Importance of agrobiodiversity and options for promoting its on-farm conservation and sustainable use: Case of West Asia dryland agrobiodiversity project

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Abstract

West Asia encompasses the mega-center of diversity of species of global importance (wheat, barley, lentil, and many forage legume and fruit tree species) whose conservation will contribute to sustaining agriculture and food security worldwide. The landraces and wild relatives of these species form the basis of the traditional farming systems and contribute significantly to the livelihoods of local communities in the drylands and mountainous ecosystems in the countries in North Africa and West Asia. The GEF-funded project on conservation and sustainable use of dryland agrobiodiversity has developed a holistic approach to promote the conservation of the landraces and wild relatives of the species originating from Jordan, Lebanon, the Palestinian Authority and Syria. The socio-economic and farming systems surveys showed that agriculture contributes to approximately 50% of the household income and that the landraces of barley, wheat, lentil, chickpea, olive, fig, are still widely used and contribute along with livestock to the livelihoods of local communities in the target areas. The technological, institutional and policy options are developed and tested within the project, which can contribute to the improvement of the livelihoods of local communities while conserving and sustaining the natural resource base and local agrobiodiversity. This contribution presents the relationship between local agrobiodiversity and the livelihoods of local communities and the examples of technologies, add-value and alternative sources of income to improve and diversify the incomes of the main custodians of agrobiodiversity.

Introduction

Agrobiodiversity occupies a unique place within the biological diversity as it relates directly to food security and agricultural development. According to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the Convention on Biological Diversity (CBD, 2000 a), agricultural biodiversity encompasses a variety of animals, plants and micro-organisms, at genetric, species and ecosystem levels, necessary to sustain key functions of the agro-system, its structure, and processes for, and in support of, food production and security. Agrobiodiversity is actively managed by farmers and therefore the inherited indigenous local knowledge is an integral part of the agrobiodiversity conservation.

The importance of dryland agrobiodiversity has been emphasized in particular by the CBD (2000) as it relates to livelihoods of poor rural communities and to the crops and livestock of global significance. It holds genes for adaptation to harsh conditions and to climate change and provides important ecological services including obligatory rest habitats for migrating birds and animals. Over one billion people, or one-sixth of the world population, live in the drylands and their livelihoods are supported and maintained mainly by agricultural activities relying mostly on local agrobiodiversity. Therefore, drylands-agrobiodiversity deserves special attention at national, regional and international levels. The SBSTTA of the CBD recommended to the Conference of Parties to establish a program on dryland biodiversity including grassland, savannah, and Mediterranean lands.

West Asia region encompasses one of the three mega-centers of diversity and combines the

centers of origin and domestication of crops of global significance such as wheat, barley, lentil, forage legumes, and several fruit trees (Hawkes, 1983; Harlan, 1992). Landraces and wild relative species of these crops are still found in the traditional farming systems and remaining natural habitats mainly prevailing in drylands and mountainous regions. But, because of acute demographic pressure, inappropriate policies and limited research efforts, this local agrobiodiversity is increasingly threatened by recurrent droughts and climate change and by anthropogenic factors resulting in over-exploitation and miss-management mainly through over-grazing, deforestation and destruction of natural habitats for urbanization and agricultural expansion purposes. The use of improved varieties and the introduction of new crops have decreased the area under landraces even in non-optimal environments.

