Land Use and Crop Diversity in Two Iban Communities, Sarawak, Malaysia

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Abstract

The difference in agricultural strategies of two Iban communities located in the hilly interior and the coastal zone of Sarawak, respectively, is studied through interviews, field measurements, and botanical collections. The diversity of crops and farming environments is very similar in both communities, the main difference being the production of wet rice with high yields in the coastal area. Here, self-sufficiency has been achieved, and with rice as the most important cash crop, intensification of farming practices is not an immediate priority. In the hilly area, rice production is very low and although yield increases may be possible with appropriate farming techniques, self-sufficiency is unrealistic at present. The subsidised cultivation of cash crops supplements the rice production, but failure of cocoa and unstable prices of pepper and rubber illustrate the need for careful monitoring of cash crop schemes. In addition, alternative indigenous cash and subsistence crops represent a largely unexplored potential which may prove essential for the development of remote communities in Sarawak.

Keywords

Shifting cultivation, upland rice, wet rice, rice yields, pepper, rubber, cocoa, indigenous vegetables.

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The classic description of the traditional Iban farming system (Freeman 1955) perfectly fits Conklin's (1957) definition of integral pioneer shifting cultivation where settlements are moved to access new primary forest areas for exploitation. Today the Iban, which is the largest ethnic group in Sarawak, are almost completely sedentary, and shifting cultivation of upland rice is carried out primarily in secondary forest and is only one of several components of their farming system (Cramb 1993; Padoch 1982). Cultivation of rubber and other cash crops has been known to Iban farmers since the last century and is now common even in fairly remote areas (Cramb 1988). Furthermore, secondary crops in different farming environments and wild plants collected in the forest play a significant role in the overall production supplying food and many other products (Christensen 1997; Cramb 1985).

This diversity of farming environments and crops is important not only in the hilly, remote areas but also to Iban settled in the more densely populated coastal zone. Significant numbers of Iban moved to the coastal areas in the 1950'es and took up intensive wet rice cultivation as land for upland rice and rubber had become scarce in certain parts of the interior (Cramb 1988; Sutlive 1992). Moreover, traditional shifting cultivation of wet rice in the interior is found in various degrees of intensity (Padoch 1982), and only few studies have looked into these diverse agricultural strategies of the Iban.

Based on case studies in two Iban communities situated in 1) the thinly populated, hilly interior and 2) the easily accessible and more densely populated coastal area, this paper elucidates differences and similarities in farming practices between these communities. Key elements, including crop selection, field sizes, field distribution and rice yields, are used to describe the present state of agricultural development and illustrate the importance of different farming environments as described by Christensen & Mertz (1993) - in this context farming environments refer to field or garden types as defined by their major crop(s). The success or failure of these environments as contributors to the subsistence of the communities, and the potentials for development, including introductions of new cash or subsistence crops, are discussed.

Areas of Study

Two Iban communities in the Lubok Antu District, Sri Aman Division, Sarawak were chosen: Nanga Sumpa, upper Batang Ai watershed, and Marup Baroh, lower Batang Ai watershed (Figure 1).

Nanga Sumpa has 28 households and 180 inhabitants (1995), including children in boarding school but excluding men having migrated for temporary employment. The village is situated at the Delok River (Figure 2) accessible only by 1.5 hours boat-ride from the Batang Ai hydroelectric dam. From there bus connections to the towns of Lubok Antu (10 km) and Sri Aman (75 km) are available. Average annual rainfall is 3450 mm (DID 1993). The area is very hilly with steep escarpments along rivers and only few, small riverine plains. The soils are unsurveyed but red-yellow inceptisols/ultisols seem to dominate as elsewhere in the interior of Borneo (DoA 1968). The natural vegetation is mixed hill dipterocarp rain forest but the area is today dominated by secondary forest at various stages and farm land. Only few areas with mature forest are found in the village territory. Farming practices of upland rice are very similar to those described earlier for the Iban of the same region (Jensen 1966; Padoch 1982) and other Bornean shifting cultivation systems (Chin 1985; Dove 1985) with the exception of few, more recent introductions such as the use of chain saws for felling and herbicides for weed control.

Marup Baroh has 26 households and 134 inhabitants. The village is situated 500 m from the main highway in Sarawak, 3 km from Engkilili town and 35 km from Sri

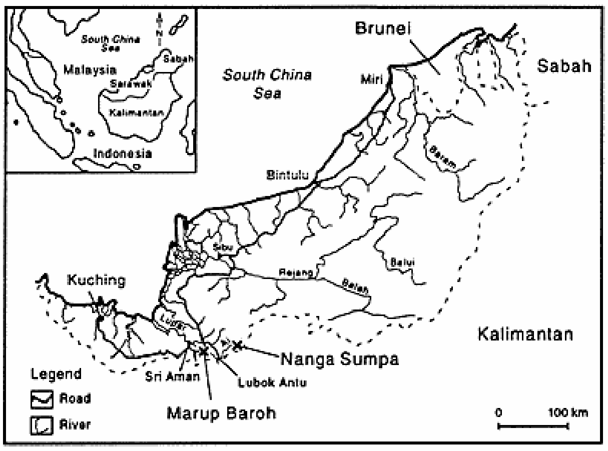

Figure 1: Map of Sarawak with locations of study areas (adapted from Cramb & Dixon 1988).

