and use it as a tool to encourage domestication of other potential species. Results are under analysis but quick summary was made and reported back to farmers within a week. Meat preference after consumption showed indeed a different observation from earlier survey studies (Table 3).

Table 3. Summary of results on consumer poultry meat preference in Chatenga Village.

Meat type	Rank	Frequency of farmers (%)
Duck meat (10 weeks old)	1	40.6
Chicken meat (20 weeks old)	2	23.4
Duck meat (20 weeks old)	3	17.2
Broiler meat (8 weeks old)	4	14.1
Chicken meat (10 weeks old)	5	4.7

Results showed importance of other species and hence the need to promote them in the villages.

There will be an attempt to generate genetic parameters (h^2, genetic correlations) for chickens by tracing the pedigree through the hen. Hens from the centres will have their chicks traced up to several hatches and generations. Dealing with flock species under free - ranging system, it is not possible to trace pedigree through the cockerels that will be distributed to farmers. These cockerels will join others in the flocks where random mating will be taking place. On the other hand, hens and their hen offspring will be followed. Currently the hen pedigree recording system is in place at the Bunda breeding centre and will be expanded to the village breeding centres and farmer breeders so as to increase number of records. Through individual identification, individual records will be collected and this will contribute to appropriate genetic improvement of the species.

Training component

Trainings are being arranged for farmers in various aspects relating to rural poultry management, supplementation, housing, disease control and record keeping. Breeder farmers will be trained on creation of local multiplication centres, the cockerel exchange system and periods of exchange, early weaning, among others. The committee will be trained on leadership and the whole project concept for easy of following at later stages. There will also be some individuals selected from farmers and trained to be technicians for administration of vaccines. These training will equip farmers with techniques to follow after the project phase for the sake of sustainability of the project.

Project targets and stakeholders

Farmers are the centre of the project and they are involved in decision making on activities of the project. This so far has started well through the observed participation in formation of committees, selection of sites, construction of structures and administration logistics for NCD vaccine. Vaccination program has had spin off effect to other villages.

Farmers will also be responsible for sales from proceeds at the breeding centres (culled stock, breed stock and excess birds and eggs) and security of the centres (through community policing). The project targets resource poor farmers in the rural areas and this includes families with malnourished children under – five, female headed poor households or families, old people without external support but capable to do minor activities such as keeping poultry and others described to be below poverty line

The project has involved the extension workers as front line staff from the Ministry of Agriculture at EPA level. These will also be involved in training and extension advisory role. It is expected that Non - Governmental Organisations dealing with promotion of food security in rural areas will be interested to collaborate

Expected output from the project

It is expected that breeding and multiplication centres of breed stock will produce seed stock for different species of birds that will be distributed to farmers in the villages. This will directly contribute to improved village poultry production and diversity, resulting to increased animal protein intake among smallholder farmers. The project incorporates poultry production within existing farming systems and this will ensure a sustainable contribution to stable food security. Farmers will be equipped with technologies that will intervene in current constraints, hence improve their poultry production. Applied technologies will be developed for researchers and extension workers to effectively assist the farmers.

The smallholder resource poor farmers will therefore benefit from the integration of different species nutritionally, socially and economically. This will also lead to sustainable conservation, management, improvement and utilisation of indigenous poultry genetic resources.

Sustainability of the project

The active participation of farmers will make the program sustainable after the initial funding phase. The project is taking place in the villages, using the traditionally kept indigenous species and utilising the existing farming systems. Farmers are also decision makers and in control of breeding centres. Acquisition of breed stock (live birds and fertile eggs) from breeding centres and breeder farmers will include traditional stock sharing systems locally known as *Chipazga* or *Chakhola*. This ensures farmers of all categories to get access to species of their need. The contributory vaccination program will be simple and affordable by all farmers through cash payment or any other method of payment agreed by the community.
Farmers will be in control of sales of birds at breeding centres and the vaccine revolving fund. The training component will also contribute to sustainability of the program.

The cycle of operations between the breeding centres, breeder farmers and production farmers incorporates, among others, activities of a cockerel exchange program, which works with indigenous species that are already adaptable to the local environment.

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Literature

Aganga, A.A., Omphile, U.J., Malope, P, Chabanga, C.H., Motsamai, G.M. and Motsumi, L.G. 2000. Traditional poultry production and commercial broiler alternatives for smallholder farmers in Botswana. Livestock Research for Rural Development (12) 4. www.cipav.org.co/lrrd/lrrd12/4/Aga124a.htm

Dessie, T and Ogle, B. 1996. Studies on Village Poultry Production in the Central Highlands of Ethiopia. Workshop proceedings, Tune Landboskole, Denmark.

Dolberg, F. 2001. A livestock development that contributes to poverty alleviation and widespread improvement of nutrition among the poor. Paper presented at a workshop on Malnutrition in Developing countries: Generating Capabilities for Effective Community Action. IFAD, September, 2001. Livestock Research for Rural Development (13) 5. www.cipav.org.co/lrrd/lrrd13/5/dolb135.htm

GoM. 1998. National Livestock Development Master Plan. Final Report. Department of Animal Health and Industry, Ministry of Agriculture and Irrigation, Lilongwe, Malawi.

Gondwe, T.N.P., Ambali, A.J.D., Chilera, F.C., Lwesya, H., and Wollny, C. 1999. Rural poultry biodiversity in Lilongwe and Mzuzu Agricultural Development Divisions (ADD), Malawi. Malawi Journal of Science and Technology, 5:17 - 25.

Gondwe, T.N., Chilera, F.C., Phoya, R.K.D. and Jonazi, J.B. 2000a. On-farm and on-station evaluation of growth and reproductive characteristics of pigeons in Malawi. Regional Conference on Sustainable Animal Agriculture and Crisis Mitigation in Livestock Dependent Systems in Southern Africa (Proceedings in Press). Malawi Institute of Management, Lilongwe, Malawi.

Gondwe, T.N., Chilera, F.C. and Ambali, A.J.D. 2000b. Constraints to rural poultry production and diversity in Lilongwe and Mzuzu Agricultural Development Divisions, Malawi. Regional Conference on Sustainable Animal Agriculture and Crisis Mitigation in Livestock Dependent Systems in Southern Africa (Proceedings in Press). Malawi Institute of Management, Lilongwe, Malawi.

Huque, Q.M.E., Chowdhury, S.A., Haque, M.E. and Sil, B.K. 1999. Poultry research in Bangladesh: present status and its implication for future research. In: Poultry as a Tool in Poverty Eradication and Promotion of Gender Equality. Proceedings of a workshop. www.husdyr.kvl.dk/htm/php/tune99/15-Huque.htm

Jansen, HA. 2000. Structures for improving smallholder chickens in Bangladesh Breeding Strategy. In: S. Galar, J. Boyazoglu and K. Hammond (eds.) ICAR Technical Series No. 3. Workshop on Developing Breeding Strategies for Lower Input Production Environment, Bella, Italy

Kitalyi, A.J. 1997. Village chicken production systems in developing countries: What Does the future hold? World Animal Review, 2: 48 - 53.

Kolstand, N. and Abdou, FA. 2000. NORFA: The Norwegian - Egyptian Project for improving local breeds of laying hens in Egypt. In: S. Galar, J. Boyazoglu and K. Hammond (eds.) ICAR Technical Series No. 3. Workshop on Developing Breeding Strategies for Lower Input Production Environment, Bella, Italy

Mopate, L.Y. and Lony, M. 1999. Survey on family chicken farms in the rural area of N'Djam'ena, Chad. Livestock Research for Rural Development (11) 2. www.cipav.org.co/lrrd/lrrd11/2/chad112.htm

NEC. 1999. Annual Economic Report. National Economic Council of Malawi. Ministry of Finance, Economic Planning and Development, Lilongwe, Malawi.

NSO 2000. National Statistical Office. Press Report on National Statistics, 1998. Zomba, Malawi.

COMMUNITY BASED PROMOTION OF RURAL POULTRY DIVERSITY, MANAGEMENT, UTILISATION AND RESEARCH IN MALAWI

T.N.P. Gondwe, C.B.A. Wollny, A.C.L. Safalaoh, F.C. Chilera and M.G.G. Chagunda
Department of Animal Science, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi.
E-mail: tgondwe@chirunga.sdnp.org.mw

Key words: rural poultry, characterisation, community-based management, Malawi

ABSTRACT

Rural poultry constitutes over 80 % of total poultry population and is raised and utilised by about 80 % of human population primarily based in rural areas and occupied by subsistence agriculture. Different poultry species are raised, mostly indigenous to the locality except in chickens where traces of Black Australorp breed are identified. Most of the species are known by vernacular names that describe their phenotype. Some phenotypes need attention to rescue them from disappearing in the rural areas. Despite their importance, rural poultry has received little attention in terms of improving their management, productivity and diversity. Several constraints such as Newcastle disease outbreaks, predation, poor housing, feeding and mating systems were identified in earlier studies.

A community based project on improving and sustaining food self-sufficiency through promoting integration, multiplication and intensified utilisation of diversity of rural poultry has just started in villages of Mkwinda and Mitundu Extension Planning Areas (EPA), Lilongwe Agricultural Development Division. These villages surround Bunda College of Agriculture. The project aims to operate through open nucleus breeding centres established in rural communities and managed by a committee of farmers. The farmers and other community-based stakeholders are fully participating in all aspects and all decisions are made by the community committees. Two breeding and multiplication centres are established, one from each EPA, with an additional set up at Bunda College to conduct complementary trials. Breeding farmers from within the community will multiply and distribute breed stock to other farmers. Different species and strains of poultry (chickens, pigeons and ducks) will be raised and performance evaluated at the centres. The above average performing birds will be selected as breeding stock for farmers. Distribution will be through the traditional stock sharing system. The project plans technical interventions such as Newcastle disease vaccination, feed supplementation and early weaning. Village committees and breeders will be trained on rural poultry management to sustain the program afterwards.

The project is in its early implementation phase and aims at increasing flock sizes and flock integration among rural households; improved productivity through selection and evaluation; reduced mortality; and improved nutritional, social and economic contribution of poultry biodiversity to rural human communities. These include malnourished children, the aged and female- headed households, thus contributing to food security and managing poultry genetic resources.

Introduction

Malawi has about 86 % of its human population living in rural areas and these are mainly occupied with smallholder subsistence farming (NSO, Press release, 2000). The majority are resource poor, with over 60 % being food insecure (NEC, 1999). These farmers grow different crops and are the custodian of more than 80 % of total national livestock population (GoM, 1998). Their annual per capita income could be as low as 74 US$ equivalent (Gondwe et al. 1999) mainly derived from crop production. Poultry is the most dominant species and more than 80 % of the national poultry population is kept in the rural areas. Chickens constitute the majority (83 %) followed by pigeons (14 %) and ducks (2 %). Most of these are indigenous except in chickens where traces of Black Australorp (BA) breed can be found. These BA chickens were introduced through a cross breeding program that has existed for over 40 years in an attempt to improve the local chicken (GoM, 1998). In most households, women and children are caretakers of traditional poultry kept on free-range extensive system.

Malawi has an annual animal protein consumption of 6.0 kg per capita well below the average of Africa (12.0 kg). These lead to maternal mortality and over 50 % of children in rural areas to be malnourished (NEC, 1999). Poultry in rural areas could play a role to contribute to nutritional status of human being in this arena. The Government attempted to improve local chicken production through crossbreeding with a dual - purpose breed Black Australorp (BA). The program seems to be failing generally due to technical constraints, complexity of farming systems and the different uses farmers attach to their indigenous poultry, which the cross breeding program was missing. The BA seems not to adapt well to the harsh village-scavenging environment. Against this background, efforts were taken to initiate studies and improvement programs in rural poultry considering the existing diversity, the role of poultry to the society, and the prevailing farming systems. The paper presents the community-based project aiming to contribute to food self-sufficiency among smallholder farmers through promoting and improving poultry species in an integrated system without changing the cultural and farming system.

Project research area and background studies

The project has been initiated in Lilongwe Agricultural Development Division (LADD), specifically in villages of Mkwinda and Mitundu Extension Planning Areas (EPAs). These are villages that surround Bunda College of Agriculture. In these villages, researchers have had earlier studies on evaluation of poultry biodiversity, on-farm and on-station species characterisation and flock monitoring (Gondwe et al., 1999). A catalogue of local names for poultry in Chichewa was established (Table 1). Most of the names were descriptive, based on phenotype such as feather plumage, legs, tail feathers, head, other features or simply colour.

Monitoring studies determined prevalence of different types of poultry within species in the area (Table 2). From these, it was noted that phenotypes *Kansilanga* (freezled), *Tsumba* and *Kameta* (Naked neck) were relatively few in flocks. Black Australorp breed trace was identified but constituting an insignificant proportion of total chicken population. On the other hand, *Simboti* (dwarf) and *Kachibudu* were missing among flocks. These phenotypes need care to prevent them from extinction. Ducks had few *Kawangi* while phenotypic diversity distribution was equal in pigeons. The prevalence of pigeons and ducks in relation to chicken was still low and need to improve. The same trend is being observed from current monitoring results.

Table 1. Catalogue of local names of poultry in Chichewa.

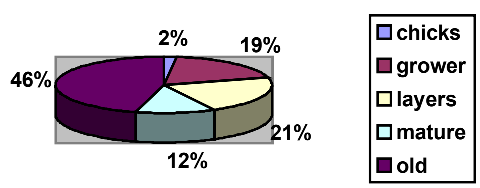
Species	Name	Phenotypic description	Basis for the name
Chicken	Kachibudu	Without tail feathers	Physical appearance
	Kameta	Naked neck	
	Masapa	Feathers on legs	
	Kambwata / Simboti	Dwarf with short legs	
	Kansilanga	Frizzled (with rough feathers)	
	Tsumba	Feather hill on head	
	Kawangi	Black with white spots resembling a predator for chicks called Kawando (Guinea fowl type)	Colour
	Chiphulutsa	Grayish like ash	
	India	Came from India (Exotic)	Origin
	Mikolongwe	Bought from Veterinary centers (BAs)	
Ducks	Yoyera	White in colour	Colour
	Yakuda	Black in colour	
	Kawangi	Like a predator for chicks	
Pigeons	Boli	Black with white strips around neck (Zebra type)	Colour
	Nyemba	Bears colour of beans	
	Kaphulusa	Grayish like ash	
	Chimwendomphako	Big size with feathers on legs	Physical appearance

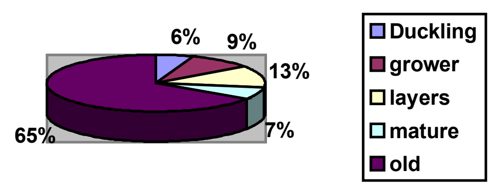
Source: Gondwe et al. (1999)

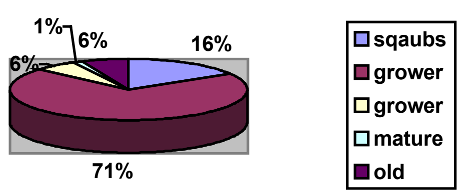
Distribution of flocks by age groups was in favour of old birds (over 52 weeks) in chickens and ducks and growers (20 - 30 weeks) in pigeons. This showed that farmers keep their birds for a long time. Chicks and ducklings of less than 10 weeks of age were least in proportion. This suggests high mortality rates resulting from diseases and predators, hence the age group that is prone and needs care. In pigeons the low number of squabs arise since this is the group that is mostly consumed. Growers, mature and old pigeons are used for breeding. Inbreeding within flocks is probably occurring due to lack of cockerel exchange system and record keeping.

Table 2. Flock structure and distribution of different types of poultry in Mkwinda EPA, LADD.

Species / Type	Type	Percent of population
Chickens	Chiphulutsa	13.4
	Kameta	0.3
	Kansilanga	0.3
	Kawangi	12.2
	Mikolongwe	0.6
	Tsumba	0.2
	Yakuda	40.4
	Yofira	16.4
	Yoyela	16.2
Pigeons	Boli	27.1
	Chimwendomphako	15.0
	Chiphulutsa	16.4
	Kapambwe	7.9
	Mpheta	11.4
	Nyemba	7.1
	Yoyela	15.0
Ducks	Kawangi	5.4
	Yakuda	63.6
	Yoyela	31.0







Age group distribution: Chicks, ducklings and squabs (1 - 10 weeks); Grower (>10<=20 weeks); Grower/ layers (>20 <=30 weeks); Mature (>30<=52 weeks); old (>52 weeks).

Figure 1. Flock distribution by age groups in Mkwinda EPA.
The major constraints to poultry production were Newcastle disease (NCD) outbreaks in chickens in the months of September to December every year; predators in pigeons, chickens and ducks; poor housing and prolonged weaning periods in chickens and ducks. There is also haphazard sharing of breed stock among relatives, friends and others, more within the village than between villages.

Approach to the community based project

This project is designed to promote breeding of diversity of poultry species in the rural areas while at the same time putting necessary intervention measures to identified constraints. Unlike other projects related to poultry, such as the Bangladesh (Jansen, 2000) and Egyptian Models (Kolstand and Abdou, 2000), the current project concentrates on indigenous poultry species of chickens, pigeons and ducks. The goal is to improve productivity of meat and egg production and sustain diversification within flocks utilising the existing free-range system. All management decisions are taken and implemented by the community and accompanying research is based on full farmer participation.

Breeding and performance testing

There are two breeding centres established in the Chatenga and Chinungu villages of Mkwinda and Mitundu EPAs, respectively. These sites were identified upon agreement by traditional chiefs that surround the areas, in prior consultation with Government Extension Officers from the EPAs. Clubs were formed to run the centres and the activities of the project. These include assisting in construction of traditional poultry houses, working out logistics and administration of vaccines through a contributory system and later running the stock distribution and sharing system from the breeding centres. The breeding centres are therefore, under full control of the rural people through the club committee. Construction is underway an d almost complete for Chatenga centre. An additional centre is already established at Bunda College to provide facilities for complementary on-station research.

At these centres indigenous chickens, pigeons and ducks will be stocked for multiplication and improvement. Each bird will be individually identified through numbered wing and leg bands. All birds will be raised under traditional free-ranging system. Supplementation will be done using traditional maize bran. The birds will be under performance evaluation for meat, egg production, hatchability, mothering ability and adaptation. Young cocks will be evaluated for growth traits up to the point they start crawling (reproductive maturity, at 20 weeks) and top 10 to 25 % will be recommended for breeding purposes and distributed to farmers. Selection will be based on a index that will be established in due course, taking into account different traits of use at village level. The hens will be evaluated for egg production, hatchability, mothering ability, among other traits.

In addition to breeding centres, some farmers with high flock diversity have been selected to be breeders and fertile egg producers. Currently there are 10 farmers selected in consultation with field extension staff of the EPAs from Mkwinda EPA. The process for Mitundu is currently ongoing. These will have their birds individually tagged and subjected to evaluation as at the breeding centres. There will be sharing of breed stock with the breeding centres and fellow farmers.

The set-up of an open nucleus breeding system for rural poultry is outlined in Figure 2. Production farmers will obtain superior breed stock from breeder farmers and from the breeding centres. Breeder farmers will obtain top young evaluated cockerels from the Breeding centres. On the other hand, there will be cockerel exchange among breeding centres and breeder farmers in form of a six months cockerel cycle to reduce chances of inbreeding.

Farmers who will be interested to have their birds tested will bring six weeks old cocks to the breeding centres of choice where they will be evaluated up to 20 weeks of age. Depending on the performance birds will be recommended for use in breeding or for consumption.

Breeding centres, breeder farmers will have their birds vaccinated against Newcastle disease from May. Other farmers in the villages will be encouraged to vaccinate their birds. This will be facilitated by field workers from EPAs but coordinated by the Committee of the club. Vaccines will be shared at cost recovery through monetary and egg contribution to a revolving fund run by the committee. Early weaning will be encouraged in chickens to increase laying cycle. The hens will be forced to abandon their chicks at the sixth week to induce laying. Promotion of supplementation and protection of chicks from day and night predators is planned.

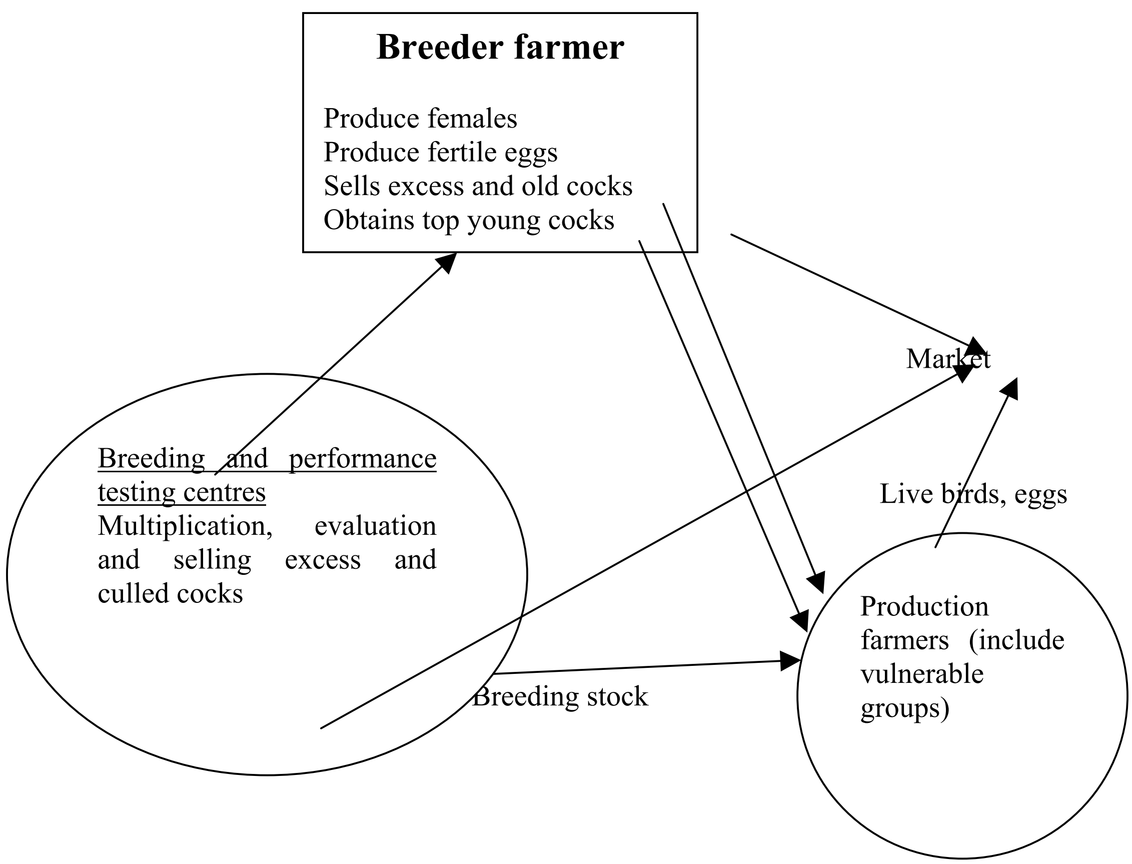


Figure 2. Interaction between farmers, breeders and evaluation centres in the villages.

Research component of the project

In direct collaboration with the community farmers the project conducts research to characterise indigenous poultry aiming to develop applicable technologies and interventions.. On-farm monitoring study is in progress where flock census is taking place. Information obtained from every household in Mkwinda and Mitundu EPA include:

- flock dynamic (distribution by age, type and sex over time)
- growth
- egg production and related traits
- mortality and its causes
- socio-cultural factors and effects
- contribution of different poultry species to human diets and income generation
- testing of interventions
-

A meat preference and acceptability test trial with farmers has taken place in Chatenga. Meat from chickens, ducks and pigeons is being evaluated at two different age groups.

There will be an attempt to generate genetic parameters (h^2, genetic correlations) for chickens by tracing the pedigree through the hen. Hens from the centres will have their chicks traced up to several hatches and generations. Dealing with flock species under free - ranging system, it is not possible to trace pedigree through the cockerels that will be distributed to farmers. These cockerels will join others in the flocks where random mating will be taking place. On the other hand, hens and their hen offspring will be followed. Currently the hen pedigree recording system is in place at the Bunda breeding centre and will be expanded to the village breeding centres and farmer breeders so as to increase number of records. Through individual identification, individual records will be collected.

Trainings are being arranged for farmers in various aspects relating to rural poultry management, supplementation, housing, disease control and record keeping. Breeder farmers will be trained on creation of local multiplication centres, the cockerel exchange system and periods of exchange, early weaning, among others. The committee will be trained on leadership and the whole project concept for easy of following at later stages. There will also be some individuals selected from farmers and trained to be technicians for administration of vaccines. These training will equip farmers with techniques to follow after the project phase for the sake of sustainability of the project.

Farmers are the centre of the project and they are involved in decision making on activities of the project. This so far has started well through the observed participation in formation of committees, selection of sites, construction of structures and administration logistics for NCD vaccine. Farmers will also be responsible for sales from proceeds at the breeding centres (culled stock, breed stock and excess birds and eggs) and security of the centres (through community police). The project targets resource poor farmers in the rural areas and includes
families with malnourished children under – five, female headed poor households or families, old people without external support but capable to do minor activities such as keeping poultry and others described to be below poverty line

The project has involved the Extension workers as front line staff from the Ministry of Agriculture at EPA level. These will also be involved in training and extension advisory role. It is expected that Non - Governmental Organisations dealing with promotion of food security in rural areas will be interested to collaborate

Expected output from the project

It is expected that breeding and multiplication centres of breed stock will produce seed stock for different species of birds that will be distributed to farmers in the villages. This will directly contribute to improved village poultry production and diversity, resulting to increased animal protein intake among smallholder farmers. The project incorporates poultry production within existing farming systems and this will ensure a sustainable contribution to stable food security. Farmers will be equipped with technologies that will intervene in current constraints, hence improve their poultry production. Applied technologies will be developed for researchers and extension workers to effectively assist the farmers.

The smallholder resource poor farmers will therefore benefit from the integration of different species nutritionally, socially and economically. This will also lead to sustainable conservation, management, improvement and utilisation of indigenous poultry genetic resources.

Sustainability of the project

The active participation of farmers will make the program sustainable after the initial funding phase. The project is taking place in the villages, using the traditionally kept indigenous species and utilising the existing farming systems. Farmers are also decision makers and in control of breeding centres. Acquisition of breed stock (live birds and fertile eggs) from breeding centres and breeder farmers will include traditional stock sharing systems locally known as Chipazga or Chakhola. This ensures farmers of all categories to get access to species of their need. The contributory vaccination program will be simple and affordable by all farmers through cash payment or any other method of payment agreed by the community.
Farmers will be in control of sales of birds at breeding centres and the vaccine revolving fund. The training component will also contribute to sustainability of the program.

The cycle of operations between the breeding centres, breeder farmers and production farmers incorporates, among others, activities of a cockerel exchange program, which works with indigenous species that are already adaptable to the local environment.

Acknowledgement
The authors acknowledge gratefully the funding received for this project (SADC/UNDP/FAO RAF 97/032), which is under the project on Management of Farm Animal Genetic Resources in the SADC region.

Literature

GoM. 1998. National Livestock Development Master Plan. Final Report. Department of Animal Health and Industry, Ministry of Agriculture and Irrigation, Lilongwe, Malawi.

Gondwe, T.N.P., Ambali, A.J.D., Chilera, F.C., Lwesya, H., and Wollny, C. 1999. Rural poultry biodiversity in Lilongwe and Mzuzu Agricultural Development Divisions (ADD), Malawi. Malawi Journal of Science and Technology, 5:17 - 25.

Jansen, HA. 2000. Structures for improving smallholder chickens in Bangladesh Breeding Strategy. In: S. Galar, J. Boyazoglu and K. Hammond (eds.) ICAR Technical Series No. 3. Workshop on Developing Breeding Strategies for Lower Input Production Environment, Bella, Italy

Kitalyi, A.J. 1997. Village chicken production systems in developing countries: What Does the future hold? World Animal Review, 2: 48 - 53.

Kolstand, N. and Abdou, FA. 2000. NORFA: The Norwegian - Egyptian Project for improving local breeds of laying hens in Egypt. In: S. Galar, J. Boyazoglu and K. Hammond (eds.) ICAR Technical Series No. 3. Workshop on Developing Breeding Strategies for Lower Input Production Environment, Bella, Italy

NEC. 1999. Annual Economic Report. National Economic Council of Malawi. Ministry of Finance, Economic Planning and Development, Lilongwe, Malawi.

NSO 2000. National Statistical Office. Press Report on National Statistics, 1998. Zomba, Malawi.

AGROECOSYSTEM CHANGE AND THREATS TO AGROBIODIVERSITY IN THE TROPICAL MOUNTAINS OF XISHUANGBANNA, YUNNAN, CHINA

By Guo Huijun, Christine Padoch, Coffey Kevin, Chen Aiguo, Fu Yongneng

Agroecosystems in the Xishuangbanna Dai Autonomous Prefecture of southern Yunnan Province (China), as in much of Southeast Asia, are undergoing rapid and profound change. Among the transformations most significant for agrobiodiversity is a decline in the practice of shifting cultivation and its replacement with plantations of industrial crops including rubber and a host of fruits grown in monocultures. Where possible in the region, rice cultivation in paddies is also being extended. Although agricultural patterns in the Southeast Asian region have always been highly dynamic, the scope and pace of the changes occurring now may be unprecendented and have yet to be fully appreciated.

Xishuangbanna is within the center of diversity for rice and is home to more than 400 upland rice varieties. This case study explores ongoing and future effects of these shifts on the conservation of the diversity of upland rice as well as of many vegetables commonly intercropped with rice in swiddens. It also discusses the possible effects of replacing cyclic cultivation systems with far less diverse and permanent plantations. The paper suggests that these changes may also have complex effects on the diversity of other cultural practices. The possible economic, political, and demographic causes of these shifts are also discussed. Finally, the paper outlines some recent and promising countercurrents to agrobiodiversity loss. As some smallholder households explore new agricultural opportunities they are adding diversity to plantations of industrial crops.

MANAGING DIVERSITY IN THE AGRICULTURAL LANDSCAPE: CASE STUDY - GHANA

Edwin A. Gyasi (Ph.D.)
Professor, Department of Geography and Resource Development, University of Ghana, Legon, and Leader, West African Cluster of WAPLEC (United Nations University Project on People, Land Management and Environmental Change)

ABSTRACT

Diversity is a resource inherent in nature. It is reflected variously, notably by composition of the biophysical environment. How to use the diversity of natural resources without destroying it is a fundamental challenge. Over the ages, human societies have developed systems that, at one and the same time, seek to secure food supplies whiles, as far as possible, maintaining natural ecological integrity including diversity of natural species. Foremost among them is small-holder farming systems through which are domesticated and conserved the world's largest pool of plants and animals used to feed humankind. For reasons that still remain inadequately understood, these biodiverse traditional systems together with their underpinning indigenous knowledge have come under threat. This paper describes traditional systems of managing diversity of the biota in agricultural landscapes with a focus on sites of conservation effort under the United Nations University Project, on *People, Land Management and Environmental Change (PLEC)* in Ghana. Strengths and weaknesses of the systems are discussed as are the threats posed to them by, among other factors, pressures of production, exotic systems, and changing dietary habits. Attempts by PLEC to build upon the traditional systems to conserve agro-bio-diversity and their impact on the landscape are evaluated, all with reference to PLEC sites in Ghana's major agro-ecological zones: humid forest, dry savanna, and semi humid forest-savanna, but most especially southern sector of the forest-savanna. Finally lessons are drawn, and their policy implications highlighted.

INITIAL DESCRIPTION OF IN SITU CONSERVATION OF UPLAND RICE IN NAM NUNG COMMUNE, KRONG NO DISTRICT, DAKLAK PROVINCE, VIETNAM

Pham Van Hien [1], Tran Van Thuy [1], H' Wen [1], Tran Trung Dung [1], and D. Jarvis [2]

[1] Tay Nguyen University, Central Highland of Vietnam. Email: pvhien@dng.vnn.vn
[2] International Plant Genetic Resource Institute. Email: D.Jarvis@cgiar.org

Daklak site is new site of phase two of Strengthening the Scientific Basis of *In Situ* conservation of Agricultural Biodiversity: Vietnam Country Component.

Nam Nung Commune (Krong No District of Daklak Province) is belonging to the ecological sub-zone ChuJangSin Low Mountain of Daklak province. Nam Nung has covered by 22,135 hectares of natural area, including 2708 hectares of agricultural land (12.2% of natural area); 16,040 hectares of forest land (72.4% of natural area). With average elevation of 760 m above mean sealevel. Climatically, Nam Nung is also characterized by monsoon tropical climate regime of Daklak province. The average temperature is about 23.3 ^{0}C; total amount of rainfall is about 2177 mm/year.

Total population of Nam Nung commune consists of 6758 peoples from 1288 households, the people of Nam Nung of major Mnong ethnic groups. This is the very poverty commune of Daklak province. Whose livelihood is based on Swidden agriculture with mainly traditional upland rice. Our project were selected 3 villages and surveyed 90 household where is recorded information on name, number of variety cultivated, characterized by qualitative and quantitative, …etc. Morphological criteria used to distinguish each variety and human use. Where the Cropping systems of farmers are very diversity, special diversity of upland rice varieties, Once were more 291 samples upland rice collected, more 15 kindsol main crop and large field, such as: Upland rice, low land rice, maize, Mungbean, Soya bean, groundnut, other beans, traditional vegetables, pepper, sugar, etc.

This is very diversity of upland rice, it causes of: Many different Ecological Sub-zones; Many difference time of the growth and harvest (variety 65, 90, 120, 150 and 180 days); Many difference ethnic groups, so every group has the Characteristic traditional culture and the Religion of different ideological systems; Traditional polytheism to worship different upland rice varieties; Experienced keeping varieties, traditional keeping varieties of the upland rice as a dowry of mother…etc.

More over, the solicitude is the biodiversity and the diversity genetic plants to be the process of the decreasing genetic. In the causes of:
The change of traditional trees by improved trees with higher yield (hybrid maize); The increasing of industrial trees (Coffee, rubber, pepper) dominate the better economic traditional trees; The tendency of monocropping systems for agricultural commodity production; The risk of changeable weather, etc.

Therefore, The tendency research in Nam Nung is how to strength the scientific basis of in situ conservation of agricultural biodiversity, including collection and details description traditional plant kinds, upland rice varieties. The research of in-situ conservation with the fully participation of farmers, the training, experience sharing to the strengthen capacity in the activities related to genetic resources conservation in order to support the people in Nam Nung commune Krong No district for theirs rural development programs.

HOME GARDENS AND THEIR ROLE IN THE CONSERVATION OF TARO DIVERSITY IN VIETNAM

Nguyen Thi Ngoc Hue[1], Dinh Van Dao[1], B.R. Sthapit[2], P.B. Eyzaguirre[3], Luu Ngoc Trinh[1], Nguyen Phung Ha[1]

[1] Plant Genetic Resources Center, Vietnam Agricultural Science Institute (VASI), Thanh Tri Hanoi, Vietnam

[2] International Institute of Plant Genetic Resources (IPGRI), APO Regional Office, c/o 3/202 Buddha Marg, Nadipur Pata, Kaski District Pokhara-3, Nepal

[3] International Institute of Plant Genetic Resources (IPGRI), Via dei Tre Denari, 472/a, Maccarese, 00057 Rome, Italy.

ABSTRACT

Home gardens, known in Vietnamese as *vuon nha*, reflect complex layers of meaning to the farmers who create them. In Vietnam, home gardens are patches of land of varying dimensions surrounding rural houses that are commonly planted with fruits and vegetables. Taro is one of the target crops identified by the global project of "Contribution of home gardens to *in situ* conservation of plant genetic resources in farming systems" in Vietnam. Better understanding of home gardens in Vietnam and the ways that they can serve as conservation sites for taro other indigenous crops is essential. This study was conducted primarily to determine the nature of home gardens, the activities of garden custodians, and the role home gardens may have in conserving taro genetic resources. Surveys of home gardens and interviews of garden custodians were made in four locations in the country. The home gardens in different zones generally differed in their size, structure, and the manner in which they were maintained. Taro was selected as a key species because it is common in home gardens from the North to the South of Vietnam, as well as in the larger agroecosystem. At present, all cultivars currently in use by farmers are local varieties or landraces. They are uniquely adapted to home garden conditions in the different parts of the country. Taro varieties are used as food, fodder, medicine, and for ritual purposes. Taro is important in household food security because it is a crop that is often used and maintained by rural women. Study results indicate that during the long history of taro cultivation, local people in Vietnam have accumulated rich indigenous knowledge and experience in the use and management of taro resources. Different varieties of taro are grown for different purposes and under different maintenance regimes depending on the farmer making the selections. The fact that a number of discrete varieties of taro were found in home gardens within a common agroecosystem suggests that home gardens are good avenues by which to conserve the genetic diversity of taro.

MANAGING BIODIVERSITY IN AGRICULTURAL ECOSYSTEMS

LOCAL MANAGEMENT OF AGRICULTURAL BIODIVERSITY BY COMMUNITIES IN KENYA

Ms ISABELLA A. MASINDE
ITDG-EA.

The Intermediate Technology Development Group is committed to finding practical solutions to poverty. It works with the poor to improve their livelihood. It has a number of projects in Kenya, Zimbabwe and Peru. An important aspect of the work is that it is working towards improving the ecological and human condition in the arid and semi arid lands (ASALs). In Kenya, the Rural Agriculture and Pastoralism Programme (RAPP) works with poor communities in Arid and Semi-Arid Lands (ASALs). The activities of RAPP are focused on food security, sustainable livelihoods, technology development and adoption, policy advocacy, institutional development and gender dimension in development. For example, the Marginal Farmers Project (MFP) is one of the projects under the RAPP implementing food security activities. A major component of this project was a two-year Agricultural Biodiversity Conservation (ABC) study. The study, which focused on the conservation and sustainable use of plant biodiversity in agriculture, namely crops and wild foods growing in farmers' fields, field margins and adjacent wild areas.

The first part of this paper discusses; the ABC findings. The second part, focuses on community based tsetse control work, also being implemented under MFP in southern Kenya in areas of conflict between local communities and wild-life conservation.

Part 1

The ABC Study

Bearing in mind the current gaps in understanding and unanswered questions relating to the conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA), the ABC project set out to answer the following three specific research questions:

- To what extent do farmers want to maintain a number of varieties and crops in the farming system? And what are the reasons for this (why/why not)?
- What techniques and strategies do farmers use to maintain a number of varieties and crops on their farms?
- What forces - positive and negative - help or hinder the maintenance of a number of varieties and crops by farmers?

The study was based on the key assumption that on-farm maintenance of a high diversity of crops provides or supports the sustainable use of agricultural biodiversity. The study recognized the need to consider plant biodiversity in agriculture in the context of wider ecological system and accordingly, paid due attention to all other aspects of agricultural biodiversity in agricultural ecosystem; soil organisms, trees, livestock, etc. and the interactions between these components and plant biodiversity.

