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Farming Operations and Labor Requirements for Paddy Cultivation in Sarawak, East Malaysia

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I Introduction

The author conducted a field survey research project for 7 weeks beginning November 2, 1976, on "Agricultural Potential in the State of Sarawak" as one of six members of a survey team sent from the Center for Southeast Asian Studies, Kyoto University. The authour's responsibility included investigation of wet paddy cultivation patterns, techniques used and associated problems regarding mechanization.

The State of Sarawak has recently been confronted with a decrease in the self-sufficiency in rice. The import of rice in 1974 amounted to about 40 percent of the total required (10). This is due to the fact that the rate of increase of rice production continues to be low relative to the rate of increase in the area's population. Therefore, in order to achieve self-sufficiency, the government urgently needs to increase rice production through the introduction of modern methods of cultivation.

Rice cultivation in Sarawak is greatly hampered by topographical conditions not suited for securing irrigation water in spite of its favorable climate. Sarawak is located close to the equator and its climate is defined as a tropical reinforest type receiving 2,000 to 6,000 mm of annual precipitation. The land is mountainous except for coastal areas. It is characterized by gently folded low mountains and hilly lands spread over most parts of the country. The low lands, or coastal areas, consist of riverine and marine sand and mud. Thick peat layers are often developed in the low lands because of the favorable climatic conditons for vegetation. In addition, the low lands often suffer from floods as well as seawater intrusion, therefore have not been widely used for paddy cultivation in the past. Under these natural circumstances hill paddy cultivation in the mountain areas has been the major method of rice production for a long time. Recent population pressures and the difficulties of production increase in hill paddy areas make it necessary to grow more rice under wet paddy conditions in the low lands. Yet, since the topographical conditions limit supplemental irrigation only to certain fortunate areas, natural rainfall is the only source of water in most parts of the low lands.

It is of urgent need for the government and the farmers to establish wet paddy production systems which will not only assure sufficient yield to the farmer but also

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result in an increase overall marketable supply of rice. A detailed examination of the present farming operations including cultivation patterns, techniques, equipment and their limitations is necessary in instituting technological improvements.

Limited information is available on tropical rice cultivation methods (3, 7, 8), especially about that in Sarawak. This field research was conducted to obtain detailed information on cultural farming practices in Sarawak. The information reported is based upon field observations and interviews made with farmers and extension workers. Specific objectives of this research were as follows.

1. To identify present farming methods and the types of tools and equipment used.
2. To identify the factors and conditions making up the present forms of paddy cultivation.
3. To identify the labor requirements for present farming operations.
4. To identify specific farming operations requiring improvements of technology.
5. To make inferences for the future prospects of mechanization programs.

II Farming Operations and Techniques

There are two main operation systems of paddy cultivation. They are the hill paddy system and the wet paddy system. Hill paddy cultivation is important in terms of present acreage but its significance is likely to diminish in the future since it is under a process of gradual decrease (12). The wet paddy system is far more important because of its great potential to increase rice production and is therefore the subject of this paper.

1. Land preparation

Land preparation starts during the latter part of the dry season, usually July and August. The manner of land preparation is Sarawak is quite dissimilar to that of other Asian rice growing areas. The field is neither plowed nor harrowed before transplanting. Land preparation begins with slashing thickly growing weeds from 50 to 100 cm in height. Slashing is usually done by young men using a long curved blade called *Parang* (Photo. 1). The *Parang* ranges from 5 to 8 cm wide and 50 to 70 cm long. It weights from 0.7 to 1.0 kg and appears in a wide variety of shapes. Weeds are held by a wooden tool called *Kabang* (Photo. 1) used in the left hand at slashing. This operation is hard and laborious, but seems to be the only way at present of mannually removing densely growing brush and weeds. About a month's work is required for a family typically cultivating 2 to 3 acres to complete the task by *Parang*. The slashed weeds are sun-dried in the field for about a week, then are fired and burned. The field is left for a time to allow weed seeds to germinate and grow to a certain height. These weeds are again killed either by spraying herbicide or by scraping soil surface

