PLANT GENETIC DIVERSITY IN FARMING SYSTEMS AND POVERTY ALLEVIATION IN VIETNAM'S NORTHERN MOUNTAIN REGION

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ABSTRACT

Farming systems in the Vietnam's NMR are known to be highly diverse in varieties and genetic resources. Every farming system and every ethnic group in the Northern Mountain Region (NMR) has its own collection of plant varieties, including rice and maize varieties, adapted to natural and socio-economic conditions in the region. Local varieties are highly adapted and have potentially high productivity. Some of them are high-yield varieties as good as new varieties.

In agricultural production, replacement of local varieties by advanced varieties without careful consideration may lead to the loss of valuable local genetic resources and reduce the systems' diversity. Ecologically, this can reduce the systems' stability (causing pest and disease outbreak, for instance) and raises the risks for the poor people.

The preservation and improvement of traditional varieties in combination with the selective importation of new varieties having high productivity and good quality, adapted to local conditions can provide a sustainable way to stabilize local food security. This also increases income and diminishes agricultural production risks for the uplanders, especially those communities that are strongly dependant on subsistence agriculture. At the same time, this solution also makes a significant contribution to environmental protection and biodiversity preservation.

Key words: *Bio-diversity, farming system, poverty alleviation, indigenous knowledge, Vietnam's Northern Mountain Region (NMR)*

INTRODUCTION

The concept of "Sustainable Development" is now being widely discussed throughout the world. Sustainable Development means not only improving human living standards but also conserving the vitality and diversity of life on Earth. This means that we need to simultaneously carry out development to support human life and maintain the diversity and productivity of nature. It is definitely a mistake to think that *Protection* and *Development* are in opposition to each other. Actually, they are two fundamental and inseparable parts of a single process. Some people think that this is nonsense. However, it's obviously possible, and we are increasingly coming to realize that it is the wisest choice.

Biodiversity is found at several levels: genetic diversity, species diversity, and ecosystem diversity. Recently, there has been growing awareness that bio-diversity and cultural diversity are closely connected to each other. Each culture has its own modes of farming, animal husbandry, hunting, and gathering. Hence, there are specific plant and animal varieties for each mode. When cultural diversity decreases, biodiversity will be degraded as a consequence (T.D.Vien, 2002).

If you have a chance to visit Sichuan (China) or the Washington National Zoo (USA), you will find visitors taking great pleasure in watching big pandas wander about and peacefully munch on bamboo leaves. It is heart-wrenching to hear that this species is in

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danger of extinction. Therefore, both the rich and the poor throughout the world help protect the pandas.In contrast, however, not many people show much concern that many species and varieties of food plants in the tropical forests and fields, the most important foundation for human survival and development, have been rapidly disappearing. Have you ever wondered how many species surrounding us are disappearing? How many species become extinct every single day? Many authors provide different figures for the exact number of species that are lost. But it is obviously true that since the mass extinction event at the end of the Cretaceous 65 million years, biodiversity on Earth has never been as threatened as it has become in recent years.

In agricultural production, replacement of local varieties by "improved" varieties without careful consideration may lead to the loss of valuable local genetic resources and reduce the diversity of farming systems. This will weaken the systems' stability (making them, for example, more vulnerable to pest and disease outbreaks) and will raise risks for poor people, drastically affecting the level of poverty. This is why we are especially concerned with conserving genetic resources and biodiversity in the Northern Mountain Region of Vietnam (NMR), along with the selective improvement of traditional varieties. We believe this to be an effective way to increase food productivity, raise incomes, and reduce risks for poor upland people.

PLANT VARIETY DIVERSITY IN FARMING SYSTEMS

Most of the farming systems in NMR show great diversity in species, varieties and genes. In search of a way to improve the productivity of the systems based on rainfed cropping (depending only on natural rainfall) and to ensure food security for the local people, a survey was carried out by our team on plant varieties in paddy fields and swiddens of 130 households in 5 communes in 5 different climatic subregions in Dien Bien District, Lai Chau province. The survey found 94 different species of crops. Of these, 8 are staple food crops, 35 are fruit-trees, and 22 are vegetables (see appendix 1). Many of these can be effectively used in the selection or the improvement of varieties, as well as in the creation of new varieties by cross-breeding. In this report, we will discuss only the genetic diversity of rice and maize, the two major food crops of the NMR's ethnic groups.

RICE GENETIC SOURCES

Traditional rice varieties are very diverse and abundant. We found 60 different rice varieties, of which 47 are swidden rice and 13 others are wet-rice.

These rice varieties are very diverse in morphology, yield, and quality. For instance, the height of rice varieties varies from 0.9 to 1.6 meters; stems have several different colors (pale green, brown, violet, dark green); and yields taken from the survey results vary from 100 kg/1000m^2 up to 400kg/1000m^2. The results of our collection of rice varieties are shown in tables 1 and 2.

