CHAPTER 4

RESULTS

4.1 Crop livestock mixed farming systems of Chitawon, Nepal

Chitawon district, which lies in the central development region, is one of the intensive land use areas in the inner *terai* range of Nepal. The two study sites i.e., Lanku and Tandi represent upland maize and lowland rice based crop livestock mixed farming systems of Chitawon district respectively (Figure 2, 3).

Agriculture is the mainstay of villagers in these sites. Crop production and animal husbandry are the main farming enterprises, where, integration of crops, vegetables, animals and trees are normally found. Various components of the typical mixed farming system has been shown in figure 4.

Table 3 shows the predominant cropping calendar in the study area. The important crops grown are mustard, maize, sesame, wheat and buckwheat in the Lanku site and rice, maize, mustard, wheat and lentil in Tandi site respectively. It was found that, maize-fallow-mustard/ wheat or maize-fallow-buckwheat/ mustard is common cropping system in Lanku site, where as, maize-rice-mustard/ wheat is mostly adopted in Tandi site. To safeguard crop failure, farmers have adopted various strategies such as changing crops, varieties and even planting dates. As a result, different cropping patterns are in practice. It was known while discussing with farmers that, maize sown during February/ March often fails due to lack of timely rainfall. In the recent years, wheat has been equally preferred as mustard in a rice based system. Lentil is often grown as a relay crop in rice field. Buckwheat is an alternative cash crop to mustard. The cultivation of which is largely governed by market price.

Table 3. The major cropping patterns in the Lanku and Tandi sites of Chitawon

Cropping Patterns			Site
1. Maize (Feb)	- Maize (June)	- Mustard /fallow (Oct-Nov)	- Lanku
2. Maize (March)	- Sesame (July)	- Mustard (Nov.)	- Lanku
3. Maize (March)	- Rice (June)	- Fallow	- Lanku/Tandi
4. Maize (March)	- Rice (Ju/Jl)	- Mustard/Lentil/Wheat (Oct.)	- Lanku/Tandi
5. Maize (April)	- Fallow	- Buckwheat/Mustard (Oct-Nov.)	- Lanku
6. Maize (April)	- Fallow	- Mustard/Wheat (Oct-Nov.)	- Lanku
7. Fallow	- Rice	- Wheat/Lentil (Oct-Nov.)	- Tandi

Source: PRA, 1992
Note: Figure in parentheses indicate sowing month.

The cropping patterns are relatively simple, especially forage crops has no position in them although animal production plays a great role in the economy. The productivity under various land use is moderate to poor while major problems are drought due to no or insufficient irrigation especially in Lanku site.

It was observed that, animals (especially ruminants) and food crops rely on each other to survive under common rural circumstances. Since the main economic motivation of farmers is targeted through food crops, animals become an important commodities in supplying manure and draft power. As a feed back, some amount of straw, grass, weeds and crop by-products would be available for ruminants as part of their ration (Table 4).

Maize, either in the form of stover or semi dried portion above cob *(Tuppo)*, mustard *Gatte,* lentil barn, and rice straw are important crop by-products used for feeding animals (Table 4).

Table 4. Status of the major by-products used for feeding animals (3 livestock unit) in Lanku site ##

Months/ By-products	Green fodder (Kg)	Maize stover (Kg)	Mustard *Gatte* (Kg)	Lentil bran (Kg)	Rice straw (Kg)
January	-	400 (Dried)	-	-	2500
February	-	-	200	-	2500
March	-	-	100	75	150
April	-	-	60	70	100
May	300	300 (Green)	-	-	100
June	480	300 (Green)	-	-	50
July	700	1400 (Green)	-	-	25
August	610	1800 (Green)	-	-	-
September	430	800 (Green)	-	-	125
October	240	750 (Green)	-	-	150
November	210	750 (Green)	-	-	150
December	50	400 (Green)	-	-	225

Considering the average feeding pattern
Source: PRA, 1992

It was known from discussion with farmers that, feeding requirement are normally fulfilled through the supplementation of by-products. Lentil bran is the only legume source of feed, however, it is not sufficient to feed the animals. To fulfill the bulk requirements of green grass, farmers use more rice straw instead. Which reduces the quality of animal health as well as quantity of milk production.

The majority of farmers own buffalo, buffalo calves, cow, cow calves and buffalo bull/ bullocks (between 2 and 5 or more per household). Farmers also raise goats and chickens. Cow and buffalo (improved) are main animals in Tandi and Lanku sites respectively. Animals are generally stall-fed and there is deficit of feed during dry months (February to July and September to November).