Photo. 1 Parang (left) and Kabang (right)

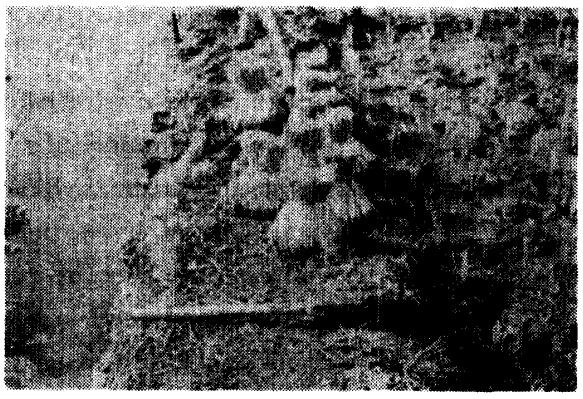

Photo. 2 Seedlings and dibbling bar

with a *Parang*. Limited leveling is usually incorporated with scraping. A *Tajak* (leveling hoe) is also used for scraping and leveling. In some areas rakes are used for leveling depending upon farming practice and availability of irrigation water. In general the field is not bunded to retain water. It appears that the primary objective of land leveling is not to keep the water in the field for controlling weeds, but to drain the water in order to avoid any risk of flood damage. At transplanting time the field is wet and muddy but not watered deeply. Consequently puddling before transplanting is not practised in general.

2. Transplanting

In Sarawak 30 to 40 day seedlings are transplanted at 30 cm intervals. The tops of the seedlings are cut off to reduce water loss and give more rigidity to the plants after transplanting (Photo. 2). Transplanting is done by dibbling with a wooden bar (Photo. 2). The types and shapes of dibbling tools vary considerably depending upon field conditions including soil moisture content, soil hardness and extent of leveling. In the most common way of transplanting a man and woman work together. The man walks ahead with his dibbling bar, and the woman follows him to place seedlings into the holes which he made (Photo. 3). A dibbling bar is usually about 1 m in length with a circular cross section. Often it has a cone shaped base tapered to a point. The

Photo. 3 Transplanting by man (dibbling) and woman (transplanting)

Photo. 4 Transplanting frame with 4 legs (left) and dibbling bar (right)

diameter of the base varies from 5 to 10 cm. When the soil is softer the larger diameter base is used. The average time needed for transplanting is 8 man-days per acre. Although not very common, a modified dibbling tool with 4 legs as shown in Photo. 4 is used. This is used by a commercial rice farmer who manages the area larger, say 12 acre, than a subsistance farmer. This tool is carried by a man making 4 holes in one operation and followed by 4 persons to transplant. This equipment makes it possible to transplant one acre every 5 man-days.

Many rice varieties are planted in Sarawak and plant characteristics vary widely, since rice is grown under a wide range of field conditions and cultivation methods. The plant characteristics are often critical factors limiting the technical improvement of farming operations or the labor efficiency of rice production as well as the yield potential and quality of rice. Since detailed discussion on the varieties is beyond the scope of this paper, a brief description is made on selected varieties. In order for the farmers to cope with a wide range of paddy growing conditions, two distinct types of rice varieties are recommended by the Department of Agriculture. They are the tall long term varieties and the high yielding short term varieties (11). The former includes Acheh 62, Lasak, Siam 29, Serendah Kuning and Kara 1. The latter includes Bahagia and Mahsuri Line 17. The plant characteristics of Acheh 62 and Bahagia are given in Table 1.