The livelihoods of local communities and the food security and agricultural development worldwide will depend on the conservation and availability of these valuable genetic resources. The CBD (1992, 2000b) and the Global Plan of Action (FAO, 1996) have stressed the need for applying complementary *ex situ* and *in situ* /on-farm conservation methodologies (Maxted et al., 1997). Over the past three decades, there is a greatly increased recognition of the importance of embedding conservation in a wider social and economic framework with a strong need for policy reforms to empower the custodians of local agrobiodiversity. *In situ* /on-farm conservation approach is becoming increasingly important in the conservation of plant genetic resources and the Global Environment Facility (GEF) has funded some projects aiming at promoting the *in situ*/on-farm conservation of agrobiodiversity. Two projects have contributed significantly to strengthening the scientific basis of agrobiodiversity in the North Africa and West Asia region (Jarvis et al., 2000), the date palm on-farm conservation (Noureddine, 2005) and the West Asia Dryland Agrobiodiversity (Mazid et al., 2007). The West Asia Dryland Agrobiodiversity project has worked to develop a holistic approach to promote community-driven actions for conservation and sustainable use of local agrobiodiversity. All these projects recommend the full involvement and empowerment of local communities for the success of conservation of agrobiodiversity.

This contribution provides information on the status and threats to on-farm agrobiodiversity in the dry areas of West Asia and the needed technological, institutional and policy options for empowering local communities to conserve and sustain the use of local agrobiodiversity.

Methodology

During the period of 1999-2005, the International Center for Agricultural Research in the Dry Areas (ICARDA) coordinated a GEF-funded regional project, "Conservation and sustainable use of dryland agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria," to promote community-based *in situ* conservation of landraces and wild relatives of species of global importance originating from the Fertile Crescent (barley, wheat, lentil, alliums, vetch, medics, grasspea, trifolium, figs, olives, almonds, pistachio, pears, prunes, apricots, etc.). The project field activities were conducted in 26 villages and 73 monitoring areas selected within the target region (Ajloun and Muwaqar in Jordan, Aarsal and Baalbeck in Lebanon, Jenin and Hebron in Palestine, and Al-Haffeh and Sweida in Syria) covering diverse ecosystems from semi-arid to high elevation and high rainfall areas and representing different farming systems in the West Asia and North Africa (WANA) region. The activities were implemented at the national level by the national research institutions (the National Center for Agricultural Research and Technology Transfer, NCARTT in Jordan; the Lebanese Agricultural Research Institute, LARI in Lebanon; the General Council for Scientific Agricultural Research, GCSAR in Syria) and by the Ministry of Agriculture and UNDP- Programme of Assistance to Palestinian People in Palestine. Technical backstopping was provided by ICARDA, IPGRI and ACSAD and several international experts contracted by the project. Specific thematic groups were established to ensure the standardization of the methodologies and approaches and the harmonization of the implementation of the activities. A socio-economic and policy thematic group was also included. The major pillars of the approach and the main outputs sought in the project were:

- Better knowledge of the status and the trends of local agrobiodiversity and major threats to it;

- Development and transfer of appropriate technologies and alternative uses of land covered in the project;
- Investigation and demonstration of add-value technologies and alternative sources of income for the people using local biodiversity;
- Development of enabling policy and legislation reforms;
- Capacity building and awareness increase about sustainable use and conservation of dryland agrobiodiversity among major stakeholders;
- Enhancing regional networking, integration and collaboration; and
- Monitoring of the progress and assessment of impacts.

Farming systems surveys were conducted in 2000 as baseline study and in 2004 for assessing the trends in landraces use and appreciation and in assessing the preliminary impacts of the projects on the livelihoods of the custodians of agrobiodiversity. Around seventy households were individually surveyed per target area during each period and their assets were assessed using the livelihood-analysis approach along with the household structure and income source, cropping systems and cultural practices, changes in land use, landrace used, seed and seedling use and exchange, and gender role in conserving agrobiodiversity. In the 2004 survey, farmers who collaborated with the project and those who did not participate in any project activities were surveyed to assess the impacts of the project interventions.

The status of agrobiodiversity was analyzed through the diversity of farming systems (type of enterprises), the average number of crops and the average crops per field, the number of varieties including landraces used for each crop, and the seed and seedling sources. Farmers were also asked about the differences in productivity and attributes between improved varieties and landraces and about the future of various crops in their farm. The sources of household income were also determined through the questionnaire. Participatory rural appraisals were conducted with groups of farmers in each target area (32-45 farmers) to assess the total number of landraces known for each crop and the major threats facing local agrobiodiversity.

