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A traditional farmers' practice of black gram (Mat-pe) (*Vigna mungo*) cultivation in Maubin township, Ayeyarwady region, Myanmar

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Abstract: The largest black gram sown areas are concentrated in Ayeyarwady Region of which the large productive areas are Danuphyu, Maubin and Nyaungtone Townships. Black gram is widely grown as a second crop after monsoon rice in the post monsoon season with residual soil moisture. The unique feature of black gram cultivation in these regions is that there exist three traditional agronomic practices, locally known as "Htun-pe, Ye-lite-pe and Khoke-phone-pe". Farmers follow one of these methods depending on the soil moisture condition of their fields and sowing time. When they have sufficient time for proper land preparation with suitable soil moisture they practice "Htun-pe". In the reverse condition, farmers follow the zero tillage systems called "Ye-lite-pe" and "Khoke-phone-pe". The latter two practices have been widely adopted by farmers in Ayeyarwady Region since 1990s. Field surveys were carried out in Maubin Township during 2005-2006 to document the information on an appropriate location-specific cultivation technology of black gram. The estimated enterprise budget indicates that Khoke-phone-pe gave the greatest benefit-cost ratio of 4.3, while Ye-lite-pe and Htun-pe contributed benefit-cost ratio of 3.7 and 3.6, respectively. It clearly shows that "Khoke-phone-pe and Ye-lite-pe" can give as much net return as "Htun-pe". Many farmers prefer "Khoke-phone-pe and Ye-lite-pe" because of its low input and low management requirement.
Key words: Black gram, Khoke-phone, relay cropping, residual soil moisture.

Introduction

A number of agricultural management practices, such as cropping patterns and sowing practices have long existed traditionally in different agro-ecological regions in Myanmar. Farmers have developed them over time with long time experiences and their needs. At present, Myanmar has been standing as a lead country of pulses production among ASEAN countries. Since 1990, the country's pulses production and export have been increasing due to the drastic rise in price of pulses, as a consequence of the liberalization of government trade policy, and introduction of new improved varieties (Myanmar Agricultural Statistics, 2001). In 2005-2006, pulses production was the second highest after rice of all the national agricultural crops production (Fig. 1 and Fig. 2). In recent years, black gram has been the biggest export crop among the pulses followed by pigeon pea and mung bean (Myanma Agriculture in Brief, 2006). The largest black gram sown areas are concentrated in Ayeyarwady Region (46 %) and Bago Region (40 % of the total) (Table 1 and Fig. 3). The most productive areas in Ayeyarwady Region are, in order of importance, Danuphyu, Maubin and Nyaungtone Townships. In these areas black gram is widely grown as a second crop in post monsoon season with the residual soil moisture after monsoon rice. The unique feature of black gram cultivation in these areas is that there are three traditional sowing practices, namely "Htun-pe, Ye-lite-pe and Khoke-phone-pe". Farmers follow one of these practices depending on the soil moisture condition and sowing time. When they have sufficient time for proper land preparation with suitable soil moisture, they practice "Htun-pe". In the reverse condition, i.e. when the land available for black gram sowing is late, farmers follow zero tillage method/ system called "Ye-lite-pe" and "Khoke-phone-pe". Information on traditional farmers' technologies, that are optimum crop management practices in a particular agro-ecological situation, is of great importance in order to increase crop productivity. These technologies or practices largely depend on agro-ecological suitability, such as rainfall, soil type, labor availability, food requirement, marketability and etc. Only a very few research works of such nature have been done Myanmar, and therefore this survey research was carried out with the objectives: (i) to observe the existing technology of black gram cultivation in lower Myanmar and its trends of production, (ii) to document the information on the appropriate location-specific cultivation technology of black gram and to disseminate it in other areas, and (iii) to identify the constraints and the potential areas for expansion of black gram production in rice based cropping system

The information of this study will be a base line for the future research efforts leading to the improved pulses production in Myanmar.