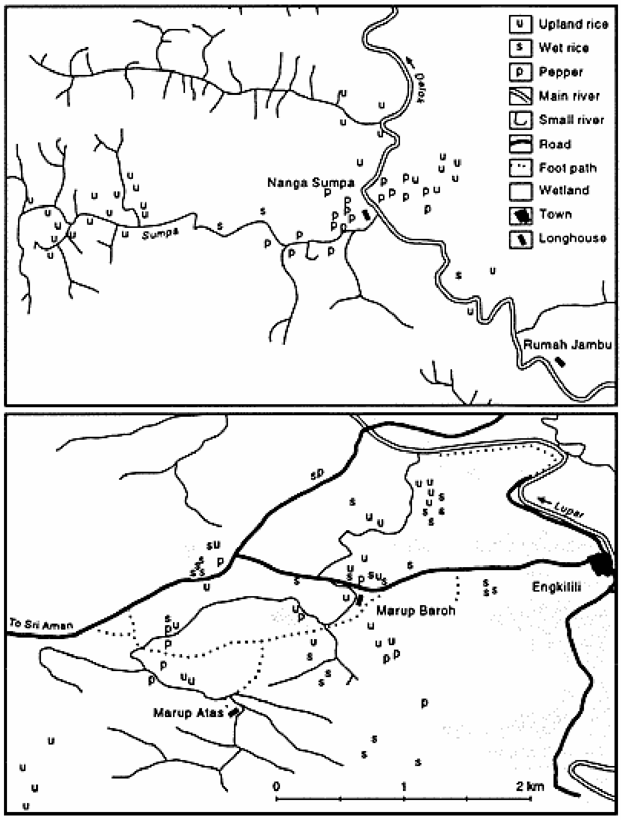

Figure 2: Distribution of rice fields and pepper gardens in Nanga Sumpa and Marup Baroh.

Aman (Figure 2). Other than Iban, numerous Chinese merchants and commercial farmers are found in the area. Average annual rainfall is 3615 mm (DID 1993). The location between the hilly interior and the coastal plains provides a topography ranging from steep hills to wide flood plains and diverse soils with histosols and alluvial entisols in the flood plains and ultisols in the hills (DoA 1968). Small patches of heath forest are left untouched but otherwise the landscape is dominated by young secondary forest and farm land. Shifting cultivation has to a large extent been replaced by semi-permanent cultivation of wet rice similar to the systems described by Padoch (1982), Seavoy (1973) and Sutlive (1992).

Methods

All Households

Interviews of all households in both communities with local English-speaking interpreters were aimed at deter-

Table 1: Farming environments in Nanga Sumpa and Marup Baroh.

Field type	Nanga Sumpa, 28 households (hh)				Marup Baroh, 24 households (hh)			
	Total	No of hh with field, (%)		Average fields/hh [1]	Total	No of hh with field, (%)		Average fields/hh [1]
Upland rice	40	27	(96.4)	1.5	24	20	(83.3)	1.2
Semi-upland rice	0				7	7	(29.2)	1
Wet rice	3	2	(7.1)	1.5	35	23	(95.8)	1.5
Pepper	24	23	(82.1)	1	12	11	(45.8)	1.1
Rubber	39	17	(60.7)	2.3	13	13	(54.2)	1
Cocoa	24	24	(85.7)	1	3	3	(12.5)	1
Vegetable, trad.	9	9	(32.1)	1	0			
Vegetable, proj.	26	26	(92.9)	1	0			
All fields	187	28	(100)	6.7	94	24	(100)	3.9
Different farm. env. [2]		7		4.0		6		3.3

[1] Only households with the field in question are included.

[2] Abandoned cocoa gardens excluded.

mining quantitative elements of the farming system such as number of fields, fallow periods, and yields. In Nanga Sumpa five series of interviews were carried out in the period 1992-96. In Marup two series of interviews were carried out in 1995-96. Rice yield data were obtained through interviews after the 1996 harvest and were based on household indications of the number of 50 kg bags used for temporary storage.

Field locations were estimated for rice and pepper gardens using a Garmin GPS. It was not possible to take readings in other farming environments because of tree cover. Readings of 65 fields (81% of total) in Nanga Sumpa and 68 (84% of total) in Marup Baroh were taken. One reading was taken at approximately the centre of each field and at the village. The error is in the order of 50 to 100 m.

Selected Households

Field size and cropping patterns of six households were surveyed. The households were chosen following a negotiation with the village. Based on interviews and observations, the six households in Nanga Sumpa are considered representative whereas in Marup Baroh they are estimated to be slightly above average as far as field numbers and production are concerned.

The perimeter of all fields was measured using measuring tape, compass, and clinometer, and the surface and projected areas of the resulting polygons were calculated. Interviews to determine the number of crops in each farming environment were carried out in the field during the cropping season to ensure that no crops were omitted.

Botanical Collections

All crops in Nanga Sumpa were recorded and identified by botanical collection or photo. Vouchers are deposited at Aarhus University, Denmark (AAU), Kew Garden, UK (K), and The Forest Department, Kuching, Sarawak (SAR). All rice varieties of Nanga Sumpa were collected in 1993 and stored at AAU.

Results

The relative importance of different farming environments in the two communities is shown in Table 1. The projected areas of fields (Table 2) are given to facilitate comparison with other studies but the surface areas may be more appropriate, notably when calculating yields, labour use, and other field size related data in hilly areas such as Nanga Sumpa. Slopes of 20 to 30° are cultivated with the same intensity as flat areas (plant spacing generally based on slope distance, not horizontal distance) and plant productivity is not necessarily higher in flat, narrow valley bot-

Table 2: Field sizes and distances to fields in Nanga Sumpa and Marup Baroh.

Field type [1]	Nanga Sumpa, 6 households (hh)				Marup Baroh, 6 households (hh)			
	Average area, m^2				Average area, m^2			
	Fields		Total/hh		Fields		Total/hh	
	projected	surface	projected	surface	projected	surface	projected	surface
Upland rice (10, 6)	7050	8560	11740	14260	2660	2780	3990	4170
Wet rice (0, 5)					7140	7140	7140	7140
Pepper (5, 6)	730	800	730	800	1340	1370	1600	1640
Rubber (2, 2)	2420	2460	2420	2460	3620	3650	3620	3650
Vegetable, trad. (4, 0)	30		30					
Vegetable, proj. (26, 0) [2]	12		12					
All fields			14930	17650			16350	16600
	Average distance, m (range)				Average distance, m (range)			
Upland rice (33, 25)			1520	(320-2670)			1280	(240-2870)
Wet rice (2, 28)			1030	(840-1210)			950	(330-1340)
Pepper (19, 11)			370	(180-850)			1000	(300-1510)

[1] No of field observations in brackets (Nanga Sumpa, Marup Baroh).