Table 1. Distribution of rice varieties by locations

Location (Commune)	No. of varieties	Percentage of total collection
Muong pon	17	28.3
Muong Pang	12	20.0
Na Tau	13	21.7
Thanh Nua	6	10.0
Muong Noi	12	20.0
Total	60	100.0

Table 2. Distribution of rice varieties by ethnic groups

Ethnic group	No. of varieties	Percentage of total coolection
H' mong	21	35.0
Kho mu	14	25.3
Thai	13	21.7
Lao	12	20.0
Total	60	100.0

As shown in the above tables, plant varieties differ not only according to different ecological conditions but also according to customs and farming practices. The more remote the location of the group, the greater the number of traditional rice varieties they possess. This demonstrates people's marvelous ability to select and create plant varieties that are very well-adapted to cope with difficult natural conditions. These varieties are a priceless genetic resource for plant breeding. They may be applied to many other locations having similar conditions

We classified the rice varieties we collected by sub-species based on criteria given by the International Rice Research Institute (IRRI) (1996), combined with the classification method of Gutchin. The result is presented in table 3.

Table 3. Classification of rice varieties by sub-species

Group of varieties	No. of varieties		Percentage (%)
	Glutinous Rice	*Non-glutinous rice*	
Indica	33	21	90
Japonica	04	02	10
Total	37	23	100

Genetic research on the rice varieties gathered in 2002 indicates that the collected samples are very diverse in all natural and morphological characteristics (see appendix 2).

Non-glutinous rice: Of 60 collected rice samples, only 23 are non-glutinous. The rest are glutinous (glutinous) rice. The higher number of glutinous varieties reflects the custom of the NMR people in food consumption. Data on yield and data from factors that influence yield show that yield potential and net yield of non-glutinous rice varieties are extremely high. For example, varieties such as *Khau cham tan* and *Khau pan lon* provide yields of more than 5 tons per ha, and *Ple lu* and *Ple mong* have prospective yields of above 3 tons/ha (see appendix 2). The question is how to bring into play the yield potential of these varieties in difficult conditions of the mountainous regions where advanced and hybrid varieties have either not yet been applied or efforts to apply them broadly to strengthen food security for the local people are encountering great difficulties.

Glutinous rice: Rice variety samples have growth periods ranging from 123 to 147 days and most of them are not photoperiod sensitive , so they can be planted in 2 crops. All have relatively tall plant heights (83.2-141.0 cm), and show little potential for intensification. This is a characteristic of most local rice varieties.

Most of the samples in the group show little or no susceptibility to pests or diseases, except for a few varieties that suffer serious damage by stem borers. Most of the varieties in the group have a high disease-resistance.

Actual yields of some varieties in the group range from 1.22 to 5.34 tons/ha, of which 8 varieties have yields of more than 3.5 tons per ha, especially the highest yield sample of G40 (*Khau Lam*) of 5.34 tons per ha.

RESULTS OF COLLECTION AND CLASSIFICATION OF MAIZE VARIETY SAMPLES

More than 20 local maize varieties were collected from 5 different ethnic minority groups of 4 provinces: Lai Chau, Son La, Hoa Binh, and Cao Bang. The results are presented in table 4.

Table 4. Distribution of maize variety samples by ethnic groups

Ethnic group	No. of varieties	Percentage (%)
Thai	6	30.0
H' mong	6	30.0
Kho mu	5	25.0
Tay	1	5.0
Muong	2	10.0
Total	20	100.0

Color of several local maize varieties

The collected maize varieties were classified by botanic characteristics, based on classification systems of Koernicke (1985), Sturvant (1988), Kulesshov (1933), Zucovski (1950) and Glodcovski (1966). Table 5 displays the results of classification of local maize varieties.

Table 5. Classification of local maize varieties

Subspecies			**Variety**				
Name of subspecies	Freq.	%	Color		Name of variety	Freq.	%
			Grain	Ear maizecob			
Ngo da			White	White	*Var. alba* AL	1	5.0
Zea mays indurate Sturt	4	20	Reddish brown	White	*Var.Latericica* Kulesh Etkozuh	1	5.0
			Violet	White	*Var. violacea* Korn.	1	5.0
			Red	White	*Var. rubra* Bonaf	1	5.0
Ngo ban rang ngua	3	15	White	White	*Var. Leucodon* AL.	2	10.0
Zea mays semiindenrata Kulesh			White	Red	*Var.albrubra* Kom.	1	5.0
Ngo nep (Glutinous maize)	13	65	White	White	*Var.alboceratina* Kulesh	6	30.0
			Yellow	White			
Zea mays Ceratina Kulesh			Combined different colors	White	*Var. luteoceratiana* Kulesh	2	10.0
					Var.multicolor. Al	5	25.0
Total	20	100				20	100.0

The collected maize varieties vary in terms of growth period, agronomic characteristics, colors of stems and leaves, grain color, and quality (appendix 4). The 20 maize variety samples are divided into 3 subspecies: *ngo da* (*Zea mays indurata Stust*), including 4 varieties; *ngo ban rang ngua* (*Zea mays semiinderata Kulesh*), including 3 varieties; and white maize subspecies (*Rea mays ceratina Kulesh*), containing 13 varieties.

