AGRICULTURAL DIVERSITY OF FOOD CROPS IN SABAH, MALAYSIA

Prepared by

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1.0 INTRODUCTION

This survey report is an initial output of the Community Biodiversity Development and Conservation (CBDC) project in Sabah, which started in 1994. This project is part of a regional CBDC programme in Southeast Asia, coordinated by SEARICE.

1.1 General Background

Sabah is one of the two East Malaysian states situated on the northern most part of the island of Borneo (Fig. 1). Sabah's land area, covering about 7.37 million hectares, is endowed with a diverse landform, vegetation, and people. About 60 percent of its area are mountainous, with an altitude as high as 4000 meters in some areas. Flat land areas are of many types, from coastal to inland valleys. The landform provides a diverse range of habitats for its diverse flora and fauna. The vegetation ranges from mangrove swamps, lowlands to mountain rainforest and even alpine type forest above 3,500 meters in the Mt. Kinabalu area. It also provides a diverse agro-ecosystem for the many indigenous communities, who are mostly subsistence farmers, utilizing traditional farming practices.

The interaction between the indigenous communities, the environments and their food crops has provided the State with a wide range of crops and remarkable varieties within crops. The interactions have also resulted in building the capacity of farmers to further develop crops through a process of continuous adaptation and experimentation. However, agricultural modernization, commercialization, intensification of production, and destruction of habitats, which are becoming more evident in the State are threatening both the crop diversity and the processes, which sustains it.

Although there have been efforts by the Agricultural Research Center for the past few years to document, assess and develop the potential of existing crops, especially the major food crops and fruit trees, there is still scant information regarding the status of crops throughout the state, in terms of their diversity, distribution and conservation. With the ever-increasing threats of genetic erosion, there is an urgent need to document the existing crop diversity and the practices that sustain it in the State to be able to come up with appropriate, integrated conservation and development strategies.

1.2 Objective and Scope

The main objective of the survey was to investigate and establish the status of agricultural diversity, especially food crops in the State. This project focuses only on the most important traditional crops. These are rice, cassava, sweet potato, taro and corn. Also included, as an inventory only are traditional /wild vegetables, spices and fruits utilized by farmers. Rice, being the major staple crop, has been documented in a detailed manner. The results is expected to provide a basic framework for understanding and initiating *in situ* conservation and development work on rice among farmers.

1.3 Methodology

The survey was done using conventional open-ended questionnaire consisting of 9 sections covering Respondent Profile, Area Profile, Crop Diversity, Indigenous Knowledge and Traditional Agricultural Practices of Wet and Hill Rice, Seed Supply System, Conservation of Rice Genetic Resources, Improvement of Rice Genetic Resources and Policy (see Appendix 1). The survey was carried out in two phases coinciding with the main rice-harvesting season between November to March in 1994/95 and 1995/96. Additional questions were included during the second survey. Because of this, the degree of analysis that can be carried out on certain aspects somewhat differs. Where relevant, two sets of tables are presented.

3 full-time staff, assisted by 15 field workers who underwent an intensive one-week training course, carried out the survey. During the survey, seed samples were collected for filing purposes. A total of 906 seed files have been collected from various districts.

The survey data was collated and sorted using the programs, ACCESS and PARADOX.

1.4 Coverage

The survey covered only accessible areas where traditional agricultural activities are still the primary means of survival. Fig. 2 shows the areas covered during the survey, representing about 80% of the proposed areas.

2.0 GEOGRAPHICAL SETTING

2.1 Brief History and Administration

Prior to 1963 Sabah was the British Crown Colony of North Borneo. The region came under British control in 1877 when a British trading syndicate, later called the British North Borneo (Chartered) Company, obtained concessions from the sultans of Brunei and Sulu and other rulers in the region. In 1881 North Borneo was made a British protectorate, but the company retained its administrative powers until 1946, when British North Borneo was proclaimed a Crown Colony. During World War II (1939-1945) Japanese forces occupied the region. When the Federation of Malaysia came to existence on September 16, 1963, British Borneo, renamed Sabah, became a member state.

Sabah has a Legislative Assembly, Cabinet and Ministerial form of government. Where State issues are concerned, the Federal Government may promote National uniformity by preparing model legislation for adoption by the states, but implementation remains a state matter. The natural resources of the state, including environment and biodiversity is administered by Sabah's government. Local authorities govern the 22 Districts and 9 Sub-Districts of the state. The Department of Agriculture under the Ministry of Agriculture, which has an office in each district, is responsible for the food production of the state. The Forest Department also under the same ministry looks after the forest.

Except for the interior part of Sabah (e.g. Districts of Pensiangan and Labuk-Sugut) most of the state is now connected by a good network of sealed and graveled roads. The opening of new roads in the interior part of Sabah, since independence has resulted in some drastic changes in the physical environment of the state. Extensive logging activities since the early seventies, followed by the opening of huge land for cash crop plantations (rubber, oil palm, cocoa) has clearly made their mark on the physical appearance of Sabah.

2.2 Landforms and Climate

Sabah's landscape is highly dissected and steep. About 60 percent of its area are mountainous. Most of the lowlands are confined to the coastal region. The extensive areas of flatland are subject to waterlogging or floods, occupied by fresh water and tidal swamps (e.g. Kinabatangan, Labuk-Sugut, and Beaufort Districts). Several broad upland valleys (e.g. Tambunan, Keningau and Tenom Districts) traverse the interior. The highest mountain ranges are found in the western part of the state (e.g. Ranau, Tambunan, and Keningau Districts). Mount Kinabalu (~ 4000 m) is the highest summit on the island (Fig. 3). Both the coastal belt and mountainous slopes are heavily forested. Tropical rainforest of one type or another characterizes most of the state. Streams are numerous and because of the rugged terrain are generally swift and interrupted by rapids. The Kinabatangan River, the longest river in the state, is navigable by light vessels for about 193-km inland from the Sulu Sea. The Labuk and Padas Rivers are also important waterways. Several large bays and natural harbors indent the coastline.

The climate of Sabah is hot and humid throughout the year and is not affected very much by severe storms and typhoons. Average total annual rainfall varies enormously between different parts of Sabah (Fig. 4). The southeastern part of Sabah (e.g. Districts of Tawau, Semporna and Lahad Datu) receive the lowest average rainfall of about 1800 mm annually, whereas the western mountainous slopes of Sabah (e.g. Districts of Tuaran, Penampang and Papar) receive the highest rainfall of more than 4000 mm annually. The distribution pattern of rainfall is also quite varied. In western Sabah, rainfall is usually concentrated during the southwest monsoon season between May-June and again at the beginning of the northeast monsoon season between October –November. In northeastern Sabah, there is usually heavy rainfall through the northeast monsoon period from November to February. Periods of long dry spells are rare. During the daytime the temperature varies little during the year, within the region of 27^{o}-34^{o} C, except for those high-altitude areas near Mt. Kinabalu. At nighttime temperature rarely falls below 20^{o} C.

2.3 Agricultural Capabilities

All the soil in Sabah can support some form of vegetation. However, not all can support intensive agriculture. Several soil units have been recognised in Sabah with different agricultural capabilities (LRDMOD, 1975). Most of the soils are derived from weathered sedimentary rocks as parent material, consisting mostly of sandstones and mudstones. This parent material form about 75 percent of the rock types found in Sabah. The rest are derived from igneous rocks (ultrabasic, basic and acidic) and a small proportion from limestones (e.g. Kinabatangan and Lahad Datu Districts). The thickness of soils developed are quite varied and greatly influenced

by the diverse landforms. Agricultural suitability of land (Fig. 5) has been proposed by the Land Capability Classification of Sabah (LRDMOD, 1976).

A large part of eastern Sabah (e.g. Districts of Kinabatangan, Lahad Datu and Labuk-Sugut) have been identified as areas suitable for intensive agriculture. Most of these areas have since been utilised for large-scale cash crop plantations (e.g. oil palm and cocoa). There are several pockets of areas identified as suitable for intensive agriculture in western Sabah. Most of these areas are utilised for wet rice production (e.g. Districts of Tuaran, Penampang and Papar), and some for oil palm plantations. The mountainous slopes of western and northern Sabah (e.g. Districts of Kota Marudu, Ranau, Kota Belud, Tambunan, Keningau, Tenom and Pensiangan), which generally have a thin soil cover, thus considered unsuitable for intensive agriculture, have been productively utilised for hill rice cultivation.

