

Assessment and Management of Rice, Taro and Tropical Fruit Trees in Contrasting Agro-ecosystems in Vietnam[†]

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ABSTRACT : Understanding farmer household and community management of crop diversity is necessary in order to effectively strengthen the local plant genetic resources management system in Vietnam. Assessment and management for distribution of farmer's cultivars of rice, taro and tropical tree species were conducted in four different agro-ecological zones in Vietnam using participatory approaches, focus surveys, diversity fairs, agro-morphological field trials, isozyme analysis to understand why Vietnamese farmers grow diverse types of these crop cultivars, when and where these crops cultivars are grown and how farmers maintain and use them. Results showed significant differences in the extent, distribution and use pattern crop cultivars diversity in contrasting environments and between community farmer households. Seed system is an important role in the access and use of diversity in eco-geographical regions.

Key words : Agro-biodiversity, Agro-ecosystem, Genetic diversity, Rice (*O. sativa*), Taro (*Colocasia esculenta*)

INTRODUCTION

Vietnam is one of the countries well endowed with plant genetic resources in general and rice, taro and TFT in particular. The data available show that Vietnamese territory is one of the centers of origin of rice, taro and many species of TFT. In the country there are programs for rice and TFT improvement aiming at answering requirements of local consumption and export. Such programs need very rich source of initial material for various options. On the other hand, the developing market economy, the cropping patterns are changing, local varieties are being replaced, have been causing serious threat of genetic erosion and extinction of traditional varieties so a complementary strategy of conserving them have become more urgent now more than ever before.

As any developing country, Vietnam needs firstly to develop the ex situ conservation to safely conserve our important and valuable eroding plant genetic resources. Parallel to the ex situ we have also developed the *in situ* conservation in a strategy of safeguarding the PGR for food and agriculture in both aspects, interspecies and intraspecies. That means we have to strengthen both formal and local PGR systems. However, how to carry out *in situ* conservation of crop genetic resources is still a quite new approach which

demands vast studies on both socio-economical and biological fields of science.

At the same time, to develop practices and systems for sustaining *in situ* managed biodiversity, IPGRI has developed two global projects as "Strengthening the scientific basis of *in situ* conservation of agrobiodiversity" and "Contribution of Home gardens to PGR conservation". Vietnam is one of countries involved in these projects. Assessment and management for distribution of farmer's cultivars of rice, taro and tropical tree species were conducted in four different agro-ecological zones in Vietnam to understand why Vietnamese farmers grow diverse types of these crop cultivars, when and where these crops cultivars are grown and how farmers maintain and use them. This report presents the results of study during 1999-2002.

MATERIALS AND METHODS

Participatory Rural Appraisal tools were used to collect the data for site selections and to study the amount and distribution of crop diversity and to understand farmers perceived use value. Focus surveys were carried out in the villages of four districts to gather the list of farmer-named crop diversity and basic socio-economic characteristics of crop growers. Diversity fair has been used as an

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entry point for on-farm conservation program in Vietnam (Trinh *et al.*, 1999). The event was used to demonstrate the farmers' planting materials of crops. The diversity block, *in situ* characterization and isozyme analysis were conducted for measuring, characterizing and assessing diversity. Descriptive statistical analyses were computed for each site and correlation matrix and analysis of varietal diversity indices using Shannon Weaver and Simpson index.

RESULTS AND DISCUSSION

The characterization of study sites

Vietnam has seven agroecosystems. It was planned to implement the *in situ* project in four of them. The criteria used in Vietnam are designed to capture the range of socio-economic, cultural and agro ecological variability within the country. Four sites in Nghia hung,

Nho quan, Da bac and Tracu districts were chosen which reflect variations in demography and ethnicity, access to market and environmental limitations (Table 1).

The amount and distribution of targeted crop variety diversity and use pattern

In Vietnam, the farmers can distinguish crop varieties and use local name to differentiate different rice and taro cultivars for their day-to-day management ease. Farmer-named cultivars used by farming community are the first indicator for the amount of diversity at a given location.