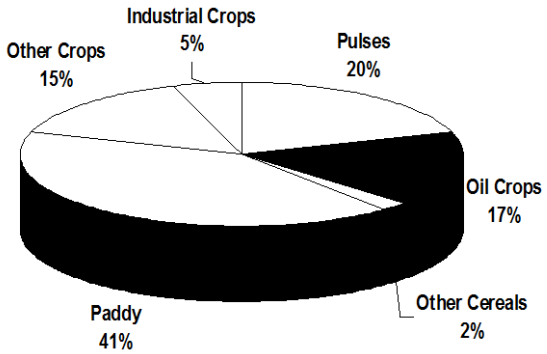

Fig.1. Crop Production of Myanmar in 2005-2006
Source: Myanmar Agriculture in Brief, 2006

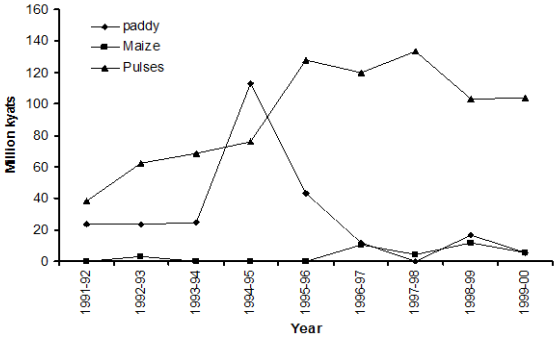

Fig. 2. Export of Main Agricultural Products from Myanmar
Source: Settlement and Land Records Department, 2001

Table 1. Black gram production in Myanmar, 2005-06

State/Region	Monsoon (Acres)	Post monsoon (Acres)	Yield/ acre	Total yield (basket)
Kachin		149	9.8	1,453
Kayar				-
Kayin		79	10.6	840
Chin		75	12.5	938
Sagaing	1838	114,719	15.7	1,827,316
Tanintharyi		107	5.8	624
Bago		434,921	15.6	6,797,815
Bago(West)		373,177	15.2	5,683,486
Magwe		19,601	14.7	287,939
Mandalay		49,914	13.4	666,352
Mon		8,338	13.5	112,646
Yakhine		43,896	9.9	433,692
Yangon		41,542	13.2	547,108
Shan(south)		26	8.8	228
Shan(north)		220	12.1	2,651
Shan(east)				-
Ayeyarwady		925,851	16.1	14,906,201
National Total	1838	2,012,615	15.5	31,235,785

Source: Food Legumes Section, Myanmar Agriculture Service, Yangon

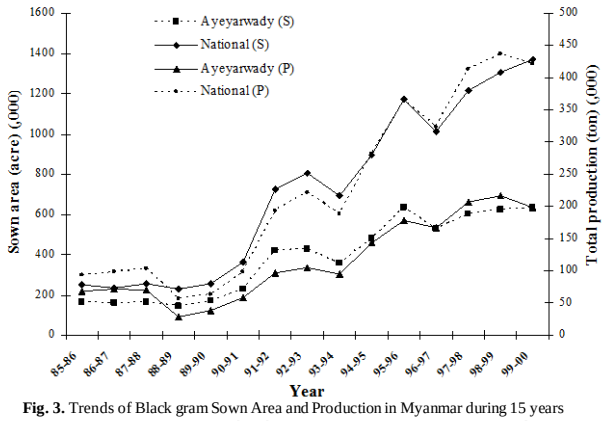

Fig. 3. Trends of Black gram Sown Area and Production in Myanmar during 15 years
Source: Myanmar Agricultural Statistics, 2003 (S= Sown Area; P= Production)

Materials and Methods

Field surveys were carried out in Maubin Township during the black gram growing season during 2005-2006. Ten farmers were randomly selected from each three villages, namely Nga-gyi-ga-yet, Kyone-soke and Alan-gyi, of Maubin Township. They were interviewed with structured questionnaires to study the farmer level production systems of black gram and demographic characteristics of farming communities. The data collected were demographic data, family size, farm size, farming experience and technical data concerning with black gram production technology. The secondary data were obtained from Myanma Agriculture Service (currently, Department of Agriculture), Maubin District and Food Legumes Section, Ministry of Agriculture and Irrigation (Currently, Ministry of Agriculture, Livestock and Irrigation).

Results and Discussion

Mono cropping of rain-fed rice was predominant in Lower Myanmar until 1952-53, and the rice varieties used were traditional late-maturing varieties such as Sa-pa-net, Bo-daw-gyi, Taung-pan, etc. with long stems and low yields. In a very few places where residual soil moisture was available for second crop, farmers cultivated Pe-nauk (a local variety of mungbean) and groundnut for their subsistence during post-monsoon season. After about 1955, black gram varieties namely, Boke-hmwe, Hin-tha-da mat-pe, which had a spread type of growth habit, were introduced into these areas as the second crop after rice. Only when there was enough time after rice harvest for optimum land preparation for the next crop, black gram was grown after normal ploughing and harrowing. This practice was called "Htun-pe" ("Htun means harrow and Pe means pulse") meaning "pulse growing after land preparation with harrow".