Table 1 Plant characteristics of Acheh 62 and Bahagia (Source: Chin, 1973)

Variety	: Acheh 62	Bahagia
Maturation (days)	: 180±5	140±5
Culm height (inches)	: 52±5	33±3
Habit	: Erect with broad droopy leaves	Erect
Photoperiod reaction	: Sensitive	Weakly sensitive
Threshing quality	: Easy	Easy
Leaf	: Broad and droopy	Broad and incline to droop
Leaf colour	: Yellowish green	Green
Grain	: Short and bold	Long and medium
1,000 grain-weight (gm.)	: 22.9	26.8
Panicle number	: 9–12	10–14
Yield potential (lb/acre)	: 3,500	4,000
Disease susceptibility		
Leaf blast	: Moderately susceptible	Resistant
Panicle blast (Neck rot)	: 〃 〃	Moderately susceptible
Sheath blight	: Resistant	Moderately resistant
Lodging	: Susceptible	Resistant
Planting distance (inches)	: 12×12	10×10
Fertiliser rate (N: P_2O_5: K_2O lb/ac)	: 20 : 27.5 : 0	50 : 40 : 30

3. Weeding

Rampant weed growth is a major problem to a wet paddy farmer. Climatic conditions are favorable for continuous weed growth throughout the year, since Sarawak receives occasional rainfalls even during the dry season. Yet due to a lack of irrigation, the amount of water in the field is insufficient to control the weeds. These conditions make weeding more difficult and labor-consuming.

Weeding is usually done by hand once or twice between transplanting and harvesting. It is predominantly the work of women. The common tool is a small round-ended iron blade set at right angles to a shaft which is imbedded in a wooden handle called *Elok* (Photo. 5). Usually the women bend or squat between the stubbles of growing rice and cut away the thick weeds. Weeding is the most tedious task of all the labor stages in the farming cycle. The efficiency of the work is often lowered by hot, and humid weather conditions during the rainy season. About 14 man-days are required to weed one acre of standard paddy field. Since many farmers consider that weeding is neither a rewarding task nor an urgent need, they often put off its completion and allow themselves to accept haphazard work. This is not to say that the importance of weeding is overlooked. Nonetheless the degree of weeding varies considerably from farm to farm depending upon the diligence of farmers. The introduction of herbicide has been unconditionally welcomed by the farmers. Detailed discussion on this subject will be made in a later section.

4. Harvesting

Harvesting takes place after the rainy season, usually in February and March. Common practice is to take only the heads along with 5 to 6 cm of straw using a special hand knife called *Ketap* (Photo. 6). A *Ketap* consists of a thin metal blade with a base of about 6 cm curved in from each end to a cutting edge of 5 cm in length. The width

Photo. 5 Weeding knife

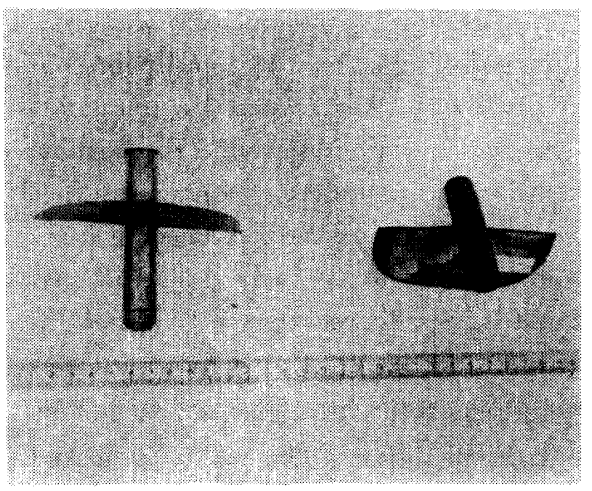

Photo. 6 Ketap

of the blade is about 4 cm. This blade is fixed in the center of a handle of bamboo or metal pipe (8 cm long by 1.5 cm diameter). The handle is held in the palm and the stem is drawn against the blade between the second and third fingers. The stem is grasped between the two upper fingers and the thumb, then by pulling the stem and applying compression with the fingers, the stem is cut. Each panicle is plucked separately with considerable speed by skillful women. Because of the wide variation in yield it is difficult to give a general figure for the rate of work. The results of this survey indicate that 18 man-days are required to harvest one acre field with an average yield of 1,800 lb. The labor requirement is high. Timeliness is most important since the risk of grain loss to birds is high. The mature crop must be harvested without delay to place the rice safely in storage as quickly as possible. The use of sickles would be one way to increase the harvesting rate, but such a method has not become popular among ordinary farmers in spite of government recommendation. Farmers regard their paddy as something sacred. They have a belief in paddy spirit. Their paddy therefore must be taken care of tenderly with a minimum of shock and cut. It is also said that if rough and drastic methods were used the paddy spirit would flee to other farms, resulting in a poor crop. Although the refusal of accepting sickles is often attributed to the belief in a paddy spirit, this does not seem to be the primary reason. A detailed analysis of the harvesting operation suggests that there are greater advantages at the present stage of farming technology to use the *Ketap* rather than a sickle, as discussed in detail in a later section of this paper.