Choice of rice, taro and fruit trees cultivars by farmers and their extent and distribution is often guided by multi-uses of cultivars and farmer ecological circumstances. The farmers in all study sites still grow many local varieties of rice, taro and fruits especially in

Table 1. The characterization of study sites in Vietnam

Main Characterization	Sites			
	Nghiahung lowland (Red River Delta)	Nhoquan Highland	Dabac Mountain	Tracu lowland (Mekong River Delta)
Elevation (m)	1	100	600	1
Temperature (°C)				
- Annual average	28	27	23	32
- Maximum,	36	38	38	35
in month	Jul.	Jul.	Jul.	Apr.
- Minimum,	15	13	7	27
in month	Jan.	Jan.	Jan.	Jan.
Precipitation (mm)				
- Annual average	1550	1900	1900	1850
- Maximum,	350	390	450	415
in month	Aug.	Aug.	Aug.	Jul.
- Minimum,	18	20	10	0
in month	Nov.	Dec.	Jan.	Feb. - Mar.
Landraces diversity				
- Lowland rice	High	Intermediate	Intermediate	Intermediate
- Upland rice	0	Low	High	0
- Taro	Medium	Medium	High	Low
- Tropical fruit tree	Low	High	Low to medium	Medium to High
Extent of genetic erosion	Low-medium	Medium	Medium	High
Ethnic composition	Kinh	Muong, Kinh	Tay, Dao, Muong, Kinh	Kh'mer, Kinh
Livelihoods	Market oriented	Semi-commercial	Subsistence	Market oriented

mountainous sites where marginal environment is prominent. Under marginal environment the landraces become competitive than the modern varieties. The landraces are specific to certain agro-ecological zones. They have been conditioned to grow by farmers in different domains over time with continuous selection for adaptive traits. However, all households were not equally involved in cultivation and maintenance of landraces diversity within the village.

The study results show that there is a significant difference of extent, distribution and use pattern of targeted crop variety diversity in contrasting environments and between community farmer households. The highest number of rice cultivars was found in Tat village of Dabac mountain sites (n=27) followed by Cang village of Dabac (n=25) and Kienthanh village of Nghiahung lowland Red River delta site (n=18). The lowest number of rice cultivars was in Dong lac village.

Diversity indices across sites were computed for Shannon Weaver Index and Simpson Index to compare varietal richness of rice, the number of cultivars in a village level, and evenness, the frequency of farmers growing each cultivar at village level (Table 2). The results showed that rich cultivar diversity was found in Dabac site followed by Donglac village of Nghiahung district and Dai An village of Tracu site. Results of isozyme analysis of the rice varieties collected from contrasting sites also indicate that there is a genetic difference in farmer-named rice cultivars and Dabac has more rice diversity than other sites.

The dynamics of rice cultivated area are not stable, especially in lowlands. Comparing with the years 1999-2000, the level of modern varieties in rice production in all sites increasing in 2002. From four sites, in Tra cu, Nghia hung and Nho quan sites the traditional rice varieties are significantly decreasing. Reasons: the Government policy on changing swidden lands into forest farming in moun-

tainous sites; the introduction of modern rice from extension office; some rainfed upland varieties in Tat village are improved with good irrigation system.

In contrast with rice, up to now, all taro and almost fruits in use by Vietnamese farmers are local varieties or landraces that are adapted to field and home garden conditions in the different parts of the country. The research results show that the number of taro cultivars ranged from 4 in Dong lac village of Nghia hung to 10 in Tat village of Da bac site. Six villages were compared for taro genotypic Simpson diversity index (SI), in which evenness of cultivars was found highest in Dabac site (SI range from 0.789-0.811) followed by Quang mao and Yen minh village of Nho Quan (0.645-0.715). The variety dynamics situation at HHs level within the community was identified being stable. The variety structure is constant. Based on the category of cultivated area and number of variety cultivated household one or some cultivars of crop were grown in large area by many households which have high demand in market for quality traits defined as common cultivars at the location. Some others in diversity rich villages such as Tat, Cang and Quang Mao managed by few households in small plots. They are being maintained for specific use value and considered as rare types.

Use pattern

Study results indicate that during the long history of rice cultivation, local people in Vietnam have accumulated rich indigenous knowledge and experience in the use and management of rice resources. Different varieties of rice were grown for different purposes and under different maintenance regimes depending on the farmer making the selections (Table 3).