A common problem for black gram growing was a difficulty of a proper land preparation with a plough and a harrow for black gram after the rice harvest. The soil was too hard or too wet to plough depending on the amount of rainfall and its distribution during the late monsoon season, as well as the rice harvest time. If the farmers do the normal land preparation which takes 1-2 weeks, it will make black gram sowing late, and there will be insufficient soil moisture to facilitate the later growth of the crop, resulting in low yield. Therefore, some farmers did not prepare their lands and modified their sowing practices to coincide the sowing time with the appropriate soil moisture condition for good crop establishment. Black gram seeds were broadcast before or after the rice harvest with zero tillage. Before the rice harvest, rice stems were pressed with bamboo poles to become a slanting position for easier harvest operation. Rice was harvested manually with sickles and long rice stubbles were maintained in the field after the harvest. Black gram plants grew among the stubbles, twined them, flowered and gave a certain yield. In general, black gram seeds were broadcast on saturated soils about 3-10 days before the rice harvest, as a relay crop (by the end of Oct. to mid-Nov).

By this method, sowing time could be advanced about 2 weeks so that drought stress which generally occurred during the later stages of black gram could be avoided to a certain extent. This practice was developed in about 1958 and it was known as "Ye-lite-pe" ("Ye means water, lite means accompany"), meaning "pulse growing together with soil water". Some farmers, after the broadcasting of black gram seeds, pressed the rice stubbles again by using "Jode" drawn by draught cattle. This method was called "Joke-se" and farmers believed that it could ensure the seeds to reach or touch the soil surface. Farmers assumed that Ye-lite-pe and Joke-se was almost the same practice

because most Ye-lite-pe farmers did Joke-se practice. The sowing methods of Ye-lite-pe or Joke-se facilitated timely sowing; significantly reduced the risk of crop failure caused by drought stress and substantially reduced the expense on land preparation. This traditional sowing method of black gram was commonly practiced on the river banks after the flood water had receded in lower Myanmar (Plate 1).