5. Post harvest operation

Threshing, drying and storage are performed individually by subsistence farmers. The paddy is usually stored in panicle form for a certain period. It is placed firstly in the farm hut and then taken out at need to be threshed by foot stepping and cleaned by hand winnowing. After winnowing the cleaned grain is usually sun-dried for several days before final storage. It was noted that farmers judge the moisture content of grain from the tone of sound generated by snapping grains between their fingers. Rice polishing is done by hand pounding or by engine-powered rice polishing machine at small rice mills owned by some farmers which scattered around the farming areas. Hand pounding is not typical since rice polishing machine has become quite common (Photo. 7). The polishing machine is usually powered by a diesel engine of about 5 h.p. It is composed of a cylindrical roll with a groove and hollow cylindrical casing. The paddy is husked and polished by one operation as it goes

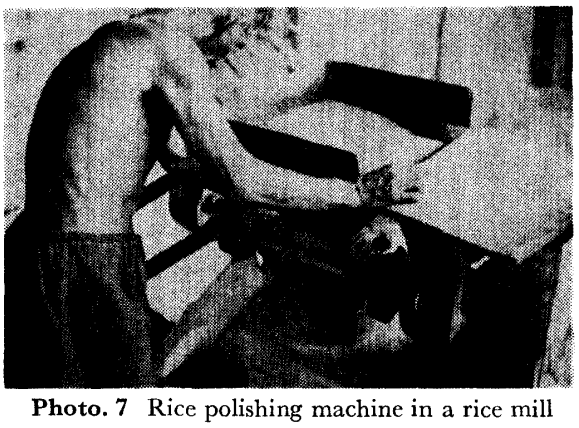

Photo. 7 Rice polishing machine in a rice mill

through the machine. Rice husking and polishing is the most mechanized segment of farming operation in Sarawak.

6. Labor requirements

It is necessary to consider labor requirements for each operation in order to evaluate technological aspects of rice production. After analyzing where and how labor is presently used to produce rice, appropriate means of increasing production efficiency can be suggested.

Table 2 shows the labor requirements for each step of wet and hill paddy cultivating operations in the field. The figures for the wet paddy system roughly coincide with the results of a survey conducted during 1968–1969 by the Economic Division of the Department of Agriculture (9). The labor requirement for the hill paddy was found to be 36 man-days per acre by the author, which is, one half of the man-days reported by Freeman in 1949–1950 (4). One of the reasons for the smaller labor requirement in this study is attributable to the reduced labor requirements for harvesting. This seems to be mainly due to the considerable reduction of the average yield for hill paddies since 1950. In fact the average yield for hill paddies has decreased by about 30 percent for the past 5 years (10). Another reason may be that less care of the hill paddy is taken in general because of the decreased interest in it. Note that labor requirement for the hill paddy is about one half of the wet paddy, while the yield of the hill paddy per acre is only about one third of the wet paddy. Therefore, it can be said that a major advantage of the wet paddy over the hill paddy is higher labor productivity.

Table 2 Time requirement for field operations, 1976.