Historical Development of Plant Biodiversity Conservation for Food and Agriculture

Up until the last decade or so, international scientists generally believed that the best way to conserve plant biodiversity was to collect samples from farmers' fields and preserve these in national and international `gene banks'.

It is now realized that this approach is inadequate for at least four reasons[3]:

- gene banks cannot `store' the farmers' knowledge and experimentation that creates and maintains agricultural plant diversity, so this vital dynamic component of agricultural plant diversity is missing in gene bank collections;
- Gene bank storage is relatively expensive and risky. For example, seeds in gene banks are generally stored in cool conditions, which requires special equipment dependent on power supplies: if there are power failures, the seeds can be irretrievably damaged;
- it is often very difficult for ordinary farmers to obtain seeds from gene bank collections, as the individual seed samples are usually small (the seeds are not intended for general distribution), and the gene banks may be far away;
- Gene banks cannot store all plant biodiversity from a given area or ecosystem, so they tend to focus on material which is easy to collect; remote and rare material may be missed out.

So instead of relying on conservation in gene banks (often referred to as *Ex Situ* conservation), many people now promote `conservation through sustainable use'. There is of course still an important role for gene banks, but it is more limited for the reasons outlined above. Therefore, the general consensus of opinion is that we must now also encourage and support conservation through sustainable use in farmers' fields (also referred to as *In Situ* or on-farm conservation).

In Situ conservation is promoted in the *Convention on Biological Diversity*, which 174 countries, including Kenya have ratified. In this Convention, the world's governments promise to conserve biological diversity, to make sure that it is used in a sustainable way, and to share out the benefits of using biological diversity fairly to everyone. Box 1 [or Annex A] summarizes the key decisions regarding agricultural biodiversity made by the Conference of the Parties to the CBD over the years[4].

In Situ conservation also forms a significant part of the *Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture*, which was formulated by the FAO International Conference and Programme on Plant Genetic Resources and agreed in Leipzig in 1996. This provides a detailed 20-point global action plan for the conservation of biodiversity in agricultural plants: see Annex B[5].

Finally and most recently, people have recognized that *In Situ* or on-farm conservation should take into consideration the whole ecological system in which farmers are farming. This is because agricultural biodiversity includes not only genetic and species diversity but also diversity of agro-ecosystems as a whole[6].

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[3] For more on this, see van Hintum, 1994.
[4] For more information on the CBD, see the Convention website www.biodiv.org
[5] Copies of the Global Plan are available from www.ICPPGR@FAO.ORG
[6] For more on the ecosystems approach, see the report on the international workshop on opportunities, incentives and approaches for the conservation and sustainable use of biological diversity in agriculture, held 2-4 December 1998 in Rome, Italy (available from CBD website, as above).

An ecosystem consists of a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. Thus agro-ecosystems need to be considered at several levels or scales, for instance, a leaf, a plant, 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. At a higher level still, the full assemblage of ecosystems constitutes the global biosphere.

ABC Research Outputs

The quantitative and qualitative data from the ABC project fieldwork, combined with information from secondary sources, was used to:

- identify the actions farmers take to maintain on-farm agricultural plant diversity;
- identify the core constraints to on-farm agricultural plant diversity conservation and sustainable use at individual household and at community level;
- identify supportive actions that could be taken at community, national, and international level.

Methodology

For this study, Kenya was one of the countries selected where many farmers still actively manage a relatively wide range of agricultural biodiversity on-farm, and where Intermediate Technology Development Group (ITDG) has active programmes relating to food security and sustainable agriculture. the research focussed on experience in what are often called the `marginal lands'[7] for two reasons. First, these areas have characteristics, which support a higher level of agricultural biodiversity, such as low levels of biomass harvesting, crop chemical application, and mechanization, and a diverse landscape[8]. Second, these areas make up a significant percentage of total agricultural land in many countries in the South:
The focus of the ABC Project was on collaborative research involving all relevant stakeholders at local and national level as partners in the information collection, analysis and interpretation process. Country level stakeholders included case study communities and their representatives; local and national level government officials with responsibility for agricultural policy and planning; and staff of non-governmental agencies working on agricultural plant diversity issues at local and national level.

To this end, the Project discussed the research objectives and approach with case study communities at sensitization meetings held before work began, to establish that communities were willing to participate in the research.

Site Selection
The ABC project was implemented in Gikingo and Maragwa Locations, Tharaka District, Kenya- all areas where Intermediate Technology Development Group has good working relations with farmers, and that are representative of `marginal' agricultural lands

'Marginal' is the term used by the UK Department for International Development Environment Research Programme to describe agricultural areas that are less suited to the commercial production of cash crops. However, these areas provide the livelihoods for a significant

[7] Arid and Semi-Arid Lands (ASAL) in Kenya, Natural Regions IV and V in Zimbabwe, and IT-Peru
[8] For more on this, see Edwards, et al pp. 192-200 in Wood and Lenne (1999).

proportion of the world's farmers and tend to have higher agricultural plant biodiversity on-farm than more commercial agricultural areas, hence are highly relevant for this project.

Two sites with reasonably similar agro-ecological conditions were, selected. Each site included between 20-30 villages as shown in Box 3. Within each site, households were selected to represent variation in the factors assumed to influence on-farm agricultural biodiversity: distance to local market centres; soil quality; and cultivated area[9].

Box 3: site selection

Tharaka District 30 Units (villages) in Maragwa Location 21 Units (villages) in Gikingo Location

Focus Crops

In order to keep information collection and analysis manageable, it was decided to focus the Project on the on-farm conservation and sustainable use of diversity in a limited number of crops. The criteria used for focus crop selection were that they should:

- Play a significant role in local farming systems in the case study areas;
- Retain significant genetic (i.e. within-crop) diversity within the case study areas.

It was decided to focus on sorghum (*Sorghum bicolor)*, pearl millet (*Pennisetum vulgare)*. Cowpeas (*Vigna unguiculata)* and gourds were also studied because, whilst they may not play a significant role in local farming systems, diversity is keenly preserved for cultural and social reasons: it was therefore felt that studying them may provide useful insights.

Field Work Tools

The Project set out to answer the research questions set out in Chapter 1 by using a mixture of participatory rural appraisal (PRA); individual household questionnaires; focus group discussions; and seed sampling. Fieldwork was spread over 18 months to two years

PRAs were conducted at village level at each case study site to gather information on the topics outlined in Box 4, in order to provide general background to agricultural plant diversity use in the area and to set the scene for subsequent household interviews. The methods used included mapping, brainstorming, scoring, ranking, flow diagrams, transect walks and time trends in detailed group discussions, key informant interviews, and direct observation. As PRAs on general community resource issues had been conducted relatively recently in a number of the sites, secondary information from these PRAs was also incorporated where appropriate.

[9] Parameters to define the range in these factors were identified by farmers separately in each country and are defined later in this report.

Box 4: Topics covered in PRAs in case study villages

- **Village resource map**, showing types of land, boundaries, physical and infrastructure features.
- **Farming practices**: soil fertility management, planting systems, post-harvest processing and crop storage, sources of seed, availability of wild fruits and food.
- **Crops and varieties grown**: lists of crops and varieties grown; for what purpose (food security, income, etc); reasons for growing a number of different crops and varieties.
- **Biodiversity time line**: factors affecting biodiversity over time, and local variety history, including the time and means of introduction of key varieties in the area.
- **Key criteria** (see *First round interviews* below): community definitions of large and small-cultivated area; good and poor quality land.
- **Seed specialists**: key informants within the village on seed keeping and maintenance of agricultural plant diversity (farmers known for their specialist skills in seed care)

Individual household interviews

The purpose of the individual household interviews was to be able to compare the impact of the three different influential factors on the management of agricultural plant biodiversity by households within countries and also between the three case study countries. To what extent are these different factors important; and in what way do they influence agricultural plant biodiversity management?

In this section, we outline three key issues in agricultural plant diversity conservation that require further research and the experience of other researchers and projects in dealing with them. The first question is; is agricultural plant diversity important to farmers?. The second question is; what skills and techniques do farmers have for managing agricultural plant diversity? The third question is; the impact of national policies and programmes.

Is agricultural plant diversity important to farmers?

It has sometimes been suggested that conserving agricultural plant diversity and using it sustainably does little to contribute to farmers' immediate livelihood needs, and therefore farmers cannot be expected to give high priority to agricultural plant diversity conservation, especially if this carries costs to the farmer.

The evidence so far is that many farmers in the South *do* value having agricultural plant diversity in their farming system, and in fact complain that they do not have enough. For example, this has been the experience with millet farmers in Rajastan, India; with sorghum and millet farmers in Zimbabwe, and with sorghum farmers in Tharaka, Kenya[10]. This is for a mixture of economic, socio-cultural and environmental reasons.

[10] For more on this, see Woods and Lenne, 1996; Witcombe et al, 1998; and Cromwell and van Oosterhout, 2000.

However, the evidence so far also suggests that farmers do not simply conserve the same collections of plants year after year like a gene bank. Rather, they adjust the mixture of plants they use all the time - one researcher therefore describes farms as `dynamic conservation reserves'[11]. These adjustments can be in response to market prices, climate changes, etc.

What skills and techniques do farmers have for managing agricultural plant diversity?

The evidence so far[12] is that agricultural plant diversity is affected by five aspects of farmer decision-making: what morphological characteristics to select for (note that farmers cannot distinguish molecular characteristics); what farming practices to use; where to plant; size of population to plant; and seed source(s).

We do know that farmers vary in how they manage agricultural plant diversity. For example, according to the 1998 *State of the World's Plant Genetic Resources* report[13], some potato farmers in Cusco, Peru, manage 150 varieties; whereas in Iringa, Tanzania, no farmer maize varieties are maintained any more.

The International Plant Genetic Resources Institute (IPGRI) project *Strengthening the Scientific Basis of In-Situ Conservation*, involving 9 countries, will hopefully tell us more about the biology and socio-economics of the use of farmers' varieties. In particular, the project hopes to synthesize information about how to counteract the economic and other forces that contribute to the loss of farmers' varieties[14].

The impact of national policies and programmes

There is some research evidence available that suggests national policies and programmes have a big impact on how farmers use agricultural plant diversity. However more work needs to be done to identify exactly how these policies and programmes could be adjusted to make them more supportive for on-farm conservation of agricultural plant diversity.

For example[15]:

- **input subsidies** and **rural credit programmes** are usually tied to seeds of `modern' varieties and chemical inputs, which pushes farmers to use these inputs instead of using agricultural plant diversity to sustain their agricultural systems;
- policies that promote the **cash economy** and **modernization** push farmers to simplify their farming systems, including agricultural plant diversity, in favor of selling crops in the market to buy factory-made goods;
- **drought relief hand-outs** often only contain seed of `modern' varieties of the main crops, which makes it very difficult for farmers to maintain biodiversity of local crops and minor crops after a drought;
- Countries often want to sign up to **international agreements** like those under the World Trade Organization in order to get trade benefits, but this can also require them to sign up to intellectual property rights systems that could jeopardize local communities' rights to protect and develop their indigenous agricultural biodiversity.

[11] Louette et al 1997.
[12] Jarvis and Hodgkin, 2000.
[13] FAO, 1998.
[14] Devra Jarvis at IPGRI, Rome (d.jarvis@cgiar.org), is managing this project.
[15] This list is taken from Cromwell and van Osterhout (2000) based on experience in Zimbabwe, but similar experiences have also been documented in a number of other countries.

Conclusion and Recommendations

Farmers need support that releases them, especially women farmers from time consuming reproductive workloads such as grinding by use of stones and mortaring the maize so that they can spend more time on activities that promote conservation of agricultural biodiversity.

National governments and the international community should make conservation of agricultural biodiversity the top priority not only ex-situ but also on farms (in-situ).

A measure that recognizes and protects farmers from activities that denies them the rights to control and own their traditional knowledge and agricultural resources such as seeds.

Protection from processes that make small-scale farmers to be dependent on seed companies.

Measures that ensure benefits to communities of small-scale farmers involved in maintaining agricultural biodiversity.

Extension activities to provide forums such as seed fairs for farmers to disseminate their accumulated traditional knowledge on agricultural biodiversity."

Build capacity of organization and farmers to enable protection of indigenous knowledge, through training and provision of resources.

Strengthen community capacity and build indigenous knowledge in agro-biodiversity management and strengthen seed exchange mechanisms at community level. These include traditional medicine, seed specialists, herbalists and paravets.

Promote farmer's initiatives in diversity management through incentives

Support disadvantaged groups (women and youth) who play a major role in diversity management through trainings and provision of resources

Regular awareness workshops should be held for the local communities on indigenous knowledge, farmer' rights and other issues which affect the agricultural production and may hinder sustainable use of plant genetic resources for food security

Coordinate and integrate National policies, strategies, programs and action plan at all levels in order to enhance conservation and sustainable use of agro-biodiversity.

Part 2

Community based Tsetse Control

The Intermediate Technology Development Group- East Africa (ITDG-EA) is facilitating the implementation of a community based tsetse control project-the Kathekani Mbung'o initiative. The initiative is funded by DFID through the Kenya Trypanosomosis Research Institute (KETRI) to enhance the capacity of Kathekani community to sustainably control tsetse through transfer of the KETRI developed technologies, specifically tsetse trapping technology. The Mbung'o initiative is being implemented within the framework of ITDG's on-going food security work- the Marginal Farmers Project which is funded by DFID-JSF and the European Union (EU).

Kathekani area is a marginal farming area in agro-ecological zone 5 and 6. The area borders Tsavo East National Park. The park is a suitable habitat for tsetse flies because of the presence of wild ungulates, particularly the buffalo. The tsetse flies re-invade Kathekani area causing a lot of harm on livestock. Tsetse flies bite livestock and transmit nagana (trypanosomosis) disease. The damage caused to livestock production by tsetse flies and nagana is ranked top livestock problem in Kathekani. Tsetse re-invasions and transmission of nagana threatens livestock production-an important source of food and income for about 3,500 households (about 7 members per household).

By the beginning of this project in December 1999, livestock numbers had been drastically reduced due to disease rather than drought (Fiona Percy, Kathekani baseline report, 1996). This resulted in the need for food relief almost every year. A review of the MFP has revealed that, the community has been able to control the tsetse numbers and they have been reduced from 1000 per trap in 1997 per year to 100 in 2000. This has encouraged the community to introduce more livestock.

The purpose of the initiative is to increase livestock production for farmers in Kathekani through reduced incidences of tryponosomosis. To achieve this purpose the Kathekani Mbung'o project seeks to accomplish the following objectives;

- Establish community capacity for sustainable control of tsetse flies through transfer of tsetse-trapping technology;
- Reduce incidence of tsetse flies and therefore tryponosomosis;
- Increase national and international actions for supporting transfer and wider uptake of tsetse control technologies;
- Develop participatory approaches of community tsetse control; and
- Develop appropriate monitoring and evaluation systems of community based tsetse trapping technology.

The intervention of ITDG-EA/MFP in tsetse fly control in Kathekani has brought about significant reduction in the number of tsetse flies and incidence of trypanosomosis. The reduction is leading to the revival of the livestock industry that had virtually collapsed. The complementary activity of decentralised animal health that trains and equips community based animal health personnel will play a big role in the revival of the livestock industry. It is evident that this intervention is bearing fruit. There is a wide range of technological innovations and adoptions in the project sites. These include: livestock breed improvement; animal feed improvement; intergration of ethnoveterinary knowledge into animal health care system; revival of cattle dips; adoption of drip' furrow and pump irrigation; soil conservation; adoption of drought tolerant short cycle crops and apiculture.

The intervention has focused on institutional development and technological development. Committes have been set up to co-ordinate and plan the Mbung'o (tsetse fly) project activities. There are three main committees: village committees, locational committees and Mbung'o Central Committee (MCC).

The major outcome that was anticipated of tsetse fly control is increased livestock production due to reduced incidence of nagana that has previously led to heavy losses of livestock (Omwega 1999). Benefits related to improved livestock health and production include:

- Increased milk production for better family nutrition and sales accruing to women;
- Increased market sale price from healthy and higher sale weight of the animal;
- Increased numbers of livestock' therefore more income opportunity;
- Savings on treatment and tryps prevention costs;
- More land, previously highly infested with tsetse flies released for grazing;
- Increased local supply of meat to butchers and improved cash economy; and
- Improved long term security through investment in healthy herds.

If the above benefits are realized and sustained, it can be anticipated that poverty will be reduced in the long run. The evaluation of this project revealed that there are already some gains. Respondents to the interviews reported that they are no longer bitten by tsetse flies on their way to fetch water. Most respondents indicated a willingness and rediness to restock cattle even though they had previously lost their herds due to tsetse fly-related diseases.

INTRODUCTION OF AFRICAN INDIGENOUS RICE (*ORYZA GLABERRIMA* STEUD) GENE TO RICE (*ORYZA SATIVA* L.) FOR SUSTAINABLE AND HIGH YIELDING RICE PRODUCTION IN AFRICA — A CASE OF RICE BIODIVERSITY —

Ryuichi Ishii (College of Bioresource Sciences, Nihon University, Fujisawa, Kanagawa, 252-8510, Japan)

In Africa, particularly in West Africa, rice consumption has been increasing with a remarkable rate due to increase of population and also due to the change of eating habit caused by the development of urbanization. In West Africa more than 50 % of rice is produced under upland conditions, and hence development of varieties and cultivation technologies for upland and moreover, LISA conditions have been so far strongly expected.

Oryza glaberrima, an indigenous African rice, has many desirable traits, although, the yielding capacity is low compared with *Oryza sativa,* the normal rice species which is often called Asian rice. The first desirable trait of *Oryza glaberrima* is strong weed competitiveness, which is extremely important trait when rice is grown in upland conditions. The second one is drought tolerance in terms of grain yield, and the third one is high adaptability to low fertilizer conditions, which is appreciated as one of the major LISA factors. The last one will be high protein content of the grain, which is an important trait for the improvement of human nutrition in Africa. A project of "Development of Interspecific Hybrid Rice between *Oryza sativa* and *Oryza glaberrima*" was initiated in West Africa Rice Development Association (WARDA) located in Cote d'Ivoire around 1990, aiming to combine the above mentioned desirable traits of *Oryza glaberrima* with high yielding capacity of *Oryza sativa.* The stage of breeding and agronomic characterization in the project has been successfully achieved, and now they have been into the final stage of seed multiplication and technology transfer. It can be said that the project of the interspecific rice which got a new name of NERICA (New Rice for Africa) is an example of rice biodiversity. The outline of this attractive project for food security in Africa will be reviewed in the paper presented.

MANAGING PLANT GENETIC DIVERSITY FOR OPTIMAL PRODUCTIVITY IN DIVERSE AGRICULTURAL LANDSCAPES

S. Jana, Department of Plant Sciences, University of Saskatchewan, Saskatoon, Canada S7N 5A8

As human needs are modulated by cultural, social and economic factors, so is the biodiversity in both natural and agricultural ecosystems. There is ample evidence that the conversion of natural ecosystems to human-managed agroecosystems has destroyed or degraded natural habitats of plants and animals, and adversely affected biodiversity. Although agriculture has led to a diverse array of agroecosystems around the world, it has also led to the aggressive expansion of a few crop species. Despite the fact that crop yield, rather than conservation, was the main priority of farmers through the history of agriculture, there remained abundant genetic diversity in agricultural plants and animals. The situation changed rapidly with the introduction of modern plant breeding at the beginning of the last century. We witnessed massive loss of genetic and species diversity in modern agroecosystems.

The predominant factors contributing to the accelerated genetic erosion are the never-ending emphasis on higher yield, better quality and greater genetic uniformity. Human societies have become increasingly dependent on the high productivity of a few selected species, and thus become vulnerable to ecological and genetic instability. For this reason, sustainable management of genetic diversity in the agricultural landscape has become a conservation imperative. Here we describe a simple and inexpensive scheme for sustainable management of genetic diversity in annual crop species.

Select a genetically diverse set of *ex situ* preserved crop genetic resources (CGR) of a target species with widest possible genetic diversity. In the absence of genetic information on CGR, choose accessions from a wide range of agroecological conditions. Synthesize a genetically heterogeneous population of the selected CGR and maintain parts of this population (subpopulations) in farmlands representing diverse agroecosystems with distinctive physical and ecological characteristics. Allow adaptive genetic changes to occur within and between these subpopulations. Genetic diversity will increase as the spatial genetic differentiation between subpopulations increase.

Evidence from genetic surveys of plant populations indicates that populations maintained in contrasting agroecological conditions develop distinctive multi-character associations due to adaptive multigenic organization. This is a powerful evolutionary process capable of enhancing genetic differentiation between subpopulations and increasing spatial genetic diversity. Natural selection may be complemented by conscious selection of crop genotypes for specific niches, as has been practiced by peasant farmers in traditional agroecosystems through millennia. These then would be the modern equivalent of landraces that thrive in traditional agroecosystems and serve as rich reservoirs of genetic diversity. This dynamic conservation scheme can be modified to conserve perennial species, as well as a multitude of agricultural species to meet diverse human needs.

In recent years, participatory plant breeding or involving producers in breeding and selection of crop varieties for specific farming conditions has been emphasized. Focusing on niche-specific adaptation these practices would rapidly increase biodiversity in agroecosystems, as has been found in participatory rice improvement in Nepal (Sthapit et al. 1996 and later).

DIETARY DIVERSITY, GLOBAL CHANGE AND HUMAN HEALTH

Timothy Johns, School of Dietetics and Human Nutrition, Macdonald Campus, McGill University, Ste Anne de Bellevue, Quebec, H9X 3V9, Canada
johns@macdonald.mcgill.ca

Ingested plant and animal products offer functional benefits to health in addition to essential nutrition. This recognition parallels a growing appreciation that emerging diseases of global importance with a dietary basis can be better addressed through a diversity of species and genotypes, rather than by focussing on single chemical entities within a minimized source base. While traditional systems typically provide diets varied in composition, contemporary global socio-economic, cultural and environmental changes that limit dietary options set the stage for new epidemics. Micronutrient deficiencies which remain serious global concerns are for burgeoning urban populations potentially compounded by diseases of energy over-consumption such as diabetes, cardiovascular disease and cancer. Moreover, reduced or non-existent intake of fruits, vegetables and other traditional plant products represents a paucity of the phytochemical factors that might help counter the adverse effects of contamination, the highly oxidizing conditions associated with substandard cooking practices or other environmental deficiencies characterizing many circumstances of urban poverty.

The success of agriculture focussed on a few staple crops in addressing fundamental problems of food security ironically contributes to new health problems, both as the source of inexpensive carbohydrates and fats and by disrupting physiological balance normally maintained through diversity.

Indigenous resources are often superior to alternate foods although their biological benefits may remain unrecognized by scientists. Nutrient, digestive, antioxidant, hypoglycemic, immunomodulating, pharmacological and other properties that meet local and regional needs can offer a rationale for the conservation of these resources. As well regional commercialization of traditional species and elaboration of dietary supplements and other products that can be harvested sustainably can offer economic opportunities for local communities.

Indigenous knowledge in addition to offering insight into the properties of plants and animal products can be a focal point for the maintenance of cultural integrity, and procurement and preparation of indigenous foods can help to enforce and restore social structures. Thus socio-cultural considerations are essential both for identifying diversity and as an avenue by which diversity is conserved under changing economic conditions.

Within the disease context that accompanies disruption of traditional human ecology, biological and cultural diversity in concert with scientific investigation offer a means for optimizing the necessary adaptations to the dietary and environmental change confronting humans in developing and developed countries alike.

BIODIVERSITY IN FLOOD AND LANDSLIDE HAZARD MANAGEMENT IN THE RIO GRANDE VALLEY, JAMAICA

ABSTRACT

The Rio Grande Valley is an agricultural area in the eastern part of the Caribbean Island - Jamaica. The Valley, which covers about one-third of the parish of Portland, spans about 286,000 hectares. The combination of physical conditions in the area (temperature, rainfall, and soil type) gives rise to high agricultural productivity. Agricultural produce in the Valley is principally a variety of fruit and cash crops, including banana, coffee and a wide range of ground products.

The area is prone to flooding and landslides due to a combination of its geology topography, and climatic conditions. Past and current farming practices have exacerbated the vulnerability of the area to these hazards. Nevertheless, research showed that there were many examples of sound, innovative resource management practices employed by small farmers at the demonstration site examined. Some of the farmers utilised a variety of agronomic measures which included mixed cropping, agro-forestry, kitchen gardens, bush fallowing and crop rotation. It was further observed that farmers were cognizant of the role played by trees and shrubs in reducing soil erosion.

The poster will illustrate the farmers' uses of bio-diversity (cultivated and wild growing plant species) as a hazard management strategy on flood and landslide prone farms at the Jamaica-PLEC demonstration site. Other past and current functions that bio-diversity play will also be highlighted, along with the challenges the farmers face in farm management.

NATURAL SYSTEMS AGRICULTURE: A NEW OPPORTUNITY FOR AVIAN CONSERVATION IN AGROECOSYSTEMS.

Gregory A. Jones and Kathryn E. Sieving, Dept. of Wildlife Ecology and Conservation, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida, USA.

During its first years, the American Ornithologists Union (AOU) actively promoted the study of avian food habits, due to concerns over legislation permitting the destruction of species popularly considered to be agricultural pests. At the request of the AOU, the USDA Section for Economic Ornithology (SEO) was established to study the interrelation of birds and agriculture. Many studies conducted by the SEO found that most birds utilizing agroecosystems were providing a benefit to farmers by destroying pests through insectivory. SEO reports recommended conservation of many such beneficial avian species, encouraging agricultural producers to increase their presence and use of cropped areas by providing suitable habitat within these systems. However, as agriculture has focused upon the goal of increased production, structural attributes most utilized by avian species within agricultural landscapes have been eliminated. Many researchers have documented the detrimental effects of increased chemical use, mechanization, and homogenous farmland structure on avian populations attempting to utilize agroecosystems. Natural Systems Agriculture (NSA) holds that if agroecosystems are modeled after natural ecosystems that the benefits of Agricultural systems that are modeled after natural ecosystems should exhibit many functional attributes and processes that stabilize natural systems including vegetation adapted to the local climate, closed nutrient cycling, effective resource partitioning, soil preservation, and biological methods of crop protection. Therefore, by mimicking the local natural vegetation structure of native biological communities, farmers can emulate a whole package of patterns and processes that have developed over an evolutionary time frame exhibited by these ecological systems. Ornithologists have an opportunity to propose management recommendations favoring avian conservation within agricultural production systems by working within interdisciplinary teams developing modern sustainable or Natural Systems Agriculture. The largely unexplored diversity of avian insect predators that could be included in natural biological regimes offers numerous possibilities for their use in cropping systems. Birds of conservation concern, both resident and migratory, can benefit from cropping systems and farmland habitat structure created to enhance insectivorous bird use of agroecosystems. Through this effort many habitat features and the structural complexity once found within agricultural landscapes supporting avian species in the past will be reintroduced. As agricultural producers recognize the importance of a structurally and biologically diverse farmed environment ornithologists can institute the resurrection of quality avian habitat within agroecosystems.

AN ASSESSMENT OF BIRD FAUNAS UTILIZING CONVENTIONAL AND ORGANIC FARMLANDS OF NORTH-CENTRAL FLORIDA.

Gregory A. Jones, Kathryn E. Sieving, and Susan K. Jacobson, Department of Wildlife Ecology and Conservation, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida, USA.

The combination of increasing awareness and support for research and development of sustainable agricultural practices is generating new opportunities to test management approaches favoring biodiversity conservation in concert with production goals of producers. Florida FIRST (Focusing IFAS Resources on Solutions for Tomorrow) embodies the Institute of Food and Agricultural Science's mandate to serve Florida's food, agriculture, and natural and human resource sectors and is currently maintaining this mandate through. Under the Florida FIRST Major Program Imperatives IFAS research programs will develop ways for managing a globally competitive agriculture that coexists harmoniously with natural terrestrial and marine ecosystems while maximizing crop and animal diversification, productivity, pest resistance and quality of plant and animal products. Our research program assesses the potential for integrating avian conservation with modern agricultural production in Florida. We intend to identify farmlands that can support substantive avian biomass and describe the potential ecological or functional roles of birds in agroecosystems. We can use this information to identify and learn about potential mechanisms whereby birds that use agricultural landscapes and cropped fields can interact positively with production in the Florida farmlands they frequent. We believe that enlightened management of farmlands will both allow farmers to meet the needs of agriculture and numerous wildlife species in ways that are satisfactory and mutually beneficial. To assess the potential for integration of avian conservation with modern agricultural production in Florida, our research program incorporates two central objectives. First, we endeavor to identify avenues for fostering bird conservation on agricultural lands without negatively affecting current levels of food production and, second, assess potential prospects for positive interactions of avian species with production such as using insectivory by native bird species to augment biological pest control in agroecosystems. Related to the first of these objectives there is a need to characterize agricultural production practices and cropping systems that affect the distribution and abundance of avian species across scales (regional to within-field scales). Rodenhouse et al. (1993) analyzed Breeding Bird Survey data from regions dominated by different major crop types in the U.S. and found that bird populations have responded dramatically to the distributions of cropped and non-cropped landscape elements. At more local scales, the distribution, relative cover classes, and juxtaposition of agricultural landscape elements (cropped fields, pastures, and uncropped areas) can determine avian community structure in agroecosystems (Freemark et al. 1993). Moreover, crop production practices and on-farm management activities can also influence bird use of specific agricultural habitats (Rodenhouse et al. 1995). Therefore, our research program addresses bird population densities and species composition differences among habitat elements (microscale), farm structure (mesoscale), surrounding matrix (landscape scale), and related management and cropping practices.

MANAGING SOILS: A CASE STUDY FROM ARUMERU, ARUSHA, TANZANIA.

By: Kaihura, F.B.S. and E.Kahembe.

ABSTRACT

Soil, a physical factor is a crucial resource for ensuring the sustainability of agriculture and crop production in particular. This paper discusses diverse soil management strategies for sustainable agricultural production in Tanzania, with reference to PLEC project sites in Arumeru, Arusha.

Crop harvesting, removal of crop residues and soil erosion have been identified as key factors of declining soil productivity and crop yields in Tanzania. A call is therefore made to develop sustainable agricultural production methods to restore and maintain soil productivity.

PLEC-Tanzania works in sub-humid uplands and semi-arid lowlands on the windward side of mount Meru. Major soils in the sub-humid uplands include Eutric Andosols, Mollic Fluvisols and Alic Andosols. Dominant soils of the semi-arid lowlands include Eutric Nitisols, Haplic Cambisols and Calcic Vertisols. Agroforesrty is the dominant land utilization type of the uplands dominated by the coffee/banana cropping system. Agropastoralism is the major land utilization type of the semi-arid lowlands with Maize/Beans cropping system dominating. Poor soil fertility is a common constraint for both sites. Nutrient leaching and erosion are major constraints of the uplands while soil erosion and moisture stress are more crucial in the lowlands. For both sites indicated constraints are also associated with loss in biodiversity. Within the agroforestry system where manure is a major input, 2 tons fym obtainable from at least 2 stall fed dairy cows within the system is required to maintain a nutrient source of an average farm size of 0.68 ha. In the lowlands, intercropping with beans is assumed to contribute to the nitrogen economy of the soil. Since beans are harvested by pulling out whole plants, the potential of bean roots to contribute to soil organic matter and nitrogen is checked. Also due to transport of grain and stover from lowlands to uplands, the production system is greatly exploitative. Agroforestry techniques and construction of biophysical structures were recommended since early 1980s for restoration of soil productivity of the lowlands. However not all farmers have access to manure in the uplands nor are farmers of the lowlands able to use inorganic fertilizers or construct expensive structures to restore soil productivity. PLEC has for the last $3^1/_2$ years been working with farmers in the two sites integrating locally developed knowledge of soil, climate and biological resources with scientific assessment of their quality in relation to crop production to develop resource management technologies capable of maintaining crop diversity, management diversity and potential for improving small scale farmer's livelihoods.

Analysis of representative soils from different cropping systems within PLEC sites indicated an overall high resilience of soils to mismanagement in the sub-humid site. They are deep with high organic matter content. The NH_4 and NO_3 nitrogen levels are also high indicating high microbial activity of these soils. The soils in the semi-arid site have low organic matter content with relatively high nutrient content in the topsoil. They are very sensitive to both natural and human induced soil degradation through soil mismanagement.

At farm level cropping and soil management systems varied between farmer categories with respect to farm size, access to inputs, labour, ability to cope with changes and accumulated knowledge on resources management. On 50 x 20 m^2 plots, a rich farmer was found to have 14 soil management strategies for soil conservation, soil moisture improvement and soil

micro/macrobial enhancement. The choice of crops on soil management structures also took into consideration feed requirements for stall fed livestock, human food consumption, market demand of farm products and children feeding habits. The poor farmer had only two soil management strategies with stunted vegetation. The poor farmer's technologies were also capital and labour sensitive. Farmers own techniques were found to be holistic and dynamic in nature but needed to be improved. It was observed that through soil management on-farm biodiversity was greatly enhanced.

PLEC is currently working with farmers with successful locally developed soil management models, integrating them with scientifically proven techniques and demonstrating improved models to the rest of the farming communities using these successful farmers as teachers. This approach of farmer to farmer exchange of knowledge in PLEC demonstration sites appears to result into fast adoption of in-situ developed technologies by farmers in collaboration with scientists and extension staff. The process also results into fast dissemination of such technologies. It is indicative that with continued work of involving farmers to be agents of change in soil management, it is likely that appropriate soil management strategies will be developed and disseminated through constant modifications of locally developed technologies and sustainable agricultural production achieved in Tanzania. Some of the already improved technologies are currently in use by both PLEC and non PLEC farmers.

FARMER MANAGEMENT OF *MUSA* DIVERSITY IN THE GREAT LAKES REGION OF EAST AFRICA

Karamura, D.A.;[1] Karamura, E.D.[1] & Sharrock, S.L.[2]
International Network for the Improvement of Banana and Plantain (INIBAP[16])

[1] Regional Office for Eastern and Southern Africa, PO Box 24384, Kampala, Uganda
[2] Parc Scientifique Agropolis II, 34397, Montpellier Cedex 5, France

ABSTRACT

Cultivation of *Musa* in the great lakes region of East Africa is an ancient tradition. This is demonstrated by wide range of varieties maintained and the different cultural practices followed by farmers in the region. Complex mixtures of cultivars are grown in perennial plantations and these are used to fulfill the farm family's needs in terms of food security, income and cultural demands. The cultivar proportions maintained depend on the value and potential of each cultivar in relation to on-farm use and income generation. However, diversity on-farm also depends on the farmers' success in integrating and utilizing the necessary cultural/traditional management practices in maintaining a perennial plantation. An understanding of farmers' traditional management practices can shed more light on the factors which affect diversity on-farm and hence assist in developing on-farm conservation strategies.

A study was carried out to determine farmer management practices and investigate the influence of these on cultivar diversity on-farm. 135 farmers were selected from 4 sites, 2 in Tanzania and 2 in Uganda. Two of the sites were from higher altitude areas (>1500 meter above sea level) and two were from a lower altitude area (< 1300 meters above sea level). Informal participatory methods were used to obtain information from farmers about the management of the crop. These included group discussions and individual interviews with a questionnaire and a checklist. The questions covered the entire crop cycle, from the selection of planting materials to the utilization of the crop and its products. A correlation analysis was carried out to see how factors related with each other and with cultivar diversity. The criteria used by farmers to select cultivars were also investigated and compared across sites. Results showed that 39 cultivars are widely cultivated across the region and that their distribution and proportion correlated with the major farmer cultivar selection criteria. Across all sites, the most important factors identified by farmers for selecting varieties were: bunch size, palatability, period of maturity and resistance to pests and diseases. The disappearance of cultivars appears to be linked most closely with pest and disease attack, declining soil fertility and the marketability of the variety. Results indicated that, over time, cultivars have been conserved on-farm mainly through the process of planting material exchange between farmers. In addition the study identified areas of farmer management that will need to be strengthened in order to assist farmers to sustainably conserve their *Musa* diversity.

[16] INIBAP is a programme of the International Plant Genetics Resources Institute (IPGRI)

DIVERSITY AND DISTRIBUTION OF PLANT PARASITIC NEMATODES OF *PHASEOLUS VULGARIS L.* AND IMPACT OF SELECTED NEMATODE MANAGEMENT STRATEGIES

N.K. Karanja[1], J.W. Kimenju[1] and I. Macharia[1] and R.A. Sikora[2]

[1] University of Nairobi, P.O. Box 30197, Nairobi, Kenya,
[2] Dept. of Plant Pathology in Soil Ecosystems, University of Bonn, Nussallee 9, 53115, Bonn

Keywords: *Bacillus*, *Rhizobium*, organic amendments, diversity, nodulation, integrated control

ABSTRACT

A study to determine the distribution and population densities of plant parasitic nematodes associated with beans was undertaken in Kakamega, KiaMachakos and Siaya districts of Kenya. *Meloidogyne spp*. and *Pratylenchus spp.* were the most predominant endoparasites, occurring in 86 and 61% of the root samples respectively. *Scutellonema* and *Helicotylenchus* species were recovered in 86 and 59% of the soil samples respectively. Field experiments were conducted to determine the efficacy of organic amendments in the control (chicken manure, compost, neem baobab and farm yard manure) of root-knot nematodes. The amendments showed varying levels of nematodes suppression with chicken manure being rated as the most effective while sisal wastes were least effective. Application of commonly used organic amendments (chicken and cow manures, *Mucuna pruriens*, *Tagetes minuta* and *Azadirachta indica*), in soil fertility management were found to stimulate build-up of the nematode destroying fungus, *Verticillium clamydosporium*, and *Bacillus Spp.* in the soil. The potential of different *Bacillus* isolates in reducing infection by rootknot nematodes in beans was investigated using Leonard jars under greenhouse conditions. The isolates had varying effect with the majority (93%) of the isolates causing a reduction in root galling when compared to the control (water). Twelve percent of the isolates were more effective than carbofuran (nematicide). In another greenhouse experiment investigating the interaction between *Bacillus spp.* and *Rhizobium* strains inoculations using N-free sterile sand, 4 out of the 20 *Bacillus* isolates significantly promoted nodulation in bean plants.

BIOSYSTEMATICS OF *PSYTTALIA* SPECIES/POPULATIONS (HYMENOPTERA: BRACONIDAE) ATTACKING FRUIT FLIES IN KENYA AND POSSIBLE BIOLOGICAL CONTROL IMPLICATIONS.

S. W. Kimani-Njogu and Maxwell K. Billah
International Centre of Insect Physiology and Ecology (ICIPE), P. O. Box 30772, Nairobi, Kenya.