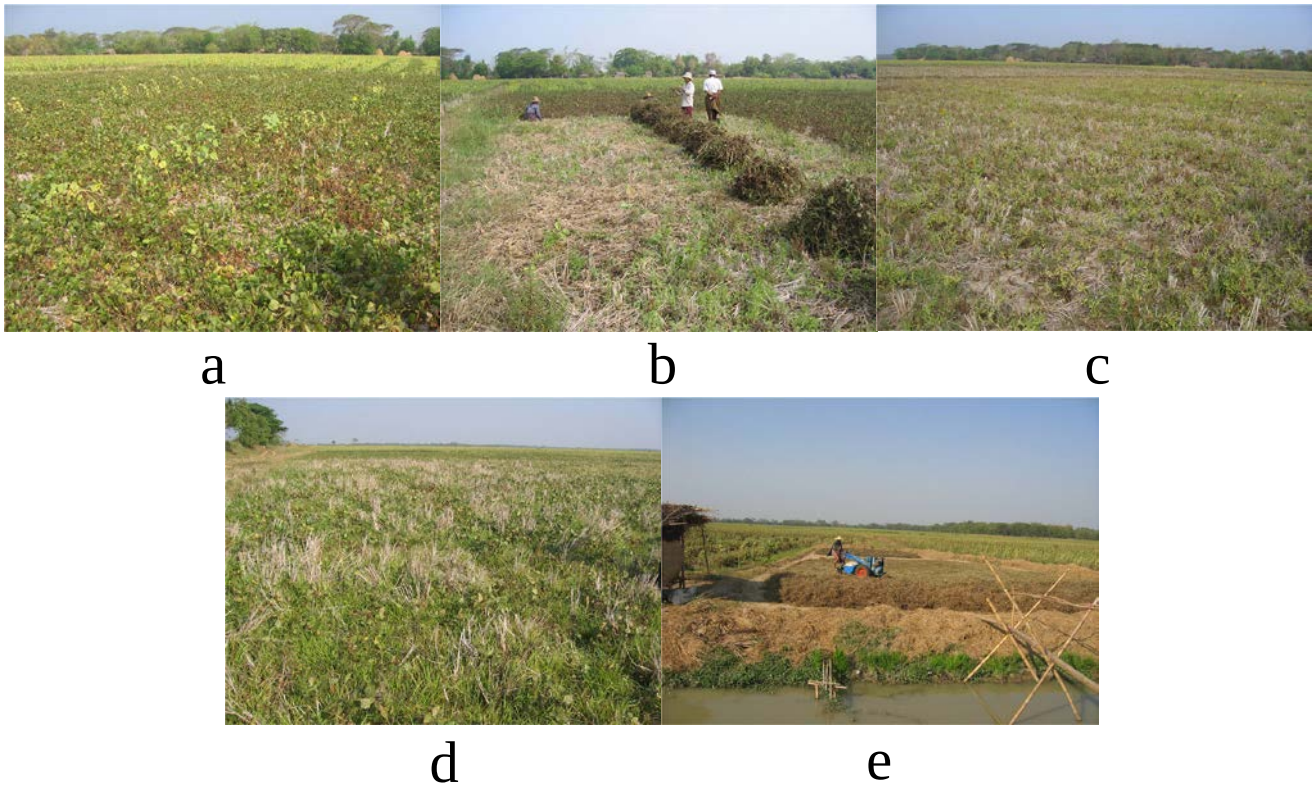

Plate 1. Black gram harvest in Nga-gyi-ga-yet Village Tract, Maubin Township (a) Khoke-phone method (black gram and sunflower before harvest), (b) Khoke-phone method (black gram harvest time- rice residues were clearly seen), (c) Khoke-phone method (black gram was harvested) (d) Ye Lite method (black gram was harvested), (e) Threshing of black gram

In late 1960s, high yielding rice varieties of short or medium duration with short stems were introduced into Myanmar. The first "Whole Township Rice Production Program" was initiated in Taikekyi Township, Lower Myanmar in 1977-78, and then these varieties were widely spread in Lower Myanmar (Rice in Myanmar, 2004). In 1980s, new improved varieties of black gram, such as Pa-le-net (P 11-30) and Ye-zin 2 (P 45-1) were distributed from the Department of Agriculture Research, and grown in Lower Myanmar. These new improved varieties have the characteristics of shorter duration compared with traditional varieties, short stems and the erect or semi-erect type of growth habit. When the seeds were sown among rice stubbles, as the farmers formerly did, the plants did not twine the rice stubbles. Moreover, they could not grow well because of poor light penetration due to the shade of the rice stubbles. In addition, farmers found difficulty to harvest the black gram plants among the rice stubbles with sickles. To solve the problem, some farmers cut the stubbles with long knives about 3-7 days after the rice harvest and left the straw residues among the black gram young seedlings. This practice was known as "Khoke-phone-pe" ("Koke means cut, phone means cover") meaning "cutting the stubble and covering the soil surface". Farmers gradually noticed that this practice gave a better black gram yield because of more moisture conservation and weed suppression due to mulching effect of rice straw. The Khoke-phone-pe technology was said to be developed by farmers of the village tracts of Tha-phu, Nan-chaung, Ye-le and Ye-kyi in Da-nu-phyu Township. After that, it was disseminated to the village tracts of Ka-nyin-kauk-kyi, Ta-zin-ye-kyaw, Kyone-yit in Nyaung-tone Township and then to Maubin Township. It became popular and widely followed by farmers in the whole Ayeyarwady Region, Lower Myanmar since 1990s.

Among these three agronomic practices, Htun-pe generally gives the highest yields. The choice of these practices firstly depends on the topography of land. The short or medium duration of high yielding rice varieties (with short and study stem) are usually grown in high land and areas of intermediate land level. These lands are not flooded or water recedes early, and rice is harvested early (Sept-Oct). Therefore, there is sufficient time for land preparation after the rice harvest, "Htun-pe" is practiced in these areas. Long-duration local rice varieties with long stems are grown in low – level lands and harvested late (Nov. – Dec.). In these areas, zero tillage method of "Ye-lite-pe" or "Khoke-phone-pe" is practiced because there will be no adequate residual soil moisture if the normal land preparation is done after rice harvest. Nowadays, because of its low input and convenience of cultivation practice farmers also practice "Ye-lite-pe" or "Khoke-phone-pe" in the areas of high and intermediate land level.

Secondly, rainfall and its distribution pattern determine the farmers' sowing practices. If early monsoon comes, rice is grown early and harvested early so that farmers have enough time for land preparation of black gram, and "Htun-pe" is practiced. In the reverse condition "Ye-lite-pe" or "Khoke-phone-pe" is taken place. Moreover, with the late monsoon withdrawal and the land is still wet, there will be late sowing of black gram if the farmers wait for the proper land condition for ploughing. Therefore, for the timely sowing of black gram, "Ye-lite-pe" and "Khoke-phone-pe" must be practiced. The annual rainfall and its distribution in Maupin Township for ten consecutive years (1996-2005) were described in Table 2.