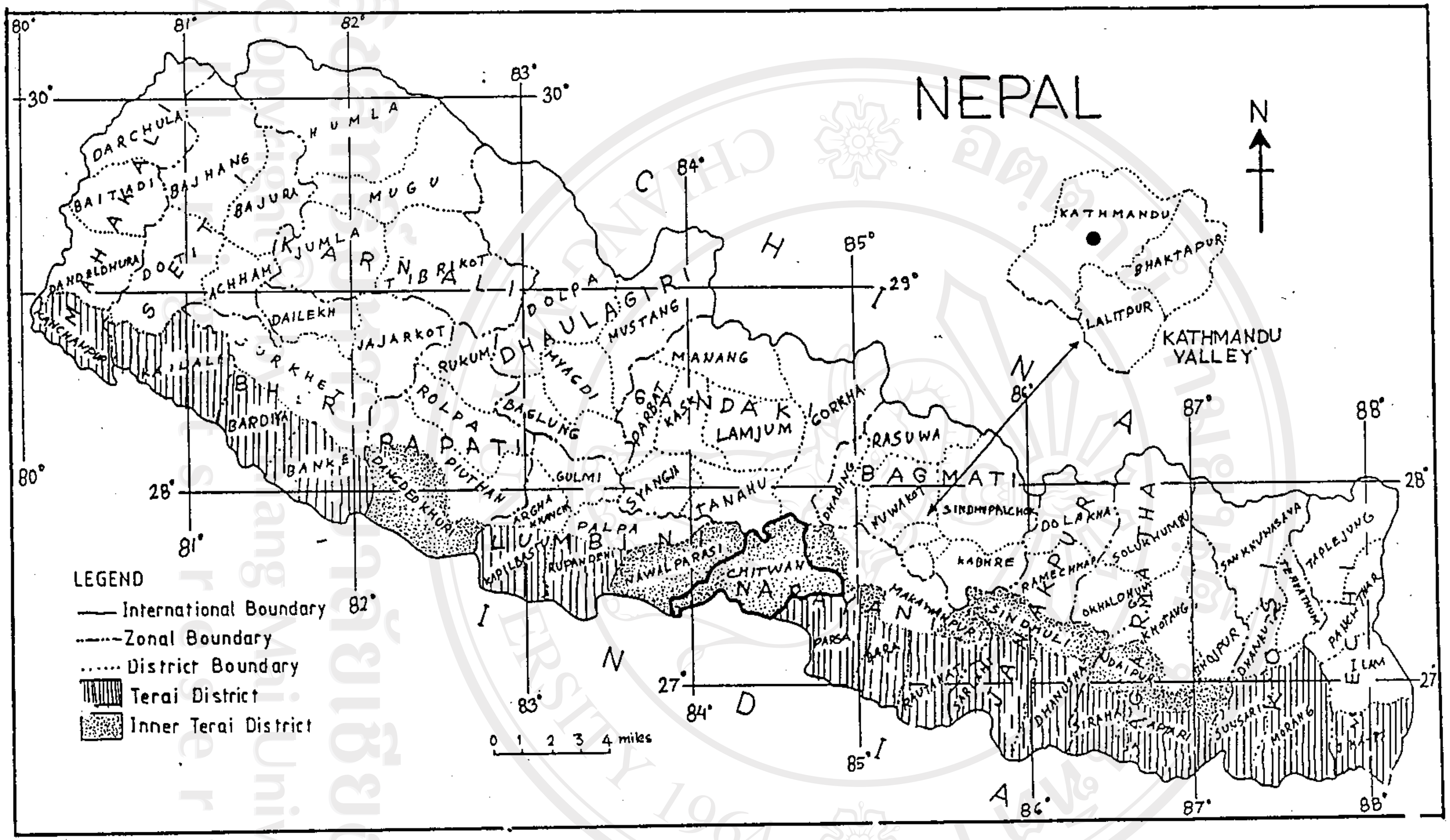


Figure 2. Map of Nepal sowing location of Chitawon district

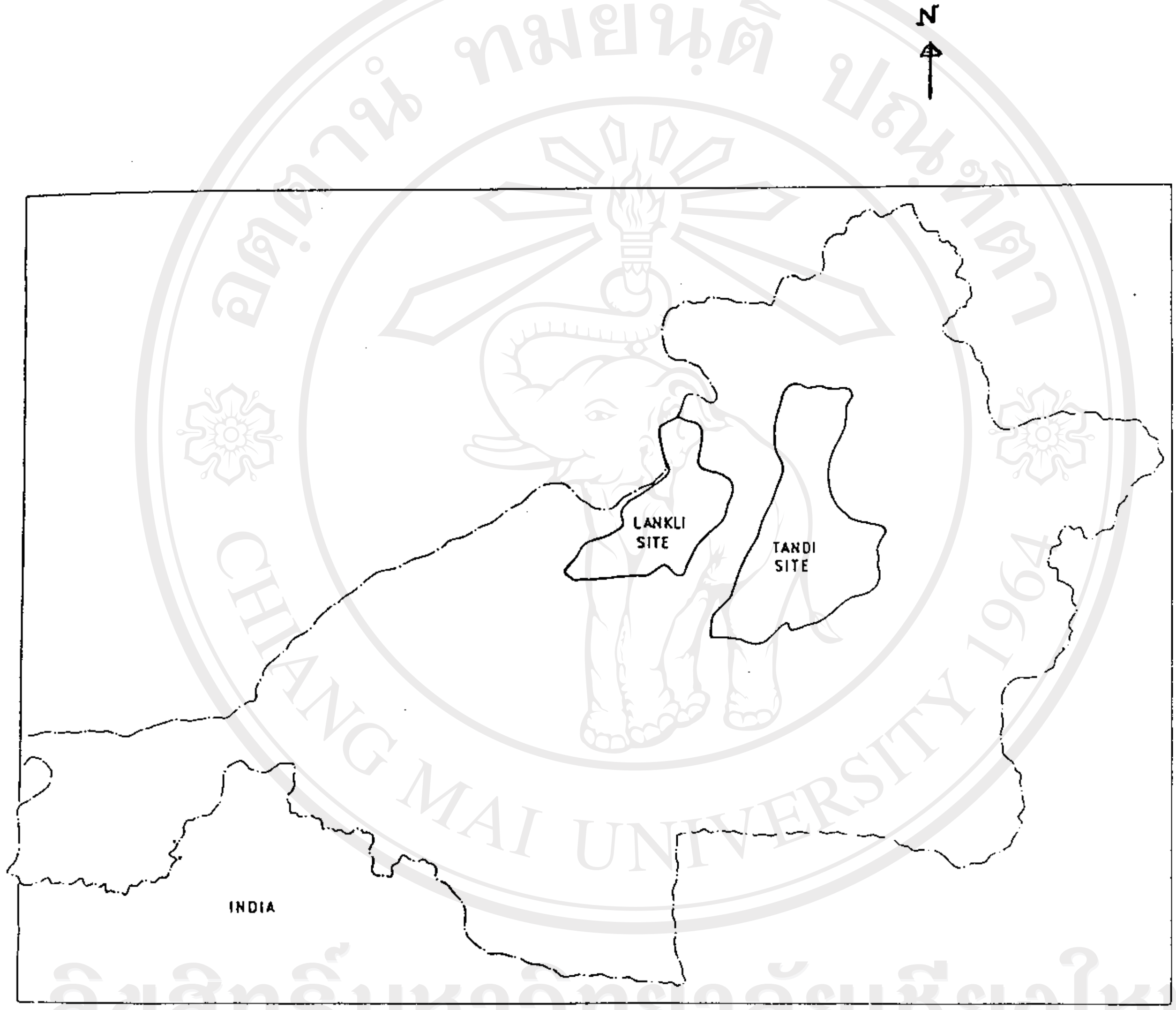


Figure 3. Map of study area

4.1.1 Introducing lablab into the cropping system

In order to improve the productivity of soil as well as to alleviate the scarcity of fodder during dry months, feasibility study was done to introduce lablab into the maize based cropping system in the study area. Since availability and distribution of labor plays an important role to make any alteration of the cropping system, an analysis of labor profile was carried out in discussion with farmers (Table 5).

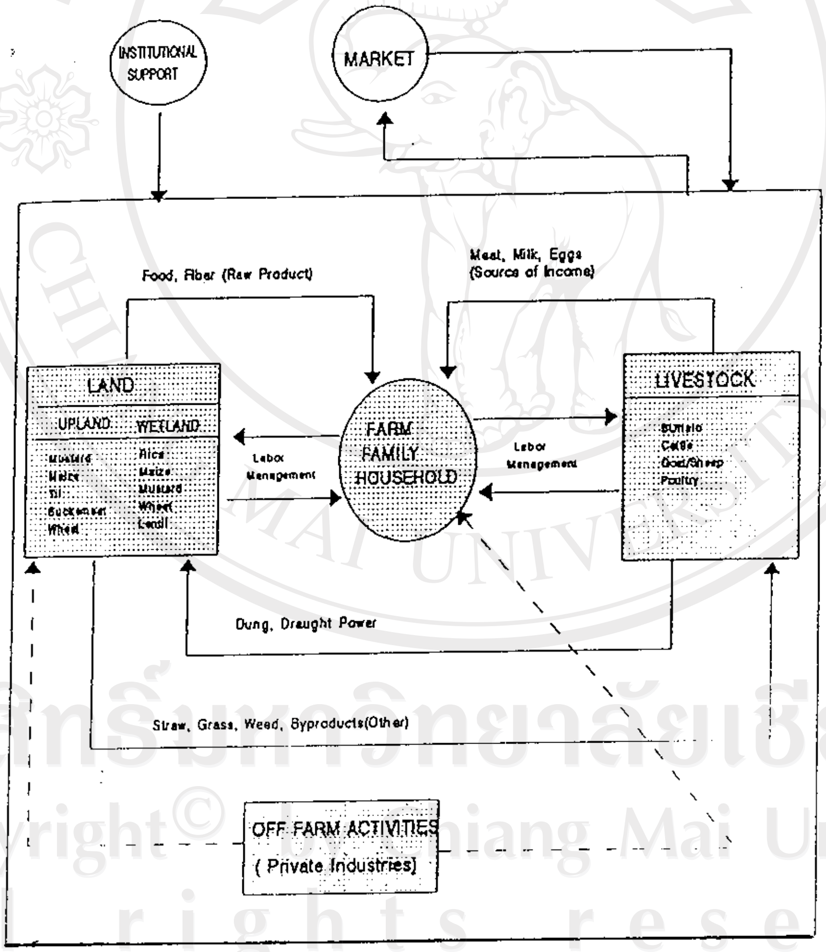


Figure 4. Various components of a mixed farming system and their relationship in Chitawon, Nepal
Source: PRA, 1992

Table 5. Labor distribution/ seasonal calendar

Months	Days involved Tandi site		Days involved Lanku site	
Jan.	21	Mustard harvest	26	Mustard harvest and land Preparation
Feb.	15	Land preparation for maize	15	Maize sowing
Mar.	15	Sowing of maize	25	Hoeing of maize, lentil/wheat harvesting
Apr.	12	Hoeing of maize	15	Land and seed bed preparation for rice
May.	13	Weeding, earthing up	25	Land preparation of maize and seed bed transplanting preparation for rice rice + maize harvest
June	25	Wage labor to	30	Transplanting transplant rice rice
July	29	wage labor + start	20	Hoeing rice maize harvest
Aug.	20	Maize harvest, field preparation and sowing sesame. Work on vegetable	8	Supervision to rice + irrigation
Sep.	15	Field preparation for mustard	10	Lentil sowing Initiation of rice harvesting
Oct.	17	Rice harvesting Mustard/wheat sowing work on vegetable	30	Rice harvesting Mustard sowing
Nov.	20	Rice and sesame harvest	20	Wheat sowing
Dec.	7	Fire wood collection and wage labor	10	Vegetable and other garden works

Note: Figure indicates effective labor days available for a household to work on a *Bigha* (0.65 ha) of land (In average)

Source: PRA, 1992

Distribution of labor in terms of active days involved in various field work for a household throughout the year was known on average basis. General distribution of labor regarding various aspects of agricultural operations were found almost similar in both sites. Labor profile developed through discussion were inclusively for crops and its related components.