All of the local maize varieties grew well in the Spring 2002 in experimental plots at Gia Lam - Hanoi. Growth periods ranged from 105 to 118 days. In this group, 2 varieties have short growth durations, 14 have medium growth durations, and the other 4 varieties belong to the longer growth durations. Plant and ear heights of maize variety samples differ greatly. The plant heights are from 137.7 cm (*Nep trang Na xac*) to 250.5 cm (*Sly eo*). The ear heights are from 47 cm (*Nep trang Na xac*) to 140 cm (*Sly eo*). All of the varieties are relatively disease-resistant cultivars.

Yield of traditional maize varieties within the group have great variation, from 34.4 to 105.4 g per plant. In other words, yields can be reached from 1.2 tons up to more than 6.0 tons of grain/ha^{-1}crop^{-1}, depending on planting density, soil fertility, water sources and level of investment.

In summary, indigenous varieties of food crops (rice and maize) are very diversified and abundant from different provinces in the NMR. Besides their advantages of high quality, high resistance to pests and disease, and superior adaptation to difficult natural conditions in various localities, many of them give yields as high as those of the new varieties. Therefore, research on food crop varieties, and the conservation, classification, assessment and reinvigoration of local varieties to help in-situ cultivation instead of replacement by new varieties must be given high priority in research. This should be done not only because of the valuable contribution it would make to conserving bio-diversity and to maintaining genetic resources for variety selection and creation, especially for those areas in the NMR that rely only upon rainfall, but because it can also make an important contribution to alleviating poverty and minimizing risk for poor ethnic minority groups, particularly for those heavily dependent on subsistence agricultural production.

THE REDUCTION OF BIO-DIVERSITY IN FARMING SYSTEMS

Anyone can give many examples of the decline in biodiversity in the mountain agroecosystems. People give many different reasons in order to explain this fact. Perhaps one of the most important causes leading to the biodiversity losses is human population increase. In 1992, when researchers from the Center for Agricultural Research and Ecological Studies (Hanoi Agricultural University), Center for Natural Resource and Environmental Studies, National University of Hanoi, and the East-West Center in Honolulu, Hawaii, first visited a Tay ethnic minority hamlet of Da Bac district, Hoa Binh, the hamlet had just 42 households. At that time the local people used torches whenever they wanted to go out in the night, and they only saw a truck driven through the hamlet once every two or three days. At that time, the farmers planted around 22 varieties of swidden rice, almost all glutinous rice, and approximately 10 varieties of wet rice, including glutinous and non-glutinous rice. Ten years later, there are 104 households in the hamlet. There is now a bus stop in the hamlet, many households have motorbikes and TV, and they are connected to the National Electric Supply system that runs by the hamlet. Now the local people cultivate only about 5 or 6 varieties of swidden rice and 4 or 5 wet rice varieties. They have also stopped planting glutinous rice on wet-fields because of its low yield. In its place, many non-glutinous rice varieties that originated from China and IRRI are being used in the paddy fields. When we asked about what happened to those indigenous traditional breeds, not one of the local people could answer. And they were just as surprised as we were when we all realized that none of these varieties were stored on their kitchen trellices to serve as seed for future crops!

Another cause of decline in the biodiversity of crop varieties, especially for important food crops such as rice and maize, is the prevalent idea among agricultural scientists and extension specialists that all indigenous traditional varieties are low yielding ones. That's why most Agricultural Development Programs and Agricultural Extension Projects have focussed on introducing and diffusing new varieties with high yield capacity. In many places, local people have been given seed from these new varieties free of charge. Once, in Ha Giang, we saw H'mong people who were animatedly flocking to the People's Committee's House to get seed for a new maize breed, and along with each kilogram of maize they were also provided with 5 kilograms of N-P-K fertilizer free of charge from a governmental support program. No one can deny the great achievements of the Program to Eliminate Hunger and Reduce Poverty in promoting and diffusing new crop breeds in the mountain regions. But everyone also recognizes that advocacy of biodiversity conservation was either very weak or entirely absent from this program. New crop varieties have been gradually replacing the traditional ones. Hence, the level of biodiversity in the mountain agroecosystems has been progressively degraded and these systems have steadily become more and more like each other over time. This monotonousness can bring some risks that humans can't control. Beginning about 1600 the people of Ireland cultivated a few, or even a single potato cultivar as a food crop and absolutely depended on this resource. During the mid-19th century, however, potato crops, which were very homogeneous, were devastated by diseases and consequently, nearly 1 million people died of starvation.