ABSTRACT

The identity of species of *Psyttalia*, parasitoids of tephretid fruit flies in Kenya, was investigated. Individuals reared from coffee infested with *Ceratitis capitata* (Wiedemann) (Medfly) and two other tephretid species in Kenya were compared with individuals of *Psyttalia concolor* (Szépligeti) from a laboratory culture in Italy used in augmentative biological control of olive fly, *Bactrocera oleae* (Gmelin). Reciprocal crosses showed full compatibility, with the production of viable female offspring up to the second generation. *Psyttalia* species from different host plants/fruits and host flies also showed full compatibility. In spite of this compatibility, various *Psyttalia* species seem to have specific host plant/fruit preferences. The potential and implications for the use of these parasitoids for integrated pest management and classical biological control is discussed.

PRO-ENVIRONMENTAL EDUCATION ON THE DIFFERENT AGE LEVEL: PROMOTION OF THE KNOWLEDGE ABOUT THE SOIL FAUNA BIODIVERSITY

Joanna Kostecka
Agricultural Academy in Cracow - Department in Rzeszów,
Institute of the Natural Basis of the Agricultural Production
ul. Cwiklinskiej 2, 35-959 Rzeszów, Poland
e-mail: jkosteck@ar.rzeszow.pl

The public knowledge about the soil fauna biodiversity is very poor. How to improve the knowledge about its importance? How to produce the society love for the soil, which will grow as a care for it without degradation activity of the mankind? Author of that poster wants to introduce her wide projects connected with pro-environmental education and didactic work with people in different age: kindergarten, primary- and secondary school pupils, students, farmers, agricultural advisors and teachers. She takes active part in popularising the meaning of protozoan, earthworms, enchytraeids, mites, spiders, soil insects and other soil animals of the food chain to farmers and pupils of local schools.

One of the best known soil creatures are earthworms. They are very handy as an didactic instrument, because they are numerous in all types of the soil, big, easy to find, identify and keep for culture.

Can a teacher use a „scientific story" to make children more sensitive to environmental issues? A better understanding of the role of soil fauna among the youngest will help eliminate the groundless fear of these animals. Making children more aware of their role for the food chain, will help them to respect and like all animals, despite their elongated shape and lack of legs.

A scientific story – "Look Inside the Soil, The Play in Four Acts" by Kostecka (1996) - lets children better understand life that lives underground. The main characters are the soil creatures. In non English speaking countries this story can help to promote two effects: understanding and love for varied soil life and pro-environmental and English education.

Poster will introduce to some checked proposals connected with soil fauna in pro-environmental activities. Between others, will lead to "home vermi-recycling system", where the organic component of waste can be changed to vermicompost right where it is produced. Children and adults, should see worms in demonstration of vermicomposting units. It also can be use at the classroom, because it is the chance to study biodiversity of the creatures involved in vermicomposting and also decrease the amount of organic waste.

Some another animal species could be found in earthworm cultures. These may include snails, centipedes, spiders or small white apterygous insects known as springtails. These animals cooperate with earthworms in the process of the mineralisation of organic matter (they break up particles of organic matter and thus facilitate the work of reducers, present but invisible to the naked eye, but surely present there, like bacteria and fungi). In a natural environment all the animals which constitute the soil fauna are also important.

Teaching objectives of using "classroom vermi-recycling system" are wide: a) to learn about other inhabitants of the soil: snails, centipedes, spiders, springtails and other soil insects, b) to relate them to earthworms in order to view natural ecological relationships, c) to understand mutual relationships between all organisms living in ecosystems.

STUDIES ON VERMICOMPOSTING OF HOUSEHOLD AND AGRICULTURAL ORGANIC WASTE: GROWING PLANTS ON VERMICOMPOST AS A WAY TO PRODUCE HIGH QUALITY FOODS

Joanna Kostecka
Agricultural Academy in Cracow - Department in Rzeszów,
Institute of the Natural Basis of the Agricultural Production
ul. Cwiklinskiej 2, 35-959 Rzeszów, Poland
e-mail: jkosteck@ar.rzeszow.pl

Production of fruits and vegetables with high qualitative parameters, provides a chance to improve human health, and the environment.

A large concentration of mineral nitrogen and potassium in soil disturbs biological relationships between soil, plants and human health. In many fruits and vegetables the nitrate and heavy metal contents exceed their permissible levels. It is possible to prevent this by replacing mineral fertilisers with vermicompost.

Vermicompost it is an organic fertilizer, which can be produced from different organic waste, using worms at a high population density in cooperation with a lot of other soil animals.

During the period of 1993-2000 experiments were conducted to check features of carrot, cucumber, tomato, leek, celery and potato cultivated on vermicompost and mineral fertilisers.

Vermicompost produced from cattle manure is a universal fertiliser and, being characterised by good physical structure as well as rich biodiversity and diversified composition, what is providing a good soil properties and fully macro- and microelements for plants. Vermicomposts used for experiments contained the following available nutrients: 450 – 665 mg NO_3, 800 – 2230 mg P, 1400 – 5225 mg K, 1000 – 1450 mg Ca, 500 –1500 mg Mg $\cdot$ kg^{-1} of dry mass. Also, 300 mg Na, 4 mg B, 8 mg Cu, 120 mg Mn, 60 mg Zn, 800 mg Fe were present per dm^3 .

Generally all experiments fitted into the established pattern:

The culture bed was always checked first for the content of nutrients needed by definite species of cultivated plant. Then the fertilisation mode was determined to achieve a balance between nutrients contributed in vermicompost, mineral fertilisers and plants requirements. Watering and other cultivation and protective measures were conducted at the same time on all parts of the experiments.

Then samples of plants from vermicompost and mineral fertilisers were compared and contents of nitrates and heavy metals (Pb, Cd, Cu and Zn) in it were determined.

In the experiments described above, it has been shown that plants growing on vermicompost were characterised by lower contents of nitrates and heavy metals, in comparison with plants cultivated on mineral fertiliser. Differences between nitrate contents in plants grown on vermicompost and those on mineral fertiliser varied within: 50% for carrot, 30-50% for cucumbers, 54% for tomato, 63 –70% for leek, 29% for celery and 47% for potato.

Differences between heavy metals levels were (varied) as follows: for carrot: Pb 39%, Cd 40%; for cucumbers: Pb 15 - 40%, Cd 2 - 75%, for tomato: Pb 19%, Cd 8%; for leek: Pb 11-15%, Cd –20 - 38%; for celery: Pb 10%, Cd 22%; and for potato: Pb – no difference, Cd 33%.
Vermicompost also had positive effects on crops by improving their processing properties: for instance better shaped carrot roots, better taste (checked by blind- testing group of people), lower foliage of cultivated tomato, therefore faster ripening of fruits and easier harvesting.

STUDIES ON VERMICOMPOSTING OF HOUSEHOLD AND AGRICULTURAL ORGANIC WASTE: BIODIVERSITY OF THE SOIL MAKROFAUNA AFTER VERMICOMPOST INTRODUCTION INTO THE SOIL

Joanna Kostecka
Agricultural Academy in Cracow - Department in Rzeszów,
Institute of the Natural Basis of the Agricultural Production
ul. Cwiklinskiej 2, 35-959 Rzeszów, Poland
e-mail: jkosteck@ar.rzeszow.pl

Conservation of the biodiversity provides a proper functioning of all environments. One of the most important is the soil. Level of the crop quarantine maintenance of the mankind, between other, depends on the soil fertility, which is also connected to the richness and biodiversity of the soil fauna.

There are a lot of evidence that introduction of vermicompost into the soil is important from the few reasons: it is raising the plant crop, the same as ensure the proper course of physiological and biochemical plant processes. In the process of mineral nourishment of plants, microelements, among others, are safeguarding the ability of selective uptake of optimum levels of other necessary elements. Another important aspect is that macronutrients are available in vermicompost, partly in mineral form (i.e. immediately absorbable) and partly in organic form, from which they are gradually set free (also by the soil edaphon), to the soil solution. It assures that plants are systematically supplied with nutrients, while nutrients are protected against leaching from the soil. That is why vermicompost out competes highly concentrated mineral fertilizer, which is a source of macronutrients, but does not assure the plants sufficient access to many microelements.

How the addition of vermicompost is affecting the soil makrofauna, which is also very important for the proper soil fertility?

The experiment was carried out in the field conditions, since one year now. Vermicompost from the household waste was added into the soil on the plot inside the closed gravel heap. After a year, samples of the soil with vermicompost added and without it, were taken. The quality and the quantity of the soil makrofauna in both types of the soil were indicated using the wet funnel extraction method.

The number of *Enchytraeidae*, *Collembola*, *Acarina*, *Diptera* larvas and other (*Diplopoda*, *Oniscoidea*) was higher in the soil with the vermicompost addition, but the differences were not statistically significant (p=0.05).

The experiment will last for the next years (with every year vermicompost addition).

EXPERIENCES OF A MULTI-DISCIPLINARY RESEARCH TEAM WITH ENHANCING THE USE OF CROP GENETIC DIVERSITY OF FARMERS IN SELECTED AREAS IN CUBA.

Humberto Ríos Labrada[1], Rodobaldo Ortiz Perez[1], Conny Almekinders[2] Gladis Verde Jimenez[3], Lucy Martín Posada[4], Manuel Ponce Brito1[1], Irene Moreno Moreno[1], Rosa Acosta Roca1[1], Sandra Miranda Lorigados[1], Ronnie Vernoy[5], Lianne Fernandez Granda[6], Ernesto Ferro Valdes[7] and Christophe Schiess[8]

1 National Institute of Agriculture Sciences.
2 Wageningen University
3 Havana Agricultural University
4 Psychological and Sociological Research Centre
5 International Development Research Centre.
6 Fundamental Research Institute in Tropical Agriculture
7 Department of Agronomy and Forestry of La Palma. Pinar del Rio University
8 Bsc Student from Swiss College of Agriculture

SUMMARY

One of the consequences of the economic crisis that Cuba is experiencing has been the rapid deterioration of the conventional, centralized seed production improvement and distribution system. In addition, the formal agricultural research and development sector has considerably been curtailed by budget cuts, comparable or more severe than in those countries where structural adjustment has had a strong impact. At the same time and as a reaction to the crisis, agricultural production has moved away from an exported-oriented, mono-culture based and high input dependent to a more diversified, low input based and local market-oriented system.

The effects of these changes on farmers' access, use and management of crop genetic diversity have not been known until researchers started systematically studying the use of bean, maize and rice varieties. Findings to date indicate that the genetic resource base is under serious pressure as a result of the interactions of agro-ecological and socio-economical conditions. However, farmers are interested to counter-balance these negative forces through alternative practices.

"Participatory Plant Breeding for Strengthening Agro Biodiversity in Cuba" is a multi-institutional and multidisciplinary project that investigates how to contribute to these alternative practices and rebuild agro-biodiversity in the country. Making use of the space opened up by the economic crisis, the Project aims to develop participative seed production, improvement and distribution practices. The Project operates in two sites, the rural community of La Palma and the rural surroundings of Havana, and uses a variety of research tools including surveys, seed fairs and field days, and participatory variety selection.

In La Palma, an agro-ecologically variable area (variations in soil texture and humidity, inclination, and fertility) farmers used relatively high levels of crop genetic diversity. Changes were apparent, due to different agro-ecological and socio-economical factors. The survey showed that farmers had substituted local rainfed rice varieties for improved varieties when pumps were introduced in the '60-70. Now that fuel and pump spare parts are not available any longer, improved varieties are increasingly of no use. Farmers have started to speak about the "old" varieties that were well suited to the low fertility rainfed hillside fields. However, these varieties

have largely disappeared and farmers are not in the position to easily search and find these seeds. Concerning beans, farmers pointed out an increase in disease infection during the last ten years. As for maize, they noted that varieties have been quite stable in terms of diseases and pest resistance.

In the area around Havana, the agro-ecological conditions are relatively uniform. Here, most farmers, organized in cooperatives, depend on the formal seed sector. With the sector in troubles, farmers are struggling. After a maize diversity fair carried out by the project, most participating farmers expressed a strong interested to improve the management of varieties on-farm. The project started to work with them and after three selection cycles: a) one cooperative became self-sufficient in seed maize (1.8 ton) on the basis of a bulk population selected by cooperative farmers. However, they have no incentive to increase their seed production since there is no local seed market. b) A second cooperative is sowing maize hybrid and bulk maize populations at the same time. c) A third cooperative also produced bulk seeds, but unfortunately they lost it because they lack proper storage conditions. d) A private farmer from the same region recognized as a hybrid seed grower, is loosing self-selected bulk seeds because he is not allowed to sow his maize seed bulk on-farm during the hybrid seed production season.

In workshops held by the project farmers expressed their wish to become seed growers for the formal sector. The formal sector gives incentives to seed growers in the form of input supply and preferential prices. The question now is how farmers will respond: will they produce seeds for enhancing crop diversity or to obtain inputs from the formal sector? or both?

In order to learn more about farmers' preferences, the project team regularly organizes field days. These field days are organized in such a way that farmers, both men and women, are interviewed about their preferences - information that is crucial to plant breeders in identifying parental materials and selection criteria. Results show that participating female farmers have preferences for yield, esthetical beans characteristics as color, shape and brightness, as well as culinary grain properties. Participating male farmers have preferences for yield, diseases resistance and pod size. Seeds selected by farmers as "most liked," were given to them a few weeks after the field day. The Project team is now studying (possible) seed exchange and diffusion among farmers. Findings will complement the sociograms made as part of the surveys.

The Project team functions as a resource-body for other researchers who are interested in similar approaches. The team is also involved in genetic analysis through collaboration with biotechnology scientists at National Research Institute of Agricultural Sciences. Later on, the team aims to embark on participatory work in the urban agricultural sector in which support to the use of crop genetic diversity seems similarly relevant.

The research group recognises as its challenge for the coming time the development of a reflection process that will contribute to learning of scientists and in the creation of an enabling institutional environment research group in the near future.

EXPLORATION, COLLECTING AND DESCRIPTION OF IN SITU AGRO-DIVERSITY OF CHILI (CAPSICUM ANNUUM AND CAPSICUM CHINENSE) IN A MEXICAN COMMUNITY

Luis Latournerie-Moreno[1], Jose Luis Chavez-Servia[2], Manuel Perez-Perez1[1], Carlos Hernández-Cruz[1], Rodrigo Martinez[1] and Luis Arias-Reyes[3]

1 Intituto Tecnologico Agropecuario No. 2 (México) – napoleon@mucuy.itaconkal.edu.mx
2 Plant Genetic Resources Institute (IPGRI-Americas) – jchavez@mda.cinvestav.mx
3 CINVESTAV-IPN Unidad Merida (Mexico) – lmarias@mda.cinvestav.mx

ABSTRACT

At Yucatan Peninsula from Mexico there is a great diversity of chili landraces (*C. annuum* and *C. chinense*). However it is unknown at regional, national and so much less international level even few researches systematized on morphological variability and its use have not been done. At community of Yaxcaba, Yucatan, Mexico, during 1999 was conducted a prospecting on chili diversity where the objective was gathering all information in order to determine the traits preferred by farmers of each local variety and landraces diversity of chili preserved on-farm. As part of the project "strengthening of the scientific basis of *in situ* conservation of agricultural diversity on-farm: Mexico country component" were surveyed 62 household where is was recorded information on name and number of variety cultivated and/or used, place where are growing (farmer field, home garden, pot or into orchard), morphological criteria used to distinguish each variety and human use (cooking, special dishes or medicinal). In addition ten plants chose randomly by farmer variety or landrace were characterized by qualitative and quantitative traits. Once were 102 samples collected, described and identified at Maya community of Yaxcaba it was determined that there are eight different morphotypes. Seven of them belong to *C. annuum* known locally as Dulce, Xcat'ic, Ya'ax ic, Cha'hua, Pico paloma, Sucurre and Maax, and one more called "habanero" from the specie *C. chinense*. Ya'ax ic landrace is being cultivated by 38% of farmers, after that habanero is the second in importance (17%), and the last one Pico paloma by 1% sowing in the farmer field and within orchard, respectively. Ya'ax ic was distinguished by long and cylindrical fruit and used to cooking a special dish called "Relleno Negro". On the other hand habanero was identified by its high pungency. All data indicated that at community level is being preserved broad variability of chili landraces as *C. annuum* as *C. chinense* recognized by local names. In the home garden often was found *C. annuum* var. *aviculare* (wild relative) growing closing to local varieties.

CONTRIBUTION OF HOME GARDENS TO *IN SITU* CONSERVATION IN GUATEMALA

Leiva, J.M., C. Azurdia, H. Ayala, W. Ovanda
Faculty of Agronomy, University of San Carlos, Guatemala

ABSTRACT

Home gardens are agroforestry systems maintained by rural farmers, fulfilling an important role in the ecological, social and economic function of communities. Their importance as a system is based on the complexity of interactions between species that occur within home gardens, and their apparent sustainability over time. For these reasons, the system has great potential for *in situ* conservation of the diversity of plant genetic resources found within them. While many studies have documented the contribution of home gardens to development, less is known about their potential contribution to maintaining diversity within agroecosystems due to the small plant populations of any given species and the strong role that human factors play in their distribution and occurrence. The present study examines the factors influencing home garden structure and function in order to provide the underpinnings for conservation policy and development measures. Two contrasting regions were studied, with differences in environment and culture: the Alta Verapaz province in the north, consisting primarily deciduous forest and inhabited by the K´ekchí, Mam and Pocomchí indigenous groups; and the semiarid region in the east of the country, home to Ladino and Cho´ortí communities. 118 home gardens were characterized in which 500 plant species were identified. In the Alta Verapaz region, 414 useful species were identified in 297 genera and 103 families. In the semiarid region, 276 useful species were found, in 208 genera and 85 families. A significant portion of the useful species in the home garden have been brought from the wild in the nearby forest, which is threatened due to high rates of deforestation in the area. Home gardens serve as sites for the domestication of some useful wild species, such as Loroco, *Fernaldia pandurata.* The key species selected for in-depth study, including DNA characterization, were: Zapote (*Pouteria sapota*), Chile (*Capsicum spp*), and Huisquil (*Sechium edule*). For these species it was clear that home gardens conserve significant genetic diversity not otherwise present within the farming system. Additionally, socio-economic studies investigated the contribution of home gardens to household income.

SOCIO-CULTURAL AND ECONOMIC FACTORS AFECTING AGRODIVERSITY CONSERVATION IN THE YUCATAN, MEXICO: A GENDER PERSPECTIVE

Diana Lope-Alzina, José Luis Chávez-Servia, Teresa Duch-Carvallo, Esmeralda Cazares, Victor Interián, Deborah Nares, and Devra Jarvis.

In situ conservation of maize, bean, squash, and chili in the *"Milpa"* (farmer plot system) is influenced by a combination of economic, social, and cultural factors that affect diversity management by the farming community. Milpa farmers in the Yucatan peninsula of Mexico recognize that at the household level, crop diversity plays a special role for the satisfaction of their primary food needs. A study was conducted to determine the affect of possible relationships between social, cultural, and economic factors and activities performed by different family members, on the intra-specific diversity of maize, bean, squash, and chili at Yaxcaba, Yucatan, Mexico. The research focused on (1) complementary activities at the household performed by both women and men, (2) how the social, cultural, and economic factors affect the maintenance of crop genetic diversity, (3) how economic incentive and factors increase or reduce the farmer interest to continue growing diverse crop populations, and (4) how farmer values derived from human "use" of intraspecific crop diversity to prepare diverse dishes. The study included examining the questions of (1) what are the factors that affect the decision-making of men and women, and subsequently influence their management of diversity on-farm, and (2) were there specific social, cultural or economic classes or distinctions between those farmers who manage more diversity and those who manage less diversity. In addition, information was dissagregated on (i) who does the actual management of crop diversity in the field, at home, at markets, and (ii) who makes the decisions on how the management is done and on which varieties are sown or kept or discarded. Thus, for the sites for this study in Yaxcaba, Yucatan, men are in performing most of the activities at the *Milpa* (or in the field), while women are responsible for preparing traditional dishes at home. However both women and men are responsible for deciding which variety to grow for different environmental, economic and cultural conditions. Women not only have knowledge of cooking qualities of different varieties but also have knowledge of agronomic qualities such as earliness and quality of straw, and ecological adaptive qualities such as disease resistance and drought resistance of varieties in different soils. The results also showed that it is possible to define certain farmers groups with similar economic activities who belong to distinct social and cultural groups. For example, farmers who conserve high crop diversity have a higher economic, social, and cultural recognition at the community level than those farmers who conserve a low number of varieties.

BIODIVERSITY IN HOME GARDENS IN NYÍRSÉG-TISZAHÁT REGION, HUNGARY: AGROMORPHOLOGICAL TRAITS USED FOR DISTINGUISHING AND SELECTING BEAN VARIETIES MAINTAINED ON-FARM

István Már[1], László Holly[1], and Devra Jarvis[2]

[1] Institute for Agrobotany, H-2766 Tápiószele, Hungary
[2] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy

ABSTRACT

In modern European agriculture, landraces of field and vegetable crops survive today in marginal areas where they were able to adapt to specific conditions, or where there is a market demand of their high quality product. Farmers have "incentives" to grow varieties when they possess the traits and characteristics that satisfy their objectives. Small-scale farmers who produce for their own or local consumption typically have a range of objectives and constraints and they care about many different aspects of a variety—not only those related to how well the variety grows on certain soil, disease, and rainfall conditions, but also those associated with how well the grain and stover serves for feed, fodder, staple foods and special dishes prepared for special occasions. As part of a project to strengthening the scientific basis of *in situ* conservation of agricultural biodiversity on-farm, participants in Hungary are working to reveal the mechanisms acting in an advanced economy for or against landraces' survival and their sustainable use. We propose that landraces conservation in advanced economies can be better understood by revealing the traditional knowledge related to the traits used for distinguishing and selecting these varieties. Since 1997, several sites have been surveyed to investigate the extent of landrace materials in farmers' fields. Nyírség-Tiszahát region is one of the targeted areas of the project. Landraces identified in the collection missions were found in home gardens. Most of the home gardens in rural Hungary have evolved from the plots that households were permitted to cultivate privately during the period in which agriculture was collectivised (1960-1989). Ranging in size from an estimated 0.5-1 ha, these garden areas have long played a significant role in meeting subsistence needs of rural households. While field crops have been generally grown on large-scale, fully mechanized farms, home gardeners have specialized in labour intensive production of preferred varieties and crops. These small repositories of genetic diversity are cultivated entirely with family labour. The names given to local bean varieties are correlated with some of the crop's agro-morphological traits, especially seed colour (e.g. fehérbab=whitebean, feketebab=blackbean, barnabab=brownbean) and can also have some reference to their traditional use (menyecskebab=young wife's bean). The seed selection process is predominantly based on traits identified during the vegetation period (shorter for fresh consumption, longer for intercropping with maize), pod lenght and shape, pod colour (in general yellow and white colours are preferred) and shape of seeds. The selection of a particular variety for quality is determined in part by postharvest handling and processing. The taste and cooking time are the primary quality parameters used for the selection and maintenance of a specific variety at the household level.

CONSERVATION AND USE OF LOCAL FIG (*FICUS CARICA* L.) AND POMEGRANATE (*PUNICA GRANATUM* L.) VARIETIES IN SOUTHERN TUNISIA.

Messaoud Mars
Institut des Régions Arides (IRA)
4119 El Fjé, Médenine - Tunisia.

Key words: Arid lands, fig, *Ficus*, pomegranate, *Punica*, genetic resources, participatory approach, *in situ*, *ex situ*, conservation, use, sustainable development.

SUMMARY

Fig (*Ficus carica* L.) and pomegranate (*Punica granatum* L.) are traditional fruit trees in Tunisia. They are well adapted to arid and semi-arid environment. They have an important ecological and socio-economic role and can valorize marginal soils and saline waters. Varieties are local and numerous but under high pressure of genetic erosion. A project has been conducted since early 90's for the conservation and use of local genetic resources. *Ex situ* collections are already established and contain, respectively, 64 and 55 accessions of pomegranate and fig. Experiences of *in situ / on farm* replantation are undertaken. Results show a considerable diversity of local germplasm. Rural areas and home gardens remain the main source and final destination of these fruit crops diversity. Farmers are the producers and the final users of the diverse plant material and agro-food knowledge. It was relatively easy to demonstrate to growers the importance of local genetic resources, but it's still hard to convince them to conserve cultivars with low economic value.

Research results were presented and discussed in several local and national, scientific meetings. Field days and demonstration sessions were organized with technicians and farmers. Project team members participated in several local festivals and exhibitions. Thus, public awareness about the importance of local germplasm in sustainable development is really improved. Technicians and growers are aware about the relative lack of adaptation of introduced varieties. Growers associations are more and more interested in the selection and improvement of local high value clones to be used in new plantations.

It was concluded since the beginning of the project that, for such activities, it's necessary to strengthen relationships between all partners (research institutions, development agencies, local organizations, local communities, authorities, growers, etc). Authorities at local and national level were gradually involved through the dissemination of technical and scientific documents generated by the project.

Local genetic resources need new approaches and techniques and further collaborative efforts to be preserved and integrated in sustainable rural development programs. It's necessary to emphasize more on *in situ* preservation of gene-pools. *Ex situ* collections of perennial woody plants present many technical problems particularly in arid zones with scarce water resources. Conservation of native land-races could be easier through the development of novel uses bringing them up as performant cultivars. However this is not a guarantee unless it's integrated in a larger sustainable agriculture development system. Such activities can not be efficiently initiated and implemented without a good financial support. Pilot experiences may have a valuable role.

LISTENING TO LANDHOLDERS: APPROACHES TO COMMUNITY NATURE CONSERVATION IN QUEENSLAND

Dr Joanne Millar
Team Leader, Community Nature Conservation
Queensland Parks and Wildlife Service
PO Box 155, Brisbane Qld Australia 4002
Tel.: (07) 3227 7919, fax (07) 3227 7676, Email: joanne.millar@env.qld.gov.au

ABSTRACT

The Queensland Parks and Wildlife Service (QPWS) established the Community Nature Conservation (CNC) Extension Network in 1998 to assist landholders, community groups and local governments with nature conservation planning and management on private and leasehold land in Queensland. The network now includes 17 regional extension officers, six Bushcare facilitators, seven Land for Wildlife coordinators and seven NatureSearch coordinators. CNC staff work across 12 bioregions with diverse ecosystems and varying levels of landholder commitment and capacity to manage and protect areas of habitat.

Nature conservation on private and leasehold land in Queensland (more than 90% of the state) has become critical for the survival of many plant and animal species, and their associated ecosystems. The conservation status of Queensland's bioregional ecosystems currently shows that 32% of the total number of regional ecosystems are either 'endangered' or 'of concern'. The new Vegetation Management Act 1999 protects 'endangered' ecosystems and those vulnerable to land degradation, and seeks to voluntarily protect 'of concern' ecosystems through a regional vegetation planning process. Only by working with landholders to encourage and enable them to retain or sell high conservation value areas, and manage other areas sustainably can Queensland prevent further loss of its natural heritage.

In 1997 the ANZECC Working Group on Nature Conservation on Private Land identified best-practice initiatives and principles for achieving ownership and involvement of landholders in nature conservation on private land. These include building relationships with landholders; incorporating best practice nature conservation into existing extension and planning programs, and focusing on outcomes, monitoring and evaluation. The QPWS Community Nature Conservation extension program has developed an integrated framework for extension delivery based on these principles and meeting a range of client needs.

In working with landholders and the community it is important to recognise the social, historical and financial context in which they live, and factors influencing their willingness and capacity to embrace conservation. Market research was conducted in 1999 using focus groups and a phone survey of 716 landholders across 12 industries to give a statewide, regional and industry perspective on issues affecting landholders in relation to nature conservation on their properties, their information needs and communication preferences.

Findings revealed that landholders require access to practical, locally relevant information using best practice examples as well as financial assistance to carry out integrated nature conservation practices. Threats to production such as weeds, feral animals, tree regrowth and water quality were considered more important than habitat decline or endangered species, although there was considerable interest in wildlife issues. The challenges ahead for Community Nature

Conservation in Queensland are to demonstrate the links between biodiversity conservation, threatening processes and farm viability; increase the availability of incentives; and build on existing landholder stewardship and experience.

INTRODUCTION

Biodiversity conservation on private and leasehold land in Queensland has become critical for the survival of many plant and animal species, and their associated ecosystems. Only 4.1% of Queensland's land area is under the protected area estate, leaving 96% of the state (of which 70% is leasehold) managed by private landholders or state forests. The conservation status of Queensland's 13 bioregional ecosystems currently shows that 32% of the total number of regional ecosystems are either 'endangered' or 'of concern' (ie. less than 10% and 30% remains in pre-European condition respectively) (Sattler and Williams, 1999).

The new Vegetation Management Act 1999 protects 'endangered' ecosystems and those vulnerable to land degradation on freehold land, while seeking to voluntarily protect 'of concern' ecosystems through a regional vegetation planning process. Leasehold and other state land is managed under the Land Act 1994. Since the establishment of the Queensland Parks and Wildlife Service (QPWS) in 1975, biodiversity conservation strategies have included land acquisition and planning, regulatory controls through the *Nature Conservation Act 1992*, and voluntary covenants or *Nature Refuge* agreements (Wells et al., 1993). These mechanisms have been largely applied to areas of high conservation significance and involve a very small proportion of highly committed landholders and local councils.

Advances in vegetation mapping and regional planning strategies have increased awareness of the extent of habitat decline and fragmentation on private land and the need to protect and enhance remnant vegetation across all regional ecosystems. Only by working with landholders to encourage and enable them to retain or sell high conservation value areas and manage other areas sustainably, can Queensland prevent further loss of its natural heritage.

QPWS has for many years been actively involved with landholders and community groups through its Park Neighbours program and the individual efforts of interpretative officers and rangers. However, QPWS lacked the resources to provide a strategic, ongoing regional advisory service across the state (Seipen & Stone, 1997). In 1998, the Service established a Community Nature Conservation extension network and became the lead agency for Bushcare (a major program of the Natural Heritage Trust) to support landholders, community groups, local government and industry to integrate nature conservation with other land uses.

This paper outlines approaches to Community Nature Conservation in Queensland based on market research and extension officer experiences of landholder requirements and some of the challenges that lie ahead.

LISTENING TO LANDHOLDERS

The ANZECC Working Group on Nature Conservation on Private Land identified best practice initiatives and principles for achieving ownership and involvement of landholders in nature conservation on private land (ANZECC, 1997). These include building relationships with landholders; incorporating best practice nature conservation into existing extension and planning programs, and focusing on outcomes, monitoring and evaluation.

In working with landholders and rural communities to build relationships, we believe it is important to recognise the social, historical and financial context in which they live, and factors influencing their willingness and capacity to embrace conservation. Regional extension staff live and work in rural communities where they gain an intimate understanding of these factors whilst endeavouring to tailor their extension approaches to individuals and groups. From the rangelands of western Queensland to the wet tropics of the north, they work with a huge diversity of landholders, local governments, industries and community groups whose level of awareness and commitment to nature conservation varies, as does their capacity to manage and protect areas of habitat.

Market research was conducted in September 1999 using a statewide phone survey and regional focus groups to gain a perspective on issues affecting landholders in relation to nature conservation on their properties, their preferences for information and communication methods (Millar et al., 2000). The phone survey of 716 rural businesses across Queensland was carried out by the Department of Primary Industries Call Centre, with 12 industries represented. Focus groups and individual interviews with industry representatives were carried out by QPWS and Ice Media Pty Ltd as part of a project to develop a multimedia CD ROM on balancing production and conservation.

The predominant industries were grazing and sugarcane, followed by horticulture and mixed grazing/cropping. Minor industries included cropping only, dairying and alternative enterprises such as aquaculture, organic crops, tea growing, emus, deer, alpaca/llama, coffee, herbs, mushrooms, nuts, teatree oil, vineyards and goats. The majority of landholders managed less than 500 ha of land, followed by those managing between 1,000 and 10,000 ha and more than 10,000 ha.

Threats to nature conservation and productivity

The three most important landholder issues for nature conservation on properties were feral animals, weeds and problems with wildlife. The next most significant issues were soil erosion, tree management and water quality. Issues such as loss of habitat, endangered wildlife species and vegetation communities, lack of fire management, and property planning and management for nature conservation did not rate highly. Threatening processes are of major concern to landholders and need to be addressed in relation to their impact on nature conservation and production. Tree management is a key issue for landholders in Queensland and provides an excellent forum for discussing the links between farm production and conservation.

There were slight variations in the issues raised by producers from different industries which reflected the problems associated with their enterprises (eg crop damage from birds and bats, weeds in grazing areas etc). Despite the lower responses to wildlife conservation issues in the survey questions, many producers expressed their support for looking after wildlife at the end of the survey when making general comments.

"At times wildlife can be destructive but we need to look after it. We are very keen on birds, and we don't have very much trouble with wildlife. I'd hate to see the birds wiped out."

"I think that all wildlife has to be protected. We told our children that if they shoot anything they have to eat it. That soon cures them!"

Balancing conservation and farm viability

Many respondents strongly expressed that striking a balance between farm profitability and nature conservation was important. Nature conservation could not be achieved at the cost of their livelihood. A few producers painted the reality of their struggle to make a living and inability to focus on conservation when they are trying to survive in their industry.

"Just that at the end of the day, everything comes down to the dollar and trying to make a living. In the sugarcane area at the moment we are struggling to stay afloat, so conservation is the last thing on our minds."

Landholders are looking for economic solutions to better integrate production and conservation. Landholders indicated that they wanted best practice examples, including benefits and costs, and information on future trends such as carbon credits. This level of interest demonstrates that landholders are serious about addressing nature conservation if they can see real benefits in terms of profitability. If conserving wildlife and flora could increase or add to their business, they are more likely to be proactive in conserving biodiversity (e.g. eco-tourism, integrated pest management -IPM, bush products).

"In the long-term we need to integrate [nature conservation] with farming activities. Nature conservation must fit in with primary production and vice versa. That's the only way it will work and that's what I try to do."

Economic information on how to profit from nature is desperately needed. There is clearly a role for extension in developing projects and case studies which can demonstrate direct and indirect economic gains to be made from ecologically sensitive production systems and alternative enterprises. Opportunities to take advantage of market niches for environmentally friendly products and accreditation schemes need to be explored and promoted.

Demand for advice, labour and financial assistance

Landholder information requirements for nature conservation rated highly for advice and assistance, and financial incentives. This was followed closely by best practice examples from landholders, future trends (eg carbon credits), regional ecosystems and their conservation status, benefits and costs of nature conservation practices and labour assistance available. About half the landholders interviewed were interested in property management planning for nature conservation, alternative enterprises, and knowing about birds and animals on their properties. How to create and manage wildlife habitat was the least popular topic for information, although it still attracted a 40 percent response.

Interest in nature conservation information and assistance did not vary significantly between industries. The only differences noted were a slightly higher interest in information on alternative enterprises amongst dairy producers. This could be a result of producers considering their options with deregulation of the dairy industry in Queensland.

The significant demand for advice and assistance reinforces the need for nature conservation extension and incentive programs. The request for financial assistance needs to be urgently addressed as it is a major barrier to achieving conservation on private land (Binning and Young, 1997).

"Financial incentives are good. They should be more easy to access than they are at the moment. The system makes it very difficult for those trying to do the right thing."

"We found out that we could get some financial assistance to fence off a sandy ridge area of our property to make it a wildlife reserve. We never knew these services existed."

COMMUNITY NATURE CONSERVATION APPROACHES

The establishment of a Community Nature Conservation extension service in Queensland has filled a vital and growing need for landholder education and assistance with biodiversity issues. An integrated framework for the delivery of Community Nature Conservation in Queensland has evolved to provide a range of programs and services to suit different levels of landholder interest in and commitment to nature conservation (see Figure 1).

Extension strategies include:

- General extension to increase landholder and community awareness and understanding of nature conservation and to build their knowledge, skills and capacity to effectively manage wildlife habitat. (e.g. field days, workshops, courses, talks and surveys)

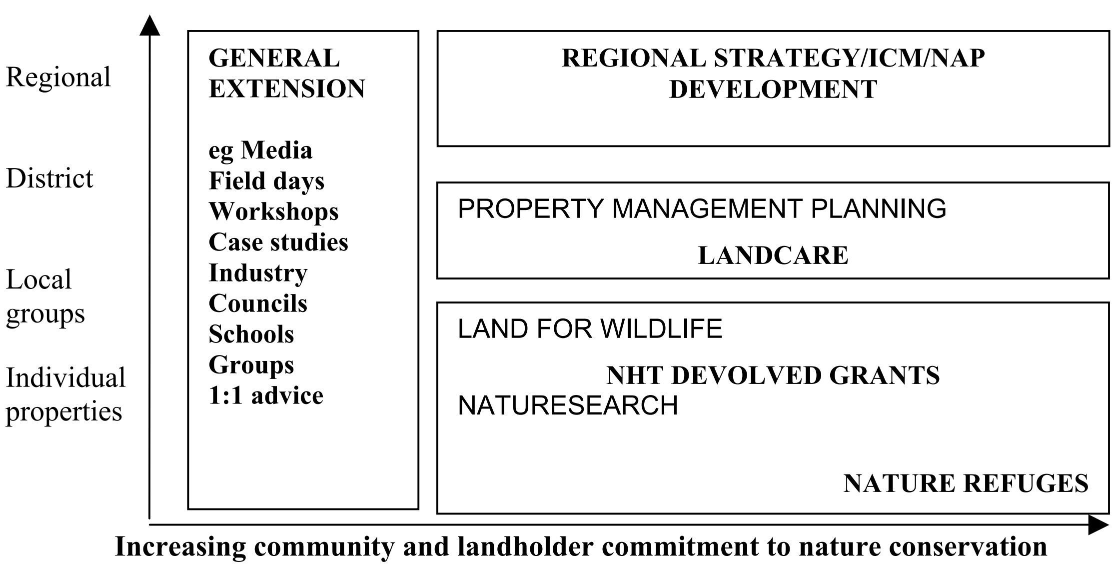
- *Integrating extension delivery with other programs to incorporate biodiversity into sustainable land and enterprise management. (e.g. Landcare, Property Management Planning, Vegetation Management, Industry extension)*

- Ensuring biodiversity elements are included at district, regional and state planning levels (e.g. regional strategies, local government and catchment plans, establishing links with protected area management).

- Giving recognition and support to landholders and councils who are committed to nature conservation (e.g. Nature Refuges, Land for Wildlife, Case Studies);

- Encouraging community involvement in conservation activities, including fauna/flora monitoring and habitat restoration (e.g. Bushcare, NatureSearch)

Figure 1 Community Nature Conservation Framework



Some key issues emerged from the market research in relation to improving extension delivery and communicating with landholders about nature conservation on private land.