Lanku site

Most of the works in Lanku site were found related to mustard and maize cultivation. However, in some areas, where farmers have access to rice cultivation, large fraction of labor are needed during transplanting and harvesting. Normally, July, June and January were reported to be maximum labor demanding months. Farmers have to be engaged from February to August in maize cultivation. Introduction of lablab seems possible in the maize based cropping systems since household labor distribution is not a problem (Table 5).

Tandi site

Most of the farmers in this area practice wet land rice based farming systems where, maize is another potential crop and farmers grow it regularly after mustard or wheat in their cropping pattern. It was found that, July, October, January, March and June are peak labor demanding months in Tandi site (Table 5). Rice is grown from July (transplanting) to October (harvesting). Mustard harvesting and then field preparation for sowing early maize is done during January. Likewise, a significant number of household labor work for the field preparation, sowing (November) and harvesting (March) of wheat are done.

It was clearly observed that, sowing maize in this area starts earlier than that of Lanku. It causes development of effective multiple cropping system which reduces fallow period. Hence, a more number of labor is required throughout the year in comparison to Lanku site.

Labor distribution shows that, average household in both study sites has a surplus of labor except during June and July (in both sites) and in October (in Tandi site). This means that, lablab can be introduced considering it's labor demand, possibly more in Lanku due to more availability of labor than in Tandi site.

Besides the analysis of labor distribution, farmers were also asked to discuss the fate of lablab in the cropping systems and the changes that may brought in the cropping management. From the discussion it was concluded that, farmers paid more attention to the yield of maize as well as to the subsequent crop along with possible way of extracting more fodder. When the possibility of intercropping lablab was raised, majority of farmers were worried about probable shading effect of lablab to the maize. However, some farmers were quite assured about the management of lablab through cutting practices. Likewise, farmers were not positive when they were asked whether some plant population of maize could be replaced with lablab in order to get maize as well as fodder yield. Farmers were more concerned to the grain yield.

4.2 Intercropping system with lablab into maize

4.2.1 Dry matter yield

Maize

Significant difference ($P < 0.05$) of total dry matter accumulation was not found between mono and intercropped maize, nor among the different lablab cutting treatments up to 60 DAS. However, at the time of maize maturity (100 DAS), intercropping slightly depressed maize dry matter (5.66 Mg ha^{-1}) but this depression was prevented if lablab was cut at 40 DAS at either heights (6.51, 6.24 Mg ha^{-1}). The depressive effect of lablab on maize dry matter was not removed when cutting was delayed to 60 DAS (5.91, 5.95 Mg ha^{-1}) (Table 6).

Table 6. Dry matter of maize (Mg ha^{-1}) at different growth stages as influenced by cropping systems and cutting management

Cropping system	Cutting (DAS)	Sev (cm)	30 DAS	40 DAS	60 DAS	100 DAS
Sole Maize	-	-	0.25	1.24	4.19	6.02
Intercrop						
MLC0	-	-	0.19	1.48	4.21	5.66
	C40,	S30	-	-	4.41	6.51
		S20	-	-	4.42	6.24
	C60,	S30	-	-	-	5.91
		S20	-	-	-	5.95
Grand mean			0.22	1.36	4.3	6.04
LSD (0.05)						0.74
(0.01)						0.93

Lablab

Total dry matter accumulation of lablab in mono and intrcrop treatments was similar up to 30 DAS. However, from 40 days onwards, monolablab consistently yielded more dry matter ($P < 0.05$) than the intercrop. At 100 DAS, monolablab yielded 3.19 Mg of dry matter per hectare. Cutting at 40 DAS, accumulated 86% of monoculture yield, which was increased to 90% when cutting was done at 60 DAS. Intercropped lablab yielded 68% of monoculture yield. Cutting depressed intercropped lablab more than in monoculture, i.e., accumulation of only about 50% dry matter to the without cutting of intercropped lablab, when cutting at 40 DAS and slightly more if cutting was delayed by 60 DAS (Table 7).

At 130 DAS, monolablab yielded 14.56 Mg dry matter per hectare. Cutting at 40 DAS, decreased dry matter yield about 20% as in 100 DAS. Delayed cutting to 60 DAS, depressed dry matter yield slightly more (32%). Intercropped lablab yielded 72% of monoculture yield, but cutting intercropped lablab depressed dry matter more than in mono i.e., accumulation of about 58% to the intercropped without cutting lablab when cutting was done at 40 DAS, and only 33% if cutting was delayed to 60 DAS.

It was observed that, from 100 days onward, there was quite a lot dry matter accumulation especially in monolablab which was 37.9 gm^{-2} day^{-1} followed by 30 gm^{-2} day^{-1} in cutting lablab at 40 DAS. Which was decreased to 23.5 g if cutting was done at 60 DAS. Intercropped lablab accumulated 73% to monolablab. Where, cutting at 40 and 60 DAS accumulated only 60% and 27% dry matter m^{-2} d^{-1} to the intercropped without cutting.

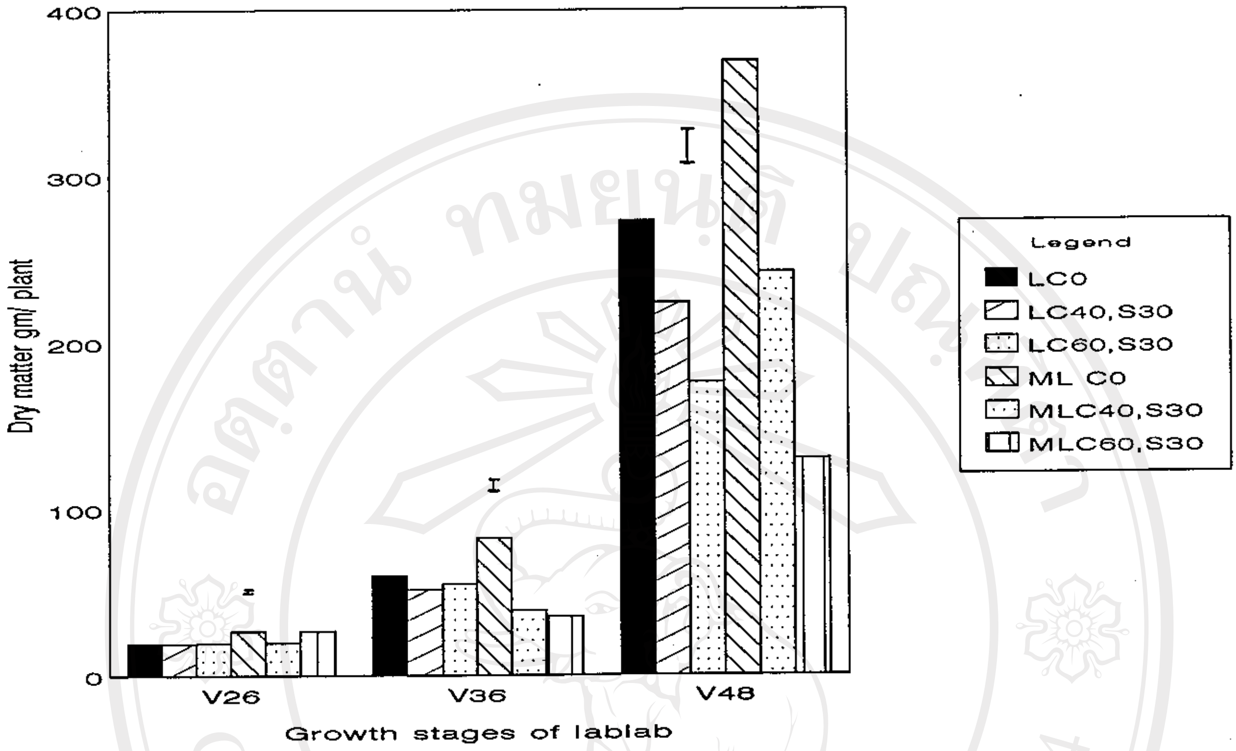
No significant difference was found between dry matter production of two severity level of cutting from the early to the final harvesting stage. Interaction between cropping system and cutting days was significant ($P < 0.05$) at 60 DAS (V26). However, it was inconsistent in the later stages.