[2] Includes all households in Nanga Sumpa.

toms which may be less exposed to sun light. The resulting yields and labour use per area unit are considerably lower. The distances from village to fields are also shown in Table 2 and the spatial distribution of rice fields and pepper gardens is illustrated in Figure 2.

Rice fields

The upland rice fields (*umai padi bukit, Oryza sativa*) are cultivated using traditional swiddening techniques and intercropped with various other crops. The cropping season is from August/September to February/March.

In Nanga Sumpa all but one household farm upland rice. The average household has 1.5 fields situated 1.5 km from the village, often in a cluster with 3-5 fields belonging to other households (Figure 2).

The average surface area of 0.86 ha is 21% larger than the projected area, indicating cultivation of steep hill sides of up to 40° inclination. Four of the six households farmed two upland rice fields with an average total projected area per household of 1.17 ha. Inorganic fertilizers are very rarely used, but sometimes fertilizer originally supplied for pepper or other cash crops is used. Paraquat, bought or supplied free for pepper, is often used as weed control combined with manual weeding. Pesticides are almost never used.

The average fallow period in Nanga Sumpa seems to be more or less stable at 5 to 7 years and all fields are cultivated for one year only before renewed fallowing (Table 3). The main reason given for maintaining this - or preferably a longer - fallow period is problems with weeds, notably *Imperata cylindrica* (L.) Beauv., *Blechnum orientale* L., *Pteridium sp.* and *Sticherus truncatus* (Willd.) Nakai. The yields in Nanga Sumpa average 350 kg per ha or 290 kg per ha when based on the surface area.

In Marup Baroh, more than 80% of the households farm small patches of upland rice despite the importance of wet rice cultivation. A farming environment distinguished only in Marup Baroh is *umai padi emperan*. It is cultivated with upland rice on irregularly flooded land and often placed near wet rice fields. Less than one third of the households farm *umai padi emperan*, and they are in the following treated as upland rice fields.

The average upland rice field is 0.27 ha (projected) and located at a distance of 1.3 km from the village. Only three households had large upland rice fields and one of these households was included in the survey. Excluding this household gives an average area of 0.19 ha only. The real surface area is only 4.5% larger as most fields are

Field type/ Season	*Nanga Sumpa*			*Marup Baroh*		
	No of fields	*Average Fallow period*	*Average years of cultivat*	*No of fields*	*Average Fallow period*	*Average years of cultivat*
Upland/1992-93	32	5.6				
Upland/1993-94	37	5.1				
Upland/1994-95	33	6.9				
Upland/1995-96	37	5.8	1	24	7.8	2
Wet/1995-96	3	0	3	35	0	12.4

***Table 3:** Fallow periods and number of years each rice field is cultivated before next fallowing in Nanga Sumpa and Marup Baroh.*

relatively flat. Small amounts of fertilizer are often used and Paraquat is used for weed control combined with manual weeding. Pesticides are rarely used.

The average fallow period in Marup Baroh is 7.8 years and each field had been cultivated for an average of two years before, the 1995-96 season being the third year (Table 3). The upland rice yields in Marup Baroh of 1130 kg/ha are much higher than in Nanga Sumpa.

All households in Nanga Sumpa cultivate wet rice (*padi paya*) in small swampy patches within upland rice fields, but only two households cultivate separate wet rice fields (*umai padi paya*). Farming practices are identical with upland rice and there is no control of water.

Wet rice is the main crop in Marup Baroh cultivated in flood plains with limited control of water flow. All but one household farm wet rice and the average field is 0.71 ha and located at a distance of 950 m from the village. The fields are generally not levelled resulting in uneven water depth. As the wet rice matures faster than upland rice, it is sown about one month later. Weeds are controlled with Paraquat and by rolling an oil drum before planting. The rice is usually sown in a nursery and transplanted 2-3 weeks after germination. The water partly controls weeds but manual weeding is also necessary. Fertilizer may be applied but is mostly cited as unnecessary. Wet rice fields are generally cultivated permanently although occasionally left a few years as grass fallow. Average yields are 2460 kg per ha.

Vegetables

No distinct vegetable gardens exist in Marup Baroh. Vegetables are grown in upland rice fields or pepper gardens or bought at the market in Engkilili.

Nanga Sumpa is self-sufficient in vegetables cultivated in upland rice fields, pepper gardens, small vegetable gardens (*kebun sayur*) next to the village, and in a communal "project" vegetable garden (*kebun sayur projek*) with subsidized seeds and fertilizer. Nearly all households cultivate an average of 12 m^2 of raised beds in the project garden.

The vegetables produced in the upland rice fields are mainly for consumption during the cropping period of rice whereas the permanent cultivation of many species but few individuals in pepper gardens and small vegetable gardens secures a more regular supply. In both communities, many

***Table 4:** Cash crop farming environments in Nanga Sumpa and Marup Baroh: number of plants (main crop only) and history of cultivation of present garden types (December 1995).*

Garden type	*Nanga Sumpa - averages/household [1]*					*Marup Baroh - averages/household [1]*				
	No of plants (range)		*Years of cultivation (range)*		*Remaining productive plants*	*No of plants (range)*		*Years of cultivation (range)*		*Remaining productive plants*
Pepper	189	(100-300)	3	(1-7)	189	263	(100-620)	5	(1-11)	263
Rubber	749	(30-3000)	?	(3->30)	?	373	(200-800)	?	(13->30)	?
Cocoa	780	(120-2000)	5.9	(5-6)	24	467	(200-1000)	10	(10)	400
Illipe nut	15	(3-40)	?		?	0				

[1] Only households with the garden in question, see Table 1.

vegetables are also collected from the wild.