The project launched several activities for improving the income of local farmers and provided the needed training and technical backstopping.

Results and discussion

Assessment of status and threats of local agrobiodiversity

The predominant farming system depends mostly on the environmental conditions, mainly the topography and the climatic conditions (Table 1). In the rangeland-dominated area, such as Muwaqqar, Jordan, and Aarsal in Lebanon, livestock is the only activity for 77% and 53% of local communities, respectively. In these two sites, the remaining farmers plant barley mainly and olive tree under irrigation in Muwaqqar and vetch and cherries in Aarsal. In the mountains of Ajloun in Jordan and Al-Haffeh in Syria, 66% and 80% of farmers, respectively, are growing mainly fruit trees and 20% are practicing both crop production and livestock raising. In Al-Haffeh, none of the farmers has small ruminants and in Ajloun farmers are mainly raising goats in semi-intensified system. In the remaining target areas, the farmers are split between crop producers and crop-livestock producers and 1-8% are exclusive herders. These results show the great diversity of the farming systems with the importance of livestock in drier and flatter areas and of the fruit trees in the mountainous areas. In Palestine the number of herders is lower, which might be due to the restricted access to rangelands because of the conflict there. The crop-livestock system is an important attribute of farming systems in arid and semi-arid areas and it contributes to the buffering of the effects of drought with livestock playing an important role in the providing cash to farmers.

Table 1. Types of predominant farming systems in the target areas in the four countries (2004 survey)

Type of enterprise	Jordan		Lebanon		Palestine		Syria	
	Muwaqqar	Ajloun	Aarsal	Baalbak	Hebron	Jenin	Sweida	Al-Haffeh
Crops only	10	66	24	58	44	42	54	80
Livestock only	77	14	53	8	2	1	2	0
Crops and livestock	13	20	18	32	54	57	44	20

The second indicator of local agrobiodiversity is shown by the number of crops used at the farm level. As shown in Table 2, the average number of crops grown in the farm ranged from 2.3 to 4.9 showing that farmers in all agro-climatic zones tend to grow more than two crops, but the highest number is in mountainous and high rainfall areas. In the latter systems, several crop species are grown in the same field as indicated by the crop diversity index.

In Ajloun and Al-Haffeh, some farmers plant up to fifteen crops in their fields with mainly fruit trees in top layer and field crops in the lower layer. Some farmers are even planting medicinal and vegetables under the fruit trees. Among the predominant fruit trees are olive, apple, grapes, cherries and figs in Ajloun, Sweida, and Al-Haffeh and among the field crops are barely, wheat, lentil, chickpea and vetch. This diversity of crops contributes to the diversification of the diet of local communities, the feed calendar for their animals, and the sources of their income. It also allows for the spread of labor needs over the whole year.

The third indicator of agrobiodiversity investigated is the number of landraces known or still in use by farmers. For fruit trees, large numbers of landraces were cited by the farmers: more than 10 landraces of olive, 20 of grapes, 15 of figs, 5 of cherries, 2 of almonds, 3 of apples, 3 of apricots and four of plums. The improved varieties are mainly used in case of apple, cherry and apricot. Barley, lentil and chickpea varieties planted are exclusively landraces, commonly designated as *baladi* (local), which might have several populations.

Table 3 shows the number of landraces known to the farmers and those actually used by them. The relatively lower number of landraces used by farmers as against the numbers known to them shows that some landraces have decreased in importance or disappeared in the target areas.

Farmers are now using mainly improved varieties in case of apple, cherries and apricot. In case of wheat in Palestine, although large number of landraces are used, farmers are importing seed of improved varieties. In other countries, the spread and adoption of improved varieties is limited because the farmers recognize the good adaptation of their landraces to the predominant harsh conditions and their crop-quality traits that meet their requirements (Table 4). In case of olive, the improved varieties in Jordan and Syria are ecotypes selected from landraces. Some farmers have even grafted landraces on the improved varieties after realizing the weakness of latter.
The farmers appreciate landraces of most crops for their adaptation to low-input conditions and to major biotic and abiotic stresses. In addition, these landraces have good quality attributes which allow the products to fetch a price premium in the market.