Table 7. Dry matter of lablab (Mg ha^{-1}) at different growth stages as influenced by cropping system and cutting management

Cropping system	Cutting (DAS)	Sev (cm)	V7 (30DAS)	V12 (40DAS)	V26 (60DAS)	V36 (100DAS)	V48 (130DAS)
Sole							
LC0	-	-	0.09	0.64	1.04	3.19	14.56
	C40,	S30	-	-	1.02	2.74	11.94
		S20	-	-	1.17	2.77	11.49
	C60,	S30	-	-	-	2.93	9.37
		S20	-	-	-	2.88	10.56
Intercrop							
MLC0	-	-	0.08	0.30	0.71	2.19	10.50
	C40,	S30	-	-	0.52	1.04	6.45
		S20	-	-	0.47	1.16	5.77
	C60,	S30	-	-	-	0.94	3.46
		S20	-	-	-	1.45	3.49
Grand mean			0.08	0.47	0.82	2.15	8.75
LSD (0.05)			0.01	0.15	0.16	0.38	1.39
(0.01)			0.02	0.29	0.22	0.52	1.86

Figure (5) reveals per plant dry matter yields of lablab. No significant differences in per plant dry matter accumulation between mono and intercropped lablab was found nor among different lablab cutting treatments up to 40 days. But, from 60 days onwards, more accumulation of per plant dry matter was observed by the intercrop treatment without cutting ($P < 0.05$), which were about 35% at V26 (60 DAS); and 37% and 44% at V36 (100 DAS) and V48 (130 DAS) respectively compared with monoculture without cutting. Cutting practice depressed per plant dry matter production as in total dry matter. In mono, this depression was only appeared at V48 (130 DAS), which was about 20% to the monoculture without cutting when cut at 40 DAS and about 32% when cutting was delayed by 60 DAS at either heights. Whereas, in intercrop, depression was higher ($P < 0.05$) irrespective of cutting days and heights consistently until final harvesting.

At 100 DAS, some 50% per plant dry matter reduction as compared to intercropped without cutting was found when cutting at 40 DAS. Effect was slightly lowered incase of cutting at 60 DAS. Depression was lessened to 38% at 130 DAS, when cutting was done at 40 DAS, where as it was increased to 65% when cutting was delayed to 6o DAS. Effect of cutting height was not significant at each growth stage, while interactive effect of cutting days and height was significant at V48 stage. It was also noted that, treatments of either severity (30 or 20 cm height) cutting at 40 DAS, accumulated more per plant dry matter as compared with the cutting at 60 DAS of the same severity in intercropped and monocropped.



Note: L= mono lablab; ML= intercrop; Co= without cutting;
C= cutting days; S= severity of cutting height
I is the standard error at each harvest

Figure 5. Dry matter weight of lablab (g $plant^{-1}$)

4.2.2 Leaf Area Index (LAI)

Maize

There was no significant differences found in LAI between mono and intercropped maize and also among different lablab cutting treatments at all growth stages (Table 8). But, higher LAI (2.3) was accumulated in intercrop than in monocrop at pre flowering stage (40 DAS). Reduction in LAI was observed at dough stage (60 DAS) in all treatments. However, trend of reduction was smaller in cutting lablab at 40 DAS as compared to the rest. No effect of cutting height on LAI accumulation was observed.

Table 8. Leaf area index (LAI) of maize and lablab at different growth stages as influenced by cropping system and cutting management

Cropping system	Cut (DAS)	Sev (cm)	30 DAS		40 DAS		60 DAS		100 DAS		130 DAS	
			M	L	M	L	M	L	M	L	M	L
Sole												
Maize			0.53	-	2.2	-	1.5	-	-	-	-	-
LC0	-	-	-	0.21	-	2.2	-	2.10	-	2.8	-	11.5
	C40,	S30	-	-	-	-	-	0.60	-	1.9	-	7.9
		S20	-	-	-	-	-	1.00	-	1.8	-	7.5
	C60,	S30	-	-	-	-	-	-	-	1.2	-	5.6
		S20	-	-	-	-	-	-	-	1.4	-	5.5
Intercrop												
MLC0	-	-	0.47	0.27	2.3	1.6	1.5	2.20	-	3.8	-	12.9
	C40,	S30	-	-	-	-	1.7	0.60	-	1.2	-	7.7
		S20	-	-	-	-	1.6	1.00	-	1.7	-	5.0
	C60,	S30	-	-	-	-	-	-	-	1.1	-	5.0
		S20	-	-	-	-	-	-	-	1.2	-	4.8
Grand mean			0.50	0.24	2.2	1.9	1.5	1.20	-	1.8	-	7.3
LSD (0.05)			-	0.04	-	-	-	0.31	-	0.5	-	1.2
(0.01)			-	0.06	-	-	-	0.43	-	0.6	-	1.6

Note: M and L denote maize and lablab respectively.

Lablab

Intercropping, in comparison with monocropping, consistently increased the accumulation of LAI from early stage (V7) to the final harvesting of lablab (V48) except at V12. Until the maturity of maize crop (100 DAS), LAI of lablab was not much increased in all treatments. However, at final harvesting of lablab (V48), LAI increased up to 12.9 in intercropped without cutting, resulting highest leaf area index which was more than four times increment from the maize maturity. Cutting reduced LAI accumulation in the beginning. However, recovery rate was as high as 640% in intercrop treatment cutting at 40 DAS as compared to 415% in the monoculture of the same cutting day from maize maturity to final harvesting of lablab (130 DAS). Increment in LAI was equally higher when cutting at 60 DAS. However, at final harvesting of lablab, accumulation of LAI was always found higher in treatments cutting at 40 DAS (Table 8).

4.2.3 Grain yield and yield components

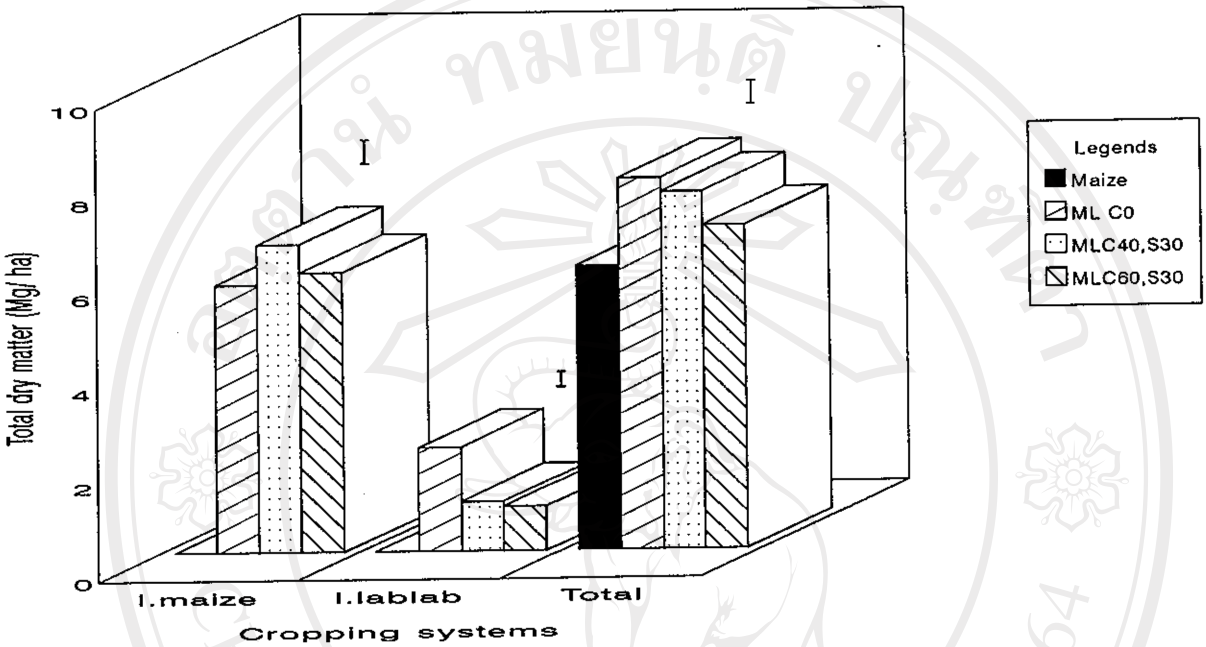
In monoculture, the maize grain yield was 3.17 Mg ha^{-1}. Intercropping with lablab had no significant effect ($P < 0.05$) on the maize yield. Cutting the intercropped lablab at 40 DAS either to 30 or 20 cm height from the base actually increased the maize yield ($P < 0.05$) to 3.82 Mg ha^{-1}. However, if cutting was delayed to 60 DAS, there was no increase ($P < 0.05$) in grain yield (Table 9). Same trend was also observed in yield components ($P < 0.05$) e.g., average number of kernels per cob and 1,000 grains weight.