Operation	Wet paddy (Average of 26 sites)		Hill paddy (Average of 6 sites)	
	man-days/acre	Percentage	man-days/acre	Percentage
Clearing [1]	10	15.2	4	11.1
Felling [2]			4	11.1
Land Preparation [3]	16	24.2		
Transplanting [4]	8	12.1		
Sowing [5]			5	13.9
Weeding [6]	14	21.3	15	41.7
Harvesting [7]	18	27.3	8	22.2
Total	66	100.0	36	100.0
Yield, lb/acre	1800 (≒1.8 t/ha)		600 (≒0.6 t/ha)	

Note:
1. Slashing weeds and small trees
2. Cutting large trees
3. Weeding by turning over surface soil and limited leveling
4. Dibbling and placing seedlings
5. Dibbling and throwing seeds
6. By hand knife
7. By ketap (ear reaping knife)

Simple calculations from the table show that to produce 1,000 lb of rice only 37 man-days are required for the wet paddy, whereas 60 man-days are required for the hill paddy. For the field operations of the wet paddy the labor requirement is 66 man-days per acre (or 1,320 man-hours per hectare assuming 8 hours of work per day). For the post harvest and other minor operations, 23 percent of additional labor is assumed based upon a previous study (1). Then, the total labor requirement for the wet paddy is estimated to be 1,620 man-hours per hectare. This figure is shown for comparison purposes in Table 3, which also shows the yields and the total labor requirements per hectare for selected Asian countries (2, 5, 13). The comparison of these figures help to clarify several points of importance which characterize the unique situation of rice production in Sarawak. The average yield per hectare in Sarawak is quite close to the yields of India and Philippines. The labor requirement however reaches 1,620 man-hours per hectare and is higher than the rest of the countries, resulting in the lowest labor productivity yield of 1.1 kg per man-hours. The high labor requirement limits both the further expansion of land area and interest in increasing production on the present land under cultivation. Efforts must be exerted first to reduce the peak labor requirements for land preparation. The harvesting operation also requires high labor, but the reduction of labor requirement by using a sickle is not so meaningful at present for various reasons stated later.

The major labor-consuming operations for the wet paddy production are field clearing (by *Parang*), 15.2 percent; land preparation, 24.2 percent; weeding, 21.2 percent; and harvesting, 27.3 percent of the total labor requirement, respectively. These labor peaks are critical because the operations must be performed during limited time periods. Labor for land preparation including clearing amounts to 26 man-days per acre which is about 40 percent of the total. This figure indicates that the weeding

Table 3 Yield and labor requirement per hectare for paddy rice by country

Country	Yield [1] (kilograms per hectare)	Labor requirement [2] (man-hours per hectare)	Labor productivity (kilograms per man-hour)
West Malaysia	2,937	—	—
India	1,869	1,000	1.9
Indonesia	2,575	1,400	1.8
Japan	6,186	315[3]	7.6
Korea, Rep.	5,324	830	6.4
Nepal	2,074	1,000	2.1
Pakistan	2,296	900	2.6
Philippines	1,737	800	2.2
Sarawak, Malaysia[4]	1,800	1,620	1.1

Note:
1). Source: FAO Production Yearbook vol. 30, 1976
2). Source: Ozaki and McColly 1968
3). Source: Statistical Yearbook of Ministry of Agriculture and Forestry, Japan, 1977
4). Source: based on the survey results, 1977

of an average holding of 3 acres requires 78 man-days, that is, a household of two working people must work 39 days to finish an area of 3 acres. Thus, high labor requirements for land preparation restrict the further expansion of land holdings above the present acreage. Therefore a technological improvement to reduce the labor requirement is most needed in this operation.

Transplanting requires 8 man-days per acre. This operation is done by dibbling and placing seedlings. Although the operation must be completed during certain periods, the date depends greatly upon weather or availability of rain water. Therefore labor for transplanting usually somewhat spread over a longer period thus resulting in decreased labor peaks. The labor-saving techniques for transplanting are not of great need at the present moment. In addition the transplanting operations are well standardized, therefore hired quality labor can sometimes be used efficiently.

Labor for weeding during the course of rice growth is considerable but also spread over a longer period, because timeliness is not so important compared to the operations such as harvesting. Also, improved land preparation before transplanting is more effective in controlling weeds, thus reducing the labor requirements for weeding as well.

Harvesting requires 18 man-days per acre and is also a labor-consuming operation. The harvesting operation must particularly be timely in order to get high quality grain and minimize field losses. A delay in harvesting results in over-ripening and over-drying, and induces cracking damage. Another reason for requiring quick harvesting is that birds may eat tremendous amounts of matured rice in the field. Thus some improved technique is required to harvest rice as quickly as possible after matuarity.

