CHAPTER VI

DISCUSSION

6.1 Significance of Red Kidney Bean to Household Economy

The Lahu and the Chinese Haw communities of Ban Kae Noi are able to utilize climatic environment to grow red kidney bean as cash crop for two periods sequentially during the rainy season, making Ban Kae Noi the major red kidney bean producing area in Chiang Mai.

The constraint of production practice is capital and labor intensive (average 1102 baht per rai). This includes high cost of seeds, herbicide and fertilizer (Table 4.12-4.13). Planting and harvesting are carried out by hand. However, the farmers are able to minimize high input cost by using their own seeds, family and exchange labor for field operation. Analysis of production cost shows that over 80 percent of total variable costs are non-cash (991 baht per rai). The crop provided a return to cash cost over 431 baht per rai. Since the crop is a short season crop, farmers are able to cultivate two crops sequentially under rainfed conditions and receiving annual income from two plantings of red kidney bean ranged from 15602 to 25432 baht per household.

6.2 Production System and Its Limitation

The red kidney bean is not indigenous crop, but being introduced from California by the Highland Development Project in early 70s as the opium crop replacement crop (Unsrisong, 1995). The commercial varieties, through farmer selection, are able to adapt to local climatic conditions. At

Ban Kae Noi, farmers use their own seeds, or from neighbors since the crop becomes commercialized.

However, yield estimation from the crop cut samples revealed that early season planting in May, over 70 percent of the farmers could produce yield more than 1500 kg ha^{-1}, and reaching maximum at 3000 kg ha^{-1}. But the second season planting in late August, only 21 percent of yield distribution was higher than 1500 kg ha^{-1}. The May planting, with evenly distributed rainfall and optimal temperature, crop growth was more vigorous, producing high biomass of over 5000 kg ha^{-1} and resulting high seed yield, averaging 3033 kg ha^{-1}. The crop mature was in 66-75 days. The late August planting, crop growth was less vigorous, as a consequence of cool temperature during growing period and developing period, producing biomass of 4114 kg $ha^{-1}$with average seed yield of 1165 kg ha^{-1}. The crop was matured over 85 days.

Farmers indicated that weed infestation and low soil fertility were the major yield limiting factors. Thus all farmers practised weed control either by hand weeding or by using herbicide such as paraquat before planting or/and approximately two weeks after planting. The spray of herbicide after crop growth required certain skill, as the chemical could easily kill the plants on contact.

Not all farmers were able to afford fertilizer application, 30 percent of the sampling households had not used chemical fertilizer

As far as the ease of cultural management are concerned, the late August planting (21.41 man-day rai^{-1}) was less laborious than May planting (24.51 man-day rai^{-1}).

6.3 Opportunity for Improving Farming Practice Through Enhancing Soil Fertility

6.3.1 Chemical fertilizer

Farmer used compound fertilizer of various grades such as 13-13-21, 15-15-15 or 16-20-0 to improve red kidney bean yield. The information from the survey data indicated that fertilized fields produced similar yields as non-fertilizer fields. It was revealed that the amount of chemical fertilizer used was not high enough to increase significant yield. There was also variation in time and methods of applications, thus making the fertilizer result not convincing.

A few farmers, notable the Chinese Haw, had been applying fertilizer twice. Thus time of application is crucial, as the crop is short maturity. The application has to be harmonized with the planting and weeding activities, so that labor could be used efficiently.

Those farmers who use chemical fertilizer would apply it at the time of planting. Several cases had been observed that the process required three-persons operation. The first person controlled the plough animal to drill and open the soil for seeding. The second person dropped the seed and fertilizer granules at 25 to 30 cm spacing, and the third person walked behind to cover the seed and fertilizer by feet.

Those who applied fertilizer after plant emergence either by placing granules near the hills or by broadcasting. The process was followed by weeding through hand hoeing to incorporate the fertilizer into the soil.

6.3.2 Rhizobial inoculation

The farmers were asked about their knowledge and experience on the use of rhizobial inoculation. They had no knowledge and experience about the nitrogen fixing role of rhizobium and its potential for increasing seed yield. It is understandable that as the rhizobial technology for red kidney bean is still at the experimental stage. There is no commercial strain released for farmer use.

When explained to farmers that field evidence from other legumes such as soybean had supported the low cost of rhizobium to provide nitrogen nutrition to the crop, farmers were interested and if field testing was positive, they would adopt it if the inoculum could be provided through the Royal Project.

Farmers also indicated that the combined effect of rhizobium and fertilizer should be larger than either factor applying separately.

6.3.3 Field experiment

The site selected for field experiment was characterized by the low pH of 4.9. Lime at the rate of 6250 kg ha^{-1} was incorporated into the soil and immediately followed by planting in May.

The result of May planting did not show any significant results of either rhizobial inoculation and chemical fertilizer. The soil acidity was not expected to change rapidly to provide favorable environment for rhizobium to fix atmospheric nitrogen. In September planting, the lime was broadcasted one month before planting and improved the soil pH to 5.9. There was still no evidence of increasing seed yield by rhizobia.

The symbiotic nitrogen fixation is commonly limited by soil infertile conditions, particularly those associated with the acid soil complex of high aluminum, manganese, low calcium and phosphorus and salinity (Beck and Roughloy, 1986). Acid soil apparently inhibits nitrogen fixation by bacteria, which may lead to nitrogen deficiency. Aaron and Graham (1991) reported soil pH 5.0 or less is common as the consequence nodulation failure in bean production. Strain of *Rhizobium liguminosalum bv. phaseoli* which differs in their tolerance to acidity were exposed to acid pH, then cell levels of potassium and calcium determined, and specific acid-shock protein identified. Lowing the external pH to 4.0-4.7 resulted in an immediate efflux of calcium from cell of both acid tolerant and sensitive bean strains. Munns *et al.* (1977) concluded that acidity, calcium deficiency and manganese toxicity tend to occur together in soils. Each has been shown to inhibit nodulation of various legumes. The three factors interact, high calcium tending