The fourth indicator of agrobiodiversity is related to the genetic diversity within the landraces, which can be revealed by genetic studies using morphological and DNA markers techniques. Landraces of field crops are formed of multilines giving them population buffering against the change in environments and seasonal conditions. This type of diversity is important for breeding programs along with the number of landraces. Farmers in the mountain-

Table 2. Average number of fields and crops per farm and crop diversity index in target areas in the four countries (2004 survey)

Item	Jordan		Lebanon		Palestine		Syria	
	Muw-aqqar	Ajloun	Aarsal	Baalbak	Hebron	Jenin	Sweida	Al-Haffeh
Number of fields/farm	2.25	2.45	3.59	4.23	5.00	4.72	4.91	2.58
Number of crops/farm	2.25	3.86	4.43	4.18	4.84	4.47	4.69	2.89
Crop diversity index	1.00	1.58	1.23	0.99	0.97	0.95	0.96	1.12

Table 3. Number of wheat landraces cited by farmers and the number of landraces and improved varieties used by them

Item	Jordan		Lebanon		Palestine		Syria	
	Muw-aqqar	Ajloun	Aarsal	Baalbak	Hebron	Jenin	Sweida	Al-Haffeh
Landraces cited	2	6	2	2	7	7	11	5
Landraces used	2	4	1	1	5	5	8	3
Improved varieties	1	2	1	1	2	2	3	1

ous areas tend to leave wild relatives of crops on the edges of their field for protection or for use as rootstocks when needed. In case of wheat and barley, some natural introgression between cultivated and wild species are observed.

Table 4. Percent of total area grown to landraces of various crops in the targets areas (2000 survey)

Crops	Jordan	Lebanon	Syria	Palestine
Barley	100	100	100	100
Wheat	95	100	95	30
Lentil	100	100	100	100
Olive	90	90	95	100
Almond	50	90	50	100
Fig	95	100	100	100
Apple	5	1	1	0
Pear	50	-	50	0
Grape	80	100	100	80
Cherries	10	30	10	-

As seen in Table 4 and confirmed by the participatory rural appraisal results, landraces of barley, lentil, fig and grape are not threatened by replacement with improved varieties in all the target areas, although these landraces are replaced by improved varieties when the growing conditions are improved and when intensification is possible. For wheat, landraces are still used in the target areas of Jordan, Syria and Lebanon, but in Palestine, the imported improved varieties are predominating due to non availability of good seeds of the landraces. For pears, apricots and almonds, the area is equally split between improved varieties and landraces. For cherries, farmers are mainly using improved varieties in the new plantations. In case of apples, area of landraces such as Sukkari and Khashabi is reduced significantly and does not represent more than 5%.

Most of the target areas have witnessed an expansion of the plantation of fruit trees, olives in Jordan, Syria and Palestine, cherries in Lebanon and Syria, and apples in Syria. This expansion is occurring at the expense of the area under the landraces of such field crops as barley, wheat and chickpea or it is occurring in lands newly reclaimed from forest and rangeland natural habitats. Farmers have also acknowledged the disappearance of some landraces of all crops and have attributed this to limited efforts to multiply their seeds within the existing informal seed production system and fruit tree nurseries. Marketing problems and storability could also have contributed to the decrease in importance of landraces.

Another major threat to local agrobiodiversity is related to loss of local knowledge due to limited interest of young generations to invest and work in agriculture.