In fact, as we described above, it is not always the case that local varieties have low yields. Also, some of the local varieties are of a higher quality than the new breeds, so they return a higher economic benefit. Muong Khuong Pig, Dong Van cow, Tu Le glutinous rice, Yen Minh non-glutinous rice, Van Yen cinnamon, Lang Son anise, Quan Ba persimmon, Muong Pon orange, etc. are very well known examples that cannot be denied.

DIFFERENT SHADES OF COLORS IN THE SAME PICTURE…

Throughout my lifetime of researching and learning about the upland agroecosystems, I have more than once asked myself, as well as my colleagues: Who really cares about biodiversity? Who actually benefits from the protection of biodiversity? On this occasion, I would like to tell you three stories. Each story tells a similar tale regarding how local people think about agro-biodiversity in their own fields. In todays world, scientists may also need to think about biodiversity from this point of view.

The 1st story. Many years ago, in Muong Thanh Valley, there was a very famous and delicious variety of orange, which was called Muong Pon. This orange became even more well known after the Dien Bien Phu Victory because of a song called " Be Van Dan forever" written by Huy Du (setting to music a poem by Trinh Duong). No one now knows why, but sometime in the early 1990s many people cut down Muong Pon orange trees and replaced them with longan and litchi trees. The area of orange trees was greatly reduced. When the people had not yet enjoyed their first harvest of longan and litchi, fruits that were valuable in the delta, they suddenly realized that 9 out of 10 visitors wanted to buy Muong Pon oranges. The economic returns from Muong Pon's oranges was much higher than longan and litchi. In the past few years both local people and the authorities have invested billions of VND to recover and multiply the valuable variety of orange in its place of origin. Also, in Dien Bien district, there was a very delicious non-glutinous rice that had been developed by the Hmong people (*ngo Meo*- Meo maize), but it was forgotten for a long time. The new high-yielding varieties are now planted everywhere in the district, accompanied by increased use of fertilizer and pesticides. Without these inputs, the yield of the new varieties is less than that of the older ones. Pest problems were interminable. One day, people recognized that while the new varieties had high productivity, the net economic returns from them less than from the

local varieties, because the old ones need only low investment but can be sold for a very high price. For instance, in Dien Bien town the price per 1 kilogram of local non-glutinous rice (*ngo Meo*) in 2001 was 8000 VND, while the price of IR64, which was well-liked by Hanoi people and was strongly recommended for development, was only 4000 VND and other varieties were only 2000 VND. One villager was happy to tell us that, fortunately, a few houses still kept Muong Pon orange and the H'mong rice variety. He said that he considered these local varieties to be especially valuable for poor people because they require only low investment but command high prices.

The second story: Vietnam has become the second largest rice exporting country in the world, but we still have some Vietnamese people who suffer from food shortages, especially people who live in remote areas where both natural and socio-economic conditions are difficult (such as steep and degraded land, rainfed agriculture dependent, low capacity to invest in intensive farming). But when these people get subsidies from the government, they are usually advised to replace their local varieties with new high-yield ones, which of course require more investment. Actually, local people are often quite often reluctant to adopt new varieties. There are many reasons for this, but one of them is that these new improved and hybrid varieties are not adapted to the natural and socio-economic conditions in many locations in Vietnam's NMR.

During a field trip to Ban Pa Sang (Thanh Nua commune, Dien Bien district), we shared the happiness of the local people and agricultural extension officers for their abundant harvest of the new maize variety HQ2000, which had a high protein content that was intended to improve the quality of daily meals for poor people. This new maize variety had a much higher yield than the old varieties and the storage bins of each household were filled with maize grain. Six months later, we returned to the hamlet on another fieldtrip. The local people sadly told us that the project for development of the new maize variety only helped them have high yield in the fields, but with this variety the harvest was lost in their houses. After several months the stored grain was severely damaged by Indian Meal Moth (*Plodia interpunctella*) and Grain Weevils (*Sitophilus zeamais*). No one would buy it, and it could not be used to make *men men.*[2] The local maize, however, was not so vulnerable to these insects. A H'mong woman said: "The new varieties are only for the rich people, they need the high yield to sell their maize immediately after harvest and to buy a Minsk motorcycle, while the poor households only need maize for *men men*, so we should keep using our own Hmong local varieties!"

The third story: Plant resource diversity in farming systems obviously brings many benefits to the local people. However, it seems that the poor people in the hamlets we have visited in many places throughout Vietnam's NMR do not pay much attention to bio-diversity conservation. In their way of thinking, the loss of local maize and/or rice varieties by replacement with new varieties is a natural process. When we tried to convince them to protect biodiversity for their own benefit and for that of their children, they looked at us with skeptical eyes. Actually, they urgently need food and clothing, and pay little attention to preserving indigenous varieties. In one small hamlet in a narrow valley in Da Bac district, the villagers told us that the loss of traditional varieties had no effect whatsoever upon them, even that their standard of living had started to improve when they began using the new varieties and applying the new technologies that they have learned from lowlanders. Thanks to the new

[2]"Men men" is maize flour, which is carefully prepared by lengthy steaming and then grinding of the kernels of maize. The dry maize flour is eaten together with vegetable soups or soybean sauce, or sometimes it is mixed into soup. The mixed soup, called "thang co", is prepared using animal bones, meat and intestines (see TDVien 2002).

varieties and improved technology, wet rice now produces two-thirds of their household's rice demand. Many households in the hamlet now eat rice three meals per day and they no longer have to eat a mixture of rice and cassava. Ten years ago, cassava was a food crop, but now it is a cash crop and used for fodder.