Landholder stewardship and experience

A major theme to emerge from the market research was that landholders have a very strong sense of stewardship and pride for the land and resources they manage. Extension approaches need to acknowledge landholder stewardship and experience in both individual and group extension. The success of the Landcare and Land for Wildlife programs have largely been due to recognition of the strength of landholder stewardship in Australia and support for on-ground activities, education and group formation (Campbell, 1994; Platt and Ahern, 1995; Curtis and DeLacy, 1996; Petrie, 1999).
Landholders are interested in wildlife, whether it is problems caused by wildlife or observing wildlife around the farm. It is important to capitalise on landholder interest in wildlife and ecological processes by working closely with other extension programs and park plans where opportunities can arise to discuss wildlife issues in the context of enterprise management or natural resource management.

Wildlife monitoring programs such as NatureSearch can involve landholders and volunteers in discovering wildlife on their properties and in their district. Nature Refuges (see Box 1), Bushcare projects, Land for Wildlife and species recovery programs also create opportunities to bring landholders, scientists and local naturalists together to share knowledge and experiences with wildlife..

Box 1 Nature Refuges

Nature Refuges are areas of high conservation value protected under the Nature Conservation Act 1992. Nature Refuges are voluntary conservation agreements negotiated between a landholder and QPWS to protect significant natural areas while allowing sustainable use. The agreements are generally binding in perpetuity, and are registered on title. Regional extension officers carry out property assessments and develop management agreements with landholders. Most new agreements have been a result of the work of regional extension officers in approaching landholders and/or responding to landholder interest. There are currently 55 declared Nature Refuges, 11 awaiting declaration and 19 agreements under negotiation bringing the total area to approximately 98,600 ha.

Preferred communication methods

In terms of communication methods, the market research results and extension experience show that landholders prefer locally relevant and available information. Best practice examples using case studies (see Box 2), on-farm visits and success stories in local papers or industry journals are the most popular ways to learn about nature conservation and how it relates to farm production (Dorricott et al., 1997; Millar et al., 2000). Discussion groups can be effective in drawing out landholder_experiences and values, and building on current practices and knowledge of their natural environment (Woods et al., 1993; Millar and Curtis, 1999; Seipen and Stone, 1997).

Box 2 Habitat Case Studies

The Habitat Case Studies project funded by the Natural Heritage Trust employed QPWS officers in Roma to demonstrate how landholders in western Queensland are maintaining wildlife in conjunction with different enterprises on their properties. Ten properties were selected for the project. Fauna surveys were conducted in conjunction with family members and field days were held for district producers to attend. Landholders shared their local knowledge of vegetation and wildlife and many discovered species they never knew existed on their farms. For example, the first case study looked at the values of retained brigalow shadelines on a wheat farm. Another case study examined fauna and vegetation management issues on the Mitchell Grass Downs on a sheep property.

Although less popular in the survey, the use of computers, videos and training courses may become more widely used in the future, as more producers embrace information technology and training opportunities through programs such as Farmbis (ABS, 1999). It will be important for landholders to access up to date and useful information from websites. CNC has established information on the Qld EPA website and has sold 185 copies of a multimedia CD ROM in five months to landholders, libraries, councils, landcare groups, environmenal education centres and schools.

Developing partnerships

Developing partnerships with other agencies and non-government organisations has enabled nature conservation extension to become integrated with other land use issues and for extension staff to work collaboratively together. Extension services in Queensland, like the rest of Australia, have historically been associated with agricultural production or soil conservation agencies (Millar, 1999). It is important to establish links with traditional extension services so that nature conservation principles and practices can be incorporated into enterprise management, financial planning, natural resource management and family succession issues.

Opportunities arise to collaborate with producing extension materials, running joint field events and training workshops. Examples include delivering workshops with Property Management Planning (*Future*profit) groups and DNR vegetation management officers, conducting field days with Landcare groups, local government and industry extension representatives and joining Greening Australia Bushcare support staff in assessing properties for devolved grants or Land for Wildlife registration. In some regions, extension staff are involved with Indigenous Land Management officers and projects or World Wildlife Fund projects.

Understanding biodiversity in the context of farming systems and how different people value biodiversity is a major challenge to extension officers across all agencies and non-government organisations. Only by working together towards a common understanding of biodiversity will changes in cultural attitudes and on-ground practices occur. A Biodiversity in PMP project is aiming to do this through training and the use of industry case studies (see box 3).

Box 3 Profit with Nature

A survey of *Future*profit facilitators was conducted to determine the extent biodiversity elements were being included in PMP workshops ways to improve delivery and training. A training program was developed by Jane Blackwood, Biodiversity for PMP officer to bring together QPWS extension staff and *Future*profit facilitators in a series of workshops held at Bundaberg, Dalby, Charleville, Charters Towers and Rockhampton. Future*profi*t staff gained knowledge of bioregional planning and how to integrate biodiversity issues into all aspects of property management planning. CNC extension staff gained a broader perspective of the PMP program and how they could contribute to better integration. Profit with Nature case studies funded by the Natural Heritage Trust have been developed with dairy, beef, banana and cane producers which demonstrate how biodiversity and sensitive management practices play a role in their farming systems.

Local government is playing an increasing role in natural resource planning and management. Extension staff give technical advice to local councils and assist with planning and extension. Land for Wildlife in Queensland is delivered as a partnership between QPWS, local governments and community organisations with assistance from the Natural Heritage Trust. As such it is a unique model in Australia (see Box 4).

Box 4 Land for Wildlife

Land for Wildlife is a voluntary property registration program to recognise and support landholders who provide habitat for wildlife on their property in conjunction with other land uses. Local government in southeast Queensland led the way by adopting the Land for Wildlife program in 1998. The program has expanded to seven additional regions involving 57 local councils from Cooktown to the Gold Coast. At February 2001, there were 1,300 property registrations including 240 landholders working towards registration. Total area of terrestrial habitat is 50,000ha, of which 13% or 6,500 hectares of retained habitat has been identified as either 'Endangered' or 'Of concern'. Expansion is being planned for Lake Eyre Basin, Northern Gulf, Desert Uplands, Central Highlands and South West Queensland.

It is also important to establish good links between off-park nature conservation programs and with park management and planning. Some examples are NatureSearch surveys conducted on Land for Wildlife properties and Nature Refuges; devolved grant recipients joining Land for Wildlife; regional biodiversity planning with EPA and field days on national parks to demonstrate best practice management practices.

CHALLENGES AHEAD

By listening to landholder concerns, and regularly reviewing our extension strategies we have been able to make significant gains for Community Nature Conservation in Queensland. However, landholder attitudes to government in Queensland and a general fear of politics surrounding environmental issues present challenges for agency conservation extension programs. Community Nature Conservation needs to be promoted as a voluntary, non-threatening, educational service. Developing partnerships with rural community groups, industries and local government builds trust at the local level and facilitates landholder involvement in conservation initiatives.

It will be important to maintain extension staff in the field who can continue to foster these relationships and assist landholders with property planning and management. It will also be necessary to explore and promote opportunities for landholders to access ongoing financial and labour assistance for nature conservation management, particularly where agreements are involved. In Queensland, financial and management assistance given to landholders entering management agreements (binding or non-binding) has been delivered through short term NHT funded devolved grants or council rate rebates. Extension officers have reported that financial assistance with fencing materials, labour, stock watering points and weed control often plays a significant role in achieving successful negotiations for nature refuges.

Not all landholders may wish to receive financial or management assistance. However, by offering landholders some assistance it demonstrates government commitment to protecting areas as partners in management agreements and public recognition of the service being provided. All levels of government and private industry need to provide a comprehensive range of incentive options to relieve the financial burden for farmers. The proposed Queensland Trust for Nature may play an important role in generating philanthropic support for conservation on private land.

The scope of management agreements and incentive mechanisms in Queensland needs further investigation. A strategy for a comprehensive range of management agreements is to be developed with appropriate criteria/benchmarks and incentives to encourage landholders to protect areas for nature conservation and sustainable land use. An understanding of landholder motivations for entering into different types of management agreements and the influence of direct financial incentives, tax incentives, valuation, and land tenure issues will be necessary. The capacity of landholders and rural communities to embrace long-term change also needs to be considered.

It is widely recognised that changing attitudes and behaviour in favour of nature conservation on private land will take a long time, particularly when many landholders remain to be convinced of the economic benefits of nature conservation practices.

Landholder and industry interest in environmental accreditation schemes and alternative enterprises provides opportunities to demonstrate economic benefits from market opportunities. There is also potential to incorporate biodiversity indicators into environment management systems. Nature conservation extension can play a role in assisting industry to address biodiversity issues in their auditing processes. Closer links need to be forged with industry organisations so that nature conservation advice can be tailored to each industry.

Community Nature Conservation will be increasingly involved in vegetation management extension and conservation planning at a regional and state level since the introduction of the Vegetation Management Act 1999. The National Action Plan for Salinity and Water Quality will also present challenges for biodiversity extension in relation to impacts of salinity on biodiversity, particularly in targeted catchments. Regional planning and implementation organisations will need technical advice and support. Community Nature Conservation will play a pivotal role in facilitating community involvement in these initiatives and linking new and existing programs for mutual benefit.

REFERENCES

Australian Bureau of Statistics (1999). *Use of information technology on farms 1998-1999.* Canberra.

ANZECC (1997). *Best practice initiatives for nature conservation on private land.* A report prepared for ANZECC Standing Committee on Conservation by the working group on nature conservation on private land.

Binning, C. & Young, M. (1997). *Motivating People: Using management agreements to conserve remnant vegetation.* Paper 1/97. National R&D Program on Rehabilitation, Management and Conservation of Remnant Vegetation.

Campbell, A. (1994). *Landcare: Communities shaping the land and the future.* Allen & Unwin: Sydney.

Curtis, A. & De Lacy, T. (1996). Landcare in Australia: beyond the expert farmer. *Agriculture and Human Values,* **13**(1), pp. 20-31.

Dorricott, K., Lawrie, B. & Voller, P. (1997). Balancing productivity and conservation in southern inland Queensland: a case study approach at the grass-roots level. In *Conservation outside Nature Reserves* (eds) P. Hale & D. Lamb. Centre for Conservation Biology, University of Qld. pp.233-240

Millar, J. (1999). The role of extension in biodiversity conservation in Queensland. Paper presented at the *International Symposium on Society and Resource Management,* Brisbane. July 7-10.

Millar, J., Chew, C., Tarrant. P. and Walsh, D. (2000). *Listening to landholders: Community Nature Conservation Market Research 2000*. Queensland Parks and Wildlife Service, Brisbane.

Millar, J & Curtis, A. (1999). Challenging the boundaries of local and scientific knowledge in Australia: Opportunities for social learning in managing temperate upland pastures. *Agriculture and Human Values* 16: pp389-399.

Petrie, M. (1999). Land for Wildlife. A local government initiative in south-east Queensland. Paper presented to the *1999 International Symposium on Society and Resource Management,* Brisbane 7-10 July 1999.

Platt, S.J. & Ahern, L.D. (1995). Nature Conservation on private land in Victoria: the role of Land for Wildlife. *In Nature Conservation 4: The Role of Networks*. Surrey Beatty & Sons, Sydney. pp. 300-311.

Sattler, P. & Williams, R.D.(eds) (1999). *The conservation status of Queensland's bioregional ecosystems.* Environment Protection Agency and National Parks Association of Queensland Inc, Brisbane.

Seipen, G. & Stone, G. (1997). Identification of rural landholders' requirements for nature conservation information in Queensland. In *Conservation outside Nature Reserves* (eds) P. Hale & D. Lamb. Centre for Conservation Biology, University of Qld. pp. 226-232.

Wells, G.D., Williams, R.D. & Taylor, P.M. (1993). Queensland's 'off-park' nature conservation scheme. In *People and Nature Conservation*. (eds) A. Bennet, G. Backhouse, T. Clark. Surrey, Beatty & Sons, Sydney.

Woods, E., Moll, G., Coutts, J., Clark, R., & Ivin, C. (eds.) (1993). *Information Exchange.* A report commissioned by Australia's Rural Research and Development Corporations. Rural Extension Centre: Gatton, Qld.

THE ROLE OF SEED GARDENS IN ENHANCING SEED SECURITY AND IMPACT ON USE AND CONSERVATION OF AGROBIODIVERSITY

Joyce Mulila-Mitti, Zambia (gerent@zamnet.zm, rhino@zamnet.zm)

The relationship between seed and food security on the one hand, and seed security and conservation of relevant crop genetic diversity on the other hand is generally acknowledged. While the impact of modern varieties on the diversity of the genetic resource base is generally perceived as negative, the experiences in Zambia support existing evidence from elsewhere, showing that modern varieties can also contribute to the diversity being grown and to farmers' food security. This paper presents these experiences and draws some lessons from them that may be relevant for identification of incentives for use and conservation of crop genetic diversity.

The SADC/GTZ project on the promotion of Small Scale seed Production by Self-Help Groups (SSSP) is one of the development agents involved in promoting farmers' access to quality seed in Choma and Kalomo districts in the Southern Province of Zambia with the objective of enhancing local level quality seed provision systems and household food security. The project's approach is based on a two-stage process that entails participatory variety selection and participatory seed production. Up to 1998/99 season, all demonstration trials and seed multiplication plots were hosted during the rainy season.

In 1999 SSSP initiated support for off-season seed production in gardens with farmer groups for modern varieties of open-pollinated maize, cowpeas and greengram. Farmers through project activities have adopted these varieties, supplied by the NARS. Seed supply was however identified by the farmers as a principal limitation in planting crops and varieties of their choice: leguminous crops were frequently lost or of low quality due to storage problems whereas seeds from modern varieties were not available, too expensive or difficult to reproduce. One of the primary objectives for the seed garden project was to gather information on the suitability of seed gardens as an alternative and complementary local level seed supply system.

Seed gardens are meant to act as a source of fresh and healthy seed for the main growing season in summer which starts in November by producing seed during the off/dry season (May to October) using wetlands or other sources of water for irrigation (i.e. dams, stream). The gardens were expected to improve farmer's seed management practices by allowing production of quality seed.

Seed gardens, set up during the off-season (winter) in frost free areas that can easily be irrigated or have enough residual moisture have demonstrated to be invaluable for (i) bulking of quality seed for farmer selected varieties for next crop production cycle (ii) training farmers in variety purity maintenance when there is minimal opportunity for contamination (iii) verification of seed variety genetic purity and physiological quality, in particular for vigour and germination capacity.

The establishment of seed gardens to develop a reliable source of good quality has proved effective in enhancement of the use and conservation of agrobiodivesity by farmers at farm level. The following elements pertaining to the seed garden project and critical in enhancing the use and conservation of agrobiodiversity have been identified and discussed in the paper.

- Suitable crop and varietal characteristics (meeting farmers' needs)
- Management of seed quality and health

- Improved seed security and maintenance of seed diversity
- Community cooperation
- Food security enhancement
- Enhancement of crop and variety diversity
- Enhancing farming systems diversity

Major lessons learnt

- The use and conservation of seed of modern varieties is enhanced by active participation of farmers in variety selection at the farm level.
- Cultivation of modern varieties does not necessarily lead to the disappearance of local landraces and can contribute to rural food security.
- NARS technology (modern varieties, production off-season) and conditions (wetlands in winter season) may be existing and adapted to local level use and contribute to seed security.
- NARS support of community-based seed programs is critical for the success and sustainability of such programs
- Successful seed production at farm level is facilitated through active well-established CBOs that are essential for effective community cooperation.
- Training and learning through experimentation form essential components in the development and adaptation of technology, and thereby to the use and conservation of crop genetic diversity.

MANAGING BIO-DIVERSITY IN AGRICULTURAL ECOSYSTEMS THROUGH SUSTAINABLE MANAGEMENT OF INSECT POLLINATORS BY RURAL COMMUNITIES

Dr. Nasreen Muzaffar
Director, Honeybee Research Institute
National Agricultural Research Centre, Islamabad - Pakistan

ABSTRACT

The honeybees (Apis spp.) and other bees (non-Apis species) are effective pollinators for seed and fruit production in agricultural ecosystems. Pesticides and monoculture have been major factors in the decline of their populations.

During present studies in 1999-2001, a community-based participatory approach, based on full and equal participation of women and men farmers was developed to create the best conditions for diversification of farm income. The honeybee and non-Apis bee populations were integrated in diverse agro-ecological areas in Hunza (2450 m) in northern mountains and Sargodha (182 m) in the plains. These two areas have multiplicity of variables. Hunza has traditional mountain agricultural ecosystem with predominantly temperate fruit trees like peach, plum, apricot, almond, cherry (Prunus spp.), pear (Pyrus spp.), apple (Malus pumila), 'unab' (Ziziphus jujuba), etc. The latter area (Sargodha) has mechanized farming system with large scale cultivation of cereals and legumes as well as oilseed, vegetable seed and fodder seed crops and tropical fruits like, citrus (Citrus spp.), mangoes (Mangifera indica), guava (Psidium guajava), 'ber' (Ziziphus hysudrica).

The hill bee Apis cerana (33 colonies) in traditional wall-, log- and pitcher hives and the Italian bee Apis mellifera (50 colonies) in low-cost Langstroth type mud- and cement hives were managed by 15 small women farmers in Hunza. A. mellifera (50 colonies) in modern Langstroth hives were kept by 10 farmers in Sargodha that is the traditional rock bee Apis dorsata area. The little bee A. florea nests were found occasionally.

Simultaneous observations were made on managed potential native non-Apis bees (Osmia, Halictus, Nomia, Megachile, Anthophora) that benefit agriculture by their different pollinating abilities. These were reared in artificial nests made from readily available plants/waste materials to manage, increase and conserve their populations in the vicinity of experimental hive bees.

On-farm pollination trials were conducted on various crops. In apples, the fruit set varied from 0-3% in muslin cloth bags, 1.6-9.1% in net cloth and 22.3-29.5% in open twigs. In almonds, the fruit set was 69.4% in open, 11.8 in net cloth and 7.4% in plants covered with muslin cloth; while in pear, fruit formation in open plants was 53.7%, in net cloth 23.3% and 3.2% in covered plants without honeybees and other insect pollinators in Hunza.

Studies were made on other crops in Sargodha area. On sunflower (Helianthus annuus), fertilization occurred in 76.3 - 84.2% florets in open heads. In flower heads covered with muslin cloth, the seed set was 0.3 - 3.5% while 4.1 - 15.5% florets were fertilized in heads covered with net cloth. On cucumber (Cucumis sativus), the weight of the fruit, on average was 2.73 kg per

plant visited by insect pollinators and 1.9 kg per on plants not visited by bees indicating more than 30% higher fruit yield by pollination. Similarly on onion (Allium cepa), seed setting in open pollinated plants was 92.3% as compared to 12.4% in net cloth and 7.6% in control.

There was net income of Rs.229,279 (US$ 3821) in Sargodha and Rs.200,013 (US$ 3334) in Hunza through the sale of honey, honeybees and other by-products by the farmer groups.

The farming communities of two agricultural ecosystems were thus made aware that honeybees and other insect pollinators are most essential for successful cultivation of these crops. In addition to increase in farm productivity and income, this participatory technology development system ensures bio-diversity, sustainable habitats and environments by pollinating not only cultivated crops, but also wild soil-holding and soil-enriching plants in uncultivated areas.

INTEGRATING WOMEN'S PERSPECTIVES AS A MEANS OF SUSTAINING CONSERVATION OF CROP GENETIC DIVERSITY ON SMALL- FARMS IN MOROCCO

F. Nassif[1]

[1] Institut National de la Recherche Agronomique (INRA), Settat BP 589, Settat, Morocco. Tel: +212 23 402626; Fax: +212 23 403209; Email:nassif@settanet.net.ma

In Morocco, women's perspectives and views on plants, particularly food crops, are often overlooked because of the prevailing assumption that male farmers are the unique experts on these crops and the ambiguous relationship between's women's acquired knowledge of agricultural production and women's status in the farm-household. As a consequence, women are seldom approached or solicited to contribute to agricultural research. The participatory gender approach adopted in investigating *in situ* conservation of agricultural diversity on-farm has attempted to ensure that women's views are identified and taken into account in the research and work agenda of collaborating communities. One activity in this direction consisted of conducting focus groups discussions with women in communities where *in situ* conservation project activities were implemented. The objectives were to 1) examine the aspects insufficiently covered in an earlier socio-economic baseline conducted with male farmers, and to 2) to determine women's views and perspectives regarding the use and maintenance of target crop landraces. A total of 89 women participated in group discussions. The focal themes included the role of women in target crop production and use, their contribution in crop selection and seed management practices, their knowledge of target crop varieties and their participation in decision-making regarding crop and variety choices. Important findings were the substantial contribution of women to crop production, particularly in the case of alfalfa and faba bean, the elaborate nature of women's knowledge of crop landraces, and the extent of variability between sites in terms of women's involvement in marketing. Women were found to be as informed as their husbands or their fathers regarding the differences between landraces and improved varieties, seed prices on the local market and crop growing conditions. Women's responsibility for livestock, crop processing, and food preparation across sites made them very knowledgeable about quality aspects. Most importantly, women knew more than male farmers with respect to the relationship between on-farm use, quality and food products from selected crops. Equally important was the result that women's views were consistent with those of male farmers, which had been collected through an earlier formal survey conducted with farm-household heads. Understanding and consideration of women's views and programming women's effective participation in project training opportunities could contribute to sustaining conservation efforts of agricultural biodiversity on-farm.

LINKING IN SITU CONSERVATION RESEARCH AND PARTICIPATORY PLANT BREEDING: THE CASE OF BARLEY IN MOROCCO

F. Nassif[1] and A. Amri[2]

1 Institut National de la Recherche Agronomique (INRA), Settat BP 589, Settat, Morocco. Tel: +212 23 402626; Fax: +212 23 403209; Email:nassif@settanet.net.ma

2 International Center for Agricultural Research in the Dry Areas (ICARDA). 301 ICARDA-Jordan<ICARDA-JORDAN@CGIAR.ORG).

Barley is grown by the majority of farmers in Morocco, covering an area of more than two million hectares annually, and characterised by its multiple uses as food and feed. While barley is produced across all agro-ecological zones of Morocco, typical barley producing areas are found in the most fragile marginal edges of arid and semi-arid zones characterized by their high intra and inter-annual climatic variability. Although nineteen barley varieties have been developed by the National Agricultural Research Institute (INRA), farmers continue to use barley landraces or what farmers commonly refer to as "chîir beldi". Socio-cultural and economic studies were undergone to elucidate the reasons behind farmers' low use of improved barley varieties. Results showed that in addition to the socio-economic and institutional factors of seed unavailability, seed prices and farmer's limited resources, newly released varieties were not always been adapted to the difficult environments under which barley is produced. In order to better fit farmers' needs a participatory plant breeding (PPB) project* was initiated with the objectives of 1) understanding farmers' selection criteria, 2) encouraging and strengthening farmers' participation in variety development, and 3) offering to farmers a wide range of adapted material to their specific natural and socio-economic conditions. The PPB experience on barley and together with the *in situ* conservation of agro-biodiversity on-farm project (see Nassif1.doc) have mutually reinforcing results. They have been instrumental in rediscovering the importance of barley landraces from both farmer and *in-situ* conservation perspectives. Results included promising lines selected by farmers and breeders, enhanced understanding of farmers' selection criteria, and the role played by barley landraces in farmers' fields and minds. While landraces were primarily introduced in participatory on-farm trials as checks, they were systematically and consistently identified and selected by the majority of farmers. From the farmers' point of view, landraces represented the appropriate mix of adapted material, which has evolved under their own management practices and biotic and abiotic stresses of existing environmental conditions. They also respond to farmers' search for straw, yield stability and adaptation, rather than high performance. The *in situ* conservation work confirms the adaptation potential embodied in landraces and indicates that adaptation potential is one of the reasons behind farmers' use and holding on to local cultivars. Lessons learned concern the close relationship between farmers' use and maintenance of barley landraces and farmers' desire to attain crop output under highly variable, risk prone and extremely fragile conditions. Another lesson is the realization of farmers' greater ability to evaluate, differentiate and make selection among hundreds of lines. A third lesson is the strong consistency among men and women farmers in terms of selected lines and selection criteria. Participatory barley breeding and *in situ* conservation research have both been instrumental to enhancing agro-biodiversity conservation in Morocco.

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CONSERVATION, DOMESTICATION AND VALORIZATION OF SPONTANEOUS PLANTS OF THE DESERT ZONE IN TUNISIA

Mohamed NEFFATI [1] & Habib KHEMIRA [2]

(1) Institut des Régions Arides, 4119 Médenine, Tunisie
(2) Faculté des Sciences de Gabès, Route de Médenine- 6029 Gabès, Tunisie

SUMMARY

The present report is a succinct summary of our research and development activities at the *Institut des Regions Arides* of Medenine, Tunisia. The main focus of our program is to conserve and characterize multiple-use spontaneous plant of the arid and desert regions of Tunisia and to benefit the community from our research activities by developing sustainable uses for as many of these species as possible.

We presented our main achievements in collecting seeds and target species and exchange of plant material during the last fifty years.

Replicability of the project, its economic and ecological impact, its future perspectives and the lessons learned from this experience were discussed.

- Improving the genetic potential of plant material and exploring traditional and novel uses for it can not guaranty economic profitability of conservation efforts at least in the short and medium terms. Integration of this activity into the larger agriculture production systems and sustainable use of resources have to be supplemented by other measures:

    - ♦ strengthening research structures
    - ♦ diversification of sources of revenues (other than agricultural) in marginal areas.
    - ♦ mastering of distribution networks of agricultural products
    - ♦ raising the level of awareness of the local population

- Conservation and domestication of spontaneous plants and land reclamation in arid zones is a long term endeavor due to the harsh environment and specificity of target species. In order to conserve these plants and to develop new uses within a reasonable time frame, we need to prioritize both the species and aspects to study,
- Characterization and evaluation of plants for pastoral use or land reclamation in arid zones, should lead to the selection of population or synthetic varieties with a high intraspecific genetic diversity that would be better adapted to unpredictable constraints and disturbances
- For seed handling and regardless how good are the machines available on the market we found it necessary to develop locally machines suitable for the type of seeds we have to handle,
- The large expansion area of some species and the need to develop a plant improvement program with a large genetic basis indicate clearly the importance of the regional scope of any conservation and breeding program.

A specialized national unit for the conservation and domestication of the spontaneous plants of the arid and desert zones was already established. This unit could serve as a model for countries facing similar ecological problems.

COMMUNITY LIVESTOCK IMPROVEMENT INITIATIVES: A CASE OF KATHEKANI, KENYA

Dr. Joyce Njoro- Intermediate Technology Development Group, Eastern Africa (ITDG-EA)
P.O Box 39493, Nairobi Kenya Tel: +254 2 719413, 719313, 715299, 713540
Fax: +254 2 710083 Email: njoki@itdg.or.ke

ABSTRACT

Kathekani is lies in Eastern Kenya with a semiarid climate. The area is only suitable for drought tolerant crop farming, due to erratic and unpredictable rainfall, which frequently causes crop failure. The livestock management systems in this area are historically extensive. Commonly reared types of livestock are cattle, goats, sheep and chickens. The East African goat is the breed traditionally reared by this community, however, other breeds such as the Galla exist. The area is highly tse-tse infested, leading to heavy cattle losses from trypanosomosis. This together with increased human population has compounded the land use problem with more land being opened up by the community for cultivation as farmers look for alternative livelihoods. This has led to development of semi-intensive systems of livestock production.

The grazing land has thus been reduced, creating a major constraint in livestock production despite the use of on farm crop residues for nutritional purposes a practice that is not adequate.

The approach adopted by farmers is communally managed utilisation of locally available goat genetic resources among the resource poor farmers. The Galla goat is an indigenous breed mainly found in the pastoral areas of Kenya. The natural habitat of the Galla is similar to the ecological conditions found in Kathekani. It is well adapted to harsh climatic conditions of the arid and semi-arid lands. Its advantage over the East African is its fast growth rate and it's attainment of a comparatively higher weight at maturity. The East African on the other hand is distributed all over the East African region and it has the ability to survive under harsh climatic conditions. The Galla and the East African goat are used as a local goat gene pool for the arid and semi-arid lands in Kenya, which the local community is exploiting to harness positive traits. In the case of Kathekani this is achieved through a group approach. The breeding programme is communally controlled through formation of groups with a clear goal of improving goats production

To facilitate this initiative, multiplication of the Galla goat locally is essential for distribution to the local breeders. This will reduce the logistical costs required in procurement of the Galla goat. The more informed and economically able farmers have shown an interest in the multiplication.

Technical support is provided by local personnel from the Ministry of Agriculture and Rural Development and Community-based animal health workers in areas of buck selection, disease control, feeding and general animal husbandry. ITDG-EA assists the farmers in logistical support in acquisition of Galla bucks on request. Institutional capacity building is done through training and exposure visits of the groups.

AGRICULTURAL REGIMES AND THE CONSERVATION OF FARMLAND BIODIVERSITY

Raymond J. O'Connor
Department of Wildlife Ecology
University of Maine

Effective conservation of biodiversity on agricultural land requires amelioration of production-oriented practices incompatible with wildlife. These take effect under a continent-wide distributional umbrella set by climate and land cover constraints, with local abundances then modified by regional and local land management The ecology of farmland birds has provided the clearest evidence to date that intensification of agriculture - of any kind - is deleterious to biodiversity. Intensification involves decisive regime shifts for birds, for it involves a coordinated suite of changed farming practices that have synergistic impacts on bird populations. Intensification, whether on pasture or on arable, routinely involves an environmental homogenization that immediately deprives birds of the semi-natural habitat components - shelterbelts, riparian vegetation, hedgerows and banks - that most closely approximates their natural habitats. Where remnants survive e.g. as small woodland plots - they are often subject to increased attack by predators or parasites favored by agriculture. Second, management of the homogenized habitat is incompatible with wildlife use of the land, as when early grass cultivars develop before meadow birds can breed or when strip grazing results in trampled nests or when fall ploughing removes overwinter stubbles. Third, the associated use of chemicals removes the insects and arable weeds that constitute the food base for insectivorous and granivorous species respectively, depressing North American bird populations by 25-50 million birds. Fourth, conversion rates of un-intensive farmland to other purposes is differentially favored by economic cost-benefit analyses but within North America such conversion (even to forestry) results in a net loss in bird numbers.

The principal pathways to countering these forces are four-fold. First, greater and more pro-active use of set-aside programs such as the Farm Conservation Program can effectively sequester land in a conservation-friendly status. Second, modified farming practices, in particular the use of conservation headlands kept free of pesticide applications, can dramatically influence bird reproduction and population viability. Third, expanding the regulatory definition of adverse effects in pesticide assessments to include adverse ecological effects alongside the present consideration of physiological effects on mortality and reproduction is desirable. Finally, changing the nature of agricultural subsidies from production to producer subsidies, particularly for small producers, would encourage inter-farm diversity.

AGRO-MORPHOLOGICAL DIVERSITY OF SPONGE GOURD IN IN-SITU CONSERVATION AT BARA AND KASKI ECO-SITES, NEPAL

Y. R. Pandey[1], R.B. Yadav[2], P. Chaudhary[3], S.P. Khatiwada[2], J. Bajaracharya[3], D. K. Rijal[4], M.P. Upadhayay[3], A.K. Gautam4, B. R. Sthapit[5] and D.I. Jarvis[6]

[1] Horticultural Research Station, Nepal Agricultural Research Council, Jumla, Nepal
[2] Kachorwa Research Site, Nepal Agricultural Research Council, Hardinath, Dhanusha, Janakpur, Nepal
[3] Agricultural Botany Division, Nepal Agricultural Research Council, Nepal; e-mail: jwala@unlimit.com
[4] Local Initiatives for Biodiversity, Research and Development (LI-BIRD), P.O. Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: rblibird@mos.com.np
[5] International Plant Genetic Resources Institute, APO, Malaysia, e-mail: b.sthapit@cgiar.org
[6] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy d.Jarvis@cgiar.org

Agro-morphological traits of sponge gourd (*Luffa cylindrica* L.) landraces were characterised to explore the potentiality of sponge gourd diversity and identify the unique diversity available at Begnas (600-1400 m) and Bara (80-100m) eco-sites, Nepal during 1999/2000. A total of 36 and 21 farmer cultivars of sponge gourd in Bara and Begnas respectively were studied using farmers' descriptors to assess agro-morphological diversity. Farmers who participated in diversity fair were randomly selected and their plots were visited to characterise sponge gourds in farmer's field. Because of the importance of fruits in human consumption, more emphasis on fruit characterisation was given in the study. Variability in quantitative traits was found among the landraces of both sites. In Begnas village, only 6 landraces were widely grown and they have distinct characteristics, which can be distinguished by farmer descriptors such as fruit length, colour, aroma, fruiting periods and sponginess whereas in Bara village, genetic variation was observed in fresh fruit weight and aroma. Principal Component Analysis (PCA) grouped the studied accessions into five clusters. The first principle component accounted 43.9% of the total variation in nine characters. The cluster I had maximum number of accessions (14) followed by cluster II (12). Naming and describing the farmer named variety given by the farmers are related to their use and morphological characteristics and were found useful in managing the resources in the community.

NON CONVENTIONAL FOOD AND MEDICINALS FROM AMAZON BIODIVERSITY AS PROMISING RESOURCE AND STRATEGY FOR LOCAL AND WORLD SUSTAINABILITY.

Maurizio G. Paoletti et al
(Department of Biology Padova University, Padova, Italy)

ABSTRACT

At large Amazon comprize at least 183 different human ethnic grops and one impressive number of plants (estimated to be 90.000) and huge animal species, especially invertebrates (forcasted to range between 3 and 30 millions).

The local knowledge developed especially by Amerindians is, in most cases, the only available knowledge of many plants and animal species that have been tested and used as food and medicine among other uses.

Possibly around 5000-11.000 years of experiences and trials are in the hands of these populations that have developed without use of written document one oral and traditional knowledge. This knowledge is very endangered.

We will discuss the amount of knowkedge on biodiversity collected by populations of the Alto Orinoco and in Amazon and we will discuss in particular some strategies developed to choose among the amazing diversity of invertebrates the ones better fitted for their diet.

These strategies are important to appropriately develop a suatainable use of biodiversity locally and for the international community in a sustainable way.

It will be also discussed the gap of knowledge and the empirical means to solve the way in which local sharing and preserving of local knowledge is compensated for and how the communities can protect and promoter their resources and their sustainability.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTH AND SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS

Southeast Asia Regional Institute for Community Education (SEARICE)

This paper provides the synthesis of the different experiences and lessons in managing agrobiodiversity under the complex market and production system of Southeast Asian agriculture. The discussions and arguments are based on the experiences of SEARICE in co-ordinating two regional programs on community based plant genetic resources conservation, development and use, namely CBDC (Community Biodiversity Development and Conservation Program) and BUCAP (Biodiversity Use and Conservation in Asia Program) and also from its' Philippine based field operations in Central Mindanao and Bohol.

The paper looks at conservation and management of agrobiodiversity from subsistence, upland areas to prime irrigated, market-oriented ricelands. It is argued that agrobiodiversity conservation and development should not only focus on upland, marginal ecosystems but on prime irrigated areas as well, where genetic erosion, market and cultural pressures are more pronounced. The paper likewise explores the links between production system (covering both ecosystem and market system) and farmers selection and management criteria. Farmers criteria and assessment of their agrobiodiversity determines the approach and shift from conservation to improvement. Capacity building mechanisms and the role of formal and informal institutions to strengthen farmers' role in agrobiodiversity management and the necessary institutional formation and policy amendments needed to scale up the efforts and ensure sustainability of farmers' endeavours are likewise discussed.

This paper supplements the papers of SEARICE partners that deals more on their experiences in agrobiodiversity management under intensive crop production system in Vietnam, the transitory production system in Lao PDR, the upland, subsistence production system in Thailand and the high altitude, subsistence production system in Bhutan.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE USE OF FARMERS FIELDS SCHOOLS APPROACH IN BUCAP-VIETNAM NATIONAL PROJECT

BUCAP Vietnam Country Project
National IPM Program
Plant Protection Department
Ministry of Agriculture and Rural Development
Vietnam

ABSTRACT

The Biodiversity Use and Conservation in Asia Program (BUCAP) in Vietnam is a follow-up activity of IPM and builds on the methodologies and approaches of IPM. The main approach adapted by BUCAP from IPM is the Farmer Field School (FFS) approach where community based study groups are formed composed of 20-30 farmers and extension workers who provide technical inputs and facilitation. A group field is set-up as a common learning area from which hands on exercises on ecological aspects of rice production are studied. The 'learning field' provides the main learning material, and the field exercises and special topics are rooted in the fields i.e., before starting any discussion or activity, the study group must first observe the field. FFS is more of an education tool than a high level research and in most IPM-FFS studies (e.g. defoliation studies) the outcome is known. The important aspect is the process of learning, where farmers discover on their own through a simple field experiment the results (discovery based learning).

BUCAP adapted this educational process and extended it further by engaging in research whose outcome is not pre-determined. In the process generating new information which are not known by facilitators nor by research institutions. At the same time developing the capacity of farmers to conduct crop improvement researches for improved production.

This paper looks at the use of FFS in managing agrobiodiversity by looking at rice crop conservation and improvement under prime irrigated ricelands areas of North and Central Vietnam. The selection criteria of farmers in the different provinces, the initial results of their work including needs and problem areas for both farmers and IPM-BUCAP trainers are discussed.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE MULTISTAKEHOLDER APPROACH OF BUCAP-LAO PDR NATIONAL PROJECT

BUCAP Lao PDR Country Project
BUCAP Lao PDR National Team:

- **National IPM Programme, Agriculture and Extension Agency, Department of Agriculture, Ministry of Agriculture and Forestry**
- **National Agricultural Research Centre, National Agriculture and Forestry Research Institute, Ministry of Agriculture and Forestry**
- **CIDSE Lao PDR**
- **Oxfam Solidarity Belgium in Lao PDR**

ABSTRACT

The distinguishing feature of BUCAP Lao PDR Country Project is its institutional formation. The project is currently coordinated by Oxfam Solidarity Belgium in Laos which serves as the project holder and financial overseer of BUCAP in Lao PDR. The main implementing institution are the Agriculture Extension Agency through its National Integrated Pest Management (IPM) Program and the Secondary Agricultural Technical School in Luang Prabang and Champassak province. Both implementing institutions are under the coordination of the Department of Agriculture of the Ministry of Agriculture and Forestry. CIDSE Laos provides support monitoring, backstopping and coordination for the implementation of BUCAP in the agricultural colleges and in Vientiane Municipality. The National Agriculture Research Centre of the National Agriculture and Forestry Institute provides technical backstopping and breeding materials to farmer partners of BUCAP.

BUCAP in Lao PDR is an institutional experiment. It is one of the few initiatives that try to bring both extension and research institutions together in actively implementing and monitoring community based projects in cooperation with non-government organisations. BUCAP in Lao PDR is a working model of the multistakeholder approach to project management.