Cash crops

Data on the cash crops are presented in Tables 1-2 and 4. Pepper gardens (*kebun lada, Piper nigrum*) intercropped with vegetables and tree crops are farmed by 82% of the households in Nanga Sumpa and 46% in Marup Baroh. Most of the present pepper gardens in Nanga Sumpa were started in 1992 as part of a government subsidy programme providing cuttings/rooted cuttings, fertilizer, herbicides and pesticides for the initial three years of cultivation until the first harvest. In Marup Baroh most gardens are older and started without subsidies. The average distance from village to garden is 370 m and 1000 m in Nanga Sumpa and Marup Baroh, respectively. The field sizes in Marup Baroh are twice as large as in Nanga Sumpa, but as a much higher proportion of households in Nanga Sumpa owns pepper gardens, the total area under pepper may be larger.

The rubber gardens (*kebun getah, Hevea brasiliensis*) are inherited or more recently established. Households with a long tradition in the community may own as many as ten gardens. Just over half of the households in both communities own rubber but there are three times as many gardens in Nanga Sumpa and the number of trees per garden is twice as high. However, about 15% of the rubber gardens in Nanga Sumpa are found 3-4 hours' walk upriver and not tapped anymore. Fruit trees are allways intercropped in rubber gardens which, unless tapped, tend to revert to an impenetrable secondary forest. Due to low prices during the past 5-6 years rubber was seldom tapped. A new rubber scheme was initiated in 1996 providing 480 plants of a high yielding clone to each household in Nanga Sumpa.

Cultivation of cocoa (*kuku, Theobroma cacao*) was introduced in Nanga Sumpa six years ago with a subsidy programme similar to the more recent pepper scheme. About 86% of the households joined the scheme planting an average of 780 trees. Today only a few productive trees remain in the gardens and only one household was harvesting cocoa in 1995. More than 80% of the households say that they never sold any cocoa and by July 1996, all cocoa gardens had been abandoned and some were being cut down and converted to upland rice fields for the 1996-97 season. The main problems with cocoa seem to be black pod disease (*Phytophthora palmivora* (Butl.) Butl.) and squirrels eating the pulp of almost ripe pods.

Cocoa was not introduced to Marup Baroh under a subsidy scheme and only three households have planted cocoa at their own initiative. Most of the trees are still productive and harvested regularly, but squirrels and diseases are also a major problem here.

The illipe nut (*engkabang, Shorea macrophylla*) occurs wild in the forest in Nanga Sumpa and is semi-managed or cultivated by 24 households. The trees are not planted in gardens but mostly along rivers and are subject to individual ownership. Illipe nut requires little maintenance and although the fruit yields are very irregular it is a valued crop.

Distribution of crops

A total of 79 crops was identified in the rice fields, pepper and vegetable gardens of the selected households (72 in Nanga Sumpa and 52 in Marup Baroh, see Figure 3 and Table 5). The total number of cultivated species (150) was determined in Nanga Sumpa only (Table 6). Many of these plants, mostly fruit trees, are not tended to very carefully and therefore categorised as semi-managed.

The distribution of crops (Figure 3) in the different farming environments shows a higher number of crops in Nanga Sumpa in all environments except pepper gardens, which function as the main fruit and vegetable gardens in Marup Baroh. More than twice as many crops are cultivated in upland rice fields in Nanga Sumpa than in Marup Baroh.

The range of local varieties also illustrates the crop diversity. In Nanga Sumpa, 105 rice varieties are cultivated and 79 in Marup Baroh. A number of the rice varieties are considered sacred with protective powers and these are farmed by 96% of the households in Nanga Sumpa and 87% in Marup Baroh. Furthermore, numerous varieties of other crops were recorded in Nanga Sumpa:

Banana (*Musa balbisiana x paradisiaca*)	18
Cassava (*Manihot esculenta*)	14
Chili (*Capsicum annuum*)	5
Ginger (*Zingiber officinale*)	7
Job's Tears (*Coix lacryma-jobi*)	7
Maize (*Zea mays*)	8
Sugar cane (*Saccharum officinarum*)	16
Sweet potato (*Ipomoea batata*)	9
Taro (*Colocasia esculenta*)	22

Table 5: Crops in different farming environments of six households in Nanga Sumpa and in Marup Baroh.

FAMILY	*SPECIES*	*NANGA SUMPA (1)*				*MARUP BAROH (1)*		
		UR	PG	TVG	PVG	UR	WR	PG
Amaranthaceae								
	Celosia argentea	X						
Anacardiaceae	Mangifera. cf. odorata		X	X				X
	M. indica, vel.aff.		X	X				X
	M. indica, vel.aff.			X				
	Mangifera pajang			X				
Annonaceae	Annona muricata			X				
Apocynaceae	Willughbeia sarawacensis		X					
Araceae	Colocasia esculenta	X	X	X	X			X
Arecaceae	Arenga pinnata			X				
	Cocos nucifera		X	X				X
	Elaeis guinensis							X
	Eugeissonia utilis	X						
	Areca catechu		X	X				X
Asclepiadaceae	Marsdenia tinctoria		X					
Bombacaceae	Durio spp.	X	X	X				X
Brassicaceae	Brassica juncea	X			X	X		
	Brassica sp.				X			
	Raphanus sativus			X	X			
Bromeliaceae	Ananas comosus		X					X
Burseraceae	Canarium patentinervum or C. odontophyllum		X					X
Caricaceae	Carica papaya			X				X
Clusiaceae	Garcinia mangostana		X					X
Convolvulaceae	Ipomoea aquatica			X	X			X
	I. batata	X	X					X
Cucurbitaceae	Benincasa hispida	X						
	Citrullus lanatus					X		X
	Cucumis sativa	X		X	X	X	X	
	Cucurbita moschata	X		X		X	X	X
	Lagenaria siceraria	X	X	X		X		X
	Luffa aegyptica	X						
	Mormordica charandica			X	X			
Dipterocarpaceae	Shorea macrophylla	X		X				
Dracaenaceae	Cordyline fruticosa			X				
Euphorbiaceae	Baccaurea angulata		X					
	B. motleyana							X
	Hevea brasiliensis							
	Manihot esculenta	X	X	X		X		X
	Pterococcus corniculatus	X						
	Sauropus androgynus		X	X		X		X
Flacourtiaceae	Pangium edule		X					X
Lauraceae	Litsea garciae		X					X
Leguminosae	Derris sp.		X					X
	Parkia speciosa	X	X					X