We told these people a story about Merck&Co., a company that spent millions of US dollars for research and biodiversity conservation at various places in the World. This company has successfully invented many kinds of medicine from natural resources and still seeks medicinal substances from grass, insects, and micro-organisms. Then, the farmers said, they would like to have a chance to meet the company's representatives in order to negotiate the prices of medicinal plants, which they said were still readily available in the forest surrounding the hamlet. If biodiversity conservation could bring benefits to them, the way the rice paddies and swidden fields do, they would protect these forests as well as they do their homestead gardens.

I keep thinking about the things that people in the villages have told me. This may be a great issue that needs to be discussed in this conference, or perhaps in some other forum.

CONCLUSIONS

Every farming system and each ethnic group has its own collection of plant varieties, including rice and maize varieties that are well-adapted to regional natural and socio-economic conditions. This biodiversity enhances agroecosystem sustainability under marginal conditions in Vietnam's NMR.

Genetic resources of maize and rice in Vietnam's NMR are rich and diverse. The local varieties are marvelously adapted to the ecological and cultural complexity of the locality and with only low investment provide relatively high yields, which sometimes are not less than that of the new varieties. Therefore, local varieties need to be collected, conserved, classified, and evaluated for their usefulness in breeding new varieties and reinvigorating old ones in order to support marginal areas. Conservation and improvement of local varieties can help to ensure food security for local people and also play important roles in environmental protection and bio-diversity conservation.

We, scientists, have to work together with local people to classify indigenous varieties into different yield groups in the subsistence agriculture activities of several ethnic minorities in Vietnam's NMR. Then, while some high yield local varieties can be recommended for use in other places; other low-yield varieties with valuable genetic traits should be maintained for long-term scientific research. This is the responsibility of the State. The study and use of indigenous rice and maize varieties in farming systems can help maintain biodiversity while at the same time it can make an important contribution to reducing poverty and reducing risk in upland agriculture.

Degradation of biodiversity is not a hopeless problem, as some people mistakenly believe it to be. Many things can be done for biodiversity conservation. It is important that each individual, and all research organizations, local authorities and international agencies cooperate with each other and begin to take action immediately. The most important step may be to make local people aware of the fact that they too have an important stake in biodiversity conservation and find ways to reward them for their efforts.

FURTHER DISCUSSION

1. The purpose of the *Green Revolution* and the accompanying shift to intensive farming was to eliminate hunger and reduce poverty. In intensive farming, the low yield varieties are discarded. Is a reduction of genetic resources in farming systems a necessary result of poverty alleviation?

2. Does a high level of genetic diversity indicate a low level agricultural development in a particular region? Do farmers only retain many low yield varieties because their agriculture is undeveloped? Does greater diversity in plant genetic resources have a positive correlation with higher levels of poverty?

3. The high-yield varieties usually have a low capacity to cope with marginal conditions and to resist diseases. Why do several of the indigenous varieties we collected have both of these abilities?

4. Why do farmers still use both high and low-yield indigenous varieties? Or, to put the same question another way, why do farmers not use only high-yield varieties? In addition to maintaining plant diversity to reduce risk, are there any other reasons?

5. Is the most appropriate strategy for achieving both poverty alleviation and bio-diversity conservation one based on selectively maintaining genetic bio-diversity combined with the selective importation of new genes for cross-breeding to create high-yield varieties that have high-quality and are adapted local conditions?

ACKNOWLEDGEMENTS

This paper is based on information collected while conducting research in the NMR under funding from the Ford Foundation, the Toyota Foundation, the USDA, WRI, and Danida that has been provided by grants to the Center for Agricultural Research and Ecological Studies (CARES) of Hanoi Agricultural University.

I would especially like to acknowledge the major contributions made by Dr. Vu Van Liet, Director of the Center for VAC Research and Development of HAU, for his helpful support while I was writing up the report. I want to thank my colleagues at the Center for Agricultural Research and Ecological Studies (CARES) of Hanoi Agricultural University who both contributed to this research and provided help in the preparation of this paper.

My special thanks go to the local farmers and local officials in the NMR for their help and support while we carried out our study in their fields.