2.4 Ethnic Diversity and Agricultural Practices

The indigenous communities, who make up about 70 percent of the estimated 1.4 million total population of Sabah, comprised of more than 30 ethnic groups (King & King, 1984). Although these ethnic groups share several socio-cultural characteristics, they have distinctive ethnic differences in their language dialects, attire, artifacts, music, dances, farming mode, customary laws and traditional practices. Their preference for certain types of food crops has sustained agricultural diversity in the state. Several family groups, namely, Dusunic, Murutic, Paitanic, Bajau and Malayic have been identified (Fig. 6), some occupying distinct geographical areas of settlement. A large percentage of the indigenous communities from the Murutic family resides in the southwest interior of Sabah (Districts of Keningau, Tenom and Pensiangan), along the Sapulut and Padas Rivers. The Paitanic family resides on the northeastern part of Sabah Labuk-Sugut District), whereas the Bajau and Malayic families predominantly occupy the coastal area. The Dusunic family, the most dominant group, occupies the western, northern and central Sabah. The Rungus ethnic group dominates the areas in the Districts of Kudat and Pitas, on the northern part of Sabah.

The diverse landforms provide a diverse range of habitats for their flora and fauna. Naturally it provides a diverse agro-ecosystem for the many indigenous communities, who are mostly subsistence farmers, utilizing traditional farming practices. These traditional farming practices suited to their environments are mostly common-sense knowledge gained from their years of practical farming experiences and close interaction with nature. In most of the ethnic groups, specific rules, regulations, prohibitions and rituals are practiced to a certain extent in the selection, preparation and maintenance of their agricultural plots. Informal exchange of planting materials is commonly practiced among ethnic groups to enhance their crop selection and viability in their agro-ecosystems.

3.0 RESPONDENT PROFILE

A total of 788 farmers coming from 549 villages covering 21 districts (Table 1) were interviewed. The number of respondents per district varied enormously. This is because there

are more full-time farmers planting food crops in some areas (e.g. Tambunan, Keningau, Kota Marudu, and Tuaran) and very much less in some areas (e.g. Beaufort and Pitas).

Most of the respondents are from the three main ethnic groups of Sabah, namely the Dusun, Kadazan and Murut communities. Whereas the Kadazan and Murut communities are concentrated on the West Coast and southwest of Sabah, respectively, the Dusuns are widely distributed -- they can be found in almost all the districts. Other distinct ethnic groups interviewed included the Rungus who are confined in northern Sabah, the Bajaus in the coastal areas of Kota Belud, Tuaran and Papar and the Sungais who are confined along the Kinabatangan River. Some of the other ethnic groups who are not full-time farmers are not included in the survey (Tables 2 & 3).

Table 1. Number of Respondents by District

District	No of Villages	No of Respondent
Beluran	10	12
Kota Kinabalu	9	15
Kota Marudu	40	81
Kota Belud	37	46
Kuala Penyu	12	12
Kudat	18	26
Keningau	67	98
Kinabatangan	40	49
Lahad Datu	8	11
Penampang	33	50
Papar	35	55
Pensiangan	13	14
Pitas	3	5
Ranau	49	65
Sipitang	13	17
Tuaran	60	78
Tambunan	63	104
Tenom	8	12
Beaufort	2	2
Nabawan	11	13
Telupid	18	23
Total	549	788

Table 2. Number of Respondents by Ethnic Group.

Ethnic Group	No of Respondent
Kadazan	47

Dusun	552
Murut	92
Bajau	13
Berunai	1
Rungus	27
Paitan	5
Tidung	1
Iranun	3
Iban	1
Kedayan	4
Idaan	3
Sungai	27
Others	12
Total	**788**

Table 3. Number of Respondents by Ethnic Group and by District

DISTRICT	ETHNIC														TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Beluran	-	7	-	-	1	-	-	1	-	-	-	3	3	-	12
Kota Kinabalu	2	13	-	-	-	-	-	-	-	-	-	-	-	-	15
Kota Marudu	-	80	-	-	-	-	-	-	-	-	1	-	-	-	81
Kota Belud	-	35	-	6	-	-	2	-	3	-	-	-	-	-	46
Kuala Penyu	6	4	-	1	-	-	-	-	-	-	-	-	-	1	12
Kudat	-	-	-	-	-	26	-	-	-	-	-	-	-	-	26
Keningau	-	52	44	-	-	-	-	-	-	1	-	1	-	-	98
Kinabatangan	-	24	1	-	-	-	-	-	-	-	-	-	23	1	49
Lahad Datu	-	11	-	-	-	-	-	-	-	-	-	-	-	-	11
Penampang	18	32	-	-	-	-	-	-	-	-	-	-	-	-	50
Papar	19	32	-	3	-	-	-	-	-	-	1	-	-	-	55
Pensiangan	-	-	14	-	-	-	-	-	-	-	-	-	-	-	14
Pitas	-	-	-	-	-	1	3	-	-	-	-	1	-	-	5
Ranau	-	65	-	-	-	-	-	-	-	-	-	-	-	-	65
Sipitang	-	-	7	-	-	-	-	-	-	-	1	-	-	9	17
Tuaran	1	73	-	3	-	-	-	-	-	-	-	1	-	1	78
Tambunan	-	103	1	-	-	-	-	-	-	-	-	-	-	-	104
Tenom	-	-	12	-	-	-	-	-	-	-	-	-	-	-	12
Beaufort	-	-	-	-	-	-	-	-	-	-	1	-	1	-	2
Nabawan	-	-	13	-	-	-	-	-	-	-	-	-	-	-	13
Telupid	1	21	-	-	-	-	-	-	-	-	-	-	-	1	23
Total	47	552	92	13	1	27	5	1	3	1	4	3	27	12	788

Ethnic Codes: 1=Kadazan; 2=Dusun; 3=Murut; 4=Bajau; 5=Berunai; 6=Rungus; 7=Paitan; 8=Tidung; 9=Iranun; 10=Iban; 11=Kedayan; 12=Idaan; 13=Sungai; 14=Others.

More than 50% of the respondents are above 50 years old. This bias was aimed at getting those who are knowledgeable in their traditional farming practices. Equal number of male and

female respondents were interviewed. As most of the farmers are old, the number of years that they have been farming also falls in the 30-50 years category (Tables 4, 5 & 6).

Table 4. Age of Respondent

AGE BRACKET (yrs)	NO. OF RESPONDENTS
<35	53
35-50	22
> 50	513

Table 5. Gender of Respondent

GENDER	NO. OF RESPONDENTS
Male	411
Female	377

Table 6. No of Years in Farming

YEARS IN FARMING (Yrs)	NO. OF RESPONDENTS
<10	121
11-30	90
31- 50	237
>50	307
Not specified	33

About 50% of the farmers already owned a title to their land, especially those planting wet rice. The rest who does not have titles yet are mostly upland farmers utilizing lands under customary rights, either on State land or Forest Reserves (Table 7).

Table 7. Status of Land Ownership

LAND STATUS	NO. OF RESPONDENTS
Titled	439
State	211
Reserve	22
Customary	79
No answer	37

4.0 FOOD CROP DIVERSITY

Table 8 to Table 43 shows the diversity of the selected food crops. The listings of varieties and types of crops based on local names is shown in Appendix 2.

4.1 Wet Rice

The overall total number of varieties from the survey is not available due to the different data set. There are several other problems related to the local names and characteristics given by farmers which are difficult to rectify.

Out of the 315 seed files collected, only 77 remained after being sorted out using 6 distinctive criteria including lemma and palae color, apiculus color, awning, awn color, endosperm color and endosperm type. After being sorted by local names alone, 174 remained.

Using characteristics alone, a rough picture of the total number of varieties maintained by individual ethnic groups from different districts can be obtained.

Looking at Tables 8a and 8b, one sorted by characteristic alone, and one sorted by local names and three characteristics, the huge difference in number is immediately apparent. Both tables, however, consistently show that the Dusun and Murut communities maintain a much higher diversity.

Table 8a. Number of Wet Rice Varieties by Ethnic Group, Sorted by Characteristic Only.

ETHNIC GROUP	Number Of Varieties
Kadazan	3
Dusun	28
Murut	16
Bajau	2
Berunai	5
Tidung	4
Kedayan	6
Sungai	6
Others	7
Total	77

Table 8b. Number of Wet Rice Varieties by Ethnic Group, Sorted by Local Names and Characteristics.

ETHNIC GROUP	No of varieties
Kadazan	89
Dusun	353
Murut	197
Bajau	38

Paitan	2
Kedayan	5
Iban	3
Iranun	7
Others	3
Total	697

The number of varieties in each district is less than 50 if sorted by characteristic alone (Table 9a). However, if local names are added, the number of varieties increases drastically (Table 9b). This indicates the diversity of local names given to a particular variety.

Table 9a. Number of Wet Rice Varieties by District, Sorted by Characteristic Only

DISTRICTS	**No. Of Varieties**
Beluran	17
Kota Marudu	26
Kuala Penyu	14
Kudat	20
Kinabatangan	47
Lahad Datu	10
Pensiangan	17
Pitas	14
Ranau	25
Sipitang	23
Tenom	14
Nabawan	14
Beaufort	16
Total	257

Table 9b. Number of Wet Rice Varieties by District, Sorted by Local Name and Characteristics.