This paper presents the complementation between formal and informal system in managing agrobiodiversity, the roles of the different stakeholders in strengthening farmers role in agrobiodiversity conservation under a changing agricultural and market system (from traditional, subsistence farming to intensive, market oriented system). Results of the selection and management criteria of farmers including bottlenecks in field implementation and policy concerns are discussed.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTH ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE CASE OF BUCAP-BHUTAN NATIONAL PROJECT

BUCAP Bhutan Country Project
National Biodiversity Centre
Ministry of Agriculture
Royal Government of Bhutan

ABSTRACT

Bhutan is one of the biodiversity hotspots in the world. A number of efforts are underway in conserving the rich biodiversity of the country. A few focus on agrobiodiversity conservation work like BUCAP.

Bhutan was selected as a site for BUCAP because of its unique ecosystem. The country is still in subsistence agriculture where altitude and season plays defining roles in plant genetic resources conservation and development. The challenge is how to make the system productive while maintaining the prime role of farmers in crop development and conservation.

This paper looks at the agrobiodiversity management system in Bhutan, the challenges in conserving and managing the system and how the project (BUCAP) address these challenges by linking research and extension in strengthening farmers role and building their capacities to manage the ever changing system.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE CASE OF CBDC-THAILAND

CBDC- Nan Project
Hak Muang Nan Network
Nan, Thailand

ABSTRACT

This paper looks at the experience of CBDC Nan project in using the curatorship approach for agrobiodiversity conservation under three agricultural and market systems, namely a) traditional, subsistence Northern Thailand agricultural system with indigenous peoples, b) subsistence, upland agricultural system and c) lowland rice production system. An assessment of the approach and its subsequent evolution is discussed.

The paper also discusses the different ways of bringing conservation issues and sustainable use of biological diversity to the greater public through community radio, the formation of children's cultural group, and the establishment of a province wide network of fish sanctuaries and rehabilitation of community forests supported by professionals in the province (doctors, engineers, civil servants), monks, farmers, students and development workers.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE CASE OF CBDC-VIETNAM

CBDC Vietnam
Mekong Delta Farming Research Institute
Cantho University
Can Tho, Vietnam

ABSTRACT

This paper looks at the experiences of CBDC Vietnam in conserving and managing agrobiodiversity under market oriented, intensive rice production system. The advantages and disadvantages of having the project initiated by a research institution in the Mekong Delta will be discussed. An assessment of the link between the genebank and breeding institution and farmer groups is also presented. The paper also outlines the challenges faced by a research institution in setting up a project to manage agrobiodiversity and strengthen farmers' role in agrobiodiversity conservation.

MANAGING AGROBIODIVERSITY UNDER CHANGING SOUTHEAST ASIAN MARKET AND AGRICULTURAL PRODUCTION SYSTEMS: THE EXPERIENCE OF SEARICE IN THE PHILIPPINES

SEARICE

ABSTRACT

SEARICE directly implements two community based agrobiodiversity conservation and improvement projects in Central and South Philippines and provides assistance to CONSERVE, a non-government organisation based in Mindanao. This paper looks at the experiences of SEARICE in these Philippine based projects. Specifically, reviewing the shifts in approaches, the development of new methodologies and tools for community based agrobiodiversity management. The link of agrobiodiversity conservation work with the market and the accompanying advocacy work and policy discussions are discussed.

VALUING AND PROMOTING SMALLHOLDER AGRICULTURAL PRACTICES: THE APPROACH OF THE PLEC PROJECT

Miguel Pinedo-Vasquez, Christine Padoch, and Kevin Coffey

In a world where agricultural production is increasingly characterized by a very limited number of crops produced in a very limited number of ways, rural smalldholders are among the few social groups that still produce diversity in agricultural landscapes. The biological richness of small farmers' landholdings have drawn experts to collect crop germplasm and suggest actions for conserving these resources of global value. In this paper we argue that for a majority of poor rural families the most important resource is their complex and diverse resource use systems which are more than just a sum of their products. Diverse systems have a multiplicity of ecological and economic functions; the biodiversity they contain frequently has a utility or meaning beyond the specific uses of its component parts.

We focus on examples of how locally-developed management systems allow farmers in economically marginalized areas to cope with abrupt and transformative changes in their physical, biological and socio-economic environments. We present specific examples of highly dynamic agriculture, agroforestry, forest management and local conservation practices collected from PLEC demonstration sites established in the landholdings of small farmers. We discuss how farmers using these diverse systems responded to major changes including shifts in market opportunities and agricultural policies, as well as problems such as new crop diseases, and catastrophic alterations in the physical landscape.

We also discuss the issue of how to promote productive and flexible resource use systems that result in a diversity of environments in which agrobiodiversity and other biological resources are cultivated, managed and conserved. We argue that the complexity of such systems is poorly understood by most agronomists and that exchanges between agronomists and farmers rarely take advantage of the full range of farmer expertise. We describe PLEC demonstration activities where farmers (expert farmers) who have developed and successfully used diverse systems demonstrate these documented and tested technologies. Based on PLEC experience we argue that it is critical for programs seeking to protect or conserve diversity in rural smallholder agriculture to identify "expert farmers" as the most creative generators as well as potentially the most capable teachers of these complex systems of managing plants, animals, and ecological interactions.

COMMUNITY SEED BANKS AS A WAY OF MANAGING ON FARM AGRICULTURAL BIODIVERSITY.

Vanaja Ramprasad Green Foundation

Diversity is the hall mark of the dry land ecosystems in southern India largely supported by small and marginal farmers who eke out a living by subsistence farming. The underlying concept of the multicropping system in the dry land regions was based on two important factors that touched the farming systems in these regions.

Multicropping provided the balanced nutrition with a combination of pulses, oilseeds, and vegetables. Together with this diversity in the cropping system ensured insurance against failure of any one variety. The crop combination was purely a reflection of farmer,s ability to manage the given resources. Examples of the different crop combinations are the navadanya or nine seeds and the baranaja or the twelve seeds, grown as a cropping system.

The multicropping system with fingermillet (Elusine corcana)practised in the dry land regions has undergone some changes in the recent years, with the introduction of the high yielding varieties. The fall out of this change has been loss of diversity both interms of inter and intra species diversity that is so specific to the multicropping system.

The programme of "on farm" conservation has been initiated in this region basically to strengthen the existing diversity at the farm level and to retrieve the diversity that is at the threat of extinction. The major objectives have been

- To strengthen the community seed supply with a wider gene pool via the community managed seed banks
- To manage the germplasm of the diverse allied crops via the filed gene bank and enhance the quality of seeds to enable growing them under variable conditions.

Research	**On farm in situ conservation**	**Field gene bank**
Farmer led PPB for seed purification and enhancement for variable environment	Community seed bank Training in seed management	Maintenance of germplasm at the field level

Central to the work of conservation and allied activities is farmers participation . From a mere ten farmers who participated in the conservation now more than 1000 farmers participate . Farmers evaluate the varieties for preferred criteria on an yearly basis which facilitates the ongoing conservation from time to time.

Seed fairs are held in different villages which is the high point in the year round activity.Demonstration plots in the school premises provide an opportunity to make diversity in the crops visible. Farmers participating in the Onfarm conservation have been organised into farmers sanghas(clubs) All programmes related to the onfarm conservation are implemented through the sanghas. Farmers sanghas in selectd vilages have maintained seed banks through which seeds are distributed.

Farmer led seed enhancement programme includes seed purification and treatment for better yields. Women farmers play a crucial role in seed treatment, seed selection and seed storage.The prgramme has been extensively documented to highlight the different dimensions of the programme and limitations of the approach.

EMPLOYING INTENSIVE DATA PLOTS TECHNIQUE FOR UNDERSTANDING FARMERS' MANAGEMENT OF LANDRACES ON-FARM

R.B. Rana, R.K. Tiwari and P. Chaudhary

[1]Local Initiatives for Biodiversity, Research and Development (LI-BIRD), P.O. Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: rblibird@mos.com.np

Understanding of farmers' decision-making regarding the choice of and preferential treatment of varieties require detailed monitoring of the farmers' management practices including their resource base. Employing intensive data plots techniques, monitoring of 66 farm plots belonging to 34 farmers in different agro-ecological domains was completed on pilot scale at Begnas ecosite, Kaski. The results suggest that farmers' decisions regarding deployment of landraces to specific agro-ecological domain were predetermined by their in-depth knowledge on suitability of landraces to specific domains. Human managed factors such as seed rate, amount of FYM and chemical fertiliser applied, time of transplanting, weeding, irrigation, harvesting and storage for *Mansara* and *Ekle* landraces differed across households. For instance, seed rate and chemical fertiliser application significantly differed across wealth categories with resource-poor households applying higher amount, whereas for FYM application resource-medium households applied higher amount. The seed rate, amount of FYM and chemical fertiliser applied for *Mansara* was relatively higher than that applied for *Ekle*. The economics of producing these two landraces suggests that the return generated is positive even when different factors of production were included in cost, which is generally not practised while analysing subsistence-oriented production. The monetary value converted from grain and straw yield by cultivating *Ekle* was much higher than *Mansara*, which goes on to explain farmers' decision on differential area planted to landraces.

FARMERS' MANAGEMENT OF FALLOW SUCCESSION IN THAILAND

Kanok Rerkasem

ABSTRACT

The importance of fallow succession on long-term productivity of traditional shifting cultivation is well known. As long as the length of fallow periods can be kept adequately to allow fallow regeneration to reach maturity stages, the shifting cultivation will be functioning on sustainable basis. With increasing pressures on land, productivity of shifting cultivation may be declined and flipped to unproductive stage with annual weed or grass dominant fallow.

In Thailand, ethnic minorities in the northern part of the country are the major shifting cultivators who practised traditional shifting cultivation for food and some cash crops including opium. Certain groups of people, e.g., Karen and Lua, had been settled in the country for a few hundred years but others, e.g., Hmong, Lisu, Lahu, Akha and Yao, had just arrived from neighbouring countries in the sub-region for the past few decades. Since early 1970s, government policies on the suppression of opium growing area and forest protection have put tremendous pressure on land required for long fallow regeneration. Many have turned to alternative practices with commercial crop production while others are facing with difficulties in maintaining productivity of their shifting cultivation with fairly short fallow periods, up to a maximum of 6 years.

In PLEC demonstration sites, farmers are managing fallow succession successfully by their own innovation, despite the condition of the change in traditional agricultural practice in northern Thailand. In a Hmong village with more or less sedentary agriculture, a weedy species (*Mimosa invisa*) which were accidentally introduced for fencing a small vegetable garden, has shown to be very effective for building soil fertility of severely degraded land. The species is now managed as a dominant fallow species before planting the following cash crops and high value vegetables. For the Karen community site, a pioneer tree species (*Macaranga denticulata*) is used to sustain productivity of upland rice in a short 7-year cycle of rotational shifting cultivation. Management of these local fallow species by farmers may be a key to understand the success of sustainable land management. The management of these species will be presented and discussed.

PRÉSENTATION DU PROJET "PRÉSERVATION DE L'AGROBIODIVERSITÉ DU SORGHO IN SITU AU MALI ET AU BURKINA PAR L'AMÉLIORATION PARTICIPATIVE DES ÉCOTYPES LOCAUX"

Gilles Trouche, Michel Vaksmann, François-Noël Reyniers, Denis Sautier, Marcel De Raissac

RESUME

Au Mali et au Burkina, le sorgho est avec le mil la céréale de base pour l'alimentation humaine. Dans ces deux pays, les prévisions de croissance démographique pour les vingt prochaines années font apparaître une forte augmentation de la demande alimentaire. Le sorgho, qui est bien adapté aux conditions climatiques et économiques de ces régions, devra nécessairement contribuer à la satisfaction des besoins alimentaires croissants des populations rurales et urbaines. Dans certaines régions de ces deux pays, des enquêtes préliminaires indiquent une diminution préoccupante de la biodiversité de cette espèce. La concurrence du maïs en est une des raisons clairement identifiées. D'autres causes d'érosion génétique restent en l'état d'hypothèses qui seront testées durant ce projet. Face à ces deux enjeux de développement, le projet se propose de préserver l'agrobiodiversité du sorgho par l'amélioration participative des écotypes locaux dans une perspective d'augmentation de la production. Il est le résultat d'une concertation entre des institutions de recherches (CIRAD, ICRISAT, IER et IPR au Mali et INERA au Burkina) et différentes institutions sous-régionales et locales de développement. Il sera co-financé par le Fonds Français pour l'Environnement Mondial (FFEM) et par les différentes institutions partenaires. Dans une première phase, il couvrira trois régions par pays, bien différenciées par rapport aux risques d'érosion génétique, aux besoins d'intensification de la culture du sorgho et aux contextes écosystémiques et socio-économiques. Le premier objectif spécifique est la création à partir des écotypes locaux de variétés améliorées répondant à la diversité des agro-écosystèmes et des besoins des producteurs et des utilisateurs. Parmi les objectifs de sélection, figurent aux premiers rangs l'adaptation au climat par le photopériodisme, la productivité et la qualité des grains et des pailles. Une des originalités du projet sera l'utilisation de la sélection récurrente pour une conservation dynamique de la diversité génétique selon une approche de création variétale participative et décentralisée. Les autres objectifs spécifiques sont la connaissance des facteurs d'évolution de la biodiversité des écosystèmes du sorgho et l'appropriation par les agriculteurs de nouveaux modes de gestion durable de cette diversité. Pour atteindre ces objectifs, le projet s'appuiera sur des compétences en génétique, agro-écologie et sciences sociales regroupées au sein d'équipes pluridisciplinaires. Les autres méthodes et techniques utilisées seront le marquage moléculaire, le SIG, la géostatistique, le PRA, les enquêtes participatives, les ateliers d'échanges, les outils d'appui à la négociation… Trois types de produits sont attendus à l'issue du projet : du matériel végétal diversifié et amélioré; des dispositifs locaux et régionaux de concertation pour orienter la gestion de la biodiversité; un système d'information géographique intégrant les différentes composantes de la diversité .

IN SITU CONSERVATION OF BARLEY AND DURUM WHEAT IN MOROCCO

Keltoum Rh'rib[1], Mona Taghouti[1], Ahmed Amri[2]

[1] Institut National de la Recherches Agronomique (INRA), Cereals Programme, Rabat, Morocco
[2] ICARDA

Morocco presents a great diversity of environments and farming systems and subsequently is an important niche for more than 4500 species among which 14% are endemic. Morocco is well known as a many economic species especially barley and durum wheat. The local populations of these crops offers an important genepool as sources of adaptation and tolerance to many biotic and abiotic stresses. This important genetic materiel is continuously subject to genetic erosion and the rapid adoption of the newly released varieties has already reduced significantly the acreage grown to landraces in many parts of Morocco. In the mountain and oasis regions of Morocco, however, wheat and barley landraces are still widely grown by farmer. In order to better understand the amount and distribution of the existing diversity of these two crops and on-going farmer management practices that continue to ensure the sustainability of this diversity, three regions in Morocco (Rich, Tanant and Taounate) were selected on the basis of the large use of landraces by farmers, and the cooperation of farmers, local communities, development institutes and non government organizations. Eight-three landraces of barley and durum wheat, collected from the three sites, were characterized for many agro-morphological traits for the purpose of assessing the global genetic diversity in the sites, and to understand how farmer based management units, based on traits used by farmers to distinguish these units, relate to different levels of genetic distinctiveness. Statistical results (univariate and multivariate analysis) per trait and for each species, revealed a great genetic variability between and within landraces for the majority of the characters in the 3 sites. On the other hand the variance decomposition showed that the variability within landraces is the most important for the majority of the traits, except awn color and number of spikelets/spike for durum wheat, and spike length and 1000 kernels weight for barley. Factorial correspondence analysis on traits used and not used by farmers grouped the landraces into groups linked by few phenotypic characters. In addition, the quality of seeds of barley and durum wheat used by farmers was evaluated through the germination test and the determination of foreign materials. The results revealed the good ability of germination (percent of germination varying from 92% to 99%) and the good purity (percent of pure seeds varying from 94% to 99%) in local populations still cultivated by farmers in the mountains and desert regions. The fungicide treatment and cleaning of farmer's seed before sowing and chemical weeding were used as adding value techniques for barley and durum wheat. Trials were conducted at farmer's field at each of the 3 sites and on experimental station. The results on two years showed the positive effect of these technologies on grain yields especially the treatment of seeds for the two species.

IN SITU CONSERVATION OF BARLEY LANDRACES IN MOROCCO

Keltoum Rh'rib, INRA- Morocco

Morocco is known as a center of diversity for some cereal species including barley, durum wheat and wild oats. They are used as sources of resistance to major pests by many breeding programs. Few of the landraces of barley are released to farmers since 1946 and are actually used by the national breeding program as sources of adaptation, disease resistance and good grain quality.

The landraces of barley are still widely used by farmers. The release of many high yielding and semi-dwarf varieties by INRA has decreased significantly the use of landraces. The collect and the conservation *ex-situ* of samples of these populations were initiated since early 1980's. The evaluations of such populations revealed the decrease in the variability for some traits (plant height, days to heading, …) as compared to the reported data from the collections of 1924. The future use of these landraces by the farmers will be highly affected by the release of new adapted and higher yielding varieties.

The *in-situ* conservation is recently advocated as a better way to conserve a larger genetic variability of landraces as well as to take the advantages of natural selection (dynamic conservation). Though, the scientific basis for such conservation is only recently investigated by many researchers for many crops.

The Global project on *in-situ* conservation initiated by IPGRI in collaboration with many countries aims at strengthening the scientific basis of on- farm conservation of local germplasm. Morocco is among the nine countries where this project is implemented. Barley are among the species to be studied.

CONSISTENCY OF FARMERS NAMES AND AGROMOPHOLOGICAL DIVERSITY OF LOCAL TARO VARIETIES FOR CONSERVATION AND USE IN CONTRASTING PRODUCTION SYSTEMS IN NEPAL.

D.K. Rijal[1], J. Bajracharya[2], R.R. Rana[1], A. Subedi[1], Y.R Pandey[3], D. Jarvis[4] and B. R. Sthapit[5]

1 Local Initiatives for Biodiversity, Research and Development (LI-BIRD), P.O. Box No. 324, Pokhara, Nepal, Tel/fax: 977-61-26834; E-mail: rblibird@mos.com.np
2 Agricultural Botany Division, Nepal Agricultural Research Council, Nepal; e-mail: jwala@unlimit.com
3 Horticultural Research Station, Nepal Agricultural Research Council, Jumla, Nepal
4 International Plant Genetic Resources Institute, APO, Malaysia, e-mail: b.sthapit@cgiar.org
5 International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy d.Jarvis@cgiar.org

Taro (*Colocesia esculenta* (L.) Schott) is a good example of root crops of the family araceae that is important for livelihoods for small farmers and has potential for income generation. Diverse farmer varieties of taro are conserved by 900 households of Begnas village (600-1400m) in the middle hills of Nepal. Nepalese farmers classify both taro (*Colocesia esculenta* (L.) and tannia (*Xanthosoma sagittifolium*) as taro and are locally known either as *Karkalo* (leafy taro) or *pindalu* (corm taro) depending upon plant parts being used for food. Cultivar diversity was found high in Begnas ecosite (24) followed by Terai eco site Kochorwa (3) and High Mountain ecosite Talium (1). The objectives of the study are to understand farmer's method of describing taro cultivars, their consistency in naming in terms of morphology (aerial and underground parts), use value and local adaptation, and to characterize the diversity of selected taro landraces using farmers and IPGRI's descriptors. The study also aims to document uses of taro local varieties as distinguished by agro-morphological characteristics and ethno-botanical tools and to understand the extent and distribution of taro diversity managed by farmers. Farmers distinguished taro diversity by the number of farmer-named cultivars, their specific morphological characteristics and economic use values. Farmers, particularly women farmers, were reasonably consistent in describing and identifying the cultivars using farmers' descriptors. Isozyme analysis suggests that taro diversity of Begnas village be found to be genetically distinct. We found that distribution of taro diversity in Begnas eco site (600-1400m) is influenced by local adaptive traits of taro cultivars and their specific use value. The extent and distribution of taro genetic diversity can be related to multiple use values and preferences for local cuisine. Farmers use high level of diversity as a sustainable resource base in order to make appropriate farm management decisions. This taro diversity enables inter and intra species diversity to survive and adapt to different environments, new pests and changing climates and farming systems. Blending local knowledge on its specific adaptation and use value with scientific understanding can guide conservation strategies on how to conserve and deploy taro genetic diversity for the benefits of human kind.

DIVERSITY OF FARMER-NAMED FABA BEAN (*VICIA FABA* L.) VARIETIES IN MOROCCO: A SCIENTIFIC BASIS FOR *IN SITU* CONSERVATION ON-FARM IN LOCAL ECOSYSTEMS.

M. Sadiki,[1] L. Belqadi,[1] M. Mahdi,[2] and D. Jarvis[3]

[1] Institut Agronomique et Vétérinaire Hassan II, Dep. d'Agronomie et d'Amélioration des Plantes, B.P. 6202 Rabat, MOROCCO, Tel./Fax. 212 37 774869, email:sadiki@fusion.net.ma

[2] Ecole National d'Agriculture,

[3] International Plant Genetic Resources, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome Italy.

ABSTRACT

Vicia faba L., commonly known as faba bean, is the most important grain legume in Morocco. The crop is ancient in Morocco and local populations have adapted to various environmental and social cultural conditions revealing wide genetic variability for many important traits. At present, almost all cultivars (97%) currently used by farmers are local varieties or landraces. *In situ* conservation on-farm has been advocated as an approach to maintain the genetic diversity of this crop in the ecosystems where it has been generated. On-farm conservation of landraces raises issues of quantifying and assessing genetic diversity in relation to geographic distribution and to farmers' named and managed varieties (units of diversity or units of management). The objective of this study was to describe the farmers' named varieties of faba bean and to analyse the genetic differences among these names or units of management. A precise definition of farmers' units of diversity management is required for understanding the farmers' criteria for distinguishing and naming the varieties, and therefore the bases for understanding farmers' concepts in managing the diversity through cultural strategies. On-farms surveys were conducted on 185 farms distributed on 15 villages belonging to 5 communities of 2 provinces and 254 seed lots were collected along with information about the local farms, sites, and growing conditions. A list of names given by farmers for each management unit was established from this survey. The consistency of the names among farmers was verified in further investigation in a participatory way using seed characteristics and plant morphological traits. Hence samples of seed from each type were prepared and shown to different farmers across the region. Furthermore, samples from the different types were grown together in the same comparative trial on-farm and a group of farmers from different villages were asked to recognize and name the different types. The final confirmed list comprised of 24 different named varieties or types distinguished by farmers. These named varieties and/or types are differentiated by farmers based on seed characteristics, plant morphology, as well as cooking ability and taste. However, farmers also assert that within each type they were variations among seed lots grown by different farmers. Results showed only partial consistency as not all names were consistent across farmers, while other times more than one name corresponded to the same types. In addition, some generic names such as "local" were used by farmers to indicate the origin of the variety, whereas specific names usually relate to morphology, uses, adaptation, and yield components. To identify the genetic structure of these names, morphological characterization was conducted in a controlled on station experiment and in on-farm trials. The phenotypic variability was analysed within the types and between types. The study concerned 10 of the 24 described types. Seven seed lots per type were included. Large amount of phenotypic diversity was shown among these variety types with regard to most analysed characteristics. Hierarchical Cluster Analysis and Multivariate Discriminant Analysis revealed that morphological characterisation of farmers' populations of 6 among the 10 named

faba bean local varieties clearly clustered together as types. These results agree with the farmers' description of the varieties types based on phenotypic characteristics indicating that for these populations, farmers' named units are clearly distinct based on the agromorphological traits analysed in controlled experiments.

ECOSYSTEM COMPONENTS AS INDICATORS TO FARMERS TO CONSERVE, MAINTAIN AND MANAGE LOCAL CROP DIVERSITY IN BURKINA FASO.

M. Sawadogo[1], J-B., Ouedraogo[2], M.O. Belem[1], and D. Balma[1],

[1] Institut de l'Environnement et Recherches Agricoles (INERA), 01 BP 476 Ouagadougou 01, BURKINA FASO, Tel. 226 319202, Fax. 226 319206, E-mail dbal@fasonet.bf

[2] Institut (INSS)

The ecosystem provides farmers with sources of knowledge that help determine appropriate management strategies that will support the sustainability of local crop genetic resources. Supporting these strategies requires an understanding of the amount of diversity maintained on farm and the perceptions that influence farmers to maintain and manage this diversity over time. To understand the role of components of the wider ecosystem in providing indicators to farmers on which varieties to plant, when to plant, and how they will manage and conserve these varieties over time, three contrasting regions in terms of rainfall amount and distribution and incidence of genetic erosion were selected in Burkina Faso,: Ouahigouya, Tougouri, and Thiougou, and six target crops: sorghum, pearl millet, cowpea, groundnuts, okra, and frafra potatoes (*Solenostemom* sp.), were chosen. Farmer knowledge of seasons was collected, including information on the signs indicating the beginning of a season or time to plant, the signs indicating the end of a rainy season, the signs indicating that the season will be good, and the signs indicating that the season will be bad. Complementary information was collected on the types of soils, plant cultural practices, crop varieties, crop associations, crop preferences, crop products used, storage practices, preferences and selection of seeds and varieties, and genetic variability of the crops. Data were spatially analysed to map the distribution of farmers' varieties, map the factors that affect diversity, determine whether there are relationships between these factors and diversity in farmer varieties. Diversity was calculated by number of varieties of each crop using Shannon-weaver index. Information was analysed in order to determine the type of interventions and actions to be taken and in what priority order. A total of 24 plant species are used to predict the type of season across sites. Only two species are annual, the rest are perennial trees. Plant indicators include appearance of new leaves, yellowing of leaves, flowering, and ripening of fruit. Three species are most commonly used (with the highest frequency) in the three sites: in descending order of use *Lannea microcarpa* (Raisinier, Sabga), *Sclerocarya birrea* (Nobga) and *Butyrospermum paradoxum* (Karité, Taaga). Four species were used only in the northern site, Ouahigouya: *Borassus aethiopaum* (Rhonier, Koaga), *Tamarindus indica*, *Ficus gnaphalocarpa* (Figuier) and a tree known localy as "Sebeé. The rest of plant species are used at different frequencies in all sites. In addition, the appearance and or crying of certain birds, birds building their nests, insects such as lizards shedding skin, toads going from bush to ponds, star constellations, weather signs, and dates on the traditional lunar calendar were used to predict the type of season that will come and thus the variety to plant and management activity to perform. Criteria for predicting the beginning of the rainy season is extremely important as it determines sowing dates. Whether the rainy season will be good or bad determines the type of variety to grow, and predicting the end of the rainy season influences the harvesting time and the seed storage methods to be used. These decision all depend on the continued existence of the wild plants and animals that surround the farmers' environment and implies that sustainable management of crop diversity in Burkina Faso will be ineffective without sustainable management of the surrounding ecosystem.

MANAGING BIODIVERSITY IN THE HIMALAYAN FARMING SYSTEMS

K.G. Saxena[1], R.K. Maikhuri[2] and K.S. Rao[3]

[1] School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067, India. Fax: +91-11-6172438/6169962/6165886; email: kgsaxena@jnuniv.ernet.in

[2] G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, PB 92, Srinagar (Garhwal) 246174, India

[3] G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India

EXTENDED SUMMARY

The Himalayas are a vast mountain system covering partly or fully eight countries of Asia including Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. India's recognition as a 'megadiversity' country derives partly from the Himalayas distinguished as a global biodiversity 'hotspot'. This paper is a synthesis of our studies on traditional management of agrobiodiversity, changes in traditional management, driving factors and their implications in representative farming system types in the Indian Himalayan region.

Crop-livestock mixed farming sustained with organic matter and nutrient inputs from natural forest and pasture ecosystems is common all across the region but agrobiodiversity potential and nature of crop-livestock-forest-economy linkages vary depending upon the variation in the ecological, socio-economic and policy factors. Traditional agrobiodiversity management aimed for local production based food self-sufficiency to secure survival in the face of geo-climatic limitations and risks. Key features of traditional agricultural systems, irrespective of socio-cultural group involved, are: (a) realisation of ecological opportunties and constraints in respect of domestication (b) maximization of biodiversity through an appropriate mix of domesticated (crops and livestock) and associated biodiversity (within farm: multipurpose trees, shrubs, herbaceous species valued for soil fertility maintenance and pest control conventionally considered as weeds; outside farm: wild edibles, fuel wood, fodder and manure species, medicinal aromatic species in forests) in time and space, and (c) socio-cultural norms forcing social integration and reducing the risks of pest infestation, crop/livestock loss due to wildlife and ecosystem degradation. A typical traditional hill farmer, with an average holding of about 0.75 ha in mid altitude zone (800-2200 m), grows 20-35 crops. Land holdings are larger but crop diversity lower in higher altitude villages (2400-3600 m) or in the foothills. Such a high level of crop diversity is maintained by rotation of crops in time and space together with adoption of both mono and mixed cropping practices. Rainfed traditional agroecosystems are characterised by a higher level of crop and associated biodiversity as compared to the irrigated agroecosystems.

A socio-cultural change from subsistence to market economy, together with changes in traditional land/resource rights and institutions has led to a number of changes in traditional agricultural land use and biodiversity management. Policy of supplying staple food grains at subsidised price, incentives for cultivation of artificially bred irrigated cultivars of paddy and wheat or cash crops like potato and temperate fruits, and lack of any support for marketing of indigenous rainfed crops resulted in complete abandonment of or drastic reduction in area under *Fagopyrum esculentum*, *Fagopyrum tataricum*, *Flemingia vestitata*, *Hordeum himalyens*, *Panicum miliaceum*, *Parilla frutesence*, *Macrotyloma uniflorum*, *Pisum arvense*, *Vigna umbellata* and several local cultivars of rainfed paddy and wheat. This means a significant loss of

agrobiodiversity whose nutritional, economic and ecological potentials remain ‘unknown’ or ‘lesser known’ to the scientific and wider communities.

There are isolated examples of indigenous innovations of cultivation of new crops in response to restrictions on access to wild resources as a result of conservation policies. Bhotiya farmers have started cultivating eight medicinal species viz., *Allium humile*, *Allium stracheyi*, *Angelica glauca*, *Carum carvi*, *Dactlorhiza hatagirea*, *Megacarpaea polyandra*, *Pleurospermum angelicoides* and *Saussurea costus* in the last 20 years in response to termination of their traditional rights of utilization of these species in the Nanda Devi Biosphere Reserve. A larger farming community in central Himalaya has started cultivating *Cleome viscosa*, a medicinal and spice plant, which used to be harvested from the wild. Nevertheless, erosion of traditional agrobiodiversity is more extensive than the indigenous efforts towards cultivation of new crops.

Changes in crop diversity are such that economic losses due to diseases and wildlife have increased, fodder production from farm lands has declined while rates of organic manure (derived from livestock excreta and forest leaf litter) input has substantially increased. These trends imply increasing pressure on forests for fodder and manure. As soil erosion under the changed cropping patterns is quite high, instances of land abandonment and cultivation of new patches in forests are becoming more common. Abandoned agricultural land surves as refuge for biological invaders particularly *Eupatorium odoratum*, *Lantana camera* and *Ageratum conyzoides*. Enforced land tenure regimes and institutional arrangements discourage traditional ways of biodiversity and ecosystem management on a landscape scale.

Agricultural biodiversity has been a neglected dimension of conservation policies and programmes, even though it is an essential component of biosphere reserve management plans introduced in late1980s. Traditional agricultural systems have been considered more as a threat to wild biodiversity and ecosystem functions than as a potential foundation of developing ecologically sound food production systems. Many traditional crops are highly profitable but farmers adapted to subsistence economy are unable to realise potential profits from marketing. Options for conservation of biodiversity together with improvement in local economy and Himalayan ecosystem services arising out of our studies include: (a) enhancement of local knowledge of the economic potential of traditional agrobiodiversity (b) suppression of exploitation of hill farmers by middlemen in the market (c) incentives for cultivation of traditional crops with comparative advantages (d) improvement in traditional soil fertility management practices enabling a better synchrony between nutrient release and crop uptake by manipulating the quality of manure and rotation of crops in space and time (d) rejuvenation/strengthening of traditional socio-cultural norms enforcing integrated landscape management.

COMMON GROUND, COMMON FUTURE: USING ECOAGRICULTURE TO RAISE FOOD PRODUCTION AND CONSERVE WILD BIODIVERSITY

Sara J. Scherr*
Fellow, Forest Trends and Adjunct Professor, Agricultural and Resource Economics Department, 2200 Symons Hall, University of Maryland, College Park, MD 20742
Tel: (703) 758-2548; (301) 314-9091; Fax: (301) 314-9091; sscherr@arec.umd.edu

The world's biodiversity—the richness of its many species of plants, animals, birds and insects—is on the brink of a mass extinction comparable to the disappearance of the dinosaurs 65 million years ago. Globally, agricultural expansion and intensification are among the leading causes of habitat and species loss. Almost half of the world's major protected areas are themselves heavily used for agriculture, and many of the rest are "islands" in a sea of farmland. Malnutrition is pervasive among people living in at least 16 of the 25 biodiversity "hotspots" where wildlife is most at risk, even as population growth is increasing local demand for food. New forms of agriculture—"ecoagriculture"—are needed that *both* raise farm production and incomes, *and* increase wild biodiversity, in these hotspot regions. Ecoagriculture builds on the concept of "ecosystem management", by increasing wildlife habitat in non-farmed patches in agricultural landscapes, and enhancing the habitat quality of productive farmlands themselves. A global review has identified a range of ecoagriculture strategies, and well-documented examples of such farming systems that resulted from new scientific research, farmer-conservationist cooperation and innovation, and policy action. Actions are proposed to promote ecoagriculture on a scale sufficient to make a significant contribution both to conserve global biodiversity and reduce rural poverty.

SELF-SUFFICIENCY AND SUSTAINABILITY OF THE NATIVE POTATO CULTIVATION IN THE COMMUNITY OF QUILCAS, IN THE MANTARO VALLEY, IN THE CENTRAL ANDES OF PERU

Maria Scurrah[1], Raul Ccanto[2] and Noemí Zúñiga[3]
In collaboration with Grupo Yanapai

[1] CIP. Yanapai-hyo@terra.com.pe
[2] m.scurrah@cgiar.org,
[3] INIA head of genetic resources pnirgb@fenix.inia.gob.pe

Farmers in the community of Quilcas, in the central Andes of Peru, grow native potatoes using techniques markedly different from those of modern agriculture. One important difference is that Quilcas farmers still plant varieties inherited generations ago, a practice that is possible only if they can minimize the degenerating effects of viruses. Potato yields decline steadily over several years, but Andean farmers discovered that seed coming from potatoes grown under low temperatures at the upper limits of agriculture has renewed vigour – an observation that lead to a complex seed system whereby seed is constantly shifted between lower and higher altitudes. All 250 members of the Quilcas community have rights to potato lands in the highlands. A second difference is the extent of diversity. The 23 families surveyed grow more than 150 different varieties on their 35 ha of land, and this diversity gives this large potato area stability and resilience. The wisdom of giving land to many families is that each family will manage its seed differently. Each family grows its own particular mix of varieties. Nine varieties were dominant and almost all families grew these, but the average number of varieties managed by each family was 21 (range 14 to 41). A third difference between Quilcas practice and modern agriculture is that potato farming goes hand in hand with animal husbandry. Soil conservation and fertility are maintained by long rotations, linked to a pastoral system where herds of llamas, alpacas and sheep provide fertiliser for these amazing potato fields. A further difference is that potatoes are planted under a "no till" "*Tikpa*" system. The seed is placed in a hole dug by an Andean foot plow (*chakitaklla*) and then covered with a handful of manure. This system is crucial as it prevents erosion in terrain that often has over 80% gradient. The first hilling-up proceeds by turning the soil upside down, an operation done by a man-woman pair, where the woman upends the clod which the man lifts with his foot-plough. Fields are planted in "*chalo*" or Mixtures of varieties. Mixing varieties is the technique used to buffer the spread of diseases and the damage caused by frost, drought and hail, since all varieties differ in their ability to tolerate the distinct stresses, which may afflict the field in one or another year.

How has this system survived in the face of steady cultural and technical pressures to become integrated into modern society? One answer is that modern potato varieties do not grow well in the harsh conditions at high altitudes. Many modern varieties from plant breeding programs have migrated there, but they show no yield advantage and their quality is inferior to the much-appreciated floury native potatoes. So does this system have a future? With schools, communications and roads undermining the knowledge base required to maintain this system, its survival may be threatened. Changing our culture of disdain for the Andean to one of respect may give this incredible system a chance.

ECOSYSTEM "SERVICES" AND PEST SUPPRESSION IN TROPICAL IRRIGATED RICE

William H. Settle
Center for Agroecology
University of California Santa Cruz

Increasing attention is being given to an ecosystem-based perspective which holds that biodiversity provides additional "ecosystem services" in addition to the primary productivity associated with a crop plants. Pollination and pest suppression are the most obvious examples of such services.

Tropical irrigated rice ecosystems provide one of the best examples of pest suppression that results as an intrinsic "emergent property" of an agroecosystem. Work in tropical irrigated rice since 1991 has demonstrated that many tropical systems exhibit a typical seasonal pattern of interactions in which a ubiquitous and rapidly developing soil and aquatic foodweb is linked to the above-the-water (aerial) foodweb via plankton-feeding and detritus-feeding insects. These "linking species" fall prey to a rich array of generalist predator species in the rice canopy, thereby providing beneficial insect populations with a hugely abundant alternative food source very early in the season. The net result is to "decouple" predator populations from a typical dependence on pest populations, allowing them to develop <u>well in advance</u> of any potential rice pest species. The result is that early-season pest migrants find no sanctuary and pest populations have difficulty getting a foothold in the system. Under this scenario, the likelihood of pest populations "escaping" control by natural enemies to reach outbreak levels is small.

However, certain management factors can impede the effectiveness of this system-based mechanism of pest suppression . Years of experiments and farmers' experiences demonstrate that insecticides in tropical rice are virtually unnecessary and counter-productive. They disrupt the normally high-levels of pest suppression, resulting in, among other things, the dramatic "resurgent" outbreaks that characterized rice production in Asia during the 1970s and 1980s. Of a different nature, but also important are landscape-level vegetation and water patterns. Traditional small-scale "patchwork" plantings, where rice is grown most of the year in a non-synchronous landscape, appear to be most stable with regard to pest suppression. Large monocultures, especially when coupled with long dry fallow periods, are the least stable and most prone to pest problems.

Given the current global pressures on biodiversity, we must demand that research be quick to move beyond the purely investigative stage to an adaptive management phase in which research, policy development, and public education take place in a coordinated and mutually-supportive manner. The FAO has already incorporated many of the ideas presented here into their farmer training curriculum. Institutional awareness and commitment is needed for continued support to ecologically-based, mechanistically-detailed, non-formal farmer training programs.