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APPENDIX

Appendix 1: List of plant species in Dien Bien district, Lai Chau province

(Survey on 130 households)

	Vietnamese name	Scientific name	No. of households (n=130)
1	Hanh ta	*Allium ascalonicum* L.	45
2	Hanh cu	*Allium cepa* L.	12
3	Hanh hoa	*Allium fistulosum* L.	15
4	Toi	*Allium sativum* L.	18
5	He	*Allium tuberusum* Rottl. and Spreng.	10
6	Dua gai	*Ananas comosus* (L.) Merr	16
7	Binh bat	*Annona reticulata* L.	2
8	Lac	*Arachis hypogaea* L.	25
9	Cau	*Areca catechu* L.	8
10	Mit	*Artocarpus melinoxyla* Gagn.	25
11	Cai bap	*Brassica capitata* L.	6
12	Cai be trang	*Brassica chinensis* L.	50
13	Su hao	*Brassica gemmifera* Zink.	20
14	Cai be xanh	*Brassica juncea* L.	24
15	Dong rieng	*Canna edulis* Ker	15
16	ot chi thien	*Capsicum facsiculatum* Bail.	21
17	Du du	*Carica papaya* L.	47
18	Rieng	*Catimbium muticum* (Roxb.) Holtt.	6
19	Vu sua	*Chrysanthemum coronarium* L.	2
20	Cai cuc	*Chrysanthenum coronarium* L.	4
21	Chanh ta	*Citrus aurantifolia* Sw.	11
22	Buoi	*Citrus grandis* L.	9
23	Chanh yen (tay)	*Citrus limon* (L.) Burm	6
24	Cam nui	*Citrus macroptera* Montr.	7
25	Cam sanh	*Citrus nobilis* Lour	3
26	Quyt	*Citrus reticulata* Blco.	2
27	Tia to	*Coleus scutellaroides* Benth	16
28	Khoai mon nuoc	*Colocassia esculenta* (L.) Schott	14
29	Dua leo	*Cucumis sativus* L.	11
30	Bi do cuong tron	*Cucurbita maxima* L.	35
31	Bi ro	*Cucurbita moschata* Duch.	41
32	Bi do	*Cucurbita pepo* L.	47
33	Nghe	*Curcuma domestica* L.	13
34	Sa	*Cymbopogon citratus* L.	4
35	Nhan	*Dimocarpus longan var.local* Lour.	19
36	Cu mo	*Dioscorea alata* L.	9
37	Cu tu	*Dioscorea esculenta* (Lour.) Burk	7
38	Cu mai	*Dioscorea persimilis* Prain & Burkill	8
39	Rau ngo	*Enydra fluctuans*	12
40	Kinh gioi	*Esholigia ciliata* L.	11
41	Si	*Ficus benjamina* L.	5
42	Sung long	*Ficus drupacea* Maizeer	2
43	Ngai	*Ficus maliformis* King.	4
44	Sung	*Ficus rasemosa* L.	7
45	Sung xanh	*Ficus virens* Ait.	1
46	Dau nanh	*Glycine max* (L.) Merr	34
47	Rau giap ca	*Houttuynia cordata* Thunb.	17

Vietnamese name		Scientific name	No. of households (n=130)
48	Rau muong	*Ipomoca aquatica* Forssk.	5
49	Khoai lang	*Ipomoea batatas* Lamk.	3
50	Dau van	*Lablab purpureus* (L.) Sweet sub sp.	24
51	Bau	*Lagenaria siceraria* (Mol.) Stadley	39
52	Vai	*Litchi sinensis* Radlk.	4
53	Trung ga	*Lucuma mammosa* Gaertn	9
54	Muop khia	*Luffa acutagula* (L.)	12
55	Ca chua	*Lycopersicon carasiforme* Alef.	15
56	Ca chua thoc	*Lycopersicon esculentum commune* Alef.	9
57	Xoai	*Mangifera indica* L.	11
58	San	*Manihot esculenta* Grantz	27
59	Hong xiem	*Manilkara achras* (Mill) Fosb.	8
60	Muop dang	*Momordica charantia*	24
61	Gac	*Momordica cochinchinensis* (Lour.) Spreng	15
62	Dau ta	*Morus australis* Poir.	17
63	Dau meo	*Mucuna cochinchinensis* (Lour.) Merr	26
64	Chuoi	*Musa sp*.	51
65	Hung que	*Ocimum basilicum* L.	13
66	Huong nhu	*Ocimum gratissimum* L.	7
67	Lua	*Oryza sativa* L.	130
68	Cu dau	*Pachirhizus erosus* L.	18
69	Mo long	*Paederia lanuginosa* Wall.	3
70	Mo leo	*Paederia scandens* (Lour.) Merr.	7
71	Me rung	*Phyllanthus emblica* L.	3
72	Trau khong	*Piper betle* L.	3
73	La lot	*Piper lolot* C.	15
74	Rau ram	*Polygonum odoratum* Lour.	11
75	Dinh lang	*Polyscias fruticosa* (L.) Harms	9
76	Mo	*Prunus armeniaca* L.	4
77	Oi	*Psidium gujava* L.	21
78	Dau rong	*Psophocarpus tetragonolobus* L.	19
79	San day	*Pueraria thomsoni* Benth	12
80	Luu	*Punica granatum* L.	3
81	Cai cu	*Raphanus sativus* L.	23
82	Hoa hong	*Rosa chinensis* Jacq.	9
83	Su su	*Secchium edule* (Jacq.) Swartz.	4
84	Mia	*Shaccharum officinarum* L.	12
85	Ca dai de (tim)	*Solanum melongena* L.	19
86	Ca phao	*Solanum undatum* L.	15
87	Me	*Tamarindus indica* L.	4
88	Dua nui	*Trichosanthes cucumerina* L.	17
89	Dau xanh	*Vigna radiata* L.	29
90	Dau nho nhe	*Vina umbellata* (Thunb.) Ohwi & Ohashi var.	42
91	Khoai mung	*Xanthosoma sagittifilium* L.	11
92	Ngo	*Zea mays*	112
93	Gung	*Zingiber officinale* Roscoe	13
94	Tao ta	*Ziziphus manritiana* (Lamk.)	6