Various taro varieties are maintained by farmers based on their

Table 2. Richness and evenness of rice cultivars in different ecosites of Vietnam as measured by Shannon Weaver (SW) and Simpson indices (SI)

Geographic region	Macro site name	Village	Total rice cultivars	SWI	SI
Lowland	Nghiahung	Donglac	10	1.37	0.76
		Kienthanh	13	1.74	0.83
Midland	Nhoquan	Yenminh	18	1.58	0.66
		Quangmao	11	1.71	0.78
Mountain	Dabac	Cang	14	2.83	0.91
		Tat	25	3.24	0.94
Mekong Delta	Tracu	Dai An	27	0.75	3

Table 3. The upland rice diversity based on indigenous use in the mountainous site

No	Using	Variety
1	Food (rice, gleam)	Khau mon, Khau mac cai, Khau ca lan, Khau tram khao, khau tram nanh, Khau tram pom, tang san nieu, Khau cao su, ...
2	Gleam, sweet gleam, cakes	Khau khinh, Khau lao, Khau do, Khau mac cai, Khau hang mu...
3	Medicine	Khau cam pi
4	Using on traditional festivals	Khau tram hom, Khau khinh, Khau lech luong, Khau toi, Khau Lao...

preferred traits and use. Farmer preference for taro cultivars varies with local food culture (Hue, 2001). The corm of a common variety is used for food while the stem is fed to pigs; the stolon of another is chopped and boiled to make a medicine for constipation; yet another kind of taro produces a tasty new leaf and petiole which are stir-fried with garlic to make a special dish eaten on festival days. Varieties with particularly tasty corms can be grown on a large-scale for commercial production. Tropical fruit species play an important role in many areas such as source of supplemental food, nutritionally balanced diets, household incomes and national revenue. Moreover, some species are used for specific medicinal purpose, timber, fuel wood and livestock feed. For example, from 4 local mango varieties, the Thai group can prepare about 20 dishes (Table 4). The farmer in Nhoquan grows 6 varieties of banana for different uses.

Farmer management of crop diversity

1. Traditional practices

The farmer's knowledge and traditional practices are important resources for conservation and development. In the production process the farmers have selected and conserved appropriate landraces based on the specific topographic, soil fertile, utilization demand, preferences and culture custom. Although most farmers apply some criteria to describe and select seed for the next planting, the practices and level of specialization vary strongly between eco-sites in

Table 4. Diversity in use of Mango varieties at Yen Chau

No	Variety name	Local name	Use
1	Xoai tron`	Muong keo	- Eating mature fruit - The old leaves are used for tea-drink (Mango leaf drink) - Ripened mango with sticky rice
2	Xoai hoi	Muong khiu	- Eating mature fruit - Mango salad - Soup made from fish with immature mango
3	Xoai mut	Muong di	- Eating mango with rice (Mango rice) - Dried immature mango (for making sour soup) - Mango cake - Mango salad
4	Mac chai	Mac chai	- Eating mango with rice (Mango rice) - Dried immature mango (for making sour soup), - Mango cake, Mango salad - Soup made from fish and immature mango

the country.

In Dabac site, rice landraces with different growth duration were grown by Tay and Dao ethnic groups. There, upland rice diversity can be classified by crop duration: short, medium and long duration. The highest number of farmer named cultivars was found in the medium and early group than late maturing group. There are some varieties which have the same growth duration was grown mixture. Such variation on crop growth is good assets to manage diverse farming conditions. Farmers maintain large number of upland rice cultivars in traditional farming systems to suit varying soil fertility status of upland conditions.

In Nghiahung site: farmers choose local and special rice according market circumstances. The old farmers have their own traditional practice that keep high quality non-glutinous landrace Tam xoan with grain aroma such as nitrogen fertilizer should be deeply fertilized before transplant-ploughing; seed drying under medium sunlight, keep seed in clay-pot or plastic bags. The study also revealed that local aromatic rice yield is strongly related to quantity of organic fertilizer.