Table 2. Rainfall (inches) in Maubin Township for ten consecutive years (1996 - 2005)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1996		3.54		2.65	9.97	18.4	12.34	17.41	15.16	5.5	4.06		89.03
1997			3.58			10.82	27.89	19.84	19.38	4.25	1.42		87.18
1998					12.3	19.23	12.7	11.61	9.52	5.85	0.9		72.15
1999			1.18	5.85	0.87	12.24	16.61	23.1	11.87	8.61	2.22		82.55
2000			0.07	3.72	7.92	18.42	12.68	13.44	16.49	3.51	0.08		76.33
2001			2.13		18.2	18.78	28.67	24.62	10.98	10.69	2.77		116.86
2002				0.31	14.6	19.25	15.02	22.26	17.8	6.85	4.79	0.57	101.42
2003			0.16	0.39	13.1	20.33	10.36	17.4	13.48	3.23	0.39		78.85
2004				0.51	18.1	21.73	18.63	31.41	9.73	3.43			103.5
2005				2.17	6.85	14.62	25.25	15.8	12.03	3.88	1.74		82.34
10-year average			1.42	2.23	11.32	17.38	18.02	19.69	13.64	5.58	2.04	0.57	89.02

Source: Department of Meteorology, Maubin Town

Thirdly, the moisture condition of the rice fields influences the farmers' practice. Dry- up top soil is a major determinant to crop establishment when black gram seeds are sown with residual moisture. Farmers, with their intelligence and longtime experience, decide which practice they have to follow depending on the following three conditions of the soil moisture of the field after the rice harvest.

(i) "Kho-nin-khan or Byaine-nin-khan" means a bird (a pigeon or egret) can easily walk on the soil surface. There is best moisture condition for black gram seeds to germinate and seedling emergence, and either "Ye-lite –pe" or "Khoke-phone-pe" is practiced.

(ii) "Lu-nin-Khan" means a man can easily walk on the soil surface. Although the moisture is less than the No.1 condition, the soil is good for "Ye-lite –pe" or "Khoke-phone-pe".

(iii) "Nwar-nin-khan" means a cow can easily walk on the soil surface. The moisture condition is less than the above mentioned and "Htun-pe" should be done due to its good moisture condition for tillage.

Table 3 shows the trend of black gram acreage in Maubin Township during ten consecutive years (from 1996 to 2006). It indicates that, black gram sown areas in 2005-06 were two times higher than those in 1996-97 (from 35,788 acres in 1996-97 to 83,789 acres in 2005-06). The percentage of double cropping of black gram after rice increased from 30 % in 1996-97 to 60 % in 2005-06. Among the monsoon rice growing areas in lower Myanmar, there are three types of rice eco-systems depending on the water condition of rice fields– (1) Ye-taw-moe-taw, a good management of water level (2) Ye-kyi-kwin, a plot often flooded with heavy rains, and (3) Ye-net-kwin, a plot mostly flooded for the rice varieties of deep-water-rice.

The black gram acreage under Ye-taw-moe-taw and Ye-kyi-kwin are static while Ye-net-kwin acreage increased from 26,932 acres in 1996-97 to 47,839 acres in 2005-06. It was also noted that rice total sown area was increased by about 20,000 acres over ten years.

The information contained in Table 4 features the change in type of black gram cultivation. The data of 10 year-analysis showed that, among the three sowing practices, Ye-lite-pe ranged from 10-37 % and Khoke-phone-pe 12-41 % while Htun-pe ranged from 22-78 %. It was also noted that, in Maubin Township, Htun-pe was practiced most, followed by Khoke-phone-pe and Ye-lite-pe, respectively. The reason was that most farmers think that Htun-pe gave the highest yield while Khoke-phone-pe the intermediate and Ye-lite-pe the lowest. However, some farmers practice Khoke-phone-pe and Ye-lite-pe than Htun-pe more because of their low input and low management practices.