DEVELOPMENT AND STRENGTHENING PARTICIPATORY STRATEGIES OF CONSERVATION AND SUSTAINABLE UTILIZATION OF PLANT GENETIC RESOURCES OF PEARL MILLET, SORGHUM, COWPEA, AND BAMBARA GROUNDNUT IN SUB AND DESERT AREAS IN MALI

Amadou SIDIBE, Bather KONE, Mamadou KOURESSY, Michel VAKSMAN, Bakary M TRAORE, Alhousseïni BRETAUDEAU, Cheick H DIAKITE, Zié SANOGO, Mamdou A TOURE, Ousmane MAMADOU, Modibo OUATTARA, Issa S TRAORE

ABSTRACT

Pearl millet, sorghum, cowpea, and bambara groundnut constitute the basis of food for most of the rural populations in the principal agriculture areas in Mali. Threatness of disappearing of landraces and the interest of certain communities in them, motivated the initiation of the in situ conservation project in 1997 which started real activities in 1999. The partners involved in the project are (1) at the National level the Rural Economic Institute (IER, national research institution), University of Mali (Agro-physio-biotechnology laboratory of Katibougou's Rural Polytechnical Institute) and the National Direction of the Conservation of Nature (DNCN), in charge of research activities, (2) NGOs: Sahel Association of Agriculture Advisers (ACAS), Fondation of Sahel Development (FDS), and Unity Service Cooperation Mali Canada (USC), respectively reparted in three sites San, Douentza and Gao for 9 villages in total, and (3) at the International level, the International Plant Genetic Resource Institute (IPGRI) for research activities and the United Nation Agriculture and Food Organization for development aspects of the project. Different activities have been undertaken since July 1999 to December 2000. Technicians from each NGO were trained in in situ conservation concept, Diagnostic participatory (DP) tools and seed technology. Moreover, a methodological mission implying all NGOs gave rise to harmonized tools in DP for surveys on traditional knowledge on plant genetic resources, tools for storing seed etc. The results of these surveys done by NGOs showed the availability of diversity on farms, genetic erosion caused essentially by drought stress and different strategies used by farmers to preserve their landraces and seeds. More than 300 accessions of sorghum and cowpea have been collected and characterized agromorphologically on research stations. A case study demonstrated that 75 % genetic erosion of sorghum in high rainfall area resulted from intensification of maize, cotton cropping system, and drought. Geographical Information System established maps within vegetation of most of the different villages of the project. Seed diversity fairs organized at the 3 sites of NGOs clearly showed more than 200 pearl millet, sorghum, cowpea, and bambara groundnut landraces preserved by farmers. There were exchange of landraces and local knowledge on indigenous techniques, products and tools for long-term seed storage among farmers. A standard germination made on sorghum and pearl millet samples collected from seed diversity fairs displayed 50 % samples germinated above 80% and 75% respectively allowed for seed certification of these species.

ECONOMIC CONCEPTS FOR DESIGNING POLICIES TO CONSERVE CROP GENETIC RESOURCES ON FARMS

Melinda Smale[1], Mauricio Bellon[3], Devra Jarvis[2] & Bhuwon Sthapit[2]

1 Author for correspondence. International Plant Genetic Resources Institute (IPGRI) and International Food Policy Research Institute (IFPRI), 2033 K Street, N.W., Washington, D.C. 20006. e-mail: m.smale@cgiar.org.
2 International Plant Genetic Resources Institute (IPGRI), via dei Tre Denari 472/a, Maccarese, Fiumicino, Itay
3 International Maize and Wheat Improvement Center (CIMMYT), km 45 Veracruz, El Batán, Estado de México, Mexico.

Key words: Crop genetic diversity, Economic development, Policy, On farm conservation

ABSTRACT

The future food supply of all societies depends on the exploitation of genetic recombination and allelic diversity for crop improvement, and many of the world's farmers depend directly on the harvests of the genetic diversity they sow for food and fodder as well as the next season's seed. On farm conservation is an important component of the global strategy to conserve crop genetic resources, though the structure of costs and benefits from on farm conservation differ from those associated with ex situ conservation in gene banks. A fundamental problem that affects the design of policies to encourage on farm conservation is that crop genetic diversity is an impure public good, meaning that it has both private and public economic attributes. This concept is defined and made operational in order to assist practitioners in identifying (1) least-cost sites for on farm conservation (2) policy instruments most suitable for supporting conservation once a site has been located. Published findings regarding prospects for on farm conservation as economies develop are summarized and empirical examples of suitable policies to support farmers' decisions are placed in the context of economics principles.

AGROBIODIVERSITY; A CASE FOR PRESERVING AND CONSERVING INDIGENOUS ECOTYPES OF NIGERIAN POULTRY.

Sokefun Olusola* and Fabule Folabi
***Faculty of Science, Lagos State University, Ojo**
PMB 1087 Apapa, Lagos Nigeria
E-mail : osokefun@hotmail.com

Key words: agrobiodiversity, animal genetic resources, genetic base, ecotypes, immunological index, microsatellite, phylogenetic,crossbreeding.

Agrobiodiversity,is the vital organic resources on which the present and future sustenance of humankind depends. The farm animal genetic resource (AnGR) sector of this provides the variety and variability of species, breeds and populations including unique genotypes which underpins an essential component of food and agricultural production.

The African sub - continent is one of the world's mega diversity centers and judicious use and enhancement of these living resources must be ensured.

This becomes important because of the highly specialized nature of the animal production enterprise, especially with poultry which is the focus of our research. Production here is dominated by as few as ten (10) primary breeders generating meat, white and brown eggs and further dominating the enterprise with a concomitant thinning of the genetic base on which the whole enterprise stands.

The Nigerian ecotypes (ecological types), our focus an indigenous small body sized mongrel with a plethora of genotypes and phenotypes that is most suited for the environment in which it is found due to adaptation, where they are raised extensively, solely on free range with little or no attention to issues of feeding and health. Still they thrive meeting about 60%of the rural meat requirement.

The immunological index, which is a measure of preparedness to diseases challenge is high when compared with the exotics that are commercially raised. The term indigenous is a term of convenience given the fact that microsatellite analysis of populations of the different ecotypes and the German Dahlem Red show clearly that phylogenetically the Nigerian indigenous is nearer to the Dahlem Red than other African ecotypes, due to various attempts at planned and indiscriminate cross breeding, the most prominent being the Western Nigerian Government program of Cock exchange dating back to 1965.

On our project farm, all Nigerian indigenous ecotypes are being preserved in - situ, with planned crossing between and within types, and also the exotics, under intensive production systems, so that the unique genotypes are preserved and indices of productivity can be measured in a controlled environment. Results obtained so far are fascinating.

ANALYSIS OF BASIC CLIMATIC CONDITIONS FOR THE *IN SITU* CONSERVATION OF PLANT GENETIC RESOURCES IN BURKINA FASO.

Léopold SOME
Institut de l'Environnement et Recherches Agricoles (INERA) 03 LP 7192 OUAGADOUGOU 03 BURKINA FASO

Key words: variability, rainfall, temperature, *in situ* conservation, plant genetic resources, Burkina Faso

ABSTRACT

As part of a project to strengthen the scientific basis of *in situ* conservation of agricultural biodiversity on-farm, researchers in Burkina Faso are working to characterise and monitor changes in the agroecosystems where the activities of the project are taking place. Basic agro ecological research relates primarily to the climate, the soil and the vegetation. This article addresses two significant climatic factors in Burkina Faso on which crop production depends on: rainfall and temperature. The daily surveys/records from 67 stations covering the period from 1950 to 1999 were used to analyse the rainfall patterns of the whole country.

A comparison between the average rainfall of 1951-1980 and 1961-1990 reveals the appearance of the 400 mm isohyet in the far north of the country and a disappearance of the one of 1200 mm in the South-West over the past 50 years. There is latitudinal sliding of all isohyets towards the South, translating to a reduction of 100 mm in average rainfall. On the contrary, the average rainfall of the decade (1990-1999) shows some improvement. The 400 mm isohyet rose up to northern border of the country, and the 1100 mm isohyet reappeared in the South. This rainfall dynamics has implications on genetic erosion on a North/South gradient in Burkina Faso.

The data recorded at synoptic representative stations in the project sites were used to analyse temperature patterns in the three Burkina Faso project sites. In Dori, the northernmost station, the minimum and maximum values of temperature under shade during the period of 1950-1999 were 11°C and 44°C respectively. In Pô, the station in the south, the minimum and maximum values go from 15°C to 40°C respectively. In the entire project zone, one notes an upward trend in average temperature. At Dori, there was net increase of about 1.5°C from an average of 28.5 to 30.0°C. If the trend continues, it is estimated that in the year 2010, the average temperature might be 30.5°C at Dori, 29.5°C at Ouahigouya, and 28.2°C at Pô.

Climatic conditions are critical to agricultural and economic activities for rural populations in Burkina Faso. It is interesting to note the perceptions of the rural population on climate change and variability in the last 50 years. These farmers have over time developed adaptation strategies to cope with drought and desertification. Some surveys have been carried out on a sample of 270 men and women farmers from nine (9) villages of the project sites. The results showed that the people have good knowledge of the rainfall patterns. They are conscious that changes have occurred in the climate and have as a result, abandoned some crops and varieties and have changed some of their farming systems. They have also developed local practices of maintaining plant diversity on farm.

EXPLORING THE POTENTIAL FOR CROP DEVELOPMENT AND BIODIVERSITY ENHANCEMENT: FOSTERING SYNERGY BETWEEN THE FORMAL AND THE FARMERS' SEED SYSTEMS IN CHINA

Yiching Song[1]

[1] Research fellow, Centre for Chinese Agricultural Policy (CCAP), Chinese Academy of Science(CAS), Beijing, China and post-doctor, in Department of Communication and Innovation Studies, Wageningen Agricultural University, the Netherlands, Contacting E-mail: Yiching.Song@alg.vlk.wau.nl

ABSTRACT

The paper is an introduction of an on-going research project in SW China, co-funded by Ford Foundation and IDRC. The project is a follow up research based on the main findings of an impact study of a CIMMYT's maize germplasm in SW China. The general objective of the project is to explore possible conditions for, the institutional and technological arrangements needed for collaboration between the formal and farmers' systems in crop improvement and genetic biodiversity enhancement.

Maize is the most important feed crop and the third most important food crop (after rice and wheat) in China. It is the main stable food crop for the rural poor in the remote uplands of the southwest, an agro-ecologically diverse area that constitutes the centre of maize genetic diversity in China. Over many generations, farmers have cultivated and improved maize for their survival. Most farmers still cultivate open pollinated varieties and landraces. The Chinese government has followed a modern technology-oriented approach to agricultural development, relying mainly on its formal seed system to ensure national food security. The core of this policy has been the development and distribution of hybrids, in cooperation with some of the Consultative Group on International Agricultural Research (CGIAR) centres. However, these hybrids are mainly used under uniform and high potential agricultural conditions: remote and marginal areas such as the uplands of the southwest have remained isolated from the technology development process. This project will address the problem by promoting better collaboration between the formal government seed system and local farmers' seed systems through a participatory plant breeding approach. Researchers will define the potential role of traditional knowledge systems in crop development and biodiversity enhancement, and recommend ways that the formal system can help farmers (particularly women farmers) improve local varieties, while maintaining their landraces and seed management practices. The overall aim is to improve crop development, enhance biodiversity and promote food security.

SOIL AGRODIVERSITY – AN ASPECT OF FARMERS' MANAGEMENT OF BIOLOGICAL DIVERSITY

Michael Stocking
Associate Scientific Co-ordinator, *PLEC*
University of East Anglia, Norwich, UK

ABSTRACT

Biological diversity in areas of land use (called 'agrodiversity' in the *People, Land Management and Environmental Change – PLEC -* project) is not simply a function of the diversity of species and varieties of biota. Naturally, it does concern standard ecological biodiversity aspects (often termed 'agro-biodiversity' or 'agricultural biodiversity')[17]. Usually it is used to tell the tale of how modern agricultural systems are tending to reduce biodiversity to the detriment of habitats, landscapes, ecosystem functions and the goals of the *Convention on Biological Diversity*. However, agrodiversity also contains a 'good news' story that many small-holder farmers world-wide have been managing their land use to the better conservation of biological diversity, to the improvement of their biophysical environment and to the benefit of their livelihoods.

Centred on farmers' management, this view of biodiversity as a suite of diverse activities, temporally and spatially, using diverse interactions with the biophysical environment should be a cornerstone in global attempts to conserve biodiversity. The GEF-funded *PLEC* project attempts to capture these many and varied management activities and the interactions between rural livelihoods and biodiversity. Since much of this management and associated natural biodiversity is based in and on the soil, it makes sense to focus substantial attention on what may be called 'soil agrodiversity'.

Soil agrodiversity is a subset of the more general term 'agrodiversity', the conceptual framework for which was published by Brookfield and Stocking (1999), that focuses on human-soil and soil-plant interactions. It is a state of the soil in a managed agricultural system where ecosystem functions and services have been enhanced through the manipulation of biological and organic resources (Figure 1). Where the resultant status of the soil can be indicated as fertile, productive, high quality, resilient and robust with respect to soils that have not been so manipulated, a soil could be considered as agrodiverse. Direct indicators of soil agrodiversity include the number and variety of bacteria, fungi, protozoa, invertebrate animals and other aspects of below-ground biodiversity. However, of more immediate importance to land users and their systems of management, below-ground biodiversity tracks soil-surface and above-ground biodiversity. Though the community of organisms in the soil are probably more functionally resilient than those above the ground (Giller et al, 1997), indicators of soil agrodiversity are to be found more readily in how the soil, plant residues and related aspects of water, nutrients and sediment are managed. Some of these complicated interactions are categorized in Figure 1, along with their potential beneficial effects on biodiversity and people's livelihoods.

The essential features of soil agrodiversity as presented here are reflected in beneficial attributes at three scale levels. First, **site-based** benefits include an increase in *soil resilience* or the ability of the soil to withstand external shocks such as a severe rainstorm causing floods and erosion, or

[17] The distinctive components of agricultural biodiversity listed by Cromwell et al (2001, p.80-82) are: crop diversity; 'wild' plant biodiversity; below-ground plant biodiversity; microbial biodiversity in agriculture; and arthropod biodiversity in agriculture.

a sudden change of land use such as deforestation. A resilient agrodiverse soil will recover more readily and continue to produce. This has been illustrated with respect to soil erosion and how a naturally resilient soil's capability may be exploited by land users (Stocking, 2000). *Soil quality* and *soil fertility*, both relative expressions of a soil's intrinsic value to society, are capable of manipulation and management. In an agrodiverse management system, the quality is based upon biological processes, such as the natural release of nutrients and the retention of plant-available water by an open soil structure and balanced range of particle-sizes. Therefore, as quality increases, the efficiency of utilisation of inputs usually also increases. As fertility is enhanced, the range and density of plants that can be supported also increases, with corresponding benefits to both biodiversity and livelihoods. Secondly, there are **management and organisational** benefits. An agrodiverse soil is easier to till, should require less weeding and be less costly to maintain in production. In terms of farming strategy, an agrodiverse soil holds open more cropping possibilities and many opportunities for diversified (and hence risk-minimised) land use. Thirdly, there are **landscape and social** benefits. An agrodiverse landscape enables local economies to diversify, allow farmers to trade-off activities at one site in favour of another in response to external forces such as market prices, and support whole communities in the further diversification of rural livelihoods. One of the emerging issues in rural development is the trend to a U-curve of diversification, where the poor join in non-farm activity as a survival or coping strategy, and the rich as an accumulation strategy (Maxwell et al, 2001). Since the IFAD Rural Poverty Report 2001 claims that three-quarters of the 1.2 billion people living below US$1 per day are rural, the role of agrodiversity in providing socio-economic opportunities to diversify livelihoods cannot be under-estimated. Additionally, agrodiverse landscapes built on agrodiverse soils have a far higher amenity value, attracting tourism, visits to the countryside and better policy responses from urban elites. These benefits, of course, are not solely based upon the soil, but they are literally and metaphorically rooted in systems of land use that manage the human-soil-plant interactions in such a way as to encourage biophysical diversity.

Examples of soil agrodiversity are drawn from a number of *PLEC* and non-*PLEC* sites in East Africa. In the Matengo Highlands of SW Tanzania, the land preparation technique known as *ngoro* pits is not only an ideal protection against soil degradation on these steep slopes, but also opens the opportunity for a far wider array of plants to be grown. In the Arameru District of northern Tanzania, agro-pastoralists have developed sustainable land use systems across a landscape, varying from humid high-mountain to semi-arid, that are based on maintaining high levels of soil organic matter but in radically different ways according to biophysical conditions. Finally, in Mbarara District of south-central Uganda, farmers have exploited the enormous market opportunities for banana varietals, by developing deep organic-rich soils through mulching and water-harvesting. This last case is one where in-situ conservation of rare varietals of an important food crop has occurred despite large increases in population and the influence of urban markets. Without an agrodiverse soil, including rich below-ground biodiversity, the heavy use of biological components on the soil surface and complex soil management techniques, rural poverty would be far greater.

References

Brookfield, H. and Stocking, M. 1999. Agrodiversity: definition, description and design. *Global Environmental Change* 9: 77-80.

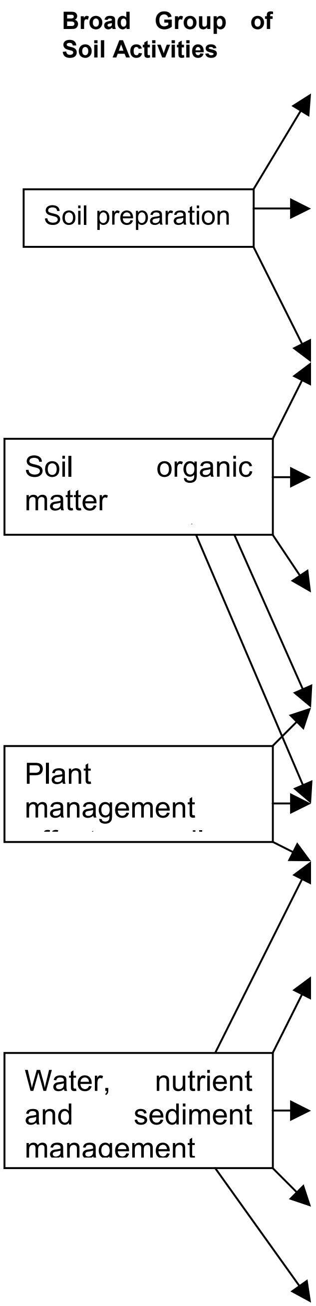
Cromwell, E., Cooper, D. and Mulvany, P. 2001. Agriculture, biodiversity and livelihoods: issues and entry points for development agencies. In: Koziell, I. and Saunders, J. (eds.) *Living Off*

Biodiversity: exploring livelihoods and biodiversity issues in natural resources management. International Institute for Environment and Development, London, pp. 75-112.

Giller, K.E., Beare, M.H., Lavelle, P, Izac, A-M.N. and Swift, M.J. 1997. Agricultural intensification, soil biodiversity and agroecosystem function. *Applied Soil Ecology* 6(1): 3-16.

Maxwell, S., Urey, I. and Ashley, C. 2001. *Emerging Issues in Rural Development: an issues paper.* Overseas Development Institute, London

Stocking, M. 2000. Soil erosion and land degradation. In: O'Riordan, T. (ed.) *Environmental Science for Environmental Management.* Second Edition. Pearson Education, Harlow, pp.287-321.



Soil-based activity	Effect on biodiversity	Implications for livelihoods
Soil tillage – conventional ploughing	Generally negative in suppressing weeds, humifying soil organic matter, depleting beneficial soil structure and creating soil surface more likely to erode	Tillage requires capital outlay in resources and substantial labour.
Soil surface formation – micro-relief. E.g. ridging practices	Positive – different plants using different ecological niches	Requires labour, but brings benefit through better water infiltration and plant cover. Indigenous systems, such as *zaï* pits, have supported livelihoods for centuries in difficult environments
Soil surface plant residues – including conservation tillage	Positive – provides for richer below-ground biodiversity, less erodible soil and conducive micro-climates.	Helps to suppress some weeds and reduce labour. In mechanised systems, additional capital resources necessary as well as herbicides.
Incorporation of residues	Ambivalent – increases humification of organic matter, but decreases soil erodibility. Soil biota may respond positively in the short-term.	Requires equipment. Residues no longer available for domestic animals – a negative impact for many tropical smallholder farmers.
Green manuring and biomass crops	Positive – can greatly increase soil organic matter and water-holding capacity with benefits for soil quality and resilience.	Takes land out of direct production – but minimised if green manure grown on residual soil water out-of-season. Needs expenditure in seeds and equipment.
Weed mulching and weed fallow	Positive – increases organic matter, reduces soil disturbance and allows soil recuperation.	Takes land out of production – but low cost fallowing, with some beneficial weed species.
No-till and direct drilling	As for 'Soil surface plant residues'	As for 'Soil surface plant residues'. Direct drilling equipment expensive.
Contour planting	Positive – retains water and sediment, reduces erosion rate.	Low cost plant management option with large pay-back in soil quality and future yields.
Sediment traps – structures or live barriers	Ambivalent – creates new fields at expense of loss of soil from upper slopes. But net economic benefit positive and prevents further problems downstream	Where used to trap sediment, large increase in livelihood support giving production where none had been possible before. Investment of labour and capital in building and maintenance.
Fertilisation – organic or inorganic	Positive – increases potential biomass and plant diversity. Some chemical toxicity side-effects possible with inorganics.	Labour and/or cost of inputs. Nutrient additions of inorganics have immediate effect but productivity gains may not last.
Irrigation	Positive – increases potential plant production and lengthens growing season.	Expensive to install and maintain. Many associated problems of maintenance and environmental impacts such as salinisation.
Soil and water conservation structures	Positive – increases productive potential by retaining soil and water on-site.	Expensive to install and maintain.

Figure 1. Soil agrodiversity – components, implications and effects

RESTORING BIODIVERSITY THROUGH AGRICULTURAL INTENSIFICATION IN THE RAINFOREST REGION OF MADAGASCAR

Erika Styger, Erick C.M. Fernandes and Harivelo 'Mparany' Raktondramasy

One of the earth's hot spots in biodiversity, the rainforests of Madagascar, are threatened by slash and burn agriculture. Through repeated burning and cropping, primary vegetation is rapidly converted to a herbaceous, species poor and exotic fallow vegetation, where rainforest species stop to regenerate and were soils and their microbial life, more specifically native mycorrhizal species, rapidly degenerate and get lost, not sustaining any further agricultural production.

We hypothesize that through developing fire-less upland farming practices, nutrient cycling in the agricultural system can be improved, thus raising and sustaining its productivity. Furthermore the development of native mycorrhizal fungi, important symbionts for many forest species and agricultural crops, is enhanced in healthy soils. Based on the mycorrhizal presence, rainforest tree cultivation will be possible. By integrating indigenous tree species into agroforestry systems, rural population can benefit from a wide range of species providing high quality wood, food, fiber and medicinal products.

Our research shows that improved yields were obtained by replacing burning through mulching, guanophosphate application and leguminous fallow cultivation in a rotation of upland rice, beans and ginger. We initiated the first endomycorrhizal species inventory from various primary and secondary vegetation types in the agro-ecological system, and we observed a decrease in mycorrhizal species diversity with increasing landscape degradation. This suggest that an inoculation of the agricultural soils, with native mycorrhizae species could have an important impact on rainforest tree establishment and growth and on improving crop productivity. In order to be able to propose indigenous trees for cultivation in agroforestry systems, we identified 260 useful rainforest species through an ethnobotanical survey. The local population selected the 10 most preferred species per category of use.

Our results indicate that in the fast degrading landscapes of Madagascar, more stable, resilient and diversified farming systems can be developed through agricultural intensification based on biological and agro-ecological dynamics. This allows to restore below and above ground biodiversity fulfilling essential functions within the agro-ecosystem, at the same time providing rural population with essential products for an improved lively-hood and contributing to the conservation of one of the worlds' most unique biological diversity.

WHO MAINTAINS CROP GENETIC DIVERSITY AND HOW?: IMPLICATIONS FOR ON-FARM CONSERVATION AND PARTICIPATORY PLANT BREEDING

A. Subedi[1], P.C. Chaudhary[1], B.K. Baniya[2], R.B. Rana[1], D.K. Rijal[1], R.K. Tiwari[2], and B.R. Sthapit[3]

[1] Local Initiatives For Biodiversity, Research And Development (Li-Bird), P.O. Box No. 324, Pokhara, Nepal, Tel/Fax: 977-61-26834; E-Mail: Aslibird@Mos.Com.Np

[2] Agricultural Botany Division, Nepal Agricultural Research Council, Kaski Site, Nepal

[3] International Plant Genetic Resources Institute, Apo, Malaysia, E-Mail: b.sthapit@cgiar.org

A network in a social system refers to the interpersonal relationship of a set of persons connected together through flow of information, goods or implementation of joint activities or other social bonds of one kind or another. Analyzing the networks of a social system traces such relationships, identifies nodal persons in the system and can capture the context of the social relations within which actors participate and make behavioral decisions. It has been widely reported that seed requirements in most farming communities are fulfilled through informal seed supply systems and on-farm management of crop genetic resources. Farmer networks play important role in such flow of genetic materials. Farmer networks have been found to be playing significant role in the flow of information in the Nepalese hill farming communities. However, study on how informal flow of seed materials through farmer's networks has been lacking. Hence farmers network analyses were conducted at Begnas and Kachorwa eco-sites to explore and examine the informal flow of rice seeds through networks, to identify nodal farmers in the networks and examine whether nodal farmers play key role in maintenance of genetic diversity.

The study employed sociometric survey using snowball-sampling technique. Initial sample of 24 respondents was drawn randomly from the respondents of baseline survey, stratified along well-being and gender categories. There after the respondents took the respondents from the sociometrically identified individuals interviewed. The network analyses show that the seed flow networks in both the eco-sites, Begnas and Kachorwa, are weak; i.e., the individuals are not well connected. There are several smaller networks. However, a few larger networks do exist in which a few individuals occupy key positions. Within these larger networks, there are several cliques (i. e. sub-network) which are inter-linked through certain individuals. Seed flows occur mainly through exchange (54-63%; grain to seed or seed to seed), gift (20-31%) followed by purchase (10-14%). The key individuals or those linking the sub-networks to one another are playing significant role in the flow of genetic materials. Some of the key individuals also have links outside the village bringing in new genetic materials, thus deploying new varietal diversity within the village.

Further analysis of the nodal persons in terms of their household level diversity maintenance shows that majority of them belong to high to medium diversity maintaining group of farmers. Thus, most farmers who occupy nodal position, are found to have more network connection within and outside the community; they play important role in the flow of genetic materials and creating and managing crop diversity on-farm. Such individuals can be effectively involved in participatory plant breeding; seed supply system and training for other purposes.

MANAGING CROP DIVERSITY ON-FARM: A CASE STUDY FROM NEPAL

Anil Subedi

ABSTRACT

Nepal is small geographically, but is an important centre of agricultural biodiversity. The rich Nepalese agro-biodiversity has evolved over time and space due to extreme variations in altitude and environmental conditions. Crop production takes place between 70 to 3000 m elevation where a wide range of micro-ecological niches are found, and varied crop production systems are being practiced by the farmers. A great diversity is found within most of the food crops and large part of the arable land is planted by local cultivars. In addition to the physical and ecological conditions and the natural evolutionary process, the diversity that exists on-farm has also been greatly influenced by diverse social, cultural and economic conditions of the farming communities. Numerous ethnic groups with varying socio-cultural preferences and needs have contributed to the diversity and farmers have accumulated a wealth of knowledge on these diversities and the systems as a whole. However, due to the introduction of modern varieties, over-exploitation of the natural resources, gradual social change, other development interventions affecting the habitats and production environments, and lack of supportive policy environments for the conservation and utilisation of local genetic resources, genetic erosion of the traditional crop diversity is increasing rapidly. Appropriate measures, approaches and strategies are, therefore, required for the conservation and utilisation of these crop genetic resources.

Farmers have not only been the custodians, but are also the managers of the crop diversity. In the process of conservation and utilisation, they make significant farm decisions and have developed their own management strategies. Hence, on-farm conservation of crop diversity is possible only through the active participation of farmers. In this context, *in situ* conservation of agro-biodiversity on-farm has been employed as an important strategy globally. In Nepal too, with the support from IPGRI, Nepal Agricultural Research Council (NARC), LI-BIRD (an NGO), CBOs and private entrepreneurs are jointly implementing an *in situ* crop conservation project in three different agro-ecological zones (high hills above 2000 m; mid hills at 900 to 1500 m and plains at 200-300 m). Although the project is basically designed to understand farmers decision-making processes, socio-economic circumstances and environmental factors for the existence and maintenance of the crop diversity, efforts have also been made to develop effective tools and techniques for the conservation and utilisation of the crop diversity with strong farmer participation.

Drawing upon the experiences and lessons from the project, this case study paper will focus on how farmers are managing crop diversity in different circumstances and also how collaborating agencies are trying to enhance farmers' capacity and empowerment to manage the diversity both at individual farms and landscape levels. Some of the constraints, issues and future challenges on sustaining agro-biodiversity on-farm and its management in the Nepalese context will also be discussed.

MANAGING BELOW-GROUND BIODIVERSITY: INTRODUCTORY PAPER

Mike Swift
Tropical Soil Biology and Fertility Programme, Nairobi, Kenya.

Soil organisms contribute a wide range of essential services to the sustainable function of all ecosystems, such as regulating nutrient cycles and the dynamics of soil organic matter, soil carbon sequestration and greenhouse gas emission; modifying soil physical structure and water regimes; enhancing the amount and efficiency of nutrient acquisition by the vegetation through mycorrhizal fungi and nitrogen fixing bacteria; and influencing plant health through the interaction of pathogens and pests with their natural predators and parasites. These services are not only essential to the functioning of natural ecosystems but constitute an important resource for the sustainable management of agricultural ecosystems.

The soil community which performs these functions is extremely diverse, often with more that 1000 species of invertebrates in $1m^2$ of soil. The diversity of the microbial component may be even greater than that of the invertebrates yet is only just beginning to be realised by studies using molecular methods. Few data are available from tropical regions, where it is suspected that the highest levels of diversity may be found. Consequently, although the biological diversity of the community of organisms below-ground is probably higher in most cases than that above-ground, it has generally been ignored in surveys of ecosystem biodiversity. Nonetheless rapid assessment methods have been proposed and tested and considerable progress made towards the development of indicators. The most useful approaches in this respect are those based on a selective focus on 'Key Functional Groups'.

The processes of land conversion and agricultural intensification are a significant cause of soil biodiversity loss with risks of impact on ecosystem services. Enhancement of BGBD may be accomplished by *direct* manipulation (e.g. re-inoculation with desirable indigenous organisms such as N_2-fixing bacteria or agents for biological control of plant disease) and/or *indirectly* through manipulation of the cropping system (e.g. by choice of plants, the cropping pattern in time and space, or management of organic inputs). Agricultural practices which provide good soil protection and maintain high levels of soil organic matter favour higher biodiversity. Examples include agroforestry systems, inter-cropping, rotational farming, conservation tillage, green cover-cropping and integrated arable-livestock systems. Actions that directly target the joint conservation of both above- and below-ground components of biological diversity will have environmental benefits at ecosystem, landscape and global scales. It remains a matter to be critically evaluated whether the maintenance of higher diversity entails trade-offs between agricultural production and other ecosystem services.

A COMPARATIVE STUDY OF GENETIC DIVERSITY OF FOUR MAJOR CROPS MANAGED OF ETHIOPIA

Tesema Tanto* and Abebe Demissie*

*Institute of Biodiversity Conservation and Research, P.O. Box 30726, Addis Ababa, ETHIOPIA, Tel. 251 1 612244, Fax.251 1 613722, E-mail tesematan@hotmail.com

ABSTRACT

Ethiopia is a center of origin and diversity for many cultivated crops and their wild relatives. The country is located near Equator, but due to altitudinal variation it experiences a temperate climate, especially at altitudes of more than 2000 meters above sea level. Altitude ranges from 120 meters below sea level at Dalol depression to 4620 meters above sea level at the top of mount Ras Dashen. In addition, soil variation, ecological diversity, substantial temperature and rainfall variations, and diverse social and cultural conditions have produced suitable environments for genetic variation of crop varieties. The objectives of this study was to compare the genetic diversity among four crops in Ethiopia of which two crops have Ethiopia as their center of origin (sorghum and tef) and two crops have Ethiopia as a secondary center of diversity (barley and wheat). The study focuses on comparing (1) whether the amount of variation in these different crops varies with population size or not and (2) whether farmers are consistent in naming and describing their varieties for these four crops. Diversity was measured by number of farmers varieties grown for each crop and their distribution across the regions by applying diversity indices of Simpson and Shanon-Weaver across altitudinal ranges, latitudes, longitudes and ecological regions. It was found that there was equal amounts of diversity for the crop plants of Ethiopian origin and for the crops where Ethiopia is a secondary gene center in diversity.

FARMERS' SELECTION, ENVIRONMENTAL VARIATION, AND THE DYNAMICS OF THE MAINTENANCE OF *IN SITU* CROP GENETIC DIVERSITY OVER SPACE AND TIME.

A.Teshome[1], Z. Asfaw[2,] J.K.Torrance[3], D. Patterson[3] and T.J.Arnason[1]

1. Biology Department, University of Ottawa, Canada
2. Biology Department, Addis Ababa University, Ethiopia
3. Department of Geography & Environmental Studies, Carleton University, Ottawa, Canada.

Crop landraces in Vavilovian centers of genetic diversity are important resources for global agriculture, especially because they are adapted to climates, soils, and topography that are variable and often marginal. Local farmers, using time-tested experiential knowledge and keen observation, husband this diversity. Sustainable conservation and use of this biodiversity requires in-depth knowledge of the plant biology, environmental and human factors that maintain it.

With support of the Institute of Biodiversity Conservation and Research (IBCR), IDRC, USC/Canada and IPGRI, 1992-93 research on "Factors maintaining sorghum landrace diversity in north Shewa and south Welo regions of Ethiopia" clearly demonstrated that: intraspecific variation closely accords with both folk and numerical taxonomies; as farmers' increase their selection criteria, diversity at the field level increases; farmers' knowledge of storability corresponds with laboratory estimates of resistance to rice weevil infestations; and both natural factors and farmers' selection criteria shape sorghum diversity at the farm level.

A follow-up 2000/01 study, supported by IDRC, IBCR and Addis Ababa University, again investigated landrace diversity and distribution, field size and fragmentation, seed sourcing and the farmers' selection criteria and management practices. The specific goals were to measure the dynamics of temporal and spatial variations of sorghum landraces over the intervening eight years and to address questions about the stability over time of factors supporting the maintenance of the crop genetic diversity. The same farmers were interviewed both times. Substantial changes were found in farmers' selection criteria, field size fragmentation and landrace richness planted to each field. Mapping in 2000/01 shows "specialist" (niche specific) landraces restricted to certain microhabitats and "generalist" landraces widely grown across the agroecological gradients of the research area.

In all five farming communities, the field size planted to sorghum landraces has decreased significantly due to population growth, land redistribution policy, seasonal changes, and stagger cropping followed by interspecies crop displacement. Landrace richness increased significantly in two communities [Merewa **($Z=2.07$; $P<0.01$)** and Borkena (**$Z=5.34$; $P<0.0001$**)], but decreased significantly in three [Bati (**$Z=-1.61$; $P<0.05$**), Epheson (**$Z=-7.77$; $P<0.0001$**) and Hayk (**$Z=-1.76$; $P<0.03$**)]. Landrace evenness for most landraces decreased significantly. Farmers' selection criteria, which represent farmers' need from the crop genetic resources have increased significantly (**10 in '92/'93 vs 16 in 2000/2001 at $P<0.0001$**).

The research findings will contribute directly to the sustainable conservation of the landraces and their use in heterogeneous, marginal and less-favored agricultural environments through favorable policy formulation, networking, community gene-banking and strengthening the complementarity between the *in situ* and *ex situ* conservation approaches.

CASE STUDY FOR POSTER SESSION OF THE BIO-DIVERSITY SYMPOSIUM, PLEC – JAMAICA

Thomas-Hope, Elizabeth
June 24, 2001

Demonstration Site – Rio Grande Valley, Portland

The Rio Grande Valley is a remote agricultural area in the eastern section of the Caribbean Island - Jamaica. The Valley, which covers about one-third of the parish of Portland, spans about 286,000 hectares. The combination of physical conditions in the area (temperature, rainfall, and soil type) gives rise to an area of high fertility and hence agricultural productivity. Some of the agricultural produce generated in the Valley are: a variety of fruit trees and cash crops, which include banana, coffee and a wide range of ground products.

The area is proned to flooding and landslides due to a combination of its geology, topography, and climatic conditions. Past and current farming practices have exacerbated the potential impacts to the community from these hazards.

Our research partnership with the farmers has highlighted many examples of sound, innovative resource management practices being employed at the demonstration site. Many farmers utilise a variety of agronomic measures which included mixed cropping, agro-forestry, kitchen gardens, bush fallowing and crop rotation.

It was observed that farmers were cognisant of the role played by trees and shrubs in reducing soil erosion/soil loss from natural hazards. Good vegetation cover for the soil along with plant roots helped to bind the soil and prevent it from washing away hence many farmers promoted plant growth on farm plots. They were also aware that despite the potential soil loss, the high rainfall in the area contributed to rapid plant growth.

The PLEC – Jamaica case study will involve an examination of project data to assess the farmer's conscious and unconscious use of bio-diversity (cultivated and wild growing plant species) as a hazard management strategy on flood and landslide prone farms. We will also highlight some additional functions (past and current) that bio-diversity play in the Valley along with the challenges our farmers face in farm management.

ANALYSIS OF AGRO-BIODIVERSITY AND APPROACHES OF ITS MANAGEMENT IN VIETNAM.

Luu Ngoc Trinh, Dao The Tuan
Plant Genetic Resources Center,
Vietnam Agricultural Science Institute.

SUMMARY

Agro-biodiversity is the part of biodiversity that is most frequently used and has been created by man thought the process of human civilization, then both the natural and socio-economic condition affect and contribute to its formation and evolution.

Being not big in territory, but Vietnam has a great agro-biodiversity, is one of 15 countries having the most diverse and richest plant genetic resources. Diversity in eco-geography and diversity in ethnic culture are the main factors that have created the agro-biodiversity of Vietnam.

During the last four decades of the 20th Century as whole the World, the history of Vietnam had passed unprecedented transformation, which conducts to considerable changes in agro-biodiversity. Since 1994, the Plant Genetic Resources Center under the Vietnam Agricultural Science Institute has been systematically assessing the agro-biodiversity in various areas of Vietnam. Village is taken as the unit of assessment. From each district, three villages representative to its three most relevant ecological zones were assessed. The assessing form consists of 9 tables: Cultivated Land and Cropping System; Pattern of Crop Rotation, Intercalation and Intercropping; Varieties and Crop Species; Main Natural Plant Species; Races and Species of Raising Animal; Natural Animal Species; Plant Disease and Pest Insect Species; Quantity of Pesticides Used per Unit of Cultivated Land; Occurrence of Disease and Pest Epidemic and Change in Crop Varieties Composition afterward. Assessing data were collected from different periods since 1960.