For taro management, based on the characters of different varieties, the planting materials may be cormels, head of corms; eyes of corms, seed, suckers and stolon with some sprouts. Taro planting material management is totally informal and 100 % of farmers saved these materials for their use, replacing them mostly after 3-5 years. Farmer has experience in choosing the seedling for planting purpose and they are sanitarians for corm or cormel before planting using of traditional methods. Local fruit trees are maintaining mainly in home garden. In each ecosite the farmer have TFT own traditional cultivation and propagation.

2. Seed supply system and farmer selection for genetic diversity of target crops

The study results indicate that seeds of rice and taro local varieties are maintained and kept by most of the farmer HHs in contrasting ecosites. The farmers select themselves seed of local varieties by 6 steps: field selection, culms selection, panicles selection after harvest, drying and cleaning, storages between two seasons, and grain selection before growing. In contract, due to high technical requirement of F1 seed selection and production, the hybrid variety seeds to farmers were supplied by state seed companies. Farmers selected improved varieties after buying headline varieties of national office. The self selected duration from 4-5 seasons after buying one from national offices. Thus in study sites, the farmers were not able to obtain their preferred cultivars for rice because the seed were not available through formal seed system. It is required more effort to conserve by improving local seed service or exchange.

For fruit trees almost local materials supplied to farmers by Fruit research Institute, the rest by exchanging and gift. The farmer seed network analysis shows that the seed flow networks in three sites Nhoquan, Nghia hung and Dabac are weak. The farmers in communities are not well connected. There are some smaller networks in Nho quan and Da bac. In Tra cu seed flow network is strengthened from 2000. Seed flows occur mainly through exchange and gift for upland rice and taro in mountainous sites. The 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 managing crop diversity on farm. Such farmers can be effectively involved in PVS, PPB and crop conservation at community level.

3. Gender role in crop diversity maintenance

There is a significant difference between ecosystems in the responsibilities and decision-making roles of men and women farmers in targeted crop production activities. The women in mountainous area are more important partners in producing food for household use than that in other ecosystems. In Dabac, the role of Tay women is very important on crop seed selection and maintenance. They completely respond on field selection, hill and panicle selection before harvest and prepared seed before sowing. Gender role depends on specific crops and tasks. Male role is more important in rice, fruit tree, while female plays more important role in upland crop and root crop including taro production (Table 5). The diversity of crop variety factor was affected by economic status at all villages. The medium households have tendency to maintain more crop and varietal diversity than rich and worse off ones. The rich group is rich in resource so they can invest in growing new crop to gain better economic results.

Table 5. Role of gender in decision-making on cultivation of crop species

No	Crop species group	Husband (%)	Wife (%)	Both (%)
1	Calorie-rich food crops	23	63	14
2	Cash crops	30	50	20
3	Fruit tree	67	30	3
4	Medicinal plants	29	62	9
5	Ornamental plants	76	15	9
6	Root and tubers	20	73	7
7	Spice plants	20	75	5
8	Vegetable crops	21	72	7

CONCLUSION

1. There are significant differences in the extent, distribution and use pattern crop cultivar diversity in contrasting agro ecosystems and between community farmer households. Choice of target crop varieties by farmers and their extent and distribution is often guided by multiuse of targeted crop varieties and farmer ecological circumstances. In each site the farmers own cultivated practices specified to their agro-ecological conditions. The change of cultivated area under a local variety might have some influence from government policy, farmers socio-economic status, land holding and land plot, kind of soil, culture, religious and farmer decision making to landraces conservation.
2. Seed system is an important role in the access and use of diversity. Seed flows occur mainly through exchange and gift for upland rice and taro in mountainous sites. Some farmers occupy positions in the communities and have network connect within and outside the community. These farmers play important role in the flow of genetic materials and management crop diversity on farm.
3. There is a significant difference between ecosystems in the responsibilities and decision-making for men and women farmers in target crops production activities. Men have a stronger role in the cultivation of rice and fruit tree, while women play more important to taro.
4. Vietnamese small farmers who have a wealth of experience in targeted crop conservation and utilization, can play *in situ* conservation of crop diversity because of their management and use of local crops population in a wide range of environments. Farmer and market preferences of crop cultivars for specific Vietnamese food culture have been contributing *in situ* conservation of large crop diversity.

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