Table 3. Trends of monsoon rice and black gram cultivation in Maubin Township during ten consecutive years (1996 – 2006)

Year	Rice Growing Areas (Acres)				Black gram area (Acres)	Black gram %
	Yetawm-oetaw (high-land)	Yegyi Kwin(low-land)	Yenet kwin (flooded-land)	Total area (Acres)		
1996-97	76,506	14,078	26,932	117,516	35,788	30
1997-98	76,506	14,078	26,758	117,342	46,696	40
1998-99	76,506	14,078	27,129	117,713	43,258	37
1999-00	76,506	14,078	36,959	127,543	43,109	34
2000-01	76,506	14,078	42,447	133,031	42,442	32
2001-02	76,506	14,078	43,408	133,992	44,913	34
2002-03	76,506	14,078	43,406	133,990	45,503	34
2003-04	76,506	14,078	43,517	134,101	48,064	36
2004-05	76,506	14,078	47,520	138,104	57,835	42
2005-06	77,172	14,917	47,839	139,928	83,789	60

Source: Myanma Agriculture Service, Maubin Township

Table 4. Trends in sowing practices of black gram cultivation after monsoon rice in Maubin Township during ten consecutive years (1996 – 2006)

Year	Black gram Area (Acres)			Yelite%	Khoke- Phone %	Htunpe%
	Yetawm-oetaw (high-land)	Yegyi Kwin(low-land)	Yenet kwin (flooded-land)			
1996-97	76,506	14,078	26,932	117,516	35,788	30
1997-98	76,506	14,078	26,758	117,342	46,696	40
1998-99	76,506	14,078	27,129	117,713	43,258	37
1999-00	76,506	14,078	36,959	127,543	43,109	34
2000-01	76,506	14,078	42,447	133,031	42,442	32
2001-02	76,506	14,078	43,408	133,992	44,913	34
2002-03	76,506	14,078	43,406	133,990	45,503	34
2003-04	76,506	14,078	43,517	134,101	48,064	36
2004-05	76,506	14,078	47,520	138,104	57,835	42
2005-06	77,172	14,917	47,839	139,928	83,789	60

Source: Myanma Agriculture Service, Maubin Township

Table 5. Estimated enterprise budget for Ye-lite-pe in Maubin Township, 2005-06

Operation	Requirement	Rate (Kyat)	Kyat/ acre
Cultivation			3,000
Broadcasting	1 person	500	500
Weeding	3 person	500	1500
Pesticide Application	2 person	500	1000
Inputs			14,100
Seed	12 pyi	1000	12000
Rhizobium	2 packet	50	100
Pesticides	1 bottle	2000	2000
Harvest			9,000
Harvesting	6 persons	500	3000
Transport to thresh floor	2 person	500	1000
Threshing		5000	5000
Total cost			26,100
Yield per acre		8 basket	
Price		12000 kyat	
Gross benefit			96,000
Net benefit			69,900
Benefit-cost ratio			3.7

Source: Myanma Agriculture Service, Maubin Township

Table 6. Estimated enterprise budget for Khoke-phone-pe in Maubin Township, 2005-06

Operation	Requirement	Rate (Kyat)	Kyat/ acre
Cultivation			7,000
Broadcasting	1 person	500	500
Cutting Rice-residue		4000	4000
Weeding	3 person	500	1500
Pesticide- application	2 person	500	1000
Inputs			12,100
Seed	10 pyi	1000	10000
Rhizobium	2 packet	50	100
Pesticides	1 bottle	2000	2000
Harvest			9,000
Harvesting	6 person	500	3000
Transport to thresh-floor	2 person	500	1000
Threshing		5000	5000
Total Cost			28,100
Yield per acre		10 basket	
Price		12000	
Gross benefit			120,000
Net benefit			91,900
Benefit-cost ratio			4.3

Source: Myanma Agriculture Service, Maubin Township

In order to give more specific information for the comparative purposes, general production costs and returns for different production system are shown in Tables 5, 6 and 7. The estimate enterprise budget indicates that Khoke-phone-pe gave the greatest benefit- cost ratio of 4.3 while Ye-lite-pe and Htun-pe contributed benefit-cost ratio of 3.7 and 3.6 respectively. It clearly shows that "Khoke-phone-pe and Ye-lite-pe" can give as much net return as "Htun-pe". This explains why farmers in these regions widely adopt their traditional practice of "Khoke-phone-pe and Ye-lite-pe".