Appendix 2: Yield and its components of local rice varieties

Local variety	panicles /clump	Spikelets per panicle	Percent of filled spikelets (%)	Weight of 1000 seeds	Estimated yield		Actual yield	
					g/clump	quintal/ ha	g/clump	quintal /ha
Khau Ma Cha	2.7	70.0	94.2	34.4	6.1	27.4	5.0	22.5
Khau Chien Cang	3.9	104.1	95.3	29.6	11.4	51.3	6.4	28.8
Ple Thai	3.6	100.3	85.5	34.2	12.8	66.6	6.6	29.7
Khau Cham Tan	4.2	238.5	85.2	29.6	25.3	113.8	13.3	59.8
Khau Pan Lom	4.0	86.3	90.4	26.4	8.2	96.9	5.6	50.4
Ngo Meo	3.8	101.3	91.5	28.4	10.0	45.0	5.6	25.2
Ple Lu	4.9	174.3	83.0	26.7	18.9	85.0	8.3	37.4
Khau Xi Toi	3.7	73.8	90.1	33.0	8.17	36.8	4.7	21.2
Ple Mong	4.0	154.0	90.1	28.6	15.8	71.7	7.3	32.8
Ngo Mong Xi	4.9	78.6	94.0	29.8	10.8	48.6	5.6	25.2
Ple Chau Cha	3.1	63.5	89.6	27.6	4.84	21.8	3.6	16.2
Ple Pau Re	2.3	64.5	90.1	29.2	3.9	17.6	2.7	12.2
Khau Tay Lau	2.5	80.2	92.5	37.0	6.9	30,9	3.1	13.9
Mua Chua Lia	3.0	77.9	92.3	26.4	5.7	25.6	4.4	19.8
Ple Hoa Dan	3.7	101.0	85.1	28.2	8.7	39.2	5.6	25.2
Ple Do	3.5	51.3	94.5	31.0	5.3	23.8	4.4	19.8
Khau Bai	3.8	91.4	92.3	33.6	10.7	48.2	5.7	25.6
Ple Hoa Chua	4.2	97.0	96.1	27.6	10.8	48.6	5.6	25.2
Ple Haa Do	3.5	70.9	87.8	27.8	6.1	27.3	4.5	20.2

Appendix 3: Yield and its components of local glutinous rice varieties

Local variety	panicles /clump	Spikelets per panicle	Percent of filled spikelets (%)	Weight of 1000 seeds	Estimated yield		Actual yield	
					g/clump	quintal /ha	g/clump	quintal /ha
Khau Ta Bong	3.8	67.1	94.9	35.6	8.6	38.8	5.7	25.6
Khau Ma Co	3.0	151	84.3	40.1	15.3	68.8	6.8	30.6
Khau Hay Loc	3.2	99.3	97.2	40.7	12.6	56.7	5.3	23.8
Khau Lanh Lan	3.9	140.3	84.5	36.3	16.8	75.6	7.7	34.6
Ngo Gan van	3.7	99.3	97.2	39.6	10.3	46.4	6.1	27.5
Khau Pom Lon	3.9	136.7	88.7	25.1	9.4	42.3	7.2	32.4
Ple Dan	4.0	96.8	90.0	37.2	12.9	58.0	6.1	27.4
Khau Tang San	3.7	53.6	88.8	39.7	6.9	31.0	4.5	20.2
Khau Non	4.2	55.3	90.0	34.6	7.2	32.4	4.4	39.6
Khau No	3.0	65.0	92.5	41.8	7.5	33.8	5.2	23.4
Khau Xe Lon	4.3	80.4	92.6	33.4	10.7	48.2	6.1	27.4
Ngo Boong	3.7	73.0	93.2	39.0	12.5	56.3	6.7	30.1
Tua Chua	4.6	99.7	95.2	27.0	11.8	53.1	7.8	35.1
Ple Lia	4.2	99.6	92.2	28.4	10.3	46.4	8.8	39.6
Nep Cam	2.7	53.7	91.2	33.8	4.5	20.2	3.8	17.1
Ple Lau Hi	3.6	104.7	86.7	36.0	11.8	52.9	6.6	29.7
Ple on Lanh	2.8	104.2	93.4	40.4	8.4	37.8	5.6	25.2
Ple Ta Da	3.0	79.8	92.9	43.6	9.7	43.7	5.8	26.1
Khau Hin	2.4	157.3	86.7	36.3	11.9	53.4	6.7	30.2
Khau Lam	3.4	163.1	92.4	38.6	19.8	89.1	14.1	53.4
Khau Lanh Cot	3.1	148.6	86.4	30.1	11.9	53.6	6.9	31.0