Threshing, drying and storage are done individually, since most farmers are of subsistence. Therefore the amount of rice to be processed at one time is not large and these operations are not critical time-wise at present. However if an increase in rice production is to be achieved, the introduction of mechanical post harvest operations will become essential, since a large amount of rice for market must be handled and processed quickly to avoid any serious grain losses during these operations. The problems of cracks and damage during processing of tropical rice has been fully reported in a recent research (6). The mechanical properties of tropical rice in Sarawak associated with damage by mechanical processing operations must be clarified in future research.

III Comments on Future Technological Improvement

Small cultivated area of 2 to 3 acres per family is common throughout the wet paddy areas in Sarawak. They are often divided into smaller fields and scattered

over several locations. Field operations are solely done by hand. The use of large scale machinery is technically impossible. Limited numbers of power tillers and other machinery have been introduced to selected wet paddy areas under government subsidy. They are still used on an experimental basis but negligible in numbers. Introduction of modern machinery should be considered after a detailed study of its technical and economic feasibilities.

Here an analysis and comments are made on land preparation and harvesting to provide a basis for reduction of high labor requirements in those operations. Special attention is directed to finding a way of achieving technical innovation in the operations with minimum prerequistites.

1. Improvement of land preparation

As stated previously high labor requirements for land preparation is a critical factor. Due to the shortage of labor at the time and the lack of suitable techniques to cope with difficult field conditions, the present method of land preparation is far from sufficient to produce an increased average yield. Because of the lack of draft animals no plowing and leveling is practised. The fields are uneven and therefore keeping water by the bund is not only meaningless but also hazardous. Without plowing or harrowing it is very difficult to eradicate the weeds. Therefore some mechanical power must be introduced for land preparation at an appropriate time in the future. This should be done after careful consideration and selection of the types of machinery suited for the field conditions. The types of machinery to be possibly introduced will be either the rotary tiller or the power cultivator depending upon the field conditions and cropping systems. The rotary tiller is a popular tillage machine used throughout many of the rice producing countries of the world. The land can be prepared much more rapidly with a rotary tiller than with other means. One of the advantages of the rotary tiller is that it pulverizes the soil more than a plow and reduces the number of operations necessary to complete puddling. The power cultivator is smaller in engine power and lighter than the rotary tiller and uses the rotary blades assembly to support the body and propel it forward without wheels. The introduction of the power cultivator may be more feasible from an economical point of view. Through study of economic and technical aspects of various types of rotary tillers and power cultivators will be necessary to determine their adaptability and timeliness of introduction.

One of the recent innovation in land preparation is the introduction of herbicide and chemical fertilizer. The effects of herbicide in reducing weeding labor requirement are especially appreciated by the farmers. On the other hand use of chemical fertilizer appears to be limited to selected areas. Possible reasons for this are as follows.

1. Effects of fetilizer application often come to naught because of flood, disease and drought which are not yet under control.

2. Local rice varieties are not suitable for fertilizer application and it often results in lodging, and undesirable growth of leaves.

3. Cost of fertilizer is still high for subsistence farmers.

The introduction of herbicide has been welcomed without reserve by the farmers. The usual way of using herbicide is to spray it on the weeds at the beginning of land preparation. They are left until they are well sun-dried for burning. The field is again left for a while until the seeds of weeds remaining on the field germinate and grow a little. These young weeds are killed by the second spraying of herbicide. Labor requirement for spraying is only 1 man-day per acre. Subsequent operations are the same with the traditional methods. The advantages of using herbicide are as follows.