(Continued)

FAMILY	*SPECIES*	*NANGA SUMPA*				*MARUP BAROH*		
		UR	PG	TVG	PVG	UR	WR	PG
Leguminosae	Psophocarpus tetragonolobus	X						
	Vigna unguiculata	X		X	X			
Liliaceae	Allium tuberosum	X			X			X
Malvaceae	Abelmoschus moschatus	X		X				
Meliaceae	Lansium domesticum		X					X
Merispermataceae	Albertisia sp.		X	X				
Moraceae	Artocarpus communis							X
	A. integer	X	X	X				
	Artocarpus sp.		X					X
	Artocarpus spp.	X	X	X		X		X
Musaceae	Musa acuminata x balbisiana		X	X		X		X
Myrtaceae	Psidium guajava		X	X				X
Oxalidaceae	Averrhoa carambola		X	X				X
Piperaceae	Piper betle		X	X				
	P. nigrum		X					X
Poaceae	Coix lacryma-jobi	X				X		
	Cymbopogon citratus			X	X			X
	Oryza sativa	X				X	X	
	Sacharum officinale	X	X	X				X
	Zea mays	X		X	X	X	X	X
Rubiaceae	Morinda citrifolia			X				
Rutaceae	Citrus aurantifolia			X				
Sapindaceae	Dimocarpus longana							X
	Nephelium spp.		X	X		X		X
Schrophulariaceae	Artanema sp.					X		
Solanaceae	Capsicum annum		X	X				X
	Nicotiana tabacum	X						
	Solanum macrocarpon	X	X	X		X		
Sterculiaceae	Theobroma cacao							X
Zingiberaceae	Alpinia officinarum			X				X
	Curcuma sp.		X	X				
	Kaempferia galanga	X	X					
	Zingiber officinale	X			X			X

Discussion

As Nanga Sumpa is a traditional shifting cultivation community located in a quite remote hilly area with low population density, it would be tempting to assume that the farming system is fundamentally different from the coastal system in Marup Baroh. It seems, however, that the cultural heritage and agricultural traditions shared by the communities, have caused many aspects of the two systems to be alike.

The most clear distinction is the choice of farming upland or wet rice. In Nanga Sumpa, upland rice is dominant partly because extending the cultivation of wet rice is impossible unless steep hill sides are terraced. In Marup Baroh, wet rice is the most important, but almost all households still farm upland rice despite lower yields. Upland rice is considered superior in eating quality and religious prescriptions require the cultivation of sacred rice varieties in upland fields. In addition, the prestige of investing hard labour in large upland rice fields is of some importance.

The spatial distribution of fields is quite similar in both village territories (Figure 2), including the arrangement of rice fields in clusters, known to facilitate labour exchange and social activities (Chin 1985; Dove 1985). The fairly equal distances between villages and fields may have arisen for different reasons: even though land is abundant in the territory of Nanga Sumpa, much of the area in a radius of 0.8-1 km from the village is occupied by cash crops or fruit gardens. As fields situated more than 1-1.5 hours in walking distance (2-3 km direct line) are not desirable, the upland rice fields are restricted to an area located 1-3 km from the village. In Marup Baroh, the few upland rice fields found almost 3 km away from the village reflect the large area that, historically, belonged to the community. However, in the past considerable tracts of land near the village have been sold to commercial farmers and most fields - even pepper gardens - are now situated more than 0.8 km away.

The similar total rice field area per household in the two communities reflects the maximum manageable farm size of subsistence households at a certain level of labour availability. The productivity of the land, however, is very different, and the higher rice yields in Marup Baroh do not only illustrate the higher production potential of wet rice, but also indicate unusually low yields of upland rice in Nanga Sumpa (Table 7). This may be caused by short fallow periods, but the present data do not allow for correlating reduced fallow periods with poorer yields. Also, some empirical data suggest that this correlation is not so easily obtained: secondary forest upland rice fields have been reported to produce higher yields than mature forest fields (Table 7). Moreover, Roder et al. (1995) have, with extensive material from Laos, not been able to determine any relationship between different fallow periods of secondary forest fields and yields.

Weeds, however, are mentioned as a major cause of low yields in Nanga Sumpa reflecting that fallow periods may have reached a critical low by not being able to shade out

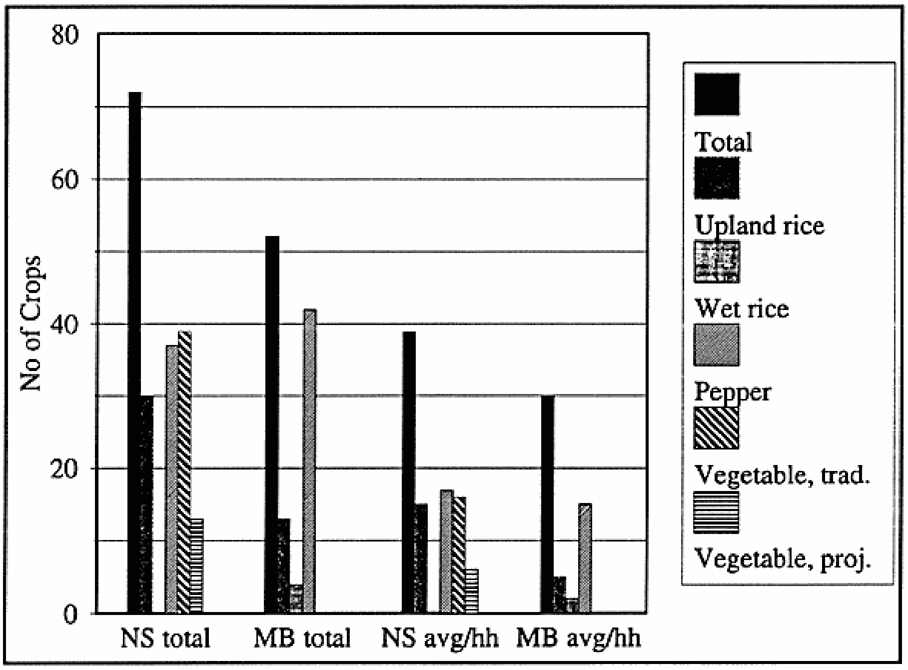

Figure 3: Distribution of crops in different farming environments of Nanga Sumpa (NS) and Marup Baroh (MB). (Avg/hh=average per household).