Appendix 4: Characteristics of several local maize varieties

Local variety	Glutinous/ non- Glutinous	Leaf and stem colour	Grain colour	Quality	Height of plant (cm)
1. Ngo nep nuong	Glutinous	Green, violet	Violet-white	Delicious	200-220
2. Poc cu mua dua	non- Glutinous	Green	White	Delicious	220-250
3. Po cu chia	non- Glutinous	Green	White	Delicious	200-220
4. Po cu mua dua don	Glutinous	Green	Milky	Delicious	220-250
5. Pau cu thai	non- Glutinous	Green	White	Delicious	270-300
6. Khau lim lam	Glutinous	Green	White	Delicious	200-220
7. Ngo nep	Glutinous	Green, violet	Violet-White	Delicious	200-220
8. Ngo nep	Glutinous	Green, violet	Violet-White	Delicious	220-250
9. Khau li on	Glutinous	Green	Violet-White	Delicious	200-220
10. Pau cum lau	Glutinous	Dark Green	Violet-White	Delicious	180-200
11. Nep trang 2	Glutinous	Green, violet	White	Delicious	180-200
12. Nep trang Na Xac	Glutinous	Green, violet	White	Delicious	160-180
13. Nep vang Pieng Ta	Glutinous	Green	White	Delicious	160-180
14. Nep trang	Glutinous	Green, violet	White	Delicious	200-250
15. Khau li on lon	non- Glutinous	Green	Violet	Delicious	200-230
16. So lip lo cut	Glutinous	Green	Yellow White	Delicious	160-180
17. Ngo nep	Glutinous	Green	White	Delicious	180-200
18. Silivimse	non- Glutinous	Green	Red	Medium	200-220
19. Sly eo	non- Glutinous	Green	Yellow	Medium	180-200
20. Khau li dinh	non- Glutinous	Green	Dark red	Medium	200-220

Appendix 5: Yield and its components of local maize varieties in spring 2002

Local variety	Length of Maize ear (cm)	Diameter of maize ear (cm)	Number of lines on maize ear (lines)	Number of grain in line (grain)	Weight of 1000 grain (g)	Grain Yield (g/plant)
1. Ngo nep nuong	17.39	4.19	14.6	28.4	255.4	66.5
2. Poc cu mua dua	20.23	4.63	13.6	33.9	287.7	101.5
3. Po cu chia	18.84	3.74	13.0	29.8	255.5	79.3
4. Po cu mua dua don	16.25	4.46	13.0	27.0	258.7	93.0
5. Pau cu thai	23.38	4.41	14.2	37.1	253.5	105.4
6. Khau lim lam	18.32	4.37	14.4	29.5	203.3	67.1
7. Ngo nep	18.38	4.16	13.4	29.5	158.1	51.2
8. Ngo nep	18.66	4.10	14.8	31.4	183.5	67.1
9. Khau li on (glutinous)	17.57	4.58	15.0	28.6	184.4	71.5
10. Pau cum lau (glutinous)	17.36	4.19	13.2	26.8	185.1	53.1
11. Nep trang 2	19.03	5.21	15.8	34.1	190.0	81.2
12. Trang Na Xac	16.84	3.99	11.2	25.6	201.7	57.4
13. Nep vang Pieng Ta	14.23	3.82	12.0	18.2	162.5	34.4
14. Nep trang	17.85	4.52	16.6	27.4	181.3	74.8
15. Khau li on lon	18.51	4.67	14.2	29.3	196.6	65.3
16. So lip lo cut (yellow glutinous rice)	17.04	4.10	13.8	29.0	194.3	64.0
17. Ngo nep	16.20	3.90	14.0	30.0	184.4	64.5
18. Silivimse	16.25	4.06	12.8	28.1	229.5	72.9
19. Sly eo	17.05	3.71	13.0	30.2	222.9	69.1
20. Khau li dinh (ngo te)	18.02	4.36	14.6	29.2	243.7	84.8