DISTRICT	**No of varieties**
Kota Kinabalu	15
Kota Belud	68
Keningau	200
Penampang	66
Papar	100
Tuaran	100
Tambunan	148
Total	697

The diversity is better expressed indirectly by the number of varieties maintained by each farmer of a particular ethnic group and district. The major ethnic groups, comprising the Kadazan, Dusun, Murut and Sungai maintain about 3-4 varieties, regardless of whether they are of the same or different varieties to their neighbors (Tables 10 & 11). This number correlates well with the number of varieties maintained by each farmer in most of the districts -- that is at least 3 varieties.

Table 10. Number of Wet Rice Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran		43	5
Kota Kinabalu	9	17	2
Kota Marudu	2	19	9
Kota Belud	30	91	3
Kuala Penyu	11	67	6
Keningau	57	281	4
Kinabatangan	3	7	2
Penampang	31	81	2
Papar	46	123	3
Pensiangan	1	1	1
Pitas	1	3	3
Ranau	10	51	5
Sipitang	8	44	5
Tuaran	38	132	3
Tambunan	76	275	3
Tenom	4	31	7
Beaufort	1	9	9
Nabawan	3	6	2
Total	339	1281	74

Table 11. No of Wet Rice Varieties Per Ethnic Group

ETHNIC GROUP	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Kadazan	44	136	3
Dusun	237	897	3
Murut	22	106	3
Bajau	12	40	3
Berunai	1	7	7
Rungus	-	-	-
Paitan	2	3	1
Tidung	1	5	5

Iranun	3	7	2
Iban	1	3	3
Kedayan	3	19	6
Sungai	4	14	3
Others	9	44	4
Total	339	1281	3

The data from Table 12 should be treated with care, since a lot of the respondents were not able to give all the detailed characteristics. The type of wet rice that they maintain comprises mainly of late maturing, tall, white seeded, non-aromatic, non-glutinous and moderately lodging resistant varieties. Moderate drought and flood tolerance are the major characteristics maintained. It is interesting to note that there is quite a few early maturating, purple and red seed coats and aromatic varieties. There are also varieties that are drought resistant.

Apart from eating, rice is usually used for making rice wine and cakes. *Rice is also used in cultural ritual and "sogit"* (Table 13).

Table 12. Number of Wet Rice Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
Early	32
Medium	25
Late	203
B. Plant Height	
Short <80 cm	7
Medium 81-110cm	8
Tall >110cm	210
C. Seed Coat Color	
White	306
Purple	65
Red	41
Brown	9
Mixture	
D. Aroma	
Yes	87
No	523
E. Endosperm type	
Glutinous	30
Non-glutinous	561
F. Lodging resistance	
Strong	22
Moderate	136

Weak	41
G. Drought tolerance	
High	16
Medium	41
Low	4
H. Flooding tolerance	
High	6
Medium	33
Low	14

Table 13. Number of Wet Rice Varieties by Use

USE	No. of varieties
Food	337
Rice wine	339
Flour	4
Cake	240
Selling	92
Chicken /animal feed	22

4.2 Hill rice

Again, the total varieties from each ethnic group and from each district cannot be established with certainty. Two sets of data are presented to give some idea. Using characteristics alone in sorting the number of varieties in the first table (Table 14a) and using variety name with additional characteristics in the second table (Table 14b), a huge difference can be observed. There is a drastic reduction in the number of varieties if the local varietal name given by a particular ethnic group is ignored. This smaller number appears to be more realistic.

Out of the 591 seed files collected, only 128 remained after being sorted out using the 6 distinctive criteria mentioned earlier for wet rice. After being sorted by local names alone only 377 remained.

From Tables 14a and 14b, the Dusun and Murut stands prominently above the rest in maintaining a higher number of varieties.

Table 14a. Number of Hill Rice Varieties by Ethnic Group, Sorted by Characteristics Only

ETHNIC GROUP	Number Of Varieties
Kadazan	3
Dusun	85
Murut	56
Rungus	19
Paitan	8

Kedayan	3
Sungai	21
Others	10
Total	205

Table 14b. Number of Hill Rice Varieties by Ethnic Group, Sorted by Using Local Names and Characteristics

ETHNIC	No of varieties
Kadazan	21
Dusun	646
Murut	200
Bajau	15
Iranun	2
Others	1
Total	885

The number of varieties by districts also becomes drastically reduced if the local name is ignored (Tables 15a & 15b). Each district shows less than 50 varieties.

Table 15a. Number of Hill Rice Varieties by District, Sorted by Characteristics Only

DISTRICTS	No. of Varieties
Beluran	12
Kota Marudu	37
Kuala Penyu	3
Kudat	26
Kinabatangan	59
Lahad Datu	22
Pensiangan	27
Pitas	17
Ranau	50
Sipitang	28
Tenom	18
Nabawan	19
Telupid	22
Total	340

Table 15b. Number of Hill Rice Varieties by Districts, Sorted by Local Names and Characteristics

DISTRICT	No of varieties
Kota Kinabalu	18
Kota Belud	131

Keningau	298
Penampang	88
Papar	49
Tuaran	178
Tambunan	123
Total	885

Each farmer maintains at least 3 varieties in most of the districts (Table 16). The Dusun, Murut, Rungus and Sungai are listed on the top -- they maintain up to 5 varieties (Table 17).

The data from Table 18 needs to be treated with care, since not all respondents gave complete answers. The usual varieties that farmers maintain are those that are medium to late maturity, medium in height, white in seed coat color, both aromatic and non-aromatic, non-glutinous, moderate lodging resistance and moderate drought resistance. It is interesting that there are farmers who maintain varieties with early maturity, short plant height, strong lodging resistant and high drought tolerance.

Table 16. No of Hill Rice Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran	7	37	5
Kota Kinabalu	10	25	2
Kota Marudu	77	495	6
Kota Belud	33	185	5
Kuala Penyu	1	6	6
Kudat	26	189	7
Keningau	65	397	6
Kinabatangan	49	290	5
Lahad Datu	10	59	5
Penampang	26	154	5
Papar	18	56	3
Pensiangan	14	68	4
Pitas	4	43	10
Ranau	64	411	6
Sipitang	13	114	8
Tuaran	65	327	5
Tambunan	52	192	3
Tenom	12	92	7
Beaufort	0	0	0
Nabawan	12	68	5
Telupid	23	106	4
Total	581	3314	5

Table 17. No of Hill Rice Varieties Per Ethnic Group

ETHNIC GROUP	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Melayu	-	-	-
Kadazan	10	25	2
Dusun	416	2262	5
Murut	85	580	6
Bajau	3	15	5
Berunai	-	-	-
Rungus	27	199	7
Paitan	3	33	11
Tidung	-	-	-
Iranun	1	2	2
Iban	-	-	-
Kedayan	1	8	8
Idaan	-	-	-
Others	8	54	6
Sungai	26	135	5
Total	581	3314	5

Table 18. Number of Hill Rice Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
Early	25
Medium	732
Late	778
B. Plant Height	
Short	22
Medium	682
Tall	265
Others	826
C. Seed Coat Color	
White	821
Black	176
Brown	31
Purple	182
Others	471
D. Aroma	
Yes	632
No	914
E. Endosperm type	
Glutinous	118

Non-glutinous	1428
F. Lodging resistance	
Strong	274
Moderate	858
Weak	175
G. Drought tolerance	
High	258
Medium	951
Low	369
Others	781

In terms of other uses, most of the surplus is used for making rice wine for their own consumption (Table 19).

Table 19. Number of Hill Rice Varieties by Use

USE	No. of varieties
Rice wine	1175
Flour	23
Cake	167
Selling	131
Chicken /animal feed	123
Food	703

4.3 Cassava

The total number of varieties per ethnic group and per district is also problematic. Again two tables are presented.

Based on characteristics alone (Table 20a) and based on local name with added characteristics (Table 20b), the number of varieties sorted out do not differ drastically. This probably indicates that the diversity of local names for cassava is not as high as in rice.

Table 20a. Number of Cassava Varieties by Ethnic Group, Sorted by Characteristic Only

ETHNIC GROUP	No of Varieties
Kadazan	10
Dusun	101
Murut	57
Bajau	3
Berunai	4
Rungus	26
Paitan	6
Tidung	2

Kedayan	3
Sungai	15
Others	30
Total	257

Table 20b. Number of Cassava Varieties by Ethnic Group, Sorted by Local Names and Characteristics

ETHNIC GROUP	No of varieties
Kadazan	30
Dusun	429
Murut	106
Bajau	2
Iranun	2
Kedayan	2
Others	1
Total	572

The estimated number of varieties for each district looks quite acceptable, except for those in Ranau, Keningau, Tambunan and Tuaran (Tables 21a & 21b). This could be due to the larger number of respondents, thus the more diverse description of a particular variety.