Table 6: Cultivated (Cu), semi-managed (Sm) and naturalized (Na) species in Nanga Sumpa. Wi=wild.

Family	*Name*	*Status*
Acoraceae	Acorus gramineus Sol.	Cu
Agavaceae	Cordyline fruticosa (L.) A. Chevalier	Cu
Amaranthaceae	Amaranthus tricolor L.	Cu
	Celosia argentea L.	Cu
Amaryllidaceae	sp. 1	Cu
	sp. 2	Cu
Anacardiaceae	Anacardium occidentale Linn.	Cu
	Mangifera indica vel aff. Linn.	Sm
	M. indica vel aff. Linn.	Sm
	M. cf. odorata Griff.	Cu
	M. pajang Kost.	Sm Wi
		Sm Wi
	M. sp.	Sm Wi
Annonaceae	M. torquenda Kost.	Cu
Apiaceae	Eryngium foetida L.	Wi (Na)
Apocynaceae	Willughbeia sarawacensis (Pierre) K. Schum.	Sm Wi
Araceae	Amorphophallus sp. 2	Cu
	Colocasia esculenta (L.) Schott	Cu
	Homalomena sp. 1	Cu
Arecaceae	Areca catechu L.	Cu
	Arenga pinnata (Wurmb.) Merrill	Sm Wi
	Cocos nucifera L.	Cu
	Elaeis guinensis Jack.	Cu
	Eugeissonia utilis Becc.	Wi Sm
Asclepiadaceae	Marsdenia tinctoria (Roxb) R. Br.	Cu
Asteraceae	Cosmos sulphureus Cav.	Cu
Bignoniaceae	Crescentia cujete L.	Cu
Bombacaceae	Durio crassipes Kosterm. & Soeg.	Sm Wi
	D. kutejensis vel aff. (Hassk.) Becc.	Sm Wi
	D. oxleyanus vel aff. Griff.	Sm Wi
	D. cf. zibethinus Murray	Sm Wi
Brassicaceae	Brassica juncea L.	Cu
	B. sp. 1	Cu
	Raphanus sativus L.	Cu
Bromeliaceae	Ananas comosus (L.) Merr.	Cu
Burseraceae	Canarium patentinervium Miq./C. odontophyllum Miq.	Sm Wi
Cactaceae	Opuntia sp.	Cu
Cannaceae	Canna edulis Ker.	Cu
Caricaceae	Carica papaya L.	Cu
Clusiaceae	Garcinia celebica V. Sl.	Sm Wi
	G. mangostana L.	Cu
Convolvulaceae	Ipomoea aquatica Forsk.	Cu
	I. batatas (L.) Lam.	Cu
Crassulaceae	Bryophyllum pinnatum (Lam.) Oken	Cu
Cucurbitaceae	Benincasa hispida (Thunb.) Cogn.	Cu
	Cucumis sativus L.	Cu
	Cucurbita moshata Duch. ex H. J. Lam	Cu
	Lagenaria siceraria (Molina) Standl.	Cu
	Luffa aegyptica P. Miller	Cu
	Mormordica charandica L.	Cu
	Sechium edule (Jack.) Schwarz.	Cu
Dioscoreaceae	Dioscorea alata L.	Cu Na
Dipterocarpaceae	Shorea macrophylla (De Vr.) Ashton	Sm Wi
Euphorbiaceae	Baccaurea angulata Merr.	Sm Wi
	B. edulis Merr.	Cu Wi
	B. motleyana Muell. - Arg.	Cu
	Euphorbia antiquorum vel aff. L.	Cu
	Hevea brasiliensis (Willd. ex Adr. de Juss) M.-Arg.	Cu
	Manihot esculenta Crantz.	Cu
	M. glaziovii Muell.-Arg.	Cu
	Pterococcus corniculatus (Sm.) Pax & Hoffm.	Cu
	Sauropus androgynus (L.) Merr.	Cu
Flacourtiaceae	Flacourtia rukam Zoll. et Mor.	Cu Wi
	Pangium edule Reinw.	Cu
Hypoxidaceae	Curculigo villosa (Kurz) Merr.	Cu Wi
Lamiaceae	Hyptis suaveolens (L.) Poit.	Cu Wi
	Litsea garciae Vidal	Sm Wi
Leguminosae	Derris sp.	Sm Wi
	Indigofera tinctoria L.	Cu
	Mucuna pruriens (L.) DC.	Cu
	Parkia speciosa Hassk.	Cu Wi
	Phaseolus vulgaris L.	Cu
	Psophocarpus tetragonolobus (L.) DC.	Cu
	Senna occidentalis (L.) Link.	Na
	Vigna unguiculata (L.) DC.	Cu
Liliaceae	Allium tuberosum Rottler ex Sprengel	Cu
Malvaceae	Abelmoschus esculentus (L.) Moench.	Cu
	A. manihot (L.) Medic.	Cu
	Hibiscus rosa-sinensis L.	Cu
	H. sabdariffa L.	Cu
Maranthaceae	Maranta arundinaceae L.	Cu
Meliaceae	Lansium domesticum Corr.	Cu Sm Wi
Menispermaceae	Albertisia sp.	Cu Wi
Moraceae	Artocarpus communis Forst.	Cu
	A. heterophyllus H. J. Lam	Cu
	A. integer (Thunb.) Merr.	Cu Sm Wi
	A. odoratissimus Blanco.	Sm Wi
	A. sarawakensis Jarrett	Sm Wi
Musaceae	Musa acuminata x balbisiana L.	Cu
	M. hirta Becc.	Cu Wi
Myrtaceae	Psidium guajava L.	Cu
	Syzygium aqueum (Burm. f.) Alston	Cu
	S. malaccense (L.) Merr. & Perry	Cu
Oxalidaceae	Averrhoa carambola L.	Cu
Pandanaceae	Pandanus kamii B.C.Stone	Cu Sm Wi
	P. odoratissimus L. f.	Cu
Pedaliaceae	Sesamum indicum L.	Cu
Piperaceae	Piper arborescens Roxb.	Na Wi
	P. betle Bl.	Cu
	P. nigrum L.	Cu
Poaceae	Coix lachryma-jobi L.	Cu Wi
	Cymbopogon citratus (DC.) Stapf	Cu
	C. cf. nardus L.	Cu
	Gigantochloa levis Merrill	Sm Wi
	Oryza sativa L.	Cu
	Saccharum officinale L.	Cu
	Setaria italica (L.) P. Beauv.	Cu
	Sorghum bicolor L.	Cu
	Zea mays L.	Cu
Rubiaceae	Coffea canephora Froehner	Na
	Morinda citrifolia L.	Cu
	Urophyllum sp. 1	Na
Rutaceae	Citrus aurantifolia (Christm.) Swing.	Cu
	C. grandis (L.) Osbeck	Cu
	C. sinensis (L.) Osbeck	Cu
Sapindaceae	Dimocarpus longana var. malesiana Leenh.	Cu
	Euphoria microcarpa Radlk	Cu
	Lepisanthes alata (Bl.) Leenh.	Sm Wi
	Nephelium cuspidatum Bl.	Sm Wi
	N. lappaceum L.	Sm Wi
	N. mutabile Bl.	Sm Wi
	N. reticulatum Radlk.	Sm Wi
	N. uncinatum Leenh.	Cu
	N. spp. (prob. 3-4 spp)	Sm Wi
Solanaceae	Capsicum anuum L.	Cu
	C. frutescens L.	Cu
	Lycopersicon esculentum Mill.	Cu
	Nicotiana tabacum L.	Cu
	Solanum macrocarpon vel aff. L.	Cu
	S. melongena L.	Cu
	S. torvum Sw.	Cu Sm Wi
Sterculiaceae	Theobroma cacao L.	Cu
Tiliaceae	Corchorus capsularis L.	Cu
Vitaceae	Cissus hastata Miq.	Sm Wi
Zingiberaceae	Alpinia officinarum Hance	Cu
	Curcuma domestica Val.	Cu
	C. zedoaria Rose	Cu
	C. sp. 1	Cu
	Kaempferia galanga L.	Cu
	Zingiber cf. cassumunar Roxb.	Cu
	Z. martinii R. M. Smith	Cu Wi
	Z. officinale Rosc.	Cu
	Z. ottensii R. M. Smith	Cu
	Z. sp. 1	Cu
	Z. sp. 2	Cu
	Z. sp. 3	Cu
	sp. 1	Cu