Table 7. Estimated enterprise budget for Htun-pe in Maubin Township, 2005-06

Operation	Requirement	Rate (Kyat)	Kyat/ acre
Cultivation			18,000
Ploughing	3 person	2500	7500
Harrowing	2 person	2500	5000
Da-gyan-tone	1 person	2500	2500
Broadcasting	1 person	500	500
Weeding	3 person	500	1500
Pesticide- application	2 person	500	1000
Inputs			20,350
Seed	8 pyi	1000	8000
Rhizobium	2 packet	50	100
Pesticides	1 bottle	2000	2000
Urea	¼ bag	17000	4250
Triple super phosphate	½ bag	11000	5500
Bio-super foliar	1 bottle	500	500
Harvest			11,000
Harvesting	10 person	500	5000
Transport to thresh floor	2 person	500	1000
Threshing		5000	5000
Total Cost			49,350
Yield per acre		15 basket	
Price		12000	
Gross benefit			180000
Net benefit			130,650
Benefit-cost ratio			3.6

Source: Myanma Agriculture Service, Maubin Township

Note: 16 pyis = 1 basket, 1 pyi = 4.5 lb = 2.04 Kg, Black gram 1 bsk = 72 lb = 32.65 Kg, 1 hectare = 2.471 acres

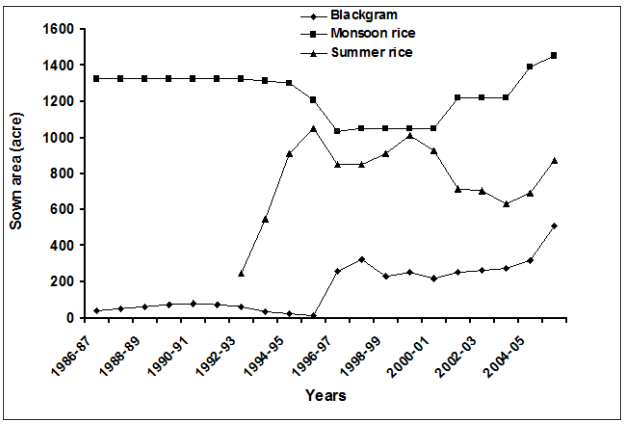

Fig. 4. Trends of Double Cropping Areas of Summer Rice and Black gram after Monsoon Rice during 20 years in Alangyi Village Tract, Maubin Township

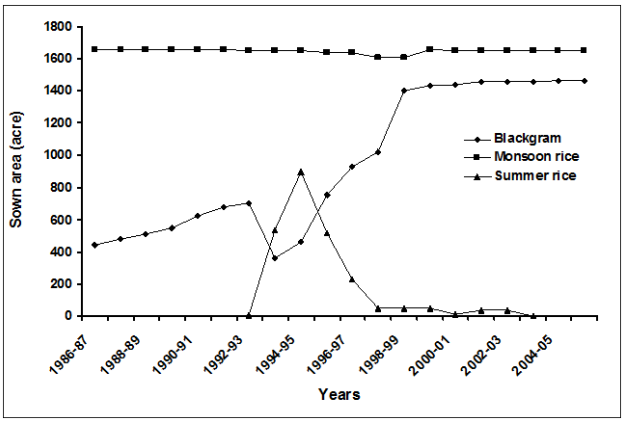

Fig. 5. Trends of the double cropping areas of rice and black gram during 20 years in Ngagyigayet village tract, Maupin Township

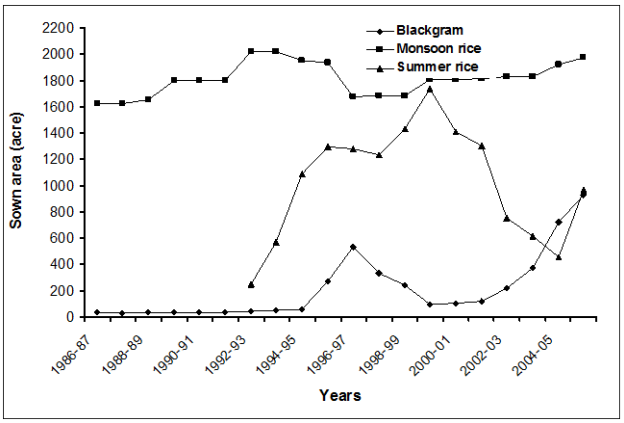

Fig. 6. Trends of Double Cropping Areas of Summer Rice and Black gram after Monsoon Rice during 20 years in Kyonesoke Village Tract, Maubin Township

Table 8. Estimate Enterprise Budget for Summer Rice (Pre-monsoon) in Maubin Township, 2005-06