Table 21a. Number of Cassava Varieties by District, Sorted by Characteristics Only

DISTRICTS	No. of Varieties
Beluran	17
Kota Marudu	26
Kuala Penyu	14
Kudat	20
Kinabatangan	47
Lahad Datu	10
Pensiangan	17
Pitas	14
Ranau	25
Sipitang	23
Tenom	14
Nabawan	14
Telupid	16
Total	257

Table 21b. Number of Cassava Varieties by District, Sorted by Using Local Names and Characteristics

DISTRICT	No of varieties
Kota Kinabalu	23
Kota Belud	56
Keningau	188
Penampang	54
Papar	47
Tuaran	98
Tambunan	109
Total	575

Each farmer from nearly all districts maintains at least two varieties. Those that maintain more -- some up to six can be found among the Muruts and Paitans -- these communities mostly practice upland farming (Tables 22 & 23). In fact, to them cassava is of equal importance to rice as their staple food.

The type of varieties maintained by farmers have diverse morpho-agronomic characteristics (Table 24). Those that stand out are varieties with white flesh color and green leaf color.

Table 22. Number of Cassava Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran	10	29	3
Kota Kinabalu	10	26	3
Kota Marudu	72	206	3
Kota Belud	29	66	2
Kuala Penyu	7	16	2
Kudat	25	95	4
Keningau	77	325	4
Kinabatangan	47	195	4
Lahad Datu	9	22	2
Penampang	31	95	3
Papar	30	63	2
Pensiangan	14	66	4
Pitas	5	30	6
Ranau	62	235	4
Sipitang	14	65	4
Tuaran	65	168	2
Tambunan	80	214	3
Tenom	12	74	6

Nabawan	12	53	4
Telupid	22	73	3
Total	633	2116	

Table 23. Number of Cassava Varieties Per Ethnic Group

ETHNIC	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Kadazan	23	48	2
Dusun	452	1366	3
Murut	84	437	5
Bajau	3	5	1
Berunai	1	4	4
Rungus	26	101	4
Paitan	4	24	6
Tidung	1	2	2
Iranun	2	3	1
Kedayan	2	6	3
Sungai	24	88	3
Others	9	29	3
Total	633	2116	37

Table 24. Number of Cassava Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
No answer	637
3-4 month	255
5-6 month	391
7-8 month	220
9-10 month	60
11-12 month	116
B. Flesh color	
No answer	354
White	969
Yellow	226
Orange	31
Purple	5
C. Phelloderm Color	
No answer	461
White	372
Reddish	585
Yellowish	144
Purple	23

D. Petiole Color	
No answer	474
Red	535
Yellow	170
Greenish	406
E. Leaf Color	
No answer	589
Green	913
Light green	48
Mixture of yellow and green	23
Light yellow	12
F. Leaf Shape	
No answer	658
Oblanceolate	135
Linear	159
Elliptic	218
Padurate	103
Lanceolate	302
Not in picture (sample)	10

About half the cassava are utilized for making wine, whereas the rest are for food and animal feed (Table 25).

Table 25. Number of Cassava Varieties by Uses

USES	**No. of Varieties**	**%**
Food	703	30
Cake	167	7
Sell	131	5
Animal feed	123	5
Vegetables	13	1
Wine	1175	50
Flour	23	1
Starch	19	1

4.4 Sweet Potato

The Dusun, Murut and Rungus communities have the highest number of varieties (Tables 26a & 26b). Less than 30 varieties, based on characteristics alone, are found in several districts (Tables 27a & 27b). Areas like Kota Marudu, Kinabatangan and Ranau have more than 20 varieties. A higher number of varieties is expected when the local variety name is included during sorting.

Table 26a. Number of Sweet Potato Varieties by Ethnic Group, Sorted by Characteristic Alone

ETHNIC GROUP	Number of Varieties
Kadazan	7
Dusun	104
Murut	50
Bajau	1
Berunai	3
Rungus	16
Paitan	10
Kedayan	2
Sungai	7
Others	21
Total	221

Table 26b. Number of Sweet Potato Varieties by Ethnic Group, Sorted by Local Names and Characteristics

ETHNIC GROUP	No of varieties
Kadazan	18
Dusun	334
Murut	44
Bajau	7
Iranun	4
Total	407

Table 27a. Number of Sweet Potato Varieties by District, Sorted by Characteristics Only

DISTRICTS	No. of Varieties
Beluran	17
Kota Marudu	28
Kuala Penyu	10
Kudat	16
Kinabatangan	25
Lahad Datu	10
Pensiangan	17
Pitas	15
Ranau	26
Sipitang	16
Tenom	12
Nabawan	13
Telupid	20
Total	225

Table 27b. Number of Sweet Potato Varieties by District, Sorted by Local Names and Characteristics

DISTRICT	No of varieties
Kota Kinabalu	9
Kota Belud	82
Keningau	100
Penampang	29
Papar	26
Tuaran	84
Tambunan	77
Total	407

Each farmer maintains an average of two varieties in most districts regardless of their ethnic groups. Those farmers that maintain more -- up to four, come from Pitas, Kudat and Kota Marudu areas, peopled by the Rungus and in the Beluran area by the Sungai (Tables 28 & 29). These communities rely on this food crop as their source of carbohydrate (Table 31). Surprisingly, the Muruts are not among them, probably because of their preference for cassava.

Table 28. Number of Sweet Potato Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran	7	32	4
Kota Kinabalu	6	10	1
Kota Marudu	68	285	4
Kota Belud	27	92	3
Kuala Penyu	7	19	2
Kudat	24	112	4
Keningau	48	126	2
Kinabatangan	36	110	3
Lahad Datu	8	22	2
Penampang	13	33	2
Papar	17	26	1
Pensiangan	11	30	2
Pitas	5	26	5
Ranau	62	290	4
Sipitang	12	28	2
Tuaran	53	128	2
Tambunan	46	97	2
Tenom	11	30	2
Nabawan	8	22	2
Telupid	20	70	3
Total	489	1588	52

Table 29. Number of Sweet Potato Varieties Per Ethnic Group

ETHNIC GROUP	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Kadazan	15	32	2
Dusun	352	1162	3
Murut	60	165	2
Bajau	4	8	2
Berunai	1	4	4
Rungus	25	115	4
Paitan	3	21	7
Iranun	2	4	2
Kedayan	1	2	2
Sungai	20	64	3
Others	6	11	1
Total	489	1588	32

The varieties that many farmers maintained are of early to medium maturity, green mature leaf color, white and red root skin color, white root flesh color and round root shape (Table 30). Most of the varieties are utilized for food and for making cakes (Table 31).

Table 30. Number of Sweet Potato Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
Early	475
Medium	516
Late	62
Others not specified	422
B. Mature Leaf Color	
Green	908
Red	153
Purple	31
Mixture	14
Yellow	26
Others no specified	456
C. Mature Leaf Shape	
Entire	612
Lobed	356
Others	459
D. Root Skin Color	
White	568
Yellow	167
Red	496

Others no specified	61
E. Root Flesh Color	
White	741
Yellow	347
Light Purple	359
Others no specified	100
F. Root Shape	
Round	749
Elongated	154
Others not specified	128

Table 31. Number of Sweet Potato Varieties by Use

USES	No. of Varieties
Food	772
Cake	396
Sell	283
Animal feed	29
Vegetable	37
Medicine	1
Wine	13
Total	1531

4.5 Taro

Taro is mostly grown by the Dusun, Murut and Rungus (Tables 32a & 32b). Less than 40 varieties can be found in several districts if sorted by characteristics alone (Table 33a). However, the number increases if local names are added (Table 33b).

Table 32a. Number of Taro Varieties by Ethnic Group, Sorted by Characteristics Only

ETHNIC GROUP	No of Varieties
Kadazan	5
Dusun	108
Murut	48
Bajau	1
Berunai	2
Rungus	31
Paitan	13
Kedayan	3
Sungai	7
Others	23
Total	241

Table 32b. Number of Taro Varieties by Ethnic Group, Sorted by Local Name and Characteristics

ETHNIC GROUP	No of varieties
Kadazan	21
Dusun	415
Murut	1
Iranun	1
Others	1
Total	439

Table 33a. Number of Taro Varieties by District, Sorted by Characteristics Only

DISTRICTS	No. of Varieties
Beluran	8
Kota Marudu	29
Kuala Penyu	9
Kudat	28
Kinabatangan	37
Lahad Datu	6
Pensiangan	12
Pitas	18
Ranau	35
Sipitang	22
Tenom	11
Nabawan	12
Telupid	15
Total	242

Table 33b. Number of Taro Varieties by District, Sorted by Local Names and Characteristics

DISTRICT	No of Varieties
Kota Kinabalu	21
Kota Belud	62
Keningau	110
Penampang	66
Papar	35
Tuaran	103
Tambunan	87
Total	484

Each farmer maintains at least two varieties (Table 34). A higher number of varieties are maintained by the Dusun in areas like Sipitang and Tuaran, and among the Rungus in Kudat (Table 35).