Agro-biodiversity data from four ecosystems of the north Vietnam was analyzed. Midland ecosystem characterized by the highest diversity in cultivated land, then has the richest diversity in natural plant and crop species. Lowland rice ecosystem characterized by the lowest diversity in cultivated land and by the 100% of the rice monoculture index. Mountain ecosystem and coastal ecosystem have the lowest rice monoculture index, the later one also characterized by the highest index of land use per year, which reaches 3.5. Agro-biodiversity from midland ecosystem and coastal ecosystem is more diverse, which is the main reason making farmers there more rich than those from the other ecosystem.

Analysis on agro-biodiversity aspects concerned with rice as a predominantly major crop in Vietnam was focused. Tendency of decreasing of rice monoculture index reflects that rice has been replaced by the other crops. Due to particular features on ecology, rice genetic diversity index has decreased in dry crop season but increased in wet crop season.

In the same condition of lowland rice ecosystem, but where the traditional specialty rice was more extended, farmers got richer. Specialty landraces play important role not only in generating more income, but also in protecting environment because no pesticide was used. In

ecosystem where exist high inter-specific diversity index, high rice genetic diversity index and high percentage of local rice varieties, there is non-significant damage of pests and diseases, which reflects the role of agro-biodiversity in control of biotic stresses. The study in this case shows a co-existence of agro-biodiversity conservation and economy development in the rural, a desirable tendency rarely found on solving the contradiction between conservation and development.

A significant number of traditional varieties of many crops having special quality and high potential to be extended in production was invented.

Approaches on agro-biodiversity management were proposed. It is discussed and suggested that special attention must be paid in *the socialization of the agro-biodiversity management and conservation.*

DIVERSITY FAIRS IN VIETNAM: A METHOD FOR RAISING AWARENESS AND LOCATING DIVERSITY AND CUSTODIANS OF CROP GENETIC DIVERSITY

Luu Ngoc Trinh[1,] Nguyen Phung Ha[1], Nguyen Ngoc Hue[1], Pham Hung Cuong[1], Bhuwon Sthapit[2], Devra Jarvis[2].

[1] Vietnam Agricultural Science Institute (VASI), Thanh Tri Hanoi, Vietnam

[2] International Institute of Plant Genetic Resources (IPGRI), APO Regional Office, c/o 3/202 Buddha Marg, Nadipur Pata, Kaski District, Pokhara-3 Nepal..

[3] International Institute of Plant Genetic Resources (IPGRI), Via dei Tre Denari, 472/a, Maccarese, 00057 Rome, Italy.

ABSTRACT

Diversity fairs bring together farmers from one or more communities to show the range of landraces that they store and cultivate. Rather than giving prizes for the best individual variety, diversity fairs award farmers or groups of farmers for the greatest crop diversity and related knowledge. In Vietnam, diversity fairs have been used as an entry point for on-farm conservation, to sensitize the farming community, to locate and identify key custodians of high genetic diversity and their associated knowledge base, and to categorize crop diversity into groups of cultivars that are common, rare, endangered and have disappeared. Where communication is difficult among farmers and with outside communities, the fair can serve as a useful means of providing access to information on local germplasm. Diversity fairs were supported in six villages in three ecosites in northern Vietnam: mountain (Da bac), mid-land (Nho quan) and Red River Delta (Nghia hung) during 1998 -1999. Farmer's cultivars were identified in participatory manner by the judging committee, as well as by farmers. Results of diversity fairs showed that the two mountainous villages of the Dabac ecosite (Cang Village and Tat Village) displayed the highest rice diversity compared to the other ecosites. Genetic diversity displayed in the fairs was higher than previously reported from these villages. Dabac site contained the highest diversity for upland rice of the three ecosites. In the lowland site of the Red River Delta, although there is less diversity, despite pressure of technical intervention, farmers have still maintained rice landrace diversity because of market incentives of high quality aromatic rice. Lessons learnt from the diversity fair were that farmers were found to be mostly consistent in identification of crop cultivars of their locality, however, there were some cases of inconsistency. Group could easily identity mistakes of each other and came into general consensus. Diversity fair stimulated both farming and scientific communities as a participatory on-farm conservation strategy because objectives of farmers and researchers were both met by this activity. Scientists also appreciated using participatory approaches for variety identification. In addition, genetic resource persons and plant breeders found the diversity fair an important method to collect crop genetic resources in more representative manner. During the diversity fair, scientists also discussed with farmers about their traditional cultural practices and botanical knowledge that farmers used for maintaining and using local crop diversity. The diversity fairs in Vietnam have now became a school for scientists, development workers and farmers to share information and knowledge among each other.

FARMER'S MANAGEMENT OF CROP DIVERSITY IN COASTAL AGROSYSTEMS, CENTRAL VIETNAM

Truong Van Tuyen*, Le Dinh Huong*, Le Thieu Ky*, and Dinh Thi Son*

*Hue University of Agriculture and Forestry, 24 Phung Hung, Hue City, Vietnam. Email: tvtuyen@dng.vnn.vn

ABSTRACT

The coastal ecology in Central Vietnam is characterized by marginal, sandy and adverse agronomic conditions. Due to a low land-man ratio, farmers practice diversifed and intensifed agriculture, which includes crop production and animal husbandry. Both rice intensification, which leads to competition between traditional cultivars and the modern ones, and livelihood diversification, e.g. pig raising and cash crop production, has had an impact on the conservation of crop diversity in the region. In 1996, a study on farmer's management of rice diversity across ecosystems of the coastal system was implemented to identify opportunities and strategy for on-farm conservation of rice genetic resources. The findings in 1996 showed that many farmers still used a diverse set of rice varieties In the eight coastal villages surveyed: 33 rice cultivars, 17 modern cultivars and 16 traditional cultivars were maintained in inter-spring season and 29 cultivars, 20 modern cultivars and nine traditional cultivars in the summer season. In 2000, data was collected from the same household. Results showed that the total number of rice cultivars was lower than that in 1996 and the number of traditional cultivar names and their distribution (indicated by number of planting households) had reduced dramatically. The most observed cause was the catastrophic flood of the century (in November 1999) that damaged seeds and destroyed the seed infrastructure of majority of the farmers in the areas. Responses from farmers, the farming community and the local government revealed problems with the current seed system as farmers were not able obtain their preferred cultivars because the seeds were not available from the informal and formal seed systems, the later of which does not support the seed flows of traditional cultivars. Two issues need to be addressed for on-farm conservation of landraces, (1) seed infrastructure, e.g. improving storage and "seed bank", at household and community level, and (2) including the traditional varieties survives into the formal seed and/or agro-supporting systems. A follow up is now underway to study the integration of conservation and sustainable livelihood, and roles of different community stakeholders involved in on-farm conservation. Applying participatory research, e.g. focus group discussion, revealed that the villagers were aware of advantages of growing different varieties among households. Encouraging this practice could increase diversity at the community level. Agricultural diversification was also found to maintain the diversity of certain crops. Pig raising at most households was linked to supporting taro conservation for the taro's feed utility. The majority of work in growing and processing taro, and for feeding pigs, is done by the wife. In addition, an expanding use of cash crops was found to help maintain bean diversity for intercropping, as this was popular with the farmers for improving soil fertility in sandy and marginal land. Participatory assessment of stakeholders' roles in crop production indicated that there was no a single best pattern of stakeholder involvement to all targeted crops identified (e.g. rice, taro and bean). Rice production management at the household level is influenced much from the formal agricultural supporting systems and local government, while decisions regarding other crop production (e.g. taro and bean), are mainly undertaken by the households and community groups (e.g. households sharing the same field plots). These findings are important considerations in establishing working

mechanism for on-farm conservation of rice, taro and bean diversity. The suggestion is taro-pig-woman group and rice-crop fields-farmer group.

THE DILEMMA OF AFRICAN AGROBIODIVERSITY: THE ROLE OF FOOD INSECURITY IN PROMOTING CONSERVATION

Jon Unruh, Department of Geography, Indiana University, 120 Student Building, Bloomington, IN 47405. Email: junruh@indian.edu.

Significant concern is being focused on the erosion of agricultural biodiversity resources which undergird important aspects of global food supply. 'Genetic erosion' of important agricultural crop varieties in areas known to be centers of diversity is thought to increase risks to global food security, through the loss of the genetic material needed to facilitate adaptation to changing problems of climate, pests, and disease. While certain processes of genetic erosion are thought to be underway in a fairly pervasive manner across important agricultural landscapes, the intersection of these processes with local cultural and political ecology can actually produce a variety of circumstances. With evidence from highland Ethiopia, this paper suggests that the processes thought to be broadly responsible for genetic erosion--processes responsible for increasing food *insecurity* among small-scale agriculturalists--are instead having the reverse effect of conserving agricultural biodiversity by continuing risk-averse behavior. The dilemma that emerges then pits food aid, extension services, and agricultural development *against* the conservation of agricultural biodiversity, in that the successful promotion of the former can have the effect of eroding the latter. International efforts to promote the conservation of crop genetic diversity need to carefully consider the outcomes of the intersection between local cultural and political ecology with broad processes thought to be responsible for significant genetic erosion, in order to realize important constraints and opportunities for conservation of agricultural biodiversity.

THE DILEMMA OF AFRICAN AGROBIODIVERSITY: ETHIOPIA AND THE ROLE OF FOOD INSECURITY IN CONSERVATION

Jon D. Unruh
Indiana University

ABSTRACT

Landrace (or *in situ*) varieties of important crop species are becoming increasingly important to global agriculture as gene banks have increasing trouble keeping pace with the need for genetic material for plant breeders. However genetic erosion (or permanent loss of genetically diverse landrace varieties) poses significant threat to the viability of important genetic material. Processes associated with food insecurity are thought to separate farming communities from agricultural systems in which landrace varieties are important components. While such processes are thought to operate in similar fashion across different cultural ecologies to erode the presence of genetic material, this paper presents evidence from highland Ethiopia in which many of these same processes operate in reverse to instead conserve agrobiodiversity. However conservation of such landrace varieties in this way presents a particular and problematic dilemma to which straightforward answers remain elusive.

Introduction

Global food supply rests precariously on a small number of crop species. Approximately 95 percent of the dietary energy provided to humans come from only 30 crops that "feed the world" (FAO 2000). Sub regionally this number increases but is still relatively small (FAO 2000). But as these crops are modified to produce more food, their genetic base narrows and they become increasingly vulnerable to devastations caused by climate variations, pests, and disease. And climate change brings with it much in the way of unpredictability for agriculture as new niches for disease and pests are created and climate variability increases.

The traditional approach to deal with the dangers of large scale crop failure due to drought, disease, and pest impacts, is to utilize genetic material contained in varieties of relevant species that have not been modified, in order to locate the genetic abilities that allow the plant to be resistant to specific problems. While gene banks have been popular for some time as a repository for much of this material, there is significant concern that such banks only capture 'snapshots' of genetic material that, once ‘banked’ are unable to express new forms which result from adaptation to changing environments and conditions, and the emerging pests and diseases which these produce. As a result significant attention is currently being placed on 'landrace' varieties of genetically diverse crop species which continue to exist in agricultural systems in specific locations of the world, and are thus able to continue to adapt to changing circumstances and environments. Such landrace locations of crop species thus provide a ‘service’ to the viability of global food supply in that they act as living repositories for genetic material valuable to future modifications of important food producing plant species.

However significant evidence exists indicating that many important locations of landrace plant varieties are under threat due to a number of processes that result in the separation of agricultural populations from land and agriculture. The resulting 'genetic erosion' is thought to seriously threaten the future viability of global food supply, due to the loss of valuable genetic material (Fowler and Mooney 1990; Madeley 1996;Tripp and van der Heide 1996; Tuxill 1999).

The processes operative in genetic erosion are those which involve problems of food security. They include famine, drought, flooding, replacement of traditional crop varieties with higher producing hybrids, poverty, conflict, land degradation, and food aid (Hutchinson and Weiss 1999; Egziabher 1991; Chitrakon et al 1999). An important assumption with genetic erosion is that the component processes occur in basically the same way across all cultural ecologies--resulting in loss of genetic material--albeit with varying rates and conditions (see discussion by Zimmer 1992). This paper presents evidence from highland Ethiopia, (long known as a center for crop genetic diversity) where several important processes thought broadly to cause genetic erosion, actually intersect with the particular cultural ecology of the highlands, to instead act in reverse to conserve genetically diverse local varieties of important crop species in a 'reservoir' effect. Fieldwork was undertaken in Ethiopia over the course of 1999, while the author served as Country Representative to the American government's Famine Early Warning System (FEWS). Food insecurity in Ethiopia in 1999 was widely regarded as the most problematic year in the country since the 1984/85 famine (UNDP-EUE 2000). Thus 1999 allowed a look at a number of the processes thought to be the primary causes of genetic erosion.

Ethiopian Agrobiodiversity

Highland Ethiopia is the center of genetic diversity for a number of important crop species, among them: barley, duram wheat, sorghum, linseed, finger millet, chick pea, cow pea, niger seed, arabica coffee, tef, ensete, and oats. While not all of these crops are originally from Ethiopia, their arrival to the highlands and subsequent cultivation in varying microclimates over the millennia have resulted in a pronounced diversification into varieties that do not exist in their areas of origin. Crop species diversity in the highlands has come to exist in part for reasons similar to other highland locations--highly dissected terrain inhabited by agriculturalists for very long periods of time, allowing for crop species to be subjected to varying microclimates and agricultural conditions (Egziabher 1991; Zimmer 1992).

Processes of Genetic Erosion in Reverse: Landrace Conservation in Highland Ethiopia

AGRICULTURE IN THE HIGHLANDS

Climate variability, and particularly drought in Ethiopia, and the subsequent food insecurity, impacts on highland agriculture with a frequency and severity that has made the country the textbook example of the climate – agriculture – food shortage nexus. While drought has particular influence on food insecurity, flooding, frost, hail and variations in seasonality also significantly affect agriculture, particularly when human vulnerability is high, causing small variations in climate to have relatively greater effect.

Agriculture in highland Ethiopia (Figure 1) has several central features. Due to the very long periods of agricultural occupation, the highlands are heavily populated. High population densities together with customary land tenure arrangements that provide for dividing holdings between offspring, means that land fragmentation and the resulting very small field sizes prevail over very large areas. Thus significant parts of the highlands resemble a vast patchwork of contiguous, irregularly shaped very small fields (Figure 2). Such small field sizes (frequently less than a hectare) do not produce an abundance of food, such that food insecurity of varying degrees for the highland population is also a prevailing feature. It is this context of very small plot size, high population density, and a high frequency of severe agricultural problems that provides the food insecurity context in which issues of genetic erosion or conservation operate in highland Ethiopia.

In a genetic erosion context, an important question for Ethiopia is, with drought and the resulting food insecurity some of the more powerful forces in the erosion of crop genetic diversity, why, in the face of an extensive history of both drought and famine (Pankhurst 1985; Webb et al 1992), has agriculture in the highlands been able to maintain significant genetic diversity of traditional varieties of crop species? Table 1 presents historical data on drought and famine on the Horn of Africa and Ethiopia. Beginning from 253 BC in Ethiopia droughts and famines appear to have been fairly frequent. Yet the presence of genetically diverse crop species continues to the present day. What is the relationship between these processes of genetic erosion and the cultural ecology which prevails in the highlands?

Erosive process - conservation result?

Risk Aversion and the scramble to replant

Risk aversion acts as an important characteristic among farmers in the highlands, and processes recognized as important to genetic erosion play a large role in such risk aversion due to their contribution to food insecurity. The frequency and severity of agricultural problems which make up these processes have contributed over time to a position of extreme vulnerability. This, together with small field size and high populations, provides a context in which agricultural production is pursued with a strategy based largely on risk averse behavior focused on minimizing the ever present threat of increasing food insecurity.

This strategy primarily entails the rapid and intensive replanting of fields and parts of fields, as crops succumb to the various problems of doing agriculture in the highlands. This replanting takes place however with crop species different than those initially planted, with substitute crops selected to both be resistant to the problem at hand (drought, disease, pests, etc.) and able to produce a yield in the remaining growing season. Often a series of replanting takes place in a given set of agricultural seasons. And while individual fields are small, crop failure and the need to replant can be variable within individual fields. If a particular crop only partially fails within a field, then only part of the field will be replanted with a different crop. Such that subsequent to one or more replantings, a particular small field can comprise a patchwork of different crop species and varieties in different stages of maturity. And while the initial crop can be a non-traditional high yielding hybrid variety planted in the hopes that a good agricultural year will allow such crops to produce significantly, replantings usually take place with local varieties known to be drought or disease resistant. Local varieties, while not high yielding, nonetheless have the genetic ability to survive given the prevailing problem.

Thus the frequency and severity of agricultural problems, combined with the vulnerability of highland populations to significant food insecurity, creates a scramble to always attempt to produce something, regardless of the agricultural problem that presents itself in any season, due to the need to feed large populations off of small fields. However such a replanting institution would achieve very little if the genetically diverse seed varieties were not available and held always at the ready over large areas of the agricultural geography in the highlands. To a significant degree it is this desperate scramble to replant, caused by food insecurity, so as to always get some production from very small fields, operating over long periods of time, that is, in effect, the motor for the maintenance of a wide array of genetically diverse crop species in the highlands.

Food insecurity in areas of the world which contain crop genetic diversity can often can lead to attempts by development agendas at replacing lower yielding traditional varieties with higher yielding hybrid varieties--thus comprising a genetically erosive process. While the Ethiopian extension service seeks to spread the use of hybrid, high yielding varieties of crop species among a wide array of farmers, in the highlands such crop replacement is problematic. Field sizes are generally too small for the extension package which is designed for a minimum sized field in terms of plowing (usually with oxen) seeds, fertilizer, herbicides and pesticides. As well, the extension service seeks to be sustainable, and thus the arrangement is to have farmers go into debt in order to obtain the extension package. But the package is not designed to effectively operate in times of climatic stress or other problems, and so the frequency of crop failure with hybrid crop varieties in the extension program is significant in the highlands. With both a failed crop and indebtedness, farmers who are already food insecure can be forced to sell productive assets in order to meet the requirements of their debt. As a result such farmers are often unable to continue in agriculture. It doesn't take many such cases in a community or larger area to convince other farmers that the extension package is too big of a risk, and is to be avoided. Other characteristics of the program can contribute to this point of view among farmers. For example the fact that the hybrid seeds included in the extension package do not produce seeds that themselves can germinate, can be a surprise that can result in considerable food insecurity and ill will toward the extension program. It is also known among farmers in certain areas of the highlands that even in good agricultural seasons, seeds that come with the extension package at times do not germinate, due presumably to the lack of field trials specific to conditions in particular areas.

Food Insecurity Promotes Landrace Conservation?

Because much of the literature dealing with genetic erosion has to do with the processes that result in food insecurity (Hutchinson and Weiss 1999 and the references cited therein) it is worthwhile to examine how the occurrence of genetic erosion coupled with food insecurity takes place at the landscape scale. While ultimate and extreme food insecurity does result in the separation of people from agricultural pursuits (e.g., out migration, destitution, etc.) it is important to consider the progressive nature of this food insecurity and how this intersects with a spatial and demographic domain. Figure 3 illustrates how progressive food insecurity results in a sequence of coping options by those affected as food insecurity worsens. With increasing food insecurity (progression down the curve in Figure 3) more assets are sold off, and decisions made that are designed to stop the slide into further food insecurity. For those that do arrive at the bottom of the curve however, complete loss of assets and out migration does serve to ultimately separate them from agricultural pursuits and thus comprises genetic erosion. But for a given extreme food insecurity set of circumstances and point in time, what is the relative number of people that occupy the bottom of the curve, versus the proportion that are arrayed at various other points along the curve? How is such a situation represented spatially? And how does such an arrangement intersect with processes of genetic erosion or conservation?

Figure 4 places the curve from Figure 3 (dashed line) over a set of concentric isobars that illustrate in both a spatial and demographic sense, how people are arrayed along the curve in Figure 3 during many situations of food insecurity. Figure 4 illustrates that where extreme food insecurity or famine operates in a form catastrophic enough to compel out migration, sale of all assets, and hence separation from agricultural production (innermost isobar), there are also large numbers of people—and proportionally more than exist within the innermost isobar--that are not affected as severely (yet). Such a population does not reside within the innermost isobar and at the bottom of the curve in Figure 3, but rather are arrayed at various stages along the curve, all the way to being unaffected by food insecurity (top of the curve in Figure 3, and outermost isobar in Figure 4). Hence the extreme food insecurity that separates households and communities from agriculture, and hence causes genetic erosion, exists to a significant degree in pockets. Such pockets of extreme food insecurity is very frequently how famine begins and operates; with some local populations better off than others, as the socio-economic segmenting effects of extreme food insecurity plays out across an affected landscape. Figure 5 illustrates this pocket spatial nature of the existence of food insecurity in actual data for the Darfur region of neighboring Sudan. While occurring in a different human and biophysical environment than highland Ethiopia, the figure does generally represent the spatial aspect of food insecurity--with the most extreme forms of food insecurity existing in pocket locations, and most of the area and the wider population existing outside these pockets. While large scale catastrophic food insecurity, such as the 1984/5 Ethiopian famine, does involve large populations across landscapes, such events begin in pockets, and less widespread and catastrophic events can play themselves out entirely in arrays of such pockets.

The implications of such a situation in a genetic erosion context is important. While the majority of people occupying most of the area around such pockets do not suffer extreme food insecurity, they are nonetheless very much aware of the existence of these pockets, and the severity of the problems underway within these. Given the history of food insecurity in Ethiopia (Table 1) this awareness is actually quite developed. Thus while a majority of people occupying such a landscape are arrayed at various points of food insecurity and vulnerability along the curve in Figure 3 their fear of course is that they too run the risk of eventually occupying such a pocket of extreme food insecurity. This, coupled with significant vulnerability, and the presence of very small fields from which to feed a large population, is again, the motor which drives such an aggressive replanting strategy in order to get something in the way of agricultural production in any given year. In other words aggressive replanting with local crop varieties in such an environment operates off of the food insecurity, poverty, vulnerability, and desperation of farmers not yet at the bottom of the curve in Figure 3 (innermost isobar of Figure 4), but who fear they could end up there.

Edge effect and Weedy Cousins

For the agricultural environment described here additional processes come into play that further encourage the maintenance of traditional varieties of genetically diverse crop species. Figure 2 not only illustrates the small plot sizes that comprise highland farms, but also a very significant edge effect created by so many small fields. As well, replanting parts of fields with different crops during the course of the agricultural season adds significantly to the overall edge effect between crops. The role of this edge effect in the maintenance of genetic diversity in traditional crop varieties is twofold. First, small patches of crops and many edges result in a greater proximity-mix of crops. For like varieties this allows for the enhanced probability of mixing of genes, and hence the potential for new varieties to emerge. This is an important process for the adaptation of plant varieties to new problems of climate (including climate change), disease, and pests.

The edge effect also allows proximity and interaction with the weedy cousins of crop varieties that frequently occupy field edge locations. These wild varieties contain a great deal of genetic diversity necessary for survival, but also do not produce as much in the way of food. Nevertheless their proximity to cultivated cousins allows for genetic traits to pass back and forth from weedy to cropped varieties, further facilitating a rich diversity of genetic possibility in the adaptation of new varieties and the maintenance of existing genetically diverse varieties. Such a situation results from the small plot sizes and replanting activities common in the highlands.

Seeds and Communities

While households in many areas of the Ethiopian highlands are compelled to keep a significant variety of traditional crop species on hand in the pursuit of food security, the community level movement of seed varieties also plays a large role in seed availability and use. Due to the number of varieties in use, and the emergence of new varieties, considerable community level movement of seeds is needed and goes on so as to provide for widespread replanting needs. Trade in traditional seed varieties within and between communities is considerable in highland Ethiopia and provides an important mechanism by which existing varieties are replenished or acquired at he household level, and how new varieties are dispersed through a community.

The Dilemma

The situation described here for highland Ethiopia presents a significant dilemma in terms of food security and conservation of important agricultural biodiversity. If it is the food insecurity, poverty, vulnerability and hence desperation which compels small scale agriculturalists to scramble to continuously replant in the face of agricultural adversity, and in turn compels them to invest considerable effort in having a wide array of traditional seed varieties always on hand, then any improvement in food security and livelihoods would then result in a decreased need to aggressively replant, resulting in real genetic erosion. In other words improved food security would likely significantly reduce the drive to always get some production from very small plots, and hence decrease the need to always have a wide array of seeds on hand for this purpose. This in turn would reduce the availability of valuable landrace varieties containing significant genetic diversity. Certainly improved food security for highland Ethiopians should be a priority in relief and development agendas for the region. It remains to be seen however if this can be done while at the same time continuing the *in situ* conservation of important landrace agrobiodiversity.

While the landrace conservation situation in highland Ethiopia presents a dilemma with no easy answers, the issue is nonetheless very relevant to an array of emerging international negotiations and treaties regarding biodiversity. Agricultural biodiversity is a common topic in this domain. However this presently exists only with regard to the physical genetic material itself (seed stock). The difference of course is that unlike naturally occurring biodiversity, agrobiodiversity exists as a result of human interaction with plant species and the landscape via agricultural systems often over very long periods of time--as is the case with highland Ethiopia. That maintenance (and continued development) of agrobiodiversity continues to exist as a result of specific agricultural communities interacting with the landscape, means that a 'service' is being provided to the wider human community in terms of continued viability of important crop species. Such ‘services’ do not presently reside in the domain of international negotiation and treaty along with other issues pertaining to biodiversity.

In a changing world, much about emerging international issues have yet to be adequately dealt with. And in many cases appropriate approaches to navigating such issues in the international domain have yet to be found. The ‘service’ provided by highland Ethiopian agriculturalists which allows for the maintenance of important agrobiodiversity is such an emerging issue that has yet to be adequately considered with in the international arena.

References

Chitrakon, S., Y. I. Sato, H. Morishima, and Y. Simamoto, 1999. *Genetic erosion of rice in Thailand.* Internet at: http://probe.nalusda.gov:8000/otherdocs/rgn9/v9p73.html.

Egziabher, Tewolde Berhan Gebre, 1991. Management of mountain environments and genetic erosion in tropical mountain systems: the Ethiopian example, *Mountain Research and Development*, 11(3): 225-230.

FAO (2000) The role of biological diversity in feeding the world. www.foa.org/biodiversity/foodsecur.

Fowler, Cary and Pat Mooney, 1990. *Shattering Food, Politics, and the Loss of Genetic Diversity.* Tucson, The University of Arizona Press

Hutchinson C and Weiss E (1999) Presented at the Technical Meeting on the FAO World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS). Prague, 21-23 June.

Madeley, John, 1996. *Yours for food: plant genetic resources and food security.* Internet at Internet: http://www.oneworld.org/aprodev/yours1.htm

Natural Resource Perspectives, Number 7, March 1996. Internet at: http;//www.oneworld.org/odi/odi_erosion.htm

Office of Arid Lands Studies (OALS) (1991) Famine Mitigation. Proceedings of Workshops Held in Tucson, Arizona, and Berkeley Springs, West Virginia. University of Arizona.

Pankhurst R (1985) The history of famine and epidemics in Ethiopia prior to the twentieth century. Addis Ababa, Relief and Rehabilitation Commission

Tripp, R., and W. van der Heide, 1996. *The erosion of crop genetic diversity: challenges, strategies, and uncertainties.* Overseas Development Institute

Tuxill J (1999) As plant species disappear, the world becomes poorer. International Herald Tribune, Friday, Sept 24.

UN Development Programme, emergencies Unit for Ethiopia (UNDP-EUE) (2000) Recent developments and events in Ethiopia. UNDP-EUE, Addis Ababa, 9 May.

Webb P, von Braun J, and Yohannes Y (1992) Famine in Ethiopia: policy implications of coping failure at national and household levels. research Report No. 92, International Food Policy Research Institute. Washington DC

Zimmer, Karl S., 1992. The loss and maintenance of native crops in mountain agriculture, *GeoJournal* 27(1): 61-72.

THE IN-SITU CONSERVATION APPROACH: ADAPTABILITY AND STABILITY OF MIXTURES OF PHENOTYPES INCLUDING THEIR LOCAL REDISTRIBUTION IN YUNGUYO, ALTIPLANO OF PERÚ, LAKE TITICACA WATERSHED.

Roberto Valdivia[1], Miguel Holle[2] and Nestor Arce[1]

[1] Centro de Investigación de Recursos Naturales y Medio Ambiente CIRNMA, Puno Perú.
[2] Centro Internacional de la Papa CIP, Lima Perú

In the area of Yunguyo (Puno, Perú), we have tried to understand the dynamics of in situ conservation of the agrobiodiversity of Andean tubers (1993 – 2000). Being an area with tradicional agriculture characteristics, it was considered that one of the intervention mechanisms was to use their own material from the microcenter, providing seed and testing the concept of "varietal mixture", as the families of this area use their own seed. In this way in 1995 – 1996 were installed "seed beds" of the 18 varieties of oca identified by the families and; starting in 1996 – 1997 these were provided in the form of a "mixture varietal". These mixture were differentiated by number of varieties forming the "mixture". There were four types of "mixtures". One, with 1 to 2 varieties of oca, one with 3 to 8, one 9 to 12 and the last one had more than twelve. After five years, the patterns of this type of mixtures are evaluated using the analysis of adaptability and agricultural stability (Finlay and Wilkinson, 1963; León-Velarde and Quiroz, 1994), in years that were climatically different and areas differentiated by the greats or least influence of the Lake Titicaca. With this it is found that those "varietal mixture" formed by 9 to 12 varieties have the better indexes of stability and an independent adaptability of the type of year and place. Mixtures with few varieties adapt better to "good" enviroments and without climatic restriction, while mixtures with "many varieties" can surpass bad environments and climatic irregularity. With the foregoing it is possible to point out that the use of "varietal mixtures" needs to be promoted in environments where the climatic irregularity is so drastic that obliges the rural families to developed mechanism to diminish the production risk. In addition it forces to think in forms of intervention of these areas in order to ensure and strengthen the in situ conservation approach.

COLLABORATIVE PROGRAM FOR THE CONSERVATION AND USE OF THE BIODIVERSITY OF ANDEAN ROT AND TUBERS (CIP – SDC) 1993 – 2003: THE CASE OF THE LAKE TITICACA WATERSHED, THE ALTIPLANO OF PERÚ AND BOLIVIA

Roberto Valdivia[1], Miguel Holle[2], Victor Iriarte[3],Nestor Arce[1], Cecilia Inohue[2], Giovanna Perazo[2] and Corine Hayano[2].

[1] Centro de Investigación de Recursos Naturales y Medio Ambiente CIRNMA, Puno Perú.
[2] Centro Internacional de la Papa CIP, Lima Perú
[3] Programa de Investigación y Promoción de Productos Andinos PROINPA, Cochabamba, Bolivia

The present study in the Provinces of Yunguyo (Peru) and Copacabana (Bolivia) was developed between 1993 and 2001 . These areas are a geographical, cultural and environmental continuity, having direct influence of Lake Titicaca in the Andean Altiplano (Highlands) . In these areas, called Microcenters of Conservation, we worked with communes and within them with rural families carrying out an inventory of their Andean tuber agrobiodiversity. We registered varietal names as named by the farm families themselves at seeding and harvest. These varieties formed their "mixtures". The destiny of production between harvest and the next seeding is selfconsumption, market sale, home processing, and seed. This made it possible to analyze the dynamics of conservation for families, years and the relation that take place from the plot to the market place. The central hypothesis is "the more use, the greater conservation." The main lessons learned refer to the understanding of the complexity of these processes, where the strategies that the farm families practice in time are the basis for the conservation. At this time, the market is apparently not influencing conservation of agrobiodiversity in the area under study.

“MAYANS FAMILY ORCHARD IN THE MAYAN CULTURE. A WAY FOR SOIL BIODIVERSITY CONSERVATION”

Maria Magdalena Vázquez G.
Quintana Roo State University
Av. Boulevard Bahía s/n. Colonia Del Bosque
C. P. 77000, Chetumal, Quintana Roo, México.
E-mail: marvazqu@correo.uqroo.mx
Phone: (01) 983 5 03 75; Fax: (01) 983 2 96 56

Mayan culture is considered one of the most important cultures of the Central American Region. They occupied part of the south of Mexico and Central America. In Mexico the main occupied areas are:

> Yucatan Peninsula, Chiapas and part of Tabasco, while in Central America they live in Guatemala, Honduras and Belize.

The main ceremonial sites were in Mexico:

> Chichen-Itzá in Yucatan; Calakmul in Campeche and Coba, Dzibanche and Kinichna in Quintana Roo

This sites have the most florecient period of their culture in the Clasic period wich means 600 A. D. to 800 A. D.

Since the most ancient time the mayan people have had a great respect for the environment and the conservation of their natural resources.

The cut, cleared ground and fire for preparing the soil to agriculture has been practiced along centuries.

The descendents of mayan’s still do it the same way for growing the vegetables they need for feeding.

In a family orchard they seed corn mixed with beans, cabage, tomatoes, pepers and letuce. In differents seasons they harverst some of these products and they can get almost the round year the necessary vegetables for their feeding.They also rise goats and cows and use the manure as fertilizing the soil.Doing this whole process they close the natural cicle of the use of the natural resources at the tropics.

Of course the extension of the areas they used for agriculture at that time comes not even close to the extraordinary amount of land that is use today.

In this study we present preliminary results of a comparative evaluation of soil biodiversity with four different types of soil management, such as:

1.)Mayan Family Orchards
2.)Sugar Cane Plantation
3.)Tropical Forest (Mahogany and Cedar trees)
4.)Cuted and cleared land.

All sites are ubicated in Quintana Roo state at the Yucatan Peninsula, México.

A total of 42 species of soil mites was recovered from mayan family orchards representing 16 families and 27 genus, while in a undisturbed surrounding tropical forest where founded 144 species representing 35 families and 44 genus. Definitely the highest species richness was found in a tropical forest.The most poor species richness was found at the cuted and cleared land and at the sugar cane plantation, where we recovered three families, two genus and seven species of soil mites.

	Orchard mayan's family	Tropical Forest	Sugar plantation	Cuted and cleared ground
Oribatida	30 spp	72 spp	5 spp	2 sp
Uropodina (mesostigmata)	8 spp	64 spp	1 sp	0 sp
Prostigmata	4 spp	8 spp	1 sp	0 sp
Total	42 spp	144 spp	7 spp	2 spp

Tropical forest, even more so than their temperate counterparts, provide a great number of habitats that conceivably could be exploited by Uropodina and Oribatida (litter, bark, rotting wood, bromeliads, mushrooms, vertebrate and invertebrate nests, etc). The fact that even this restricted orchard mayan family yielded more than 30 spp. suggest that this way of growing vegetables mixed with fruit trees helps keeping a high number of species in the soil and litter and they help to recycle the organic matter.

References.

[1] Athias-Binche, F., Écologie des Uropodides édaphiques (Arachnides: Parasitiformes) de tríos écosystémes forestiers. 1. Introduction, matériel, biologie, Vie et Milieu. 31 (1981) 137-147.

[2]Behan-Pelletier, M.G. Paoletti, B.Bisset and B.R.Stinner. 1993 . Oribatid mites of forest habitats in Northern Venezuela. Tropical zoology, Special Issue 1 : 39-54

[3]Hirschmann, W. & J. Wisniewski. 1975 – Acari Parasitiformes Supercohors Atrichopygidiina. Hirschmann 1975. Die Uropoden der Erde, Acarologie. 40 (1993) 1-466.

[4]Vazquez, M.M., Cátalogo de los ácaros oribátidos edáficos de Sian Ka'an, Q. Roo, México, Universidad de Quintana Roo, Chetumal, Quintana Roo. 1999.

[5]Walter, D.E Proctor, H.C., Predatory mites in tropical Australia: Local species richness and complementarity., Biotropica. 30 (1998) 72-81.

DYNAMICS IN THE TRADITIONAL MANAGEMENT OF NATURAL RESOURCES BY SMALL PEASANT FARMERS IN THE ALPINE MOUNTAINS OF EASTERN TYROL/AUSTRIA: ITS CONSEQUENCES ON CULTIVATION AND USE OF PLANT SPECIES

Primary Author: Christian R. Vogl
Second Author: Brigitte Vogl-Lukasser
Address for Mail: University of Agricultural Sciences, Institute of Organic Farming, Gregor M. Strasse 33, A-1180 Vienna, Austria, E-Mail: vogl@edv1.boku.ac.at

Alpine farmers have formed a landscape which is the result of continuous adaptive management of natural resources over centuries.

Until the 1960s the main parts of the managed mosaic of a typical farm in Eastern Tyrol consisted of: a) the herbal garden; b) a pasture with fruit trees; c) plots close to the homestead for vegetables, fibre crops, cereals for human consumption and fodder, d) forests used for timber, animal fodder, bedding and fire wood; e) hunting and gathering of berries, mushrooms and medical plants; and f) large alpine pastures and hay meadows in higher regions at distances of >5 km from the farm. A high diversity of animal species was kept at the farm. Main purpose of all agricultural activities had been securing subsistence

Today farmers work mainly for cash income by breeding cattle for milk and meat. Some traditional techniques of plant management for farmers' subsistence are still common: Herbal gardens (a) developed into highly diverse homegardens with vegetables, herbs and ornamentals. Traditional management of fruit trees (b) is still alive. Gathering of mushrooms, medical herbs or berries (e) is reduced in extent, but still usual. In contrast, areas for cereals, fibre crops and vegetables (c), except potatoes, were abandoned in favour of pastures and hay meadows. Fodder or bedding based on forest species (d) has disappeared. Management of higher alpine pastures and hay meadows (f) has changed significantly. As a consequence appearance of landscape has changed and agrobiodiversity is eroding, except in homegardens.

National policies and subsidies address directly and indirectly in situ conservation of agrobiodiversity. These policies have to be complemented by respecting, that, for farmers, conservation of agrobiodiversity is not only an economic issue, but a phenomena embedded in local culture, worldview and beliefs. To be successful, these aspects have to be addressed also in a dynamic concept of in-situ conservation of biological AND cultural diversity.

THE VALUE OF HOMEGARDENS AND ITS MANAGEMENT FOR THE IN-SITU CONSERVATION OF AGROBIODIVERSITY IN AN ENVIRONMENT OF CHANGE OF LAND-USE IN EASTERN TYROL (AUSTRIA).