Ethnic group, location	*Upland rice primary forest average*	*Upland rice secondary forest average*	*Upland rice average*	*Upland rice range*	*Wet rice average*
Iban, Nanga Sumpa		350	350	164-614	
Iban, Marup Baroh		1100	1100	681-1951	2455
Iban, Engkari [1]	400	600		120-850	1010
Kantu, West Kalimantan [2]	457	752			1322
Kejaman, Sarawak [3]	470	720		229-1820	
Kenyah, Sarawak [4]			700-900	180-2000	
Kenyah, East Kalimantan [5]				1780-4300	
Maloh, West Kalimantan [6]			1640	1380-1812	2376
Rungus, Sabah [7]			700		900
Taboyan, Central Kalimantan [8]		1000	1000		

1. Padoch (1982), 2. Dove (1985), 3. Strickland (1986), 4. Chin (1985), 5. Hadi et al (1983), 6. King (1985), 7. van Leur et al (1986), 8. Christensen and Mertz (1990).

Table 7: Rice yields in kg/ha of different shifting cultivation communities in Borneo.

grasses and sun ferns. More pronounced occurrence of weeds in the 1995-96 season may have been caused by the exceptionally wet month of August 1995 which prevented a thorough burn of the cleared vegetation resulting in higher survival of herbaceous weeds and low release of nutrients. As weeding is one of the most labour intensive activities in secondary forest fields (Chin 1985; Cramb 1989; Dove 1985; Padoch 1982) and substantial labour is required for pepper, rubber, and vegetable cultivation as well as off-farm work during the time of weeding, fields are likely to have been insufficiently weeded.

Thus, it may be argued that the cash crop production and the poor burn are responsible for low rice yields. However, the yields of the 1995-96 season were not rated as below average and earlier studies in the upper Batang Ai watershed (King & Jawan 1992; Padoch 1982) indicate a general problem with meeting subsistence needs in the region, supposedly unrelated to cash cropping. The rice deficits calculated in Table 8 illustrate the predicament: Based on estimated rice requirements of 200 kg/year/adult and 100 kg/year/child (Chin 1985), only one household in Nanga Sumpa produced sufficient rice for subsistence and no households sold rice in the recent past.

By contrast, the average rice production per household in Marup Baroh is 2.7 times higher, about 70% of the households are self-sufficient, and rice was sold by 44% of the households indicating the importance of rice as a cash crop. This is mainly caused by the higher yields of wet rice, but also upland rice fields are more productive in Marup Baroh as a result of the smaller and more easily managed field sizes and the rather consistent use of fertilizers and herbicides. This confirms the findings of Tie et al. (1989) that yields of local upland rice varieties in shifting cultivation may be improved with fertilizer applications.

As the production is sufficient for subsistence and sales and the possibilities for off-farm work are abundant, intensification of rice cultivation is not an immediate priority for farmers in Marup Baroh. In Nanga Sumpa, increased production is a priority and although self-sufficiency may be unrealistic within the present system, yields of rice can be increased: If upland rice field sizes are reduced, steep slopes avoided, and fields placed closer to the village, more intensive farming practices, including application of fertilizers, can be employed and may prove economical in both monetary and labour terms.