The varieties preferred by most farmers are those that have medium-late maturity, white corm flesh, green stem color and presence of corm (Table 36). Taro is mainly used for home consumption to supplement rice (Table 37).

Table 34. Number of Taro Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran	6	17	2
Kota Kinabalu	8	21	2
Kota Marudu	65	229	3
Kota Belud	24	82	3
Kuala Penyu	9	17	1
Kudat	23	137	5
Keningau	56	132	2
Kinabatangan	35	87	2
Lahad Datu	6	12	2
Penampang	22	82	3
Papar	20	39	1
Pensiangan	14	37	2
Pitas	5	30	6
Ranau	59	229	3
Sipitang	13	59	4
Tuaran	60	248	4
Tambunan	47	106	2
Tenom	12	46	3
Nabawan	11	31	2
Telupid	16	36	2
Total	511	1677	57

Table 35. Number of Taro Varieties Per Ethnic Group

ETHNIC GROUP	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Kadazan	14	30	2
Dusun	367	1192	3
Murut	71	210	2
Bajau	1	2	2
Berunai	1	2	2

Rungus	24	144	6
Paitan	3	21	7
Iranun	1	1	1
Kedayan	2	6	3
Sungai	19	41	2
Others	8	28	3
Total	511	1677	33

Table 36. Number of Taro Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
Early	54
Medium	398
Late	395
no answer	567
B. Corm Flesh Color	
White	339
White with violet tinge	177
Yellow	154
Light green	19
Others no specified	205
C. Stem Color	
Green	338
Violet	146
Black	90
Mixture	41
Yellow	29
Others not specified	233
D. Presence of cormel	
Yes	431
No	5
No answer	295

Table 37. Number of Taro Varieties by Use

USES	No. of varieties
Food	546
Cake	236
Selling/Market	252
Chicken /animal feed	67
Vegetables	195
Wine	113
Total	1409

4.6 Corn

Dusun, Murut and Rungus again have a higher number of varieties (Tables 38a & 38b). Less than 20 varieties are found in several districts if sorted by characteristics alone (Table 39a). The increased number of varieties shown in Table 39b suggests the diverse local names of corn.

Table 38a. Number of Corn Varieties by Ethnic Group, Sorted by Characteristics Alone

ETHNIC GROUP	Number of Varieties
Kadazan	5
Dusun	65
Murut	31
Berunai	1
Rungus	22
Paitan	2
Kedayan	4
Sungai	13
Others	10
Total	153

Table 38b. Number of Corn Varieties by Ethnic Group, Sorted by Local Names and Characteristics

ETHNIC GROUP	No of varieties
Kadazan	6
Dusun	260
Murut	46
Bajau	2
Iranun	3
Paitan	1
Iban	4
Total	322

Table 39a. Number of Corn Varieties by District, Sorted by Using Characteristics Only

DISTRICTS	No. of Varieties
Beluran	5
Kota Marudu	21
Kuala Penyu	7
Kudat	20
Kinabatangan	21
Lahad Datu	7
Pensiangan	8

Pitas	4
Ranau	17
Sipitang	17
Tenom	7
Beaufort	2
Nabawan	2
Telupid	8
Total	153

Table 39b. Number of Corn Varieties by District, Sorted by Using Local Names and Characteristics

DISTRICT	No of Varieties
Kota Kinabalu	4
Kota Belud	44
Keningau	94
Penampang	24
Papar	19
Tuaran	59
Tambunan	78
Total	322

Each farmer maintains at least one variety (Tables 40 & Table 41). Again the Dusun, Rungus and Murut communities grow more than one variety.

Table 40. No Corn Varieties Per Farmer by District

DISTRICT	No of Farmers	No of Varieties	No of Varieties Per Farmer
Beluran	5	5	1
Kota Kinabalu	4	4	1
Kota Marudu	61	138	2
Kota Belud	25	44	2
Kuala Penyu	6	8	1
Kudat	25	70	2
Keningau	49	97	2
Kinabatangan	34	65	2
Lahad Datu	8	14	1
Penampang	15	24	1
Papar	13	19	1
Pensiangan	9	13	1
Pitas	4	5	1

Ranau	49	96	2
Sipitang	11	33	3
Tuaran	43	62	1
Tambunan	47	81	2
Tenom	11	16	1
Beaufort	1	2	2
Nabawan	7	12	2
Telupid	16	21	1
Total	443	829	32

Table 41. Number of Corn Varieties Per Ethnic Group

ETHNIC GROUP	No of Farmers	No of Varieties	No of Varieties Per Ethnic
Kadazan	8	11	1
Dusun	315	571	1
Murut	60	111	1
Bajau	2	2	1
Berunai	1	1	1
Rungus	26	72	3
Paitan	4	4	1
Iranun	2	3	1
Iban	1	4	1
Kedayan	2	5	2
Idaan	-	-	-
Others	5	13	2
Sungai	17	32	1
Total	443	829	16

Generally, the corn varieties preferred are those that mature early, medium to tall, various kernel colors, round and medium to long in length (Table 42).

The different characters-maintained suit their daily requirements for consumption and chicken feeds (Table 43).

Table 42. Number of Corn Varieties by Morpho-agronomic Characteristics

CHARACTERS	No. of Varieties
A. Maturity	
Early	345
Medium	69
Late	9
Others not specified	209
B. Plant Height	
Short	44
Medium	173
Tall	339
Others	272
C. Kernel Color	
White	136
Yellow	210
Purple	40
Red	100
Mixture	48
Others	152
D. Kernel Shape	
Elongated	93
Pointed/Chisel like	76
Round	194
Others	269
E. Ear Length	
Short	57
Medium	174
Long	171
Others not specified	207

Table 43. Number of Corn Varieties by Socio-cultural Factors

USES	No. of Varieties
1 Food	488
2 Cake	72
3 Selling/Market	160
4 Chicken /animal feed	318
5 Wine	51
Total	1089

4.7 Traditional and Wild Vegetables

The number of vegetable types, based on local names alone, ranges from 26 to 232 in all districts surveyed (Table 44). The highest numbers recorded were from Kota Marudu and Keningau. The Dusun, Murut and Kadazan communities utilise the most (Table 45). The high diversity of vegetables correlates well with the present ecosystem of these areas, where farmers are still very much dependent on these vegetables. It must be stressed that one type of vegetable could be called differently by a particular ethnic group. Even within the same ethnic group, for example the Dusuns, one type of vegetable could be called differently.

Table 44. Number of Traditional and Wild Vegetable Types by District

DISTRICT	No of Varieties
Beluran	31
Kota Kinabalu	31
Kota Marudu	232
Kota Belud	143
Kuala Penyu	50
Kudat	106
Keningau	203
Kinabatangan	132
Lahad Datu	34
Penampang	106
Papar	85
Pensiangan	63
Pitas	26
Ranau	160
Sipitang	102
Tuaran	155
Tambunan	157
Tenom	54
Beaufort	15
Nabawan	42
Telupid	87
Total	2014

Table 45. Number of Traditional and Wild Vegetable Types by Ethnic Group

ETHNIC GROUP	No of varieties
Kadazan	131
Dusun	884
Murut	241
Bajau	28
Berunai	4

Rungus	114
Paitan	31
Tidung	5
Iranun	5
Kedayan	31
Sungai	67
Iban	3
Others	50
Total	1594

4.8 Spices

The highest number of varieties (based on local names only) recorded came from the Ranau district, followed by Kota Marudu and Kinabatangan districts. These areas are peopled by the Dusun, Murut and Sungai communities (Tables 46 & 47).

Table 46. Number of Traditional and Wild Spice Types by District

DISTRICT	No of Varieties
Beluran	22
Kota Kinabalu	3
Kota Marudu	76
Kota Belud	16
Kuala Penyu	21
Kudat	38
Keningau	14
Kinabatangan	59
Lahad Datu	17
Penampang	10
Papar	9
Pensiangan	27
Pitas	12
Ranau	82
Sipitang	29
Tuaran	16
Tambunan	15
Tenom	17
Nabawan	19
Telupid	37
Beaufort	5
Total	534

Table 47. Number of Traditional and Wild Spice Types by Ethnic Group

ETHNIC GROUP	No of varieties
Kadazan	18
Dusun	184
Murut	57
Bajau	2
Berunai	4
Rungus	41
Paitan	6
Tidung	4
Kedayan	9
Sungai	15
Others	48
Total	388

4.9 Traditional and Wild Fruits

The highest number of traditional and wild fruits (based on local names only) is recorded from Keningau district, followed by Tambunan, Penampang, Sipitang and Kudat (Tables 48 & 49). These areas are still mostly forest-covered thus the great variety of fruits utilized.