1. Reduces peak labor requirements for land preparation.

2. Fits within the present operation system, not requiring any change in other cultivation methods.

3. Application of herbicide is easy and requires no special techniques or equipment except a manual sprayer.

4. Allows to expand the acreage under cultivation.

5. Increases yield per acre.

The use of herbicide will surely be more common in years to come. This may be accelerated by two factors. One factor is that farmers in Sarawak have neither draft animals nor mechanical plowing or harrowing methods, which are also effective in controlling weeds. Another factor is that the favorable climate allows vigorous growth of various types of weeds, for which effective control is indispensable in paddy cultivation. However the use of herbicide will not solve all the problems. One of the limitations of herbicide is its ineffectiveness in killing perennial root herbs and therefore the eradication of all weeds is difficult. Also the effect of herbicide depends upon the species and types of weeds, their growing stage and the types of chemical formulation as well as other field conditions. In addition undesirable effects on the natural and ecological environment may be caused by the excessive use of herbicide. Herbicide residues may cause adverse effects on succeeding crops. And there is always the possibility of the appearance of some herbicide resistant weed species which necessitates the use of another chemical. Excessive use of herbicide is not desirable in any case. The use of herbicide should be regarded as a supplement to mechanical weed control in the future, but not a complete replacement for it.

2. Harvesting

The labor peak during harvesting is very high as stated previously. This is mainly due to the time-consuming use of the *Ketap*. Sickles are considered more efficient in general than *Ketap* from the view point of labor requirements. A shift from *Ketap* to sickle, however, has not taken place in Sarawak. The popular use of *Ketap* is some-

times attributed to the ritual attitude of farmers towards the paddy which is considered sacred and treated with great care. This reason for continued use of *Ketap* should not be overemphasized, since a shift to sickles must occur if the harvesting situation becomes really time-wise critical.

In order to find the reasons for refusal of accepting sickles by the farmers, a detailed comparison was made by evaluating every factor associated with *Ketap* and sickle harvesting (Table 4). Note the only significant advantage of the sickle over the *Ketap* is a higher efficiency of operation when yield per acre is high. As long as the yield level per acre remains the same there is no labor-saving advantage in using sickles. There are more advantages to use of the *Ketap* than the sickle. Sickle harvesting requires higher energy to cut the stalks and must be done by bending. This may be a minor disadvantage to sickles in the future. However at present these are important factors since harvesting is done traditionally by women who are not physically as strong as men. The labor required to transport heads is much smaller than for bundles of rice, and less space for storage is necessary for heads than bundles. With heads of rice, the threshing operation can be done by foot stepping, but for bundles of rice beating the heads or a thresher may be required. Therefore as long as farmers use easy shattering varieties with a yield of about 1,800 lb per acre, harvesting by *Ketap* is more suitable.

When the average yield is raised to 2,500 to 3,000 lb. per acre, the use of sickles should be recommended together with the encouragement of men to participate in the harvesting. With sickle harvesting, transportation of rice bundles to the threshing or temporary storage area becomes necessary. Of course, harder shattering varieties must be introduced to minimize grain losses during harvesting and transportation. Also at this stage the threshing method should be gradually changed to beating the

Table 4 Comparison of *Ketap* harvesting with sickle harvesting

	Ketap	Sickle
Selective harvesting	possible	impossible
Skill requirement	high	low
Energy requirement	low	high
Posture of operation	standing	bending
Hardness of operation	easy	hard
Time requirement	large and varies with the yield	small and almost fixed regardless the yield
Shattering loss	small	large
Transportation of products	easy	hard
Space needed for storage or drying	small	large
Threshing operation	foot stepping	beating heads or by thresher

rice heads or using a small thresher from the present method of foot stepping.

IX Conclusions

One of the unique features of wet paddy cultivation in Sarawak is that there is neither plowing nor harrowing before transplanting, and no draft animal is used. From the view point of cultivation practice the wet paddy cultivation is somewhat similar to the hill paddy which is still widely practised but gradually decreasing. Wet paddy farming operations are done manually and primitive yet each operation has its rationale for optimizing the entire cycle of traditional rice cultivation in Sarawak. This manual operation however can not cope efficiently at all with difficult field conditions. The labor supply, though in excess generally, becomes insufficient at the time of land preparation, weeding and harvesting, which limits the expansion of acreage of individual household. The average area under cultivation per household is therefore limited to 2–3 acres. The average yield for the wet paddy is 1,800 lb per acre. The technical improvement of certain operations and the reduction of labor requirements are needed to enable farmers to expand the acreage under cultivation and/or increase the yield per acre.