Operation	Requirement	Rate (Kyat)	Ks/ acre
Cultivation			41,000
Seedbed preparation	-	-	5000
Land preparation			20000
Seedling-uprooting	3 person	3000	9000
Transplanting	14 person	500	7000
Management			16,000
Weeding	6 person	500	3000
Fertilizer application	2 person	500	1000
Pump irrigation	3 times	4000	12000
Inputs			49,500
Seed	3 bas	2000	6000
Urea	ket	17000	17000
Triple super phosphate	1 bag	11000	5500
Murate of potash	½ bag	20000	5000
Diesel oil	¼ bag	3200	16000
	5 gallon		
Harvest			20,000
Harvesting	-	6000	6000
Transport to thresh-	1 pers	1000	2000
floor	on	100	12000
Threshing	120		
	basket		
Total Cost			126,500
Yield per acre	120 basket		
Price		1700	
Gross benefit			204000
Net benefit			77,500
Benefit-cost ratio			1.6

Source: Myanma Agriculture Service, Maubin Township

Figs. 4-6 describe the trends of double cropping patterns during twenty years in A-lan-gyi, Nga-gyi-gayet and Kyone-soke village tracts in Maubin Township respectively. It can be seen that, in some areas, instead of growing black gram, summer rice has been introduced after monsoon rice since 1992-93. The sown areas of summer rice were fluctuated and have been decreasing during the last 7-8 years in these regions. Since 1996-97 the black gram areas have been increasing in A-lan-gyi and Nga-gyi-gayet village tracts. However, in Kyone-soke village tract, the black gram areas decreased during 2000 to 2002 and after that the areas increased again. Under the current production level and marketing environment, benefit-cost ratio of summer rice in 2005-06 in Maubin Township was 1.6 as shown in Table 8, which was much lower than that of black gram. Farmers prefer black gram growing because of its high price, low input and low management requirement to summer rice growing.

Conclusion and Recommendation

Research evidences have well documented that the double cropping or crop rotation of "Monsoon Rice-Post monsoon Black gram" has more positive impacts than "Monsoon Rice-Summer Rice" and "Monsoon Rice-Post monsoon Fallow" pattern. The research carried out at Department of Agricultural Research, Yezin, Myanmar reported that rice - black gram-rice pattern gave greater positive balance of nitrogen than rice-fallow-rice pattern. It supported that legumes in the rice-based cropping systems has positive N contribution (Phyu Pya Lwin *et al.*, 2006). Rego and Seeling (1996) also mentioned that legume crop left the higher amount of N than that of non-legume crop and N uptake of cereal crops growing after legume became higher due to the increasing N availability.

Intensive rice cultivation has been carried out for many decades in Myanmar for domestic consumption and export market. Mono-cropping pattern of rice-fallow pattern is most prevalent in rain-fed rice ecosystem which results in nutrient mining. In this regard, inclusion of pulses in the farmers' cropping systems will surely sustain the soil fertility and reduce the requirement of chemical fertilizers. It is because rice crop benefits from nitrogen fixed through the *Rhizobia*-legume association. Besides, the crop rotation of rice and black gram keeps disease and insect population under control. In large areas of Myanmar the non-availability of irrigation water and delay in vacating the field after rice does not permit double cropping in post monsoon season. Planting of the next crop is not feasible because the top soil layer will dry out soon and no sufficient residual soil moisture will remain if the land preparation is done for the next crop at the time of rice harvest. Under such condition, double cropping of black gram with zero tillage (Ye-lite–pe" or "Khoke-phone-pe) can convert these mono-cropped areas, and thus increase pulse production and sustain the productivity of rice-based system.

"Khoke-phone-pe" is more beneficial than "Ye-lite-pe" or "Htun-pe" because mulching of rice straw- residues conserves soil temperature and moisture, and protects the soil against erosion. It also increases organic matter to the soil which consequently improves the soil's physical condition, and enhances biological activity and soil

fertility. More than 50 % of total rice areas in Myanmar still remain fallow during post monsoon season mainly due to the lack of residual soil moisture. If these areas are tapped for extending pulses cultivation with great efforts on research, pulses areas can be doubled.

The estimated enterprise budget of black gram production in Maubin Township, 2005-2006 indicates that "Khoke-phone-pe" gave the greatest benefit- cost ratio of 4.3 while "Ye-lite-pe" and "Htun-pe" contributed benefit- cost ratio of 3.7 and 3.6 respectively. Therefore these two traditional farmers' practices of "Khoke-phone-pe" and "Ye-lite-pe" have a great potential in rice-based system and it should be introduced into the other possible regions. The results of this survey research will make a preliminary contribution towards identifying the location-specific research and agricultural development needs. Further research should be done in the other regions where temperatures are moderate during winter for black gram growing in rice fallows, emphasizing on the identification of areas with potential to expand pulses production in Myanmar.

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