Contribution of alternative sources to total household income

Farming households in the target areas had many activities to meet their livelihood needs. They had diverse sources of income, and there were also variations in the amount and percentage of income from different sources among the four countries (Table 5). Income from on-farm activities, including return from crops and fruit trees, livestock products, and live animals, represented less than half of the total household income in the four countries. Government employment income was important in Jordan (48%) and Syria (20%), while off-farm income (from non-agricultural activities) was important in Lebanon (34%) and Palestine (26%). Livestock is the main source of on-farm

Table 5. Contribution of alternative sources to total household income (%)

Income source	Jordan	Lebanon	Palestine	Syria
Crops & fruit trees	16	28	27	34
Livestock products	15	6	6	5
Live animals	11	7	16	4
Total on-farm income	42	41	49	43
Off-farm (Agriculture)	3	3	3	1
Off-farm (Non-agriculture)	4	34	26	6
Government employment	48	10	15	20
Remittances (Outside country)	3	1	0	4
Other sources	0	12	10	26
Total off-farm income	58	59	51	57
Average household income (US$)	6896	7120	8905	2919

income in Jordan, whereas plant production (crops and fruit trees) is the major source of on-farm income in Lebanon, Palestine, and Syria.

Contribution of alternative income sources to the total household income was diverse according to the target areas in each country. In Jordan, income from government employment was significant at Muwaqqar followed by income from livestock, while at Ajloun income from crops and fruit trees was important. In Lebanon, household income from off-farm activities outside agriculture was the main source at Aarsal (mainly from quarries) and income from crops and fruit trees was the major source at Nabha. However, there were many factors that influenced the contribution of alternative sources to total household income such as farm resource availability, farmers' education, skills and experiences, and opportunities for off-farm activities.

These results showed the importance of local agrobiodiversity in the livelihoods of local communities in the remaining biodiversity rich areas. However, agriculture covered only partially the needs of local communities and most farmers had to rely on off-farm resources for securing their livelihoods. These included remittances from government employment as in case of Jordan, quarries and other non-agricultural jobs in case of Aarsal in Lebanon and Hebron in Palestine. It appears that the on-farm conservation and sustainable use of local agrobiodiversity can not be effective without improvement and diversification of incomes of the custodians of the agrobiodiversity. This diversification of income is ensured by off-farm activities. But, options for further improvement and diversification of incomes need to be investigated within any strategy for promoting the on-farm conservation of local agrobiodiversity.

Investigation of new opportunities for alternative sources of income

The future role of agricultural activities in the livelihoods of rural communities will depend on developing new technological packages to enhance agricultural productivity while sustaining the natural resource base, adding value to the products. In addition, there will be need to identify alternative sources of income in addition to the implementation of development projects to ensure rural development and better livelihoods of rural communities. The Dryland Agrobiodiversity Project initiated many business-oriented activities targeting mainly women. These activities included food processing using the products of local agrobiodiversity such as the production of jams, compotes, syrups using produce of fruit trees, and making high quality burghul and freikeh from durum wheat. The project introduced to the local market for the first time the jams and compotes made by the participating farm households from the wild relatives of fruit trees (wild plum) and of many neglected species (*Zizyphus* spp., *Arbutus* spp., *etc.*). These products are actually marketed by women cooperatives in Jordan, Lebanon and Syria. The women were also trained in home gardening to produce vegetables, herbs and medicinal plants, and to specialize in nursery management and multiplication of landraces of fruit trees. Training and technical backstopping were provided to women in the local communities on several activities allowing the diversification of incomes. Among these activities were bee keeping for honey production, making dairy products, mushroom production, soap production, etc. These initiatives allowed groups or individual farmers to improve their income and livelihoods. In Lebanon, eco-tourism was introduced in remote villages of Ham and Maaraboun, which was sustained by private eco-tour companies.

Conclusion

Agriculture and agrobiodiversity in arid and mountainous regions continue to play a key role in the livelihoods of poor communities there. The conservation and sustainable use of this agrobiodiversity will require a holistic approach allowing the empowerment of the custodians of agrobiodiversity, the investigation of add-value and alternative sources of income and the implementation of rural development projects.

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