Table 48. Number of Traditional and Wild Fruit Types by District

DISTRICT	No of Varieties
Kota Kinabalu	22
Kota Marudu	8
Kota Belud	50
Kudat	60
Keningau	104
Penampang	68
Papar	59
Pensiangan	22
Pitas	36
Ranau	81
Sipitang	65
Tuaran	51
Tambunan	70
Beaufort	27
Total	723

Table 49. Number of Traditional and Wild Fruit Types by Ethnic Group

ETHNIC GROUP	No of varieties
Dusun	88
Murut	58
Rungus	60
Paitan	36
Kedayan	39
Others	14
Total	295

4.10 Common Fruits

The three common fruits utilized by all the communities are banana, durian and rambutan. The varieties are sorted based on local name and farmer's brief descriptions.

More than 20 varieties of banana are recorded in all districts (Table 50). The highest number recorded were in the Kota Marudu, Ranau, Kinabatangan and Kudat areas. Again, Dusun, Murut and Rungus utilise more varieties (Table 51).

Table 50. Number of Banana Varieties by District, Sorted by Local Names Only

DISTRICT	No of Varieties
Beluran	39
Kota Marudu	136
Kuala Penyu	24
Kudat	87
Kinabatangan	95
Lahad Datu	31
Pensiangan	55
Pitas	32
Ranau	104
Sipitang	72
Tenom	43
Nabawan	40
Telupid	46
Beaufort	22
Total	826

Table 51. Number of Banana Varieties by Ethnic, Sorted by Local Names Only

ETHNIC GROUP	No of varieties
Kadazan	20
Dusun	300
Murut	129
Bajau	5
Berunai	7
Rungus	90
Paitan	26
Tidung	10
Kedayan	25
Sungai	67
Others	49
Total	728

More than 30 varieties of durian have been recorded in the districts of Kota Marudu, Kinabatangan, Ranau and Sipitang (Table 52). Again Dusun, Murut and Sungai utilise more varieties (Table 53).

Table 52. Number of Durian Varieties by District, Sorted by Local Names Only

DISTRICT	No of Varieties
Beluran	17
Kota Marudu	35
Kota Belud	3
Kuala Penyu	15
Kudat	9
Keningau	25
Kinabatangan	34
Lahad Datu	12
Penampang	6
Papar	18
Pensiangan	26
Pitas	7
Ranau	44
Sipitang	31
Tuaran	10
Tambunan	9
Tenom	15
Nabawan	22
Telupid	24
Beaufort	12
Total	374

Table 53. Number of Durian Varieties by Ethnic Group, Sorted by Local Names Only

ETHNIC GROUP	No of varieties
Kadazan	2
Dusun	129
Murut	55
Berunai	2
Rungus	11
Paitan	4
Iban	1
Kedayan	12
Sungai	31
Others	18
Total	285

Most districts grow more than 20 varieties of rambutan (Table 54). The highest number were in the districts of Kinabatangan, Kota Marudu and Ranau. Again, these areas are peopled by the Dusun, Murut and Sungai communities (Table 55).

Table 54. Number of Rambutan Varieties by District, Sorted by Local Names Only

DISTRICT	No of Varieties
Beluran	8
Kota Kinabalu	3
Kota Marudu	50
Kota Belud	6
Kuala Penyu	9
Kudat	20
Keningau	39
Kinabatangan	58
Lahad Datu	18
Penampang	8
Papar	11
Pensiangan	31
Pitas	7
Ranau	57
Sipitang	31
Tuaran	14
Tambunan	25
Tenom	28
Nabawan	31
Telupid	27
Beaufort	6
Total	487

Table 55. Number of Rambutan Varieties by Ethnic Group, Sorted by Local Names Only

ETHNIC GROUP	No of varieties
Kadazan	18
Dusun	182
Murut	95
Berunai	2
Rungus	21
Paitan	4
Iban	1
Kedayan	8
Sungai	32
Others	17
Total	380

5.0 SEED SUPPLY SYSTEM FOR RICE

Most of the farmers get their supply of seed from their own farm or from their neighbors and relatives. The exchange of seeds is generally limited within their village or districts (Table 56). The formal seed supply from the Department of Agriculture is confined mostly to wet rice areas in the districts of Kota Kinabalu, Kota Belud, Penampang and Papar.

Table 56. Farmer's Source of Seeds by District

DISTRICT	Own Field		Relative		Other Farmer		Government and Private Institution		No Answer		Total
		%		%		%		%		%	
Beluran	12	70.5	5	29.4							17
Kota Kinabalu	7	46.7			8	53.3					15
Kota Marudu	79	100									79
Kota Belud	24	52.2	2	4.3	6	13.1	4	8.7	10	21.7	46
Kuala Penyu	12	100									12
Kudat	26	100									26
Keningau	77	100									77
Kinabatangan	45	100									45
Lahad Datu	11	100									11
Penampang	21	42			27	54	1	2	1	2	50
Papar	22	40	2	3.6	20	36.2	9	16.4	2	3.6	55
Pensiagan	14	100									14
Pitas	5	100									5

Ranau	59	93.7	1	1.6					3	4.8	63
Sipitang	17	100									17
Tambunan	93	89.4			7	6.7	1	0.7	3	2.9	104
Tenom	10	100									10
Beaufort	2	100									2
Nabawan	12	92.3							1	33.3	13
Telupid	22	100									22

Hill rice farmers are totally dependent on the informal seed supply system. Exchange of seeds are quite common among farmers -- although with certain informal agreements. This is usually in the form of compensation including a chicken (Table 57).

Table 57. Farmer's Seed Exchange Agreement by Ethnic Group

ETHNIC GROUP	**Replace with same amount**		**Replace with double amount**		**Give a chicken as a 'sogit'**		**Replace with the same amount and a chicken**		**Change with things that have the values seeds taken**		**$10-20/tin with the owner understanding**		**Total**
		%		%		%		%		%		%	
Kadazan	7	25.9	4	14.8	12	44.4	4	14.8					27
Dusun	105	37	31	10.9	108	38	37	13	2	0.7	1	0.4	284
Murut	29	87.9			1	3			2	6.1	1	3	33
Bajau	1	100											1
Berunai					1	100							1
Rungus	5	22.7	3	13.6	12	54.6	1	4.5	1	4.5			22
Paitan	1	33.3							1	33.3	1	33.3	3
Tidung	1	100											1
Kedayan	3	75			1	33.3							4
Sungai	4	21.1	2	10.5	10	52.6	1	5.3			2	10.5	19
Others	10	100											10

Farmer's criteria for good quality seeds are quite general but holistic in nature compared to the formal system (Table 58). They do not specify seed quality in detailed terms like moisture content and germination rate. Instead, they look for the physical character and manifestation of the seed in terms of its eating quality, good yield, reasonable storability and pest resistance. This criterion is much more related to the performance of variety in a particular ecosystem, rather than the internal quality of the seed when they are distributed by the formal system. In other words, a farmer can only say whether the seed is of high quality when they have seen their performance in their field compared to other varieties.

Table 58. Seed Quality Criteria of the Informal Sector

CRITERIA	No. of Respondents
Health (free from pests and disease)	436
Good quality and good yield	8
Easy to thresh	0
No answer	237
Total	681

6.0 CONSERVATION OF RICE VARIETIES

Both male and female carry out conservation among nearly all the ethnic groups (Table 59). Although majority of the farmers have been maintaining their seeds for more than 50 years, some of them have also been acquiring and trying out new varieties (Table 60). The Kadazans seem to be among the keenest in trying out new varieties and they are the ones who is losing a larger percentage of their varieties.

Table 59. Gender Role in Rice Conservation

ETHNIC GROUP	FARMER			Wife and Husband
	Male	Female	Total	
Kadazan	3	4	7	-
Dusun	102	101	202	1
Murut	32	8	40	-
Bajau	1	-	1	-
Berunai	1	-	1	-
Rungus	18	9	27	-
Paitan	2	1	3	-
Tidung	1	-	1	-
Kedayan	2	-	2	-
Idaan	-	-	-	-
Sungai	14	11	25	1
Others	6	3	8	1

Table 60. Maximum Number of Years Rice Varieties are Maintained by Farmers

ETHNIC GROUP	1-5 years		5-10 years		11-15 years		>20 years		> 50 years		Total
		%		%		%		%		%	
Kadazan	18	42	2	5	-		2	5	21	49	43
Dusun	50	10	18	4	3	1	11	2	414	8	496

Murut	5	7	1	1	1	1	-		69	91	76
Bajau	1	8	1	8	1	8	-		9	75	12
Berunai	-		-		-		-		1	100	1
Rungus	-		-		-		7	32	15	68	22
Paitan	-		-		-		-		4	100	4
Tidung	-		-		-		-		1	100	1
Iranun	-		1	33	-		-		2	67	3
Iban	-		-		-		-		1	100	1
Kedayan	1	33	-		-		-		2	67	3
Sungai	2	7	-		-		-		25	93	27
Others	2	22	-		-		1	11	6	67	9
Total	79		23		5		21		570		

Fortunately, except for the Kadazan, Dusun, and Murut communities, the percentage of varieties lost in most communities is not significant (Tables 61 & 62). Some of the abandoned varieties from a particular ethnic group are still available from other ethnic groups.