Table 9. Grain yield and yield components of maize as influenced by cropping systems and cutting management

Cropping System	Cut (DAS)	Sev (cm)	Avg. no. of kernels per cob	1000 grain wt. in gm (14% m)	Grain yield Mg ha^{-1} (14% m)
Sole Maize	-	-	339	178	3.17
Intercrop					
MLC0			315	159	2.84
	C40,	S30	405	210	3.79
		S20	413	214	3.82
	C60,	S30	351	178	3.16
		S20	354	178	3.13
Grand mean			363	186.16	3.31
LSD (0.05)			28.22	18.76	0.39
(0.01)			39.00	25.94	0.54

4.2.4 Total dry matter production in monoculture and intercrop

Comparison of monoculture with the intercropping was made in terms of total dry matter accumulation at the time of grain yield harvesting of maize. Combined dry matter yield of companion maize and lablab in all treatments was always greater than the yield of monoculture maize or lablab (Figure 6). Total dry matter yield of intercrop maize without cutting lablab was 30% more to the monoculture maize. However, cutting practice depressed some 24% dry matter yield when cut at 40 DAS and depression was slightly more when cutting was done at 60 DAS.



Note: Maize= mono maize; ML= intercrop; C0= without cutting;
C= cutting days; S= severity of cutting height
I is the standard error at each harvest

Figure 6. Total dry matter production (Mg ha^{-1}) in mono and intercrop at maize harvest

4.2.5 Effects of intercropping on productivity of maize and lablab

Land equivalent ratio (LER) and Area time equivalent ratio (ATER) were used for evaluating productivity and efficiency per unit area of dry matter and protein yield. Cutting reduced LER in comparison with without cutting. The total dLER of the intercrop for total dry matter production at maize maturity ranged from 1.39 to 1.65. LER value noted highest for without cutting and lowest to cutting 60 DAS at 30 cm. On the other hand cutting at 40 DAS resulted the value in between (Table 10). Likewise, an Area time equivalent ratio (ATER) revealed same trend owing highest ATER in without cutting (1.44) and lowest in cutting 60 DAS at 20 cm (1.08). It showed that treatment cutting at 60 DAS of either severity reduced ATER significantly ($P < 0.05$) in comparison with cutting at 40 DAS and the without cutting (Table 10). Same trend was also observed when analyzing crude protein by ATER.

Table 10. Land equivalent ratio (LER) and Area time equivalent ratio (ATER) of dry matter and protein at maize harvest

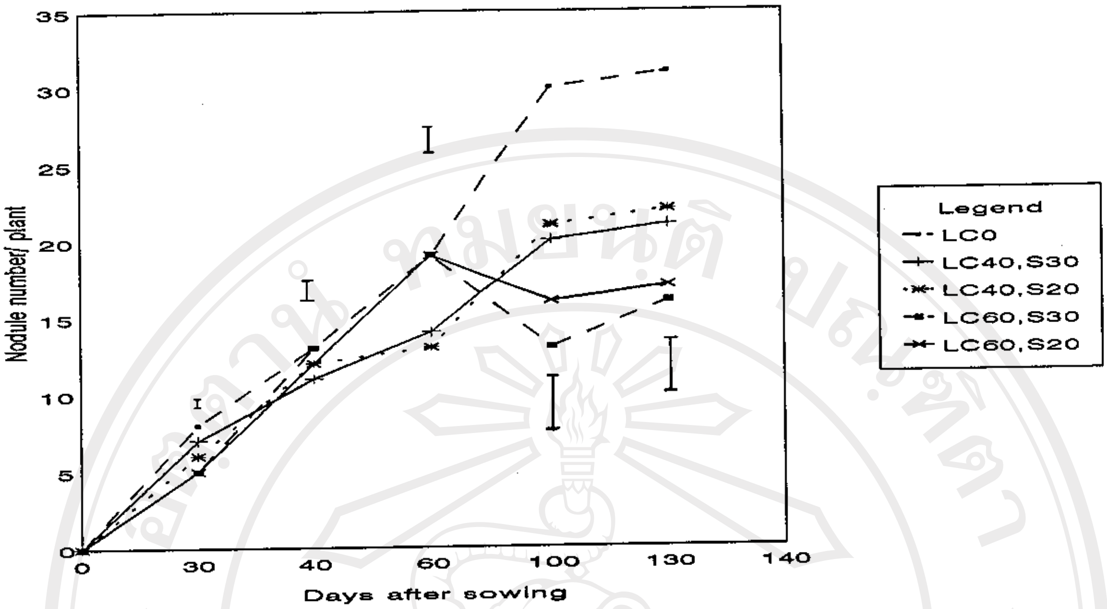
Cropping System	Cut (DAS)	Sev (cm)	LER Dry matter	ATER Dry matter	ATER Protein
Without cutting	-	-	1.65	1.442	1.440
	C40,	S30	1.42	1.370	1.407
		S20	1.38	1.307	1.252
	C60,	S30	1.28	1.120	1.132
		S20	1.39	1.085	1.103
Grand mean			1.42	1.264	1.266
LSD (0.05)			0.11	0.161	0.180
(0.01)			0.15	0.220	0.250

4.2.6 Nodulation of lablab

There was no significant differences (P < 0.05) in number of per plant root nodules between mono and intercropped lablab throughout the growth stages. Nodulation was poor until 30 days after sowing, with an average of 6 nodules per plant. Nodule number increased along with vegetative growth and reached maximum of about 30 at V48 (130 DAS), in both mono and intercrop. Cutting reduced number of root nodule in both cropping systems. In monoculture, cutting slightly reduced nodule number if lablab was cut at 40 days at either heights, whereas, the reduction was comparatively greater when lablab was cut at 60 days at V36 stage and onwards. Similar trend was also observed in intercrop. However, more reduction in nodule number was found at V36 (100 DAS) when cutting was done at 60 DAS but such effect was later disappeared at V48 (130 DAS) (Figure 7).

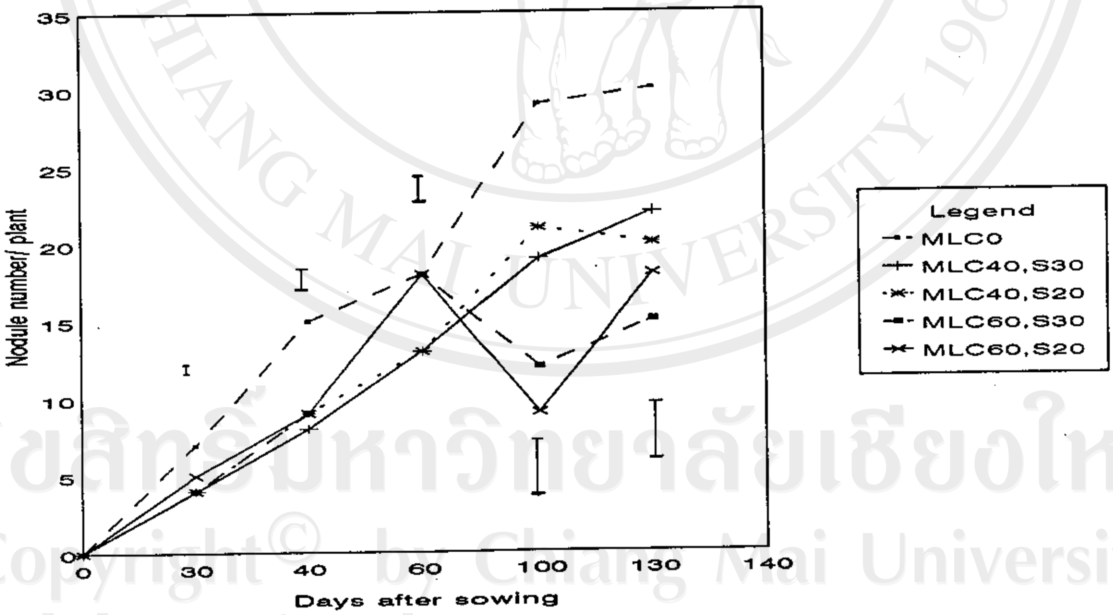
Total nodule harvesting could not be done because of profuse nature of lablab root. Therefore, number of nodule counted may reflect a trend rather than the actual total figure.