The following conclusions are drawn on the basis of this research.

1. The present manual farming method used for paddy cultivation has been developed to cope with difficult land conditions and characteristics of vegetation.

2. The method has been well suited to subsistence farming, but not for commercial rice production, since it requires considerable labor for various operations, and limits land holdings to 2–3 acres per family.

3. To produce marketable surplus of rice technological improvement is indispensable to reduce labor requirements for clearing and land preparation, the operation which requires the greatest amount of labor. One of the beneficial effects of better land preparation will be the reduction of weeds, and an accompanying decrease in labor requirement for weeding after transplanting.

4. Transplanting by dibbling and harvesting by *Ketap* (ear reaping knife) are fairly standardized operations which can be carried out by efficient use of hired labor for the time being. Harvesting by *Ketap* has more advantages than sickle harvesting for subsistence farming at present yield levels.

5. Harvesting by *Ketap* must be changed to sickle harvesting when the average yield is raised to 2,500–3,000 lb per acre. Introduction of hard shattering varieties is desirable at this stage to minimize grain losses.

6. For market rice production mechanization of post harvest operations will become a prerequisite for handling large quantities of rice and maintaining high quality rice.

V Recommendations

1. The first step to be taken for increased wet paddy production is to reduce the labor requirements for land preparation. This should be done by the effective use of herbicide and the gradual introduction of mechanical power into selected areas of Sarawak. Better weed control and land leveling will be required for effective fertilizer application and good use of water in the field in order to increase land productivity. The types and capacities of machines to be introduced must be determined after a period of experimental trials and research.

2. The second step is to increase the area of land under cultivation. But land development is generally more costly than increasing productivity of land already in use. Land clearing is especially a difficult task because of thick and rapid growing vegetation in many of the lowland areas of Sarwak. Land will revert back to jungle vegetation if not maintained properly and continuously. Development of some areas is not feasible due to the lack of roads to transport produce to market. Selection of specific areas to be developed must be made after consideration and analysis of these factors.

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References

1) Esmay, M. L. and C. W. Hall (ed.) Agricultural Mechanization in Developing Countries. Shin-Norinsha Co., Ltd. Tokyo, 1973.
2) ————. FAO Production Yearbook vol. 30, 1977.
3) Grist, D. H. Rice. Longmans, Green and Co., Ltd. London, 1968.
4) Freeman, D. Report on the Iban. The Athlone Press, London, 1970.
5) Ozaki, C. and H. F. McColly. Expert Group Meeting on Agricultural Mechanization. Asia Productivity Organization Project SYP/III/67. Vol. I, 1968.
6) Yamashita, R. Report on Drying, Storing and Milling in the Philippines. Laboratory of Agricultural Process Machinery, Kobe University, Kobe, Japan, 1975.
7) Watabe, T. Paddy Rice Cultivation in Thailand. The Southeast Asian Studies, Vol. II, No. 1, pp. 13–23, 1964 (in Japanese).
8) Tanaka, A. General Agricultural Situations in Burma. Japan Journal of the Society of Agricultural Machinery, Vol. 27, No. 3, pp. 199–202, 1965 (in Japanese).
9) ————. Handbook—Production Data for Sarawak Agriculture. Economics Division, Research Branch, Department of Agriculture, Kuching, Sarawak, p. 58, 1971.
10) ————. Agricultural Statistics of Sarawak. Department of Agriculture, State of Sarawak, Kuching, Sarawak, 1975.
11) Chin, T. H. Rice Varieties and Some Field Trials Results in Sarawak. Agricultural Research Newsletter, Vol. 3, No. 1, pp. 9–20, 1973.
12) Kyuma, K. et al. Report on A Study of Rice Cultivation in the State of Sarawak. Report submitted to the State of Sarawak by Kyoto University team, 1976 (unpublished).
13) ————. Statistical Yearbook of Ministry of Agriculture and Forestry, Japan, 1977.