Table 61. Number of Wet Rice Varieties Lost by Ethnic Groups

ETHNIC GROUP	No of varieties
Kadazan	39
Dusun	61
Bajau	5
Murut	6
Sungai	1
Kedayan	10
Total	122

Table 62. Number of Hill Rice Varieties Lost by Ethnic Groups

ETHNIC GROUP	No of varieties
Kadazan	6
Dusun	39
Bajau	2
Murut	30
Rungus	8
Paitan	2
Sungai	13
Others	1
Total	101

The common reasons why varieties are abandoned include, low resistance to pest, difficult to thresh, coupled with a reduced farm space (Table 63).

Another reason which did not come out well from the survey on why the Kadazan community is losing their varieties could be related to the communities' better exposure and access to new varieties including modern high yielding varieties.

Table 63. Farmer's Reasons for Changing Rice Varieties

ETHNIC GROUP	Low Resistant to Pest	Low treshability	Reduce farm space	Low yield
Kadazan	2	2	5	4
Dusun	55	26	21	16
Murut	2	7	4	-
Bajau	-	-	2	2
Berunai	-	1	-	-
Rungus	3	2	-	-
Paitan	-	2	1	1
Kedayan	-	1	-	-
Sungai	-	4	3	1
Others	-	-	4	-
Total	62	45	40	24

7.0 RICE IMPROVEMENT

Improvement of crops which basically involve seed selection is carried out by both husband and wife in almost all the ethnic groups (Table 64). However, the role of the wife is more prominent among the Kadazan, Dusun and Murut communities. Grandparents and other knowledgeable elders from the village also play an important role in deciding on the selection of seeds for planting.

Table 64. Gender Roles in Rice Seed Selection

ETHNIC GROUP	Wife	Husband	Wife and Husband	Grandparents	Anybody
Kadazan	18	13	10	-	4
Dusun	166	75	198	30	60
Murut	43	6	21	2	2
Bajau	5	-	4	1	-
Rungus	-	1	6	10	8
Paitan	-	1	2	1	-
Tidung	1	-	-	-	-
Iranun	1	-	2	-	-
Iban	1	-	-	-	-

Kedayan	-	1	-	1	1
Sungai	6	98	18	-	-
Others	3	-	4	1	2
Total	244	98	261	46	78

The common breeding objectives of farmers from various ethnic groups are related to improvement of yield, maintenance of varieties and acquiring of healthy seeds (Table 65).

Table 65. Rice Breeding Objectives of Farmer's by Ethnic Groups

ETHNIC GROUP	**BREEDING OBJECTIVES***			
	i	ii	iii	iv
Kadazan	-	5	2	46
Dusun	21	96	58	535
Murut	8	12	4	75
Bajau	-	1	-	10
Berunai	-	1	-	1
Rungus	8	8	6	27
Paitan	-	1	1	4
Tidung	-	-	-	1
Iranun	-	-	-	3
Iban	-	-	-	1
Kedayan	1	-	1	3
Sungai	2	15	2	26
Others	2	5	2	10
Total	42	144	76	742

*Code for breeding objectives:
(i) Get good, healthy seeds free from pest & diseases
(ii) To improve yield
(iii) Maintain seeds and avoid extinction
(iv) No answer

Farmers, especially among the Dusun community, are very careful in selecting seeds for planting. They only select those that are fully mature and healthy (free from pests and diseases) and coming from healthy stands (Table 66). They chose the best among the best. The selection process starts when the rice begins to ripen, where they are selectively isolated and looked after until harvested. Where the stands are not found in a particular area of the field, they are selected one by one during harvesting.

Table 66. Techniques in Seed Selection of Farmers by Ethnic Groups

ETHNIC GROUP	SEED SELECTION TECHNIQUES*			
	i	ii	iii	iv
Kadazan	2	1	1	6
Dusun	151	6	2	243
Murut	4	2	1	61
Bajau	1			1
Rungus				27
Paitan				2
Iranun	1			
Kedayan				1
Sungai				25
Others				6
Total	159	9	4	372

*Code:
(i) Well mature, healthy, free from pests & disease.
(ii) Selected one by one during harvesting
(iii) Selection done after harvesting

8.0 INDIGENOUS KNOWLEDGE SYSTEM

Indigenous knowledge related to traditional farming practices, in addition to those mentioned under conservation and improvement, from all the ethnic groups are more or less similar in nature -- most are common-sense knowledge gained from their years of farming experience and close interaction with nature. This knowledge is manifested in terms of rules, regulations, prohibitions, ceremonies and rituals. The traditional agricultural practices of indigenous communities in Sabah are given in a separate report. The salient features of their traditional practices is related to harmony with nature, deep sense of respect for other creatures and spirits (especially food crops that they depend on for survival), subsistence and sustainability in mind, and an in-built mechanism for the use and access of resources. Traditional practice is undergoing changes and many of its salient features are slowly forgotten and discarded, thus contributing in some cases to land degradation and unsustainable utilization of natural resources.

9.0 DISCUSSION

9.1 Crop Diversity

The observations presented in the tables generally indicate the diversities of crops maintained by a particular ethnic group in a particular district (Table 67, 68, 69,70). It is not possible to determine the overall diversity of a particular crop in the State or the diversity of a particular crop maintained by a particular ethnic group. Therefore, the overall status of crop

diversity in the State is not fully resolved. There are many reasons for this, which was not fully appreciated during the survey. The questionnaire approach which tends to focus more on what the farmer can describe, without validating them in their fields has limitations. It was found out that each ethnic group and sub-groups call the same variety of a particular crop differently, using their local dialect. For example, among the Murut communities, a particular variety of cassava may be called by a different name, depending on where they are found among the sub-ethnic group. Farmers within the same sub-ethnic group also do not necessarily give a similar description to a particular variety of crops even if they are shown a Standard Descriptors List of a particular crop. Farmers, although well acquainted with the variety of crops that they maintain, cannot remember all the fine details or differences from each variety. Since most of the farmers' farms are located far away from their home, it was not possible to check on most of the information supplied by them. To fully resolve the overall status of crop diversity in the State, tedious work involving the characterization of each variety of a particular crop will need to be carried out. The agricultural research centres of the State have already initiated this work, especially on spices, nuts and fruit trees (Wong & Lamb, 1993). Documentation of native edible plants has been initiated by UKM (Kamarudin, 1991).

Rice germplasm collection carried out by the Agricultural Research Center of Tuaran throughout the state since the early 60's has accumulated more than 1000 local varietal names for both wet and upland rice. The characteristics of each variety, however, have not been systematically recorded and sorted yet. A rough comparison between the center's list of local varietal names with the list gathered during this survey showed the occurrence of a number of additional local varietal names for wet and upland rice. This does not necessarily mean that the diversity has increased. It possibly indicates the wider spatial and ethnic coverage of the present survey. The large number of varieties by local names does not mean very much. It is interesting that out of the 906 seed files collected during the present survey, only 166 (18%) appears to be totally different, after being sorted out using six distinctive criteria described earlier, instead of relying on their local names. Although there are indications that certain ethnic groups (e.g. Dusun and Murut) maintain a higher diversity of crops (e.g. rice and cassava), it is not clearly established whether this diversity is related to their cultural mode of farming and traditional practices. For example, the higher number of varieties of most food crops associated with the Dusun ethnic group could be largely due to their larger population (25% of total population) and wider geographic location in the state—thus their association with a more diverse agro-ecosystems. In the case of the Murut ethnic group, although their population is smaller (about 5% of total population) and confined to a particular geographic area, they still subsist on diverse agro-ecosystems. Their geographic proximity with the Dusun ethnic group and the indigenous groups in Sarawak could have added to their crop varieties through informal exchange of planting materials. The availability of larger areas suitable for certain food crop cultivation (e.g. wet rice) in a particular district (e.g. Keningau, Tambunan, Kota Marudu, Kota Belud, Tuaran) generally adds to their diversity. This diversity is generally well maintained in areas where modern farming technology has not been successfully implemented yet (e.g. Tambunan and Keningau Districts) and the local climatic pattern still plays a major role.