(a)



Note: L= mono lablab; C0= without cutting;
C= cutting days; S=severity of cutting height
I is the standard error at each harvest

(b)



Note: ML= intercrop lablab; C0= without cutting;
C= cutting days; S= severity of cutting height
I is the standard error at each harvest

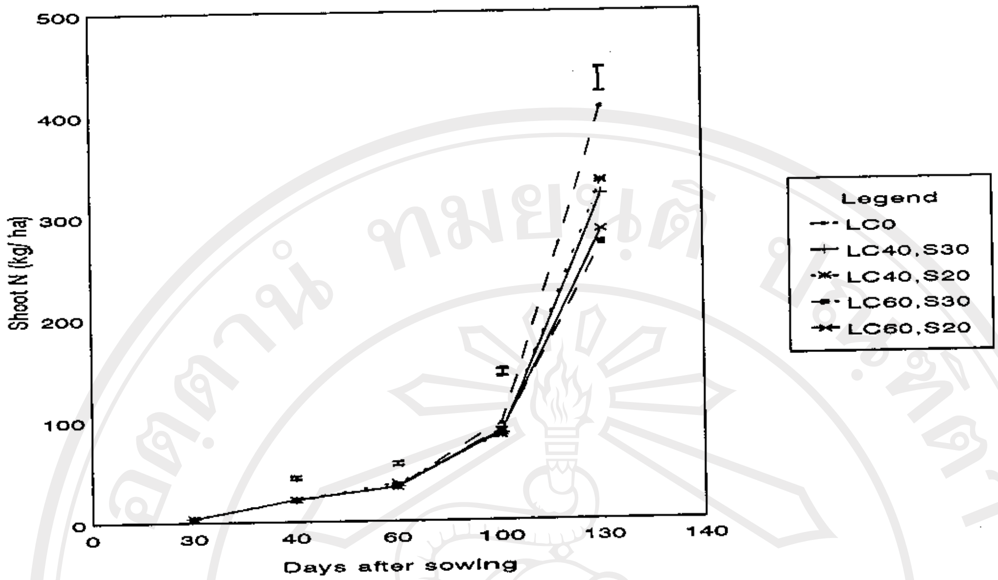
Figure 7. Number of root nodule of lablab per plant (20 cm depth)(a) monocrop and (b) intercrop

4.2.7 Total shoot nitrogen yield

Accumulation of crop N in lablab at different growth stages reflected a similar trend to that of above ground dry matter accumulation in both monocropped and intercropped (Figure 8, Table 7). Until V7 stage (30 DAS), there was no significant difference in total N between monocrop and intercrop. At 40 DAS, monolablab accumulated 21.68 Kg shoot N ha^{-1}. Intercropped lablab yielded 48% of shoot nitrogen to the monolablab. At 60 DAS, monolablab produced 33.83 Kg shoot N ha^{-1}. Intercropped lablab without cutting yielded 62% of monolablab yield. Cutting at 40 DAS to the either height resulted slightly increase in nitrogen accumulation if cutting was done in monolablab. Where as, cutting in intercrop treatments resulted slightly reduction in shoot nitrogen yield. At 100 DAS, monolablab yielded 94.97 Kg N ha^{-1}. Cutting lablab to the 40 or 60 DAS at either height slightly reduced in shoot nitrogen if lablab was cut in monolablab treatments, where as, reduction in shoot nitrogen was as high as 48% if cutting was done in intercrop.

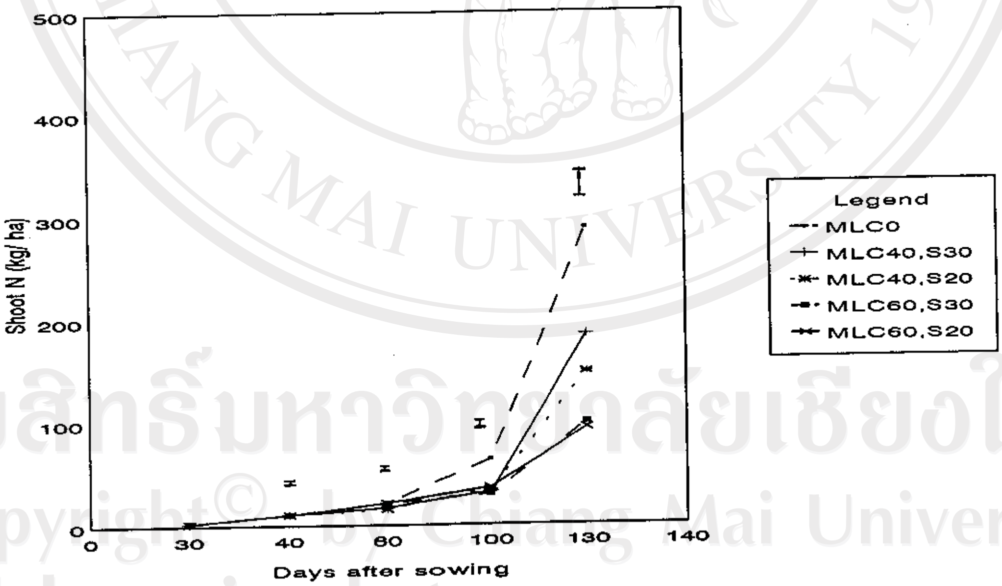
At 130 DAS, nitrogen accumulation in monolablab was 405.3 Kg ha^{-1}. Cutting at 40 DAS, depressed nitrogen yield about 20%. Depression was increased to 31%, if cutting was delayed to 60 DAS. On the other hand, intercropped lablab yielded some 71% shoot nitrogen to the monolablab. Cutting at 40 DAS accumulated about 57% of total nitrogen to the intercropped without cutting lablab. Which was only about 33% if cutting was delayed by 60 DAS.

(a)



Note: L= mono lablab; C0= without cutting; C= cutting days; S= severity of cutting height; I is the standard error at each harvest

(b)



Note: ML= mono lablab; C0= without cutting; C= cutting days; S= severity of cutting height; I is the standard error at each harvest

Figure 8. Total nitrogen (Kg ha $^{-1}$) in lablab shoot DM as influenced by intercropping; (a) monocrop (b) intercrop

4.2.8 Nitrogen fixation in lablab

The intercropped lablab showed higher relative ureide-N (RU) than monocrop throughout the growth stages. At V12 (40 DAS), Ureide-N (RU%) in monolablab was 52. Intercropping lablab increased it's RU by about 15%. At 60 DAS, monolablab without cutting reached to the RU% 55. When lablab was Cut at 40 DAS, value reduced by about 22%. Intercropped lablab without cutting showed some 10% more RU than monolablab. Cutting at 40 DAS, however, depressed 31% RU to without cutting intercropped lablab. At 100 DAS, RU% in monolablab was 59. Cutting at 40 DAS did not make any significant differences ($P < 0.05$). However, some 16% increment in RU value was found if cutting was delayed to 60 DAS. Intercropped lablab without cutting and cutting at 40 DAS showed similar result to monoculture. However, 23% reduction in RU value was found to intercropped without cutting, if lablab was cut at 60 DAS (Figure 9).