This development has to some extent occurred spontaneously in Marup Baroh and elsewhere (Cramb 1989), but it should also be encouraged through extension and research. The introduction of improved rice varieties is another possibility, at least in Marup Baroh, where access to farm supplies is easy, but the largely unexplored potential for selection and breeding of local varieties should not be underestimated.

The minimum price of rice guarantied by The National Rice Board has made rice the most attractive cash crop in Marup Baroh. By contrast, pepper and rubber are sold on an unregulated private market, and although rubber is a

Table 8: Household rice supply in Nanga Sumpa and Marup Baroh.

	Nanga Sumpa			Marup Baroh		
	Total	*Average/ household*	*Range*	*Total*	*Average/ household*	*Range*
No of Households	28			24		
No of inhabitants [1]	180	6.4	1-14	134	5.6	3-12
Number of adults > 14 years	95	3.4	1-7	83	3.5	2-8
Number of children < 15 years	85	3.4	0-7	51	2.1	0-7
Annual rice requirements, kg [2]	25800	956	200-2100	21100	917	500-200
Total rice supply 1996 harvest, kg [2]	12340	457	164-614	28100	1222	250-3150
Calc. rice deficit (-) or surplus, kg [2], [3]	-13460	-499	-1900-200	7000	304	-500-1450
Households with deficit, % [2]	96.4			30.4		
Households claiming deficit, % [2]	92.9			17.4		
Total sale of rice, 1995 harvest [2]	0	0		7200	313	0-2000
Households selling rice, % [2]	0			43.5		

[1] Includes school children but not persons working permanently abroad (1995 census).
[2] Nanga Sumpa, 27 households; Marup Baroh 23 households.
[3] Calculation: 200 kg rice/year/adult, 100 kg/year/child.

flexible crop which may be tapped only when prices are favourable (or there is an urgent cash need) (Dove 1993; Jensen 1966), and pepper cultivation also may be adjusted according to the market (Cramb 1993), the instability of prices is a major disincentive for production. Furthermore, high pest and disease pressure renders pepper and cocoa cultivation a risky activity, and whereas rice is a viable alternative to the farmers of Marup Baroh, the precarious subsistence production in Nanga Sumpa has forced this community into cultivation of these cash crops. The pepper scheme has yet to be evaluated, but cocoa cultivation in Nanga Sumpa has clearly been a failure due to inappropriate plant protection.

Development of well-known indigenous cash crops such as illipe nut (*Shorea macrophylla*), kepayang (*Pangium edule*), and rattan (*Calamus spp.*) would be appropriate in Nanga Sumpa and other remote communities in Sarawak where heavy reliance on agro-chemicals and extension services necessary for pepper and cocoa is costly. The traditional integration of these and other local tree species in rubber gardens has considerable economic potential as well as implications for maintenance of biodiversity (Godoy & Tan 1989; Gouyon et al. 1993; Lawrence 1996; Weinstock 1983) and should be given more attention.

Vegetable and fruit production is not commercially oriented in the two communities and, although highly diverse, is either limited in quantity or very seasonal. Nanga Sumpa is located too far from the market and the potential sale of vegetables is limited to tourists visiting the village. The basic needs, however, are covered and supplemented by collections of wild vegetables. The subsidized home gardening in Nanga Sumpa is an attempt to intensify vegetable production but the production methods are capital and labour intensive with terraced, shaded, and raised beds, and the cultivation of various exotic *Brassica sp.* and legumes, susceptible to pests and diseases, is promoted.

From Marup Baroh the markets in Engkilili and Sri Aman are easily reached and commercial vegetable production could be feasible. The lack of incentive to cultivate vegetables is based on the heavy labour investments needed for conventional production systems - such as the project gardens in Nanga Sumpa - and the market access renders self-sufficiency unnecessary.

More research is needed into the development of indigenous vegetables such as changkok manis (*Sauropus androgynus)*, and terong dayak (*Solanum macrocarpon vel. aff.*) as well as wild vegetables including the ferns *Stenochlaena palustris* (Burm.) Bedd. and *Diplazium esculentum* (Retz.) Sw., all of which are perennial plants producing continuous yields of leaves or fruits. As these

species are well adapted to local conditions, their requirements in terms of fertilizers, pesticides, and labour are estimated to be significantly lower than those of exotic vegetables, and notably the wild vegetables may be established in permanent groves that need little maintenance (Mertz 1997). Development and intensification of production methods of these crops may be a valuable addition to the subsistence and cash economies of farmers who experience an increasingly labour intensive production of rice and cash crops.

Conclusion

The farming systems of Nanga Sumpa and Marup Baroh are distinguished mainly by their different access to markets and topography rendering the more productive wet rice cultivation possible in Marup Baroh. The land use and farming strategies are very similar illustrated by the spatial distribution of fields and the diversity of farming environments, crops, and varieties maintained even in Marup Baroh despite its location in an area with higher population density and good infrastructure.

The cultural importance of self-sufficiency combined with low or unstable prices of rice and cash crops do not, presently, encourage further intensification in Marup Baroh. If required following population increases and resulting pressure on the land, there are, however, few technical and infrastructural obstacles for this to happen. By contrast, self-sufficiency in Nanga Sumpa is barely within reach and the low yields of rice are a strong motivation for increased cash crop production. This development, however, must be carefully monitored in order to avoid failures such as the cocoa scheme. The largely unexplored potential of indigenous species - cultivated as well as wild - needs more attention. These species already contribute significantly to the food security of the more remote communities in Sarawak (Christensen 1997) and the research into their agronomic potentials initiated by the Department of Agriculture, Sarawak, should be encouraged to continue. Before research results are disseminated through the extension system, however, it is necessary to carefully consider the socioeconomic and infrastructural diversity of farming systems in Sarawak. The success of a crop - whether indigenous or exotic or for subsistence or sale - in a given area may not be readily applied to another region with differing conditions of access and economic growth.

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