The wide range of agro-morphological characteristics of rice planted by farmers, especially hill rice cultivators, strengthen earlier observations made by Vaughan (1989) and Mariam et al., (1991). This genetic resource, if sustainably managed, can meet the specific

requirements of farmers in different ecosystems in the State. Presently, only about 30% of the seed requirement for wet rice in the State are met by the formal system using modern high yielding varieties, whereas hill rice farmers depend totally on the informal seed supply system using traditional varieties. The recent shortage of rice in Long Pasia, Sipitang due to the inability of the farmers to plant hill rice because of adverse weather conditions (Maria, 1996) could have been avoided if farmers were able to access suitable seeds through formal or informal means. Similarly, the other crops, like cassava, sweet potato, taro and corn, which also have wide agro-morphological characteristics can be further studied for their potential commercial use. Traditional vegetables, spices and fruits are still very popular among the rural communities and are gaining some appreciation in town areas. The increasing demand for these in town, if not controlled, may threaten their diversity. On the positive side, it may discourage the destruction of their natural habitats.

9.2 Threats to Crop Diversity and the Process that Sustains it

Without the necessary background information, it is not possible to assess how many genetic resources on crops have been lost or eroded. It can only be assumed that the rate of destruction and change roughly corresponds to the rate of erosion of crop diversity in a particular area. The low crop diversity recorded in several areas (e.g., Kudat, Pitas, Sandakan, Lahad Datu, Sipitang) are directly related to the commercialization of agriculture. Deforestation by logging, followed by the establishment of huge monocrop plantations of either oil palm, cocoa, rubber or fast-growing trees are the major culprits. Food crops like gathered vegetables, spices, nuts and wild fruit trees which thrive well in their natural habitats are affected most. It is possible that some of these food crops may only grow in certain areas of Sabah.

The traditional practice of mixed cropping has generally maintained the diversity of commonly grown crops, even within the large plantation areas. However, the ever-growing acreage of these plantations in competition with the land requirement of farmers will definitely limit the capability of farmers to maintain the diversity of these crops. While it is generally recognized that these plantations are necessary to generate the cash needed, it must also be recognized that the maintenance of crop diversity not only ensures that the food security of the State is guaranteed but is also a more sustainable practice. The diversity of crops together with the knowledge associated with it should be buily upon when developing appropriate biodiversity conservation strategies for the State.

While there have been attempts to increase the acreage of rice growing areas during the past few years, there is also the danger that traditional rice varieties are being displaced. The trend towards commercialization of rice in areas such as Tuaran, Kota Belud, Kota Marudu, Papar, Penampang and recently Tambunan, Keningau and Tenom is discouraging farmers to maintain their traditional varieties, which are considered to be low yielding. If the new rice varieties produced by modern technology are higher yielding, why worry about traditional seeds, one may ask. The answer lies in the fact that modern agriculture still depends heavily in the availability of biological diversity (Hobbelink, 1994). Local farmers in these areas know the risks involved in relying too much on a narrow genetic base. This could have contributed to the stubborn resistance of farmers to the government efforts towards genetic uniformity and

modernization. It is therefore necessary to be aware that while new high yielding varieties are introduced in these areas, traditional varieties that adapt well here, will need to be maintained and possibly given an equal chance to be developed further. In other words, the modern high yielding varieties should be seen as an addition to the existing diversity of rice in these areas, rather than a replacement for them. In areas that have already lost much of their traditional varieties, an informal institution may be needed to supply or reintroduce traditional varieties. It may be necessary for farmers to acquire genetic resources which the institutional system has in its gene bank and working collections, for them to maintain and adapt to their environment.

9.3 Conservation and Development Strategies on Rice

The existence of a high diversity of rice varieties among the farmers in Sabah supports the view that farmers are natural breeders, and they should be given due recognition when formulating a conservation strategy (de Boef et al., 1993; Hobbelink, 1994). According to Hobblelink, on-farm conservation has obviously been the backbone of agriculture development since farming began. But today, it is increasingly becoming recognized as a vital approach to redress the problems associated with the conventional strategies of the gene bank and nature park, which fail to recognize the role of local communities.

Exchange of seeds among farmers is usually based on mutual agreement and almost always accompanied by a chicken as a “sogit” (non-material compensation). The non-material compensation is significant because, for farmers, the process of seed exchange is not confined to the genetic stock only but the whole knowledge and culture associated with it. Berg (1994) refers to this farmer-to-farmer movement of biodiversity as “diffusion”, which means the spread of a farm technology element with enough associated diversity and skill, in contrast to “introduction” by explorers or scientists which very often come with a narrow genetic base.

The survey has indicated that most farmers have maintained their seeds for more than 50 years and the reasons why they continue to maintain a particular variety are quite different from the formal sector. Farmers allow their variety to evolve naturally and continuously, in contrast to formal breeding strategies which aim to produce stable varieties which are not supposed to evolve or undergo changes. Farmers are tolerant of intra-varietal diversity which suits their particular environment, as compared to the uniformity and wide adaptability required by the formal breeders. It appears that farmer’s conservation and development strategies are more natural and independent compared to those formal strategies which are usually dictated by formal requirements.

It must be pointed out that farmer's conservation and development strategies have limitations. For example, the number of varieties farmers can manage are quite limited, and there is the tendency to discard old varieties, once better varieties are acquired. To enable farmers to maintain a certain number of varieties economically within their existing farming system, soil suitability and seed storage will need to be strengthened and improved, using modern scientific knowledge. It may be necessary for farmers to acquire hybridization techniques and more efficient selection methods which scientists have developed. There is an

increasing realization that the innovation systems of farmers should complement the institutional innovation systems (RAFI, 1994).

10.0 CONCLUSION

10.1 Crop Diversity:

- Farmers, regardless of their ethnic group maintain food crop diversity. Each farmer maintains more than one variety of a particular food crop. In fact, where land and labor are available, farmers are inclined to plant as many varieties as possible -- mixed cropping is a norm. The more they use and depend on certain types of food, the more variety they maintain. The Murut and Rungus communities for instance, who are mostly upland farmers, distinctively show their interest in maintaining high diversity of cassava, sweet potato and corn apart from rice. Such genetic diversity provides security for farmers against pests, diseases and unexpected climatic conditions.

- The overall status of crop diversity based on the number of varieties maintained by farmers in different districts is not so bad. There are about 20-50 varieties of wet rice, hill rice, cassava, sweet potato, taro and corn recorded in almost all districts. In the interior part of Sabah most of the crop diversity is still intact. Even in the west coast area, where rapid infrastructure development is pursued at the expense of the natural resource base, the crop diversity maintained by farmers is still high. However, areas replaced by large agricultural plantations in the eastern and northern part of Sabah are the most threatened and show the least diversity.

10.2 Seed Supply System:

- Farmers still rely very much on the informal system due to its reliability compared to the formal system. Since each farmer maintains a particular variety year after year for their particular ecosystem, and they have an established seed exchange mechanism among themselves, the need for an outside seed supplier is not critical. However, in certain areas which are undergoing rapid agricultural transformation, for instance on the west coast of Sabah, seed supply from the formal sector is becoming more prominent.

- Selection of seeds by farmers is very much influenced by how a particular seed performs in their local setting and not so much on the internal qualities of the seed (for example uniformity, stable or wide adaptability).

10.3 Conservation and Development:

- The conservation practice is basically related to the survival of farmers. They tend to conserve crops that are useful to them and suited to their particular environment. The number of varieties farmers can manage are quite limited, the most about five, and there is the tendency to discard old varieties once new varieties which fit their requirements are acquired.

- On development farmers' main concern is to increase their crop yield and at the same time maintain the number of varieties. Crop improvement is basically carried out through continuous varieties which can adapt well to their local environment. They allow their crops to evolve naturally.

- The potential for improving and developing traditional rice varieties through experimentation is enormous based on the availability of a wide range of genetic agro-morphological characteristics from existing farmer's seeds, which are suited to different cropping pattern, ecosystem and socio-cultural requirements.

11.0 RECOMMENDATIONS

11.1 Immediate and Short Term

- There is a need to recognize and appreciate the contribution of subsistence farmers, through their traditional practices, in maintaining the high diversity of food crops in certain part of the State. The efforts by the farmers need to be encouraged and their practices appropriately supported to ensure that food security in the State is guaranteed.

- In certain areas where the diversity of food crops is threatened (e.g., due to large commercial plantations and logging activities), appropriate ways will have to be sought to rectify the situation.

- Availability of materials to farmers.

- Enhancement of skills e.g., IKS in conservation and development.

- Where the traditional seed supply system in a particular area is undergoing changes, there is a need to study the positive and negative impact of these changes to come up with an appropriate mechanism to ensure that the diversity of rice is maintained.

- To support the concern of farmers in increasing crop yield and at the same time maintaining their crop diversity as a risk minimizing strategy, in-depth farm studies should be made to assess the strengths and weaknesses of their present farming system.

11.2 Long Term

- To conserve discarded varieties, which are not performing very well in a particular area, a mechanism needs to be created to facilitate the transfer of these seeds to another area.

- There is a need to maintain a wide database on the existing agro-morphological characteristics of seeds available throughout the state to support the *in-situ* conservation and development work in different ecosystems.

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