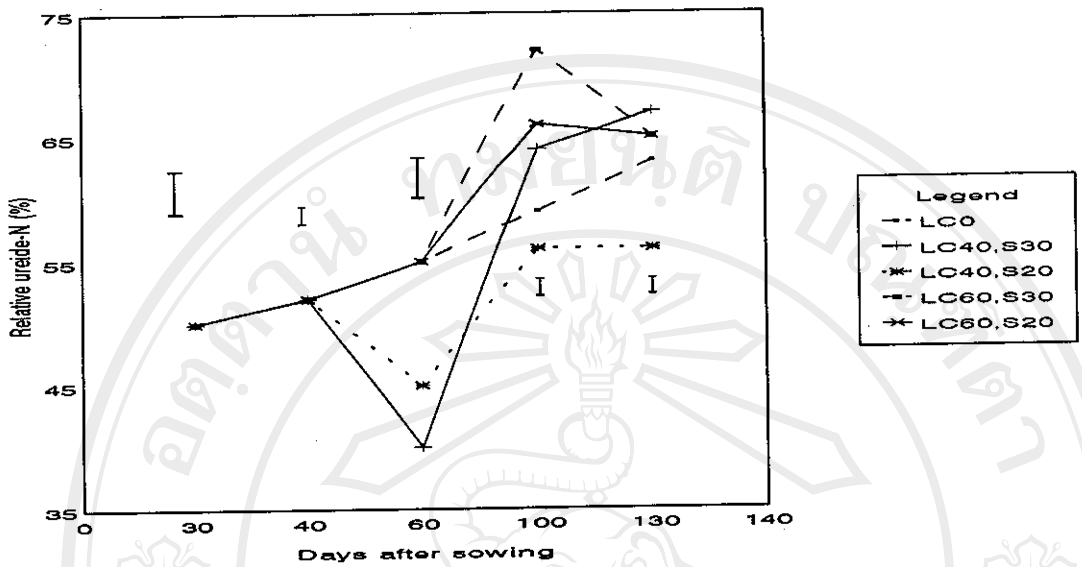
At 130 DAS, monolablab increased in RU to 63. Cutting 40 DAS at 30 cm height resulted increase in value to 67, where as, cutting at 20 cm decreased RU to 56, which was significantly different ($P < 0.05$). On the other hand, If cutting was delayed by 60 DAS, there was no significant ($P < 0.05$) difference in RU . Intercropped lablab had RU% 65. Cutting at 40 or 60 DAS at either heights of 30 or 20 cm did not make any significant difference in RU% ($P < 0.05$)

Highest values for P fix were 99% for monocrop cutting 60 DAS at 30 cm height at V36 sampling, followed by intercrop; cutting 40 DAS at 30 cm (96

%) at V48 sampling (Table 11). At V48, there was significant ($P < 0.05$) interactive effect observed between system and severity of cutting which resulted increment in P fix if it was cut at 20 cm in case of intercrop. However, there was reduction in P fix in monocrop. Similarly, significant ($P < 0.05$) interactive effect between cutting days and cropping system was found resulting decreased in P fix when cut at 60 DAS in the intercrop treatments.

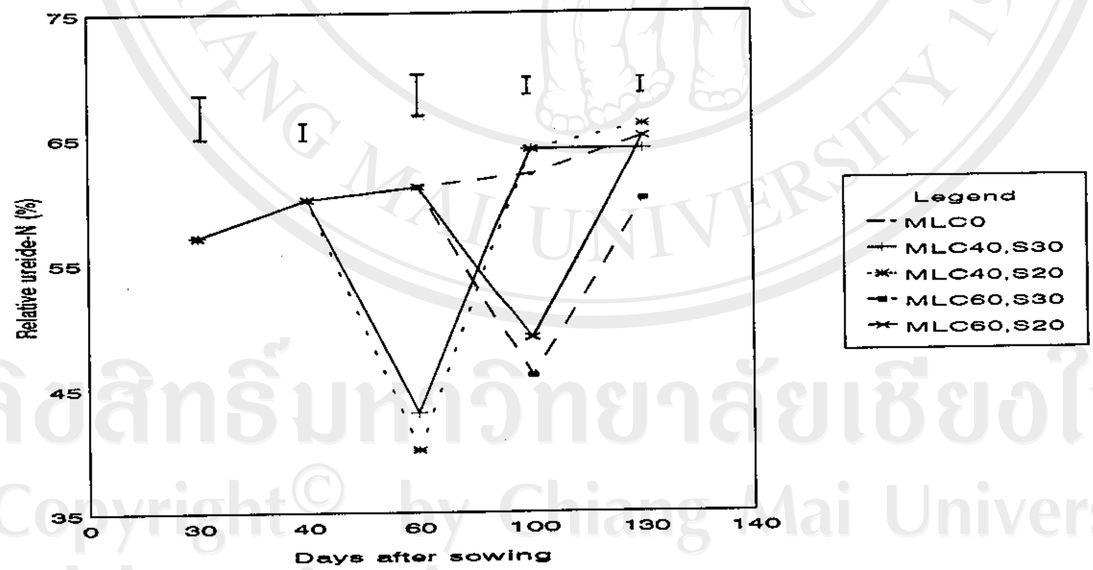
The accumulated amount of fixed nitrogen was higher in monolablab in comparison to the intercrop in all growth stages. At V26 (60 DAS), monolablab fixed 21.9 Kg N ha^{-1}. Cutting lablab at 40 DAS, yielded similar amount of fixation. Intercropped lablab depressed the amount of nitrogen fixed by 27% to the monolablab and with a further 31% depression to the without cutting when the intercropped lablab was cut at 40 DAS. At V36 (100 DAS), nitrogen fixation in monolablab was 70.3 Kg ha^{-1}. Some 20% depression in amount of nitrogen fixation was found when cutting was done at 40 DAS. Where as, similar amount of nitrogen to the monolablab was fixed if cutting was done at 60 DAS. Intercrop depressed in amount of nitrogen fixed by 26% to the monolablab and with a further 52% depression when the intercrop lablab was cut at 40 or 60 DAS of either height in comparison to the without cutting.

(a)



Note : L= mono lablab; C0= without cutting; C= cutting days; S= severity of cutting height
I is the standard error at each harvest

(b)



Note: ML= intercrop lablab; C0= without cutting; C= cutting days; S= severity of cutting height
I is the standard error at each harvest

Figure 9. Relative Ureide Index (RU %) of lablab shoot as influenced by intercropping; (a) monocrop (b) intercrop

At 130 DAS, nitrogen fixation in monolablab was 339.8 Kg ha^{-1}. Depression in amount fixed was 22% to the monolablab when cutting was done at 40 DAS (Table 12). Slightly more depression was resulted if cutting was done at 60 DAS, but contribution to the total nitrogen from the fixation was higher (90%). Intercropped lablab without cutting fixed 75% nitrogen to the monolablab. Cutting depressed in fixation by 43% to intercropped lablab without cutting, if cutting was done at 40 DAS. However, fixation from atmosphere accounted to 88% for the total nitrogen.

Table 11. The proportion of plant N being derived from nitrogen fixation (P fix) by lablab at different harvesting as influenced by cropping systems and cutting management

Cropping system	Cutting (DAS)	Sev (cm)	V7 (30DAS)	V12 (40DAS)	V26 60DAS)	V36 (100DAS)	V48 (130DAS)
Sole							
LC0	-	-	68.79	72.55	76.70	83.22	90.40
	C40,	S30	-	-	51.70	91.60	96.28
		S20	-	-	60.50	78.95	79.44
	C60,	S30	-	-	-	99.84	94.23
		S20	-	-	-	95.03	93.18
Intercrop							
MLC0	-	-	80.44	86.04	82.97	89.28	93.35
	C40,	S30	-	-	56.56	91.22	91.34
		S20	-	-	51.81	92.11	95.33
	C60,	S30	-	-	-	61.32	85.63
		S20	-	-	-	67.66	93.02
Grand mean			74.61	79.29	63.37	85.02	91.22
LSD (0.05)			-	6.43	11.49	5.85	5.46
(0.01)			-	11.81	15.88	7.92	7.37

Similarly a more reduction in fixation was found by cutting lablab at 60 DAS, where nitrogen fixation was only 30% to the intercropped lablab without cutting. In this case, contribution from fixation to the total nitrogen accumulation was also smaller in comparison to cutting at 40 DAS, i.e., 78%