Primary Author: **Brigitte Vogl-Lukasser**
Second Author: **Christian R. Vogl**
Address for Mail: Hamerlinggasse 12, A-2340 Moedling Austria, Phone Number: ++43-2236-45069; ++43-2236-7028037, Fax: ++43-2236-45069, E-Mail: vogl@edv1.boku.ac.at

The decrease of the diversity of plant species in natural ecosystems and of species or varieties in managed ecosystems is discussed in many scientific papers and is seen as a threat for nature and for the sustainable development of the human society. An ethnobotanical study with the focus on the recent development of diversity of species and varieties in 196 alpine homegardens of small peasant farmers from 12 communities of Eastern Tyrol (Austria), realized in 1997 and 1998, and interviews with 23 elderly women who reported ancient management techniques in gardens, shows a different trend in that certain case study.

Until the 60ies mean occurrence of species per homegarden did not exceed 10 species. Today a mean of 42 species can be found within a homegarden. At district level not more than the total of 51 species have been recorded until the 60ties. Today at least 587 species are grown in the homegardens in the region. 79 cultivated species in these gardens have some kind of endangered status and can be found on the Austrian red list of endangered ferns and flowering plants.

Plants grown in homegardens are used in a variety of different ways, whereby the plants grown have undergone significant change. Homegardens were previously dominated by spices and herbs for medical purposes. Vegetables and crops for consumption were grown outside the garden at several plots within a crop rotation. Most plots are now used as pasture. Now gardens are dominated by ornamentals, vegetables and herb species. New species have been introduced in homegardens in the last 20 years (e.g. about 400 species used for decoration, 45 used as spices, and 38 used as vegetables). Today, 420 of the 587 cultivated species are used for decoration. Fewer species, but with a higher abundance, are used for food (147), medicinal (79) and other purposes.

Homegardens with high agrobiodiversity in Eastern Tyrol are therefore a result of the recent 40 years. Homegardens are living gene banks where landraces, obsolete cultivars, rare species and endangered species are preserved. This agrobiological conservation can be characterized as an independent adaptive response of female farmers, due to their emic perceptions of changing internal and external processes.

WOMEN ROLE IN MAINTAINING SWEETPOTATO DIVERSITY: A LESSON LEARNT FROM SWEETPOTATO IN SITU CONSERVATION IN BALIEM VALLEY, IRIAN JAYA, INDONESIA.

Caecilia A Widyastuti, Gordon Prain, Alexander Yaku

ABSTRACT

A study of the role of women in maintaining sweetpotato diversity was conducted from 1997 to 2000 in three different sites in the Baliem valley, Irian Jaya: Waga-waga, Wesaput and Kurima villages. The objectives of the study were:(1) to understand the mechanism of dissemination and transfer processes of knowledge of sweet potato within and between generations; (2) to determine the relationship between women's status in the society and their knowledge and management of sweet potato: (3) to determine the reasons for selecting, maintaining and discarding particular sweet potato cultivars and (4) to clarify the significance of dominant cultivars and their functioning and distribution.

Data collection was done through a survey, participatory observation and direct interview. To document in detail the planting practices and allocation of space to cultivars, women's individual sweetpotato beds were mapped and bed cultivators interviewed.

Result of the study indicated that women farmers have a detailed knowledge of agro-ecological variability and zones, allocation of specific sweetpotato cultivars to particular zones, the distribution of cultivars within beds and interactions between types of cultivars and soil fertility. The changing soil fertility between new and old beds results in a gradually change in the composition of the cultivars planted there. They identified sweetpotato cultivars based on their use and agronomic characteristics. Results of the study also documented the way that knowledge of sweetpotato cultivars is exchanged within and between generations of women in Waga-waga village. The study also indicated that the status and age of women are important in sweet potato cultivation in this ethnic group. Two type of status were found to influence knowledge and management of sweet potato diversity (1) marital status and (2) achieved status.

The higher status of the first wife compared to second or subsequent wives, especially in marriages of tribal chiefs. meaning that the first wife a larger number of sweet potato beds. In the cases studied, this larger planting area contained higher diversity than other women. On the other hand women can also achieve higher status through a number of strategies associated with deployment of sweet potato diversity. It was found that women enhance their status by becoming known for developing or maintaining original sweet potato cultivars in their gardens. This status is further strengthened if they make offerings of traditional or original sweet potato cultivars such as *Arugulek, Helalekue asli,* and *Musaneken* to *honai adat*, the ancestral house of the settlement. Finally, a woman can enhance her status by developing strong relationship with relatives and friends and ancestors.

MANAGING RICE AND SOYBEAN VARIETIES IN JAVA AND LAMPUNG: TWO CASES OF FARMERS' CREATIVITY[18]

Yunita T. Winarto
(University of Indonesia)

The evolution of farming culture in Indonesia: an introduction

'… [T]hat was a period of stupidity,' stated farmers in Central Lampung in describing the condition of their mind during the previous crop farming intensification programme. That was the period when the Indonesian central government adopted the Green Revolution paradigm in crop farming programme. 'Now we have the period of enlightenment, of improving our knowledge,' referred the same farmers to recent time when they learned how to improve knowledge through the Integrated Pest Management (IPM) programme. For many farmers, IPM has improved their mind, enriched their knowledge, and empowered them so as to enable them to take decisions that – according to their viewpoint – are suit better to their existing resources and condtions (see Winarto, Maidi, and Darmowiyoto 1999; Winarto *et al.* 2000). Self-reliant on their own discoveries through a more systematic way of learning, is the most distinguished phenomenon discovered among those who experienced the ways the IPM had led them to know about things they did not know, or were allowed to do. The latter also relates to the greater courage they now have in voicing their interests, desires, problems, or arguments against any ill-wise policies and recommendations. Such an improvement leads to farmers' creativity more than in the past three decades where farmers were forced to adopt and implement the government's packages and technological recommendations.

Farmers have been and are always creative in their efforts of solving the daily problems of crop farming. What makes the differences in their current creative practices from the period prior to the introduction of IPM? My observation on the north coast of West Java and Central Lampung reveals the enrichment of farmers' knowledge and information that contribute to the wider options and references in their decision making process. They learn not only of 'what' question they should answer or refer to, but also the 'how' question in carrying out observation and practices. A wider option of pest control strategies, not merely dependent on chemical control, is a reality resulting from the improvement of farmers' creativity (see Winarto 1996; Winarto *et al.* 2000). If a diverse strategy in pest control is an evidence of the improvement of farmers' knowledge and practices, how about their choice in crop varieties?

The 'Green Revolution' in Indonesia and various developing countries was known for its contribution to the decline of the heterogeneity of rice variety (see Fox 1991; Shiva 1991, 1993). An old farmer remembered the days where he planted various rice varieties in his field in one planting season, and so also do his fellows. He seldom experienced one rice variety planted dominantly by a majority of farmers in one planting season as what is found nowadays (also see Winarto 1997). Not only in rice, the government's crash program in other crops, such as soybean, which then failed, led to farmers' abandonment of cultivating soybean for almost a decade as found in Central Lampung. The farmers named the period of abandonment as the 'sleeping years'

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of soybean cultivation (see Winarto *et al.* 2000). During my observation in the years after the introduction of IPM programme, I found a more dynamic cycle of farmers' choices of rice varieties on the north coast of West Java, and a return of diverse soybean varieties in Central Lampung. To what extent does it relate to the improvement of farmers' creativity? What factors contribute to the appearance of such phenomenon?

Creativity relates to the individuals' ability to find new strategies and produce new ideas as a result of combining a set of information existing in their cognitive minds (see Strauss and Quinn for their theory on connectionism, Strauss and Quinn 1997; also see Choesin 2001). The extent to which individuals are able to produce new ideas would depend on how they are able to combine which ideas – either the old, or the new ones, or the combination of both - in responding to particular situations. However, this ability and the available information they can obtain would also depend on the external factors. To what extent the existing circumstances enable them to freely take their own decisions, and hence, creatively produce new strategies and practices? The Green Revolution paradigm are still underlining various government programmes in increasing productivity. Yet, the 'recreation of farmers' own niche', in which farmers have the freedom to exercise their own strategies, is underway in many places (see Winarto forthcoming). Producing crops 'free from pesticides' (*bebas racun*) is the aim of some farmers in both Java and Lampung. This is one example of the farmers' desires of producing healthy crops on top of the high yielding ones as intended by the national government. In combination with farmers' self reliant on their own knowledge, discoveries, and strategies, and the change in some bureaucrats' perspectives and attitudes supporting the IPM paradigm, the circumstances the farmers have these days are favourable for their creativity to flourish.

This article examines two cases of farmers' creativity: the north coast of West Java farmers in selecting rice varieties, and the Central Lampung farmers in reproducing soybean varieties. The two cases reveal some similarities and differences in how farmers pursue their practices in finding the most favourable varieties, under what conditions do those practices persist, and what the implications are to their cultivation strategies.

Managing diversity in rice varieties: the cycle of individual choice and consensus

Whereas diversity in ecological point of view leads to a greater stability and sustainability in an ecosystem, variability in anthropological point of view enables a culture to evolve (see Johnson 1972). A diverse range of rice variety planted by farmers not only provides a greater chance to spread the risks of harvest failures, but also allows them to learn about the variability of each strand's characteristics and performances. Farmers' knowledge improves through comparative observation of diverse plants' performances in one planting season, as well as from planting different varieties in different seasons. This was the most distinctive learning process in the period prior to Green Revolution that was then being degenerated due to the decline of varieties during the period of rice intensification. Rice varieties have been a very important subject of the scientists' technological experiment in agriculture, in particular when the crops' susceptibility to pest and disease increased (see Fox 1991). VUTW (*Varietas Unggul Tahan Wereng,* the high yielding variety against *Nilapavarta l.* or brown planthopper) is an acronym known by farmers as the varieties produced by the government's seedling company that have genetic resistance towards brown planthopper. This pest has become the most significant pest in rice farming after the release of high yielding varieties (Bahagiawati and Oka 1987; Fox 1991). How to improve rice varieties' resistance towards this pest has been the highest priority in agricultural technology up to recent times. As a result, the government would enforce farmers to adopt the most resistant variety to avoid harvest failure while also keeping the high rice productivity. 'The government told us of what to plant, when, and how,' complaint an old farmer towards the government's regulation imposed to farmers to plant the 'government variety'.

In spite of the complaints, gradually, farmers undertook both the high productivity and sustainability performances into their selection process of rice varieties. The sustainability of a variety is related not only to the variety's susceptibility towards pest and/or disease, but also to the variety's performance in a particular season, i.e. the dry or the rainy season that has different climatic conditions. In turn, the latter could also be conducive for the infestation of certain pests/diseases. On the basis of their accumulative knowledge season by season, their familiarity towards which pests/diseases are used to infest their crops grow. However, despite this complex set of variables to consider to, they still strongly hold their choices on rice palatability and good quality of grains, as well as the high market demand and the best selling price they would be able to gain. The latter does of course depend on the previous seasons' experiences, which sometimes fail. Another factor that is often expressed by farmers is their motivation to keep trying new varieties, or those found promising in relation to the aforementioned performances. They have a great desire to always try a new, or another variety. The extent to which a farmer does exercise his/her own choice, however, depends on how brave he/she is to plant a variety, which is not always in conformity with his/her rice field's neighbours' choices. Again, the latter is related to the vulnerability of pest/disease infestation if a farmer plants a different maturity period of a particular variety as compared to the rest of his/her neighbours'.

Looking at how farmers take into account such a complex set of variables in making up their selection, it is apparent that farmers are always engaged in the process of learning in order to answer their own question of what to plant in the following season. Each farmer does a reflection of what has been experiencing in the past season, and of what to learn from those experiences to have a better yield, or to maintain the good harvest they were able to obtain. The past experiences were kept in their memories, and the more recent ones as a result of their current practices are added into their knowledge repertoire. Which inputs are combined into the old ones, and yields a new combination of information that further becomes the basis of their decisions, could vary individually and/or seasonally, according to the situation the individuals have to face (see Strauss and Quinn 1997 on their arguments for 'connectionism' in understanding how knowledge works and improves on the basis of the connection between the extra- and the intra-personal factors). If such a process has been part of farmers' ways of learning, what is the difference of the recent from the past experiences prior to the introduction of IPM programme?

When I visited the hamlet recently where I did my research in early 1990s, and then through short visits in 1996-1998, several farmers told me that the extension worker for their hamlet's farmers' group decided not to organize an extension meeting regularly, e.g. before the planting begins to facilitate farmers in selecting a particular variety, unless farmers themselves invite him to come. The extension worker considered farmers in the hamlet of Marga Tani, Ciasem Baru as 'clever enough' to decide on their own, in particular after their learning in Integrated Pest Management 'school'. Hence, farmers experience a lesser degree of an enforced recommendation. On the other hand, they told me of a special seminar run by the agricultural research station nearby where the agricultural experts informed farmers of a range of new varieties recently released. Despite this new source of information, farmers, as usual, obtain information of the existing new seeds and their performances from various sources: fellow farmers live within and in neighbouring hamlets, workers in the government' research station or seedlings company, traders, relatives from nearby or distant places, etc. (see Winarto 1996). I feel a greater autonomy farmers now have to make up their own decisions. An evident for this autonomy was the planting of a local variety that was not released by the government's seedling company since 1996, replacing the previously prominent high yielding variety (IR64, see Winarto 1997, 1999). A reflection and learning process continued when the farmers realized of the susceptibility of this local variety towards brown planthopper in rainy season. In line with the emerging new varieties planted by several individual farmers, on the basis of observation and comparison, farmers again made up individual selection of planting a more promising variety.

In 1999/2000, farmers experienced a decline in the sustainability of the local variety known as *Muncul*, and only a very few farmers left to plant the previously prominent high yielding variety, IR64, which had been planted continuously from 1987. At that time, a farmer-trader bought grains at the agricultural research station nearby. He observed a good quality of grains from a variety that was then known by farmers as '*Galur*'. '*Galur*' refers to the plot where the agricultural scientists used to plant the experiential seedlings. He took some amount of grains and decided to plant the seeds in his field. Later on the same seeds were officially released as *Ciherang.* His neighbour, an IPM farmer, observed the good performance of this new variety and decided to buy some grains from the farmer-trader. The seedlings grew well and the yields were high. Another IPM farmer bought the same seeds through his permanent worker who did the *bawon,* harvesting job at a farmer's field in the neighbouring hamlet. The farmer also proved that the seedling's performance and the yields were good. Through farmer-to-farmer knowledge transmission (observation, comparison, conversation, and seeds-exchange), the new variety was widely planted by farmers during the rainy season of 2000/01. Unfortunately, in that season, many farmers experienced harvest failure due to the heavy rain and storms at the time the plants were flowering. However, with the existence of other varieties, and the planting of the same variety at the time earlier than the failed ones, they learned that different characteristic of plants' growth of different varieties, as well as the planting schedule were the causal explanations of why the degree of harvest failures varied. In the following season, dry season of 2001, many farmers decided to replant *Ciherang*, but a few farmers again planted a different novel variety (e.g. *Widas*), and still some farmers planted the old ones. From the same mechanisms of obtaining seeds, these few farmers decided to try the new one. Again, through comparison and observation, the farmers learned of the different performances of varieties during the growing period, pest infestation (white rice stemborer) at the reproductive stage, and from the yields, grain quality, and price. At the time they have to select a variety to be planted in the next rainy season of 2001/02, each farmer is now considering the various types of performances of varieties planted everywhere. Some farmers already decided to try again new varieties, released by the agricultural research station (*Cimelati*), or planted by farmers in other hamlets (*Lanay,* and a *Taiwan* variety).

This story reveals how creative farmers are in selecting rice varieties, and how continuous their learning process is. Since each farmer feels free to decide on his/her own choice, a diversity of rice variety in each planting season is common. If they agree on the good performances of a particular variety, a more dominant variety planted in one particular season by a larger number of farmers will be the result. However, once the variety does not perform well as a result of various factors, the common choice could be shifted to another more promising variety, again, preceded by a more diverse outcome of varieties planted through individuals' selection. Hence, I notice a cycle of learning process with its different results: diverse varieties grown in one season, followed by a more uniform choice, followed again by the planting of a more diverse types of varieties, and so on. I argue that such a cycle is a very significant mechanism in sustaining the yields the farmers can obtain in a complex and constraining environment, such as climatic hazards, pest/disease infestation, a fluctuation in market demand and price, etc. As long as they can have an access to gain information of new varieties planted elsewhere, or released by official resources, they will always try to plant them to be able to improve their harvest yields. Selecting, trying, observing, learning, selecting, and trying again, is a way from which farmers enrich their knowledge and experiences. The same cycle of learning process is also found among those who planted secondary crops intermittently with rice. How do the latter manage the diversity of soybean varieties, which was once 'gone' from their world of cultivating secondary crops?

Managing diversity in soybean varieties: the 'return' of the 'lost' varieties

'…[S]leeping for seven years,' this is the metaphor the farmers in Central Lampung use when describing their inaction in cultivating soybean from the time the harvests of soybean continuously failed. The 'crash-program of soybean' (*Operasi khusus kedelai, OPSUS)* launched by the central government was, in farmers' eyes, the source of the failures. The program ignored the prerequisite of planting soybean according to farmers' cosmology: i.e. the need to grow plants according to the Javanese traditional calendar known as *pranata mangsa,* which refer to the move of sun from the north to the south in six months period annually (also see Indrowuryanto 1999). According to this belief, farmers can only begin planting at the appropriate month, so as to ensure the growth of a healthy crop. Once this planting cycle was broken down due to the enforced intensification programme, their crops suffered a continuous pest/disease attacks until at last, they decided to stop cultivating soybean. They felt helpless since whatever 'medicines' they used to control the soybean seed borer, they could only harvest 'empty soybeans', or 'soybeans without seeds' (*kedelai tanpa biji, kopong*). Crops vulnerability became a common phenomenon everywhere, not only for rice, the main crop, but also for secondary crops such as soybean. Again, this phenomenon proves that external factors originated from the implementation of central government's program changed farmers' habitat drastically. Not only that, the changes caused further significant consequences, i.e. the growth of farmers' ignorance of planting soybean in a sustainable manner in the changing habitat, and in the increase of uncertainty (see Hobart 1993). Farmers' confidence was gone. To return their 'lost of confidence' was not an easy effort to do. If they are now able to replant some soybean varieties, the question is: how could that be possible?

The case of farmers' experience in Central Lampung (Terbanggi Besar) is unique in which a non-government agency (Yayasan Gema Desa) initiated to assist farmers in solving this problem. This effort was continued under the collaboration between farmers, who organized themselves in a collective farmers' group known as Tim PHT (Pengendalian Hama Terpadu, IPM) Lampung and recently adopted a local name *Wakak Juko* ('grass root'), and an international NGO (World Education). This agency has been the farmers' counterpart in institutionalising the Integrated Pest Management approach since 1994. Understanding the degree of difficulties by considering their inability of finding the most effective pest control strategies, they invited national and international entomologists. From the international entomologist, farmers learned how to carry out 'studies' (experimentations). Three main 'studies' which then effectively helped them in controlling soybean pests were: 1) the most efficient and effective light-traps; 2) the kerosene light-trap and its most effective time; and 3) the nest-trap and its most effective time. In line with various other studies, gradually, farmers were able to develop a set of control strategies for two pests: *Etiella hopsoni* and *Zenckinela.* The shortened name of the seed borer, *Etiella*, was later become part of the farmers' vocabulary. At the same time as carrying out those studies, farmers replanted soybean varieties by finding seeds from various sources. They also developed an understanding of which varieties were suitable for a particular elevation and Ph condition of soil, besides reactivating their knowledge of the Javanese calendar system for cultivation (*pranata mangsa*). Referring to this calendar is still a prerequisite, even though they now have to complement it with a more careful observation and pest control management. The traditional calendar could not be the sole strategy any longer in such a vulnerable environment (see Maidi *et.al* 2001). A story told by a farmer who diligently carried out his individual studies and observation reveals how extensive his knowledge is after learning from his own observation. He told my research assistant that:

All kind of varieties can grow well in the lowland up to 600 m height above the sea level, but there are some varieties that are better suited to lowland, e.g. *Wilis, Sinyonya, Dempo* and *Kerinci*. Two varieties are well suited to higher land, e.g. *Wilis* and *Tambora*. If the soil is acid (Ph. 4-5,5) plant *Wilis* or *Rinjani*. If the soil has a high Ph, plant *Lompo Batang* or *Amerikana…*The most important things to remember are: 1) the height; 2) soil acidity; 3) Ph. degree of soil; and 4) the appropriate season, where there are heavy rainfall during flowering phase up to the filling up phase of the seeds. In a 20 day period, the rain can halt the growth of the seeds-larvae, *Etiella* (Winarto *et.al* 2000).

He also explained the details of *Etiella*'s life cycle and the period where this pest infested the seeds of soybean. By planting the varieties in month 3, 7, and 11, the heavy rainfall will occur at the time the crops reach the age of 40-60 days of planting, during the flowering and filling up stage. Under a heavy rainfall, the young fragile larvae of *Etiella* could be swept off and die. In one story, he was also able to mention 8 different varieties of soybean, which means that these varieties have not been at all extinct from his environment. As soon as he and his fellows replant the soybean varieties, an option of selecting a range of varieties again becomes available. Not only that, the farmers also carried out experiments of producing a high productivity soybean, which is also 'free from pesticides'. An example of this is a variety known as *Amerikana* of 3 m tall. A farmer–who did the experiment of improving the quality of a variety released by the agricultural research station–in collaboration with an agricultural official, named the variety as *Amerikana,* referring to its height that is as tall as an American. When I entered the farmer's office, I saw a very tall soybean plant, which almost reaches the ceiling.

Even though farmers' knowledge and practices improved through learning from experiences of replanting soybean in a different environmental condition, the efforts of returning farmer's confidence, knowledge, and practices have still to be sought. The farmer-organizers and farmer-trainers in IPM designed a special curriculum for a Farmer Field School (FFS) for Soybean and its follow up. They integrated this curriculum in the whole program of disseminating IPM strategies, i.e. by categorizing the 'school' as a more advanced IPM training. The complex set of variables that have to be taken into account in developing a sustainable cultivation strategy is the reason of why farmers themselves considered the training for soybean as having a higher level than the IPM 'school' for rice. Before conducting a FFS for soybean, the farmer-trainers decided which variety would be planted in the experimental plot. The decision could vary in different 'schools' conducted every season in different locales. By doing this, the farmer-trainers themselves have the opportunity to make comparison and observation of which varieties could grow well under what kind of conditions and treatments. Also through such a way the diverse varieties were returned to the farmers' habitat with a more promising performance. Most importantly, they were able to replant the varieties 'free from pesticides', or 'free from poison'. This motto has become the main objective of the farmer-organizers and trainers in disseminating the IPM strategy. The word 'poison' instead of 'medicines' has also been gradually part of farmers' vocabularies.

By learning from direct experience through training, in particular if the harvests are good, the IPM farmer-trainees gradually regain their confidence and knowledge of cultivating soybean. The success stories of their efforts in replanting soybean varieties with promising yields were spread to distant places, including among farmers in the other district where I also did my research. Asking my help of bringing the good quality of soybean seeds from Terbanggi Besar, and conducting a FFS for soybean are examples of the farmers' great desires to be able to replant soybean in a sustainable manner. When the harvest of the soybean experimental plot of the 'school' was good, not only the IPM farmer-trainees were happy and hence, regained their confidence, but the other farmers also praised the harvest and expressed their willingness to again, replant the soybean (see Winarto *et.al* 2000).

This story reveals how creative farmers are, once the external factors are supportive for them to pursue their own ways of learning (through trial-and-error experiments, observation, and comparison). However, the traumatic experience of the continuous harvest failures of cultivating soybean, and their ignorance of controlling the emerging pests are not easy to be healed and improved without external help. In this case, the assistance of non-government agencies and their support of inviting experts, as well as conducting the IPM training, and empowering farmers to carry out studies and pursue the IPM training on their own, are very significant. The 'adult learning process' and 'learning through discovery and experiences' as practices in the FFS have improved farmers' confidence of solving their own problems. Once, they gain the confidence, another significant snowball emerges. The empowerment process yields prominent result, i.e. of how they themselves planned and managed to disseminate the findings, strategies, crop varieties, and knowledge to a large number of farmers. Throughout this process, a reinvention of tradition as revealed in the aforementioned story is evident. Moreover, the reinventing tradition occurs in a more enriched way of cultivation within an increased uncertainty in a complex environment. By reinventing and enriching their traditional knowledge and practices, farmers are able to preserve the biodiversity of soybean varieties in a more healthy way of cultivation. This is the promising feature of producing a more sustainable agricultural system in the future.

Towards a more sustainable agriculture: a 'dream' or a 'reality'?

The two stories reveal how farmers are struggling in the current environment of crop farming with unexpected hazards, and the infestation of various kinds of pest and disease affecting the yields of their crops quite significantly. A more sustainable way of cultivating crops has been the farmers' dreams from the time they experienced continuous or repeated harvest failures. Success stories of their harvests were frequently followed with unhappy and depressing ones. In the early 1990s, farmers on the north coast of West Java experienced severe white rice stemborer attacks (see Winarto 1996). Brown planthopper again infested farmers' fields in 1998s. When I returned recently, farmers told me stories of their two consecutive harvest problems: the heavy storms and harvest failure in the rainy season of 2000/01, and the return of white rice stemborer in the late dry season of 2001 after almost a decade the pest's population did not severely damage their crops. In 1998-99, farmers in Lampung experienced severe harvest failures due to the unexpected attack of a huge population of grasshoppers. The brown planthopper was also attacking their fields at the time this pest damaging fields on the north coast of West Java. These are only part of the stories of how farmers have to cope with unexpected hazards. What does the return of white rice stemborer mean in relation to the sustainability of their eocsystem? Is it not an indication that their dreams to always have success and happy stories of harvesting crops were far from reality? I argue that farmers are still striving to have a sustainable habitat, as well as a more prosperous life without any more debts they have to bear upon by experiencing harvest failures.

Throughout their struggles, however, farmers themselves would creatively find ways of solving their immediate problems, which in turn provide an opportunity to enrich their knowledge. One alternative way of doing this as found among rice farmers on the north coast of West Java is through selecting a more promising variety on the basis of individual's choice by considering a set of various variables. Since individual farmer can pursue his/her own decision, a diversity of rice varieties could be preserved. The greater freedom farmers have in pursuing their decisions in a more ‘unforced way of government’s recommendation’ provide a more favourable climate for the conservation of diverse varieties, the shift towards other varieties, and the enrichment of farmers’ knowledge.

Nevertheless, it has not always been the case that they themselves would be able to solve problems effectively as the case of farmers in Central Lampung. The loss of confidence and feeling of helplessness underlie their decision to abandon soybean cultivation. Despite the abandonment of their practice, farmers’ knowledge of cultivating soybean according to the Javanese calendar system still constitutes part of their knowledge repertoire. Farmers realized later that practicing this knowledge solely would not yield good results in the changing environment. Since they had never had an experience of severe pest attacks and had never learned about the ways of carrying out a detailed and systematic observation as the scientists did, they were ignorant of what to do to control pest infestations. Once they learned the possible ways of controlling pests through a more systematic study and observation, then the door for searching ways of controlling pests as well as improving their cultivation strategies was opened. A reinvention of their traditional knowledge and practices in an improved way of cultivation by incorporating effective pest control strategies was the reality. Farmers’ knowledge is improving, and so also the sustainability of cultivating soybean. Into this situation that the outside helps through experts’ assistance, IPM training, and NGO’s facilitation in empowering farmers were significant in improving farmers’ own ways of learning and solving problems.

It is apparent that farmers themselves have the talents and potentials to creatively improve their knowledge and practices, and cultivate their crops in a sustainable way. However, once the external actors intervened with their world of farming through changing farmers’ own ways of cultivating crops, the unintended consequences occurred that in some cases, resulted in the abandonment of their practices, the loss of confidence, the growth of ignorance, and more severely, the creation of unsustainable and degrading environment, and the loss of rich genetic resources. The cases examined in this article prove that in such a situation, regaining farmers’ own confidence and knowledge in an improved way could be evident once they receive appropriate assistance, and a greater freedom to exercise their own decisions. As Strauss and Quinn (1997) argue, the external factors are significantly affecting the internal process of individual cognitive minds. It is thus high time to reconsider the paradigm of developing agriculture if we would like to see that a healthy and sustainable agricultural ecosystem and a more prosperous life for so many innocent farmers are a reality, and not only a dream.

References

Bahagiawati, A. and I.N. Oka

1987 Perkembangan biotipe wereng coklat *Nilaparvata lugens*. stal. di Indonesia. In J. Soejitno, Z. Harahap and H.S. Suprapto (eds) *Wereng coklat*. Bogor: Badan Penelitian Tanaman Pangan, pp.31-42.

Choesin, E.M.

2001 *Connectionism*: alternatif dalam memahami dinamika pengetahuan lokal dalam globalisasi. Paper presented at the panel of ‘Local and global knowledge: its implication on natural resource management’, in the 2nd International Symposium of Journal ANTROPOLOGI INDONESIA: ‘Globalization and local cultures: a dialectic towards the new Indonesia’, Andalas University, Padang, 18-21 July 2001.

Fox, J.J.
1991 Managing the ecology of rice production in Indonesia. In J. Hardjono (ed.) *Indonesia: resources, ecology, and environment*. Singapore: Oxford University Press, pp.61-84.

Hobart, M.
1993 Introduction: the growth of ignorance? In M. Hobart (ed.) *An anthropological critique of development: the growth of ignorance*. London: Routledge, pp.1-30.

Indrowuryanto
1999 Pranata mangsa dalam aktivitas pertanian di Jawa. In K. Adimihardja (ed.) *Petani: merajut tradisi era globalisasi*. Bandung: Humaniora Utama Press, pp.17-40.

Johnson, A.W.
1972 Individuality and experimentation in traditional agriculture. *Human Ecology* 1(2):149-159.

Maidi, Darmowiyoto, Darmaji, and Handoko
2001 *Pranata Mangsa*: yang tersingkir, yang semakin kaya. Paper presented at the panel of 'Local and global knowledge: its implication on natural resource management', in the 2nd International Symposium of Journal ANTROPOLOGI INDONESIA: 'Globalization and local cultures: a dialectic towards the new Indonesia', Andalas University, Padang, 18-21 July 2001.

Shiva, V.
1991 *The violence of the Green Revolution: third world agriculture, ecology and politics.* London: Zed Books and Penang: Third world Network.
1993 *Monocultures of the mind: perspectives on bodiversity and biotechnology.* London: Zed Books and Penang: Third World Network.

Strauss, C. and N. Quinn
1997 *A Cognitive theory of cultural meaning.* Cambridge: Cambridge University Press.

Winarto, Y.T., Maidi, and Darmowiyoto
1999 Pembangunan pertanian: pemasungan kebebasan petani, *Antropologi Indonesia* 23(59):66-79.

Winarto, Y.T., E.M. Choesin, Fadli, A.S.H. Ningsih, and S. Darmono.
2000 Satu dasa warsa pengendalian hama terpadu: berjuang menggapai kemandirian dan kesejahteraan. Research report submitted to the Indonesian FAO Inter Country Program. Jakarta.

Winarto, Y.T.
1996 Seeds of knowledge: the consequences of IPM schooling on a rice farming community in West Java. Unpublished Ph.D. thesis. Canberra: The Australian National University.
1997 Maintaining seed diversity during the green revolution era. *Knowledge and Development Monitor* 5(4):3-6.
1999 Pendekatan prosesual: menjawab tantangan dalam mengkaji dinamika budaya, *Antropologi Indonesia* 23(60):25-35.

Forthcoming The nation and the niche. In M.Dove and P.C. Sajise (eds) *Institutional context for biodiversity in Southeast Asia.*

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MANAGING PADDY AND SOYBEAN VARIETIES IN JAVA AND LAMPUNG: THE CASES OF IPM FARMERS' CREATIVITY

Yunita T. Winarto
(University of Indonesia)

ABSTRACT

Farmers are creative, and continuously modifying and accumulating knowledge. Their recent experience improved their knowledge repertoire, learned from the individual experience, and the local history of crop farming. On the basis of the new understanding and belief, farmers will find the most promising and sustainable strategies in crop farming, e.g. planting and producing the more sustainable crop varieties. The farmers' considerations include the strategies of not only obtaining high productivity, but also yield sustainability, in particular, after experiencing continuous pest and disease infestations during the Green Revolution era. After learning from the IPM program introduced to the farmers in some provinces in Indonesia in the early 1990s, their recent understanding of avoiding pest and disease improved.

The paper will describe the cases of farmers on the north coast of West Java and Central Lampung in managing crop biodiversity in paddy and soybean farming. On the north coast of West Java, the farmers were continuously practicing to plant new rice strands, with the results of diverse rice varieties planted in each season, despite the 'recommended uniform' strategy of rice farming by the government. In Central Lampung, after experiencing repetitive failures in planting soybean, in particular after the introduction of a 'soybean crash program' by the government a decade ago, the farmers were able to improve and develop the various strands of soybean varieties in order to produce the 'free-pesticide-soybean' crops in a sustainable manner. The examination will take into account: farmers' learning experience in planting rice and soybean, and the ways they evaluate and improve knowledge and practices.

DIVERSITY, SIMPLICITY, AND THE OPTIMISATION OF AGROBIODIVERSITY: INTRODUCTORY PAPER

David Wood and Jillian Lenné

“There are nine and sixty ways of constructing tribal lays,
And—every—single—one—of—them—is—right!”
Rudyard Kipling “In the Neolithic Age”

The most critical issue facing humanity is maintaining the productive base of our environment, which is under ever-increasing pressure. It has been stated that the need for diversity is universally accepted. This paper will survey (necessarily briefly):

- The quantification of biodiversity at genetic, species, and ecosystems levels (and the relation between diversity and complexity).
- What is ‘agrobiodiversity’?
- How is agrobiodiversity distributed within and between agroecosystems?

Emphasis will then be given to:

- The range of ideas on the roles of diversity in natural systems.
- Past attempts to apply natural ecosystem models to agriculture.
- Recent approaches to ‘Nature’s Fields’ (monodominant stands of cereal relatives).
- Synergies or possible conflicts between ‘ecological’ and ‘socio-economic’ reasons for diversity in agroecosystems.

The problems of generalizing the role of diversity will be illustrated by looking at:

- The role of scale:– the garden, the field, the landscape.
- Optimisation of agrobiodiversity at a time of changing and uncertain ecological principles.
- The place of wider biodiversity in agroecosystems: need there be trade-offs between conservation and utilization?

Finally, the relation between farmers’ choice and global needs in a changing setting:

- Is it possible to apply ecological principles to recommend a single general framework for the management of agrobiodiversity?
- If not, can location-specific information and traditional knowledge contribute to a flexible range of management and production options (the Kipling option)?

CULTIVATING BIODIVERSITY FOR DISEASE CONTROL, A CASE STUDY IN CHINA

Zhu Youyong
Yunnan Agricultural University, Kunming, China

The plant diversity usually suppresses disease epidemics although the ecological mechanisms are not fully known. This ecological principle is manifested in biodiversity-rich cropping practices that reduce crop diseases in many subsistence-farming systems. Modern approaches to disease control are not suitable to these farming systems. Pesticides are often costly to use. New biological technologies have only developed few disease-resistant varieties of commercial value. Many landrace varieties preferred by subsistence farmers remain susceptible to disease epidemics when farmers try to enlarge their areas for markets. As a result, these landrace varieties are often marginalized and replaced when farmers apt to plant more and more a few of commercial disease-resistant varieties. This trend threatens to survival of landrace diversity and associated cultural diversity. It is therefore urgent to find an affordable approach to disease control for landrace varieties.

Rice blast disease has been a serious problem for cultivation of glutinous rice (32% losses) and upland rice (20 –50% losses) in Yunnan, China. Both of them include many traditional landrace varieties. Various inter-plantations of glutinous rice and generally resistant hybrid indica rice were experimented and demonstrated in a large scale to assess its effectiveness of the blast disease control from 1998 to 2000. The results are very encouraging. The inter-plantation approach is simple, effective and economically viable. Farmers in Yunnan and other provinces in China are rapidly adopting the approach. Some farmers have successfully modified the recommended design of inter-plantation to suit specific needs. The mixture approach is helping revive many aromatic rice varieties, which would be very susceptible to diseases if planted in monoculture. They now suffer less disease in mixed plantations and can be produced in a larger scale for commercial markets. Our case demonstrates that proper diversification with traditional or modern crop varieties can be an economically viable option for farmers who want to expand production, and can not afford to use commercial disease - resistant varieties and pesticides for disease control. The diversified plantation also supports maintenance of farmers' landraces. The work is underway to study ecological mechanisms of disease control, and to test viable mixtures of different crop varieties or species for control of specialist and generalist pests.

IN SITU MANAGEMENT OF PLANT GENETIC RESOURCES: EVOLUTION OF PHENOTYPIC DIVERSITY OF AN INTERSPECIFIC CROSS OF MILLET (*PENNISETUM GLAUCUM* L BR) AFTER TWO SUCCESSIVE CYCLES OF CROSS POLLINATION.

ZANGRE G. Roger[1] and OUEDRAOGO Mahamadi[2]

1 Millet Breeder INERA/CREAF - Kamboinsé - Burkina Faso
2 Agronomist INERA/CREAF - Kamboinsé - Burkina Faso

Key words: interspecific crossing, *in situ* conservation, phenotypic diversity, gene flow, introgression, cultivated phenotype, intermediate phenotype, wild phenotype, Burkina Faso.

ABSTRACT

The present study is a demonstration of the value of wild forms of millet in the *in situ* conservation of plant genetic resources. Initially a broad genetic base population was created by crossing diallele F1 hybrids of cultivated millet from Burkina Faso and four wild relatives of millet (*Pennisetum violaceum*) from Burkina Faso, Mauritania, Nigeria and Senegal. The resulting population then underwent two successive cycles of cross-pollination in 1997 and 1998 according to the Irish Method in order to maximize the introgression of wild genes into the cultivated millet genome. Each cycle of cross-pollination comprised approximately 1 500 plants from which a sample of 250 female plants of the cultivated phenotype were retained for the following cross-pollination cycle.

Eleven morphological variables were observed on the sampled plants, including 3 qualitative characters related to domestication. The data analysis made it possible to account for the levels of variability of the F2 and F3 populations in cultivated, wild and intermediate phenotypes. This work is in fact a simulation of what one observes in nature between the wild and the cultivated forms of millet in Burkina Faso which evolve/move sympatrically in certain cropping systems in Burkina Faso

We are certain that the intermediate forms of millet that are common in farmers fields across Burkina Faso are crosses between the cultivated millet and the wild form *Pennisetum glaucum* L Br. The presence of intermediate forms in cultivated fields or close by is tolerated or in some cases favoured by farmers. They have several uses and are particularly preferred as ceremonial foods at weddings in certain zones.

The non-elimination of the intermediate forms by farmers is a form of management of variability, which differs from the modern method of pure line selection. This management, which can be conscious or unconscious, makes it possible to maintain gene flow between the intermediate and cultivated forms and is a source of allelic richness to the cultivated populations.