Table 12. Accumulated amount of N_2 fixed, total N and % N fixed over time by lablab at different growth stages as influenced by cropping systems and cutting management

Cropping Systems	Cut (DAS)	Sev (cm)	Fixed N_2 (Kg N/ha) V7 (30)	V12 (40)	V26 (60)	V36 (100)	V48 (130)	Total N Kg/ha V48 (130)	N from fix(%) V48 (130)
Sole									
LC0	-	-	0.43	12.8	21.9	70.3	339.8	405.3	83.8
	C40,	S30	-	-	20.5	57.2	277.6	320.0	86.7
		S20	-	-	23.5	55.0	252.3	333.0	75.7
	C60,	S30	-	-	-	70.4	248.9	271.9	91.5
		S20	-	-	-	67.6	252.6	284.7	88.7
Intercropped									
MLC0	-	-	0.43	7.1	16.2	52.0	257.4	288.6	89.1
	C40,	S30	-	-	11.7	22.7	162.4	184.9	87.8
		S20	-	-	10.6	23.9	131.1	148.3	88.4
	C60,	S30	-	-	-	22.4	74.1	99.4	74.5
		S20	-	-	-	29.9	76.4	93.7	81.5
Grand mean			0.43	9.9	17.3	47.1	207.2	-	-
LSD (0.05)			-	3.9	3.9	10.5	36.8	-	-
(0.01)			-	7.1	5.4	14.3	49.7	-	-

Likewise, there was no significant difference observed between severity level of 30 and 20 cm cutting either in monocrop or intercrop. However, interactive relationship was found between system and cutting days (Table 13).

Table 13. Accumulated nitrogen fixation (Kg N ha $^{-1}$) of lablab at different growth stages as influenced by cutting days to the cropping system

		Growth stages/ (DAS)					
		V26 (60)		V36 (100)		V48 (130)	
		Cropping systems(A)		Cropping systems(A)		Cropping systems(A)	
		Mono	Inter	Mono	Inter	Mono	Inter
No cut		21.9	16.2	70.30	52.00	339.80	257.40
(B)	C40	22.03	11.19	56.18	23.36	264.95	146.75
	C60	-	-	69.04	26.19	250.75	75.29
A		**		*		**	
B		-		*		**	
A * B		-		*		*	
LSD		2.59		5.19		25.44	

Note: * and ** indicate significant at $P < 0.05$ and $P < 0.01$ respectively

4.3 Crude Protein (CP) in lablab shoot dry matter

CP content found to be very high at the early vegetative stage (267.1 g Kg^{-1} of dry matter), slightly decreased at V12, and remained constant until V26. However,it started decreasing with very slow rate at the late vegetative (V48) stage of growth (Table 14).

There was no significant differences ($P < 0.05$) in terms of crude protein (CP) content between monocrop and intercrop, nor among the lablab cutting treatments up to 40 days. At 60 DAS, monolablab content 20.47% protein. Cutting practice did not make any significant differences ($P < 0.05$) when cutting at 40 DAS of either height in both cropping system. At 100 DAS, protein content in monolablab was

18.76%. cutting did not make any difference either cutting at 40 or 60 DAS to the cutting height of 30 or 20 cm in monolablab. Similar trend of CP content was observed in intercrop. However, cutting at 60 DAS increased CP % slightly. At 130 DAS, protein content in monolablab was decreased to 17.39%. Cutting at 40 DAS did not make any differences, however, cutting 60 DAS at 30 cm slightly increased in CP content. CP content in intercrop lablab without cutting as well as cutting at 40 DAS to the either height was similar to monolablab. But, CP content increased slightly when cut at 60 DAS to the height of 20 cm.

Table 14. Per Cent Crude Protein (CP) in lablab shoot dry matter at different growth stages as influenced by cropping systems and cutting management

Cropping system	Cutting (DAS)	Sev (cm)	V7 (30DAS)	V12 (40DAS)	V26 (60DAS)	V36 (100DAS)	V48 (130DAS)
Sole							
LC0	-	-	24.97	21.74	20.54	18.76	17.39
	C40,	S30	-	-	21.09	19.42	16.79
		S20	-	-	20.16	18.76	18.10
	C60,	S30	-	-	-	20.84	18.59
		S20	-	-	-	18.86	16.79
Intercrop							
MLC0	-	-	26.71	21.64	18.83	17.98	17.17
	C40,	S30	-	-	20.49	19.14	17.83
		S20	-	-	20.49	18.43	16.03
	C60,	S30	-	-	-	19.41	17.94
		S20	-	-	-	20.27	19.09
Grand mean			25.84	21.69	20.26	19.18	17.57
LSD (0.05)			-	-	02.00	1.16	1.58
(0.01)			-	-	02.78	1.56	2.05

Similarly, quantity of crude protein per hectare revealed the maximum protein accumulated by monocrop lablab without cutting (2.52 Mg ha $^{-1}$). Intercrop yielded less amount of protein (P < 0.05) in comparison with monocrop. However, cutting at 40 DAS have had more protein harvest in comparison with cutting at 60 DAS (P < 0.05) in intercrop. There was no more interactive difference found among cutting height, days and cropping system (Table 15).

Table 15. Crude protein content in lablab (Mg ha^{-1}) as influenced by cropping systems and cutting management

Cropping Systems	Cut	Sev	Growth stage V48 (130 DAS)
Sole			
LC0	-	-	2.52
	C40,	S30	1.99
		S20	2.07
	C60,	S30	1.73
		S20	1.77
Intercrop			
MLC0	-	-	1.81
	C40,	S30	1.15
		S20	0.92
	C60,	S30	0.61
		S20	0.66
Grand mean			1.52
LSD (0.05)			0.27
(0.01)			0.37

4.4 Economic evaluation of the different cropping systems

Gross economic return of different cropping systems are sown in table (16). Results in Table show that, monolablab without cutting could return Rs 11383 from a hectare of land. Where as, the cropping system in which lablab was cut at 40 and 60 DAS could return only about 66% and 41% respectively to the net return of monolablab without cutting.

Intercropped without cutting resulted Rs 23762 ha^{-1} which was more than 100% to the monolablab without cutting. Cutting lablab at 40 DAS in the intercrop, actually gave the highest return to all of cropping system, which resulted Rs 23800 ha^{-1}. Where as, the return was only 70% to the intercrop lablab without cutting if cutting lablab was delayed by 60 DAS. Mono maize, on the other hand, gave Rs 13150 ha^{-1}, which was only 55% to the net return of intercrop without cutting.

Table 16. Simple gross return analysis of different cropping systems (Rs ha^{-1})*

ITEMS	Cropping systems						
	I. Crop without cutting	Mono L without cutting	Mono maize	With cutting practice			
				I.crop 40 DAS	I.crop 60 DAS	Mono L 40 DAS	Mono L 60 DAS
Field Prepn.	1700	1700	1700	1700	1700	1700	1700
Fert., seed sowing dis. & pest control	3600	3600	3050	3600	3600	3000	3000
Weeding	1000	1000	1400	1000	1000	1000	1000
Harv., shelling & storage	2800	1200	1800	2900	2900	1500	1500
Total Variable cost	9100	7500	7950	9200	9200	7200	7200
G. yield (Mg ha^{-1})	2.81	-	3.10	3.70	3.10	-	-
St.yield (Mg ha^{-1})	12.10	-	12.50	12.90	12.50	-	-
Fod.yield (Mg ha^{-1})	45.30	63.30	-	27.80	17.00	49.40	38.80
N yield (Kg ha^{-1})	257.40	339.80	-	146.70	75.20	264.90	250.70
Grain [1]	16800	-	18600	22200	18600	-	-
Stover [2]	2420	-	2500	2580	2500	-	-
Fodder [3]	11325	15825	-	6900	4250	12350	9700
N [4]	2316	3058	-	1320	676	2384	2256
Total gross return	32862	18883	21100	33000	26026	14734	11956
Net return	23762	11383	13150	23800	16826	7534	4756

* Labor management largely based on PRA Approach

Note: 1 = @ Rs 600/ Qt.
2 = @ Rs 20/ Qt.
3 = @ Rs 25/ Qt.
4 = @ Rs 09/ Kg

At present 1$ = Rs 42.60 and 1 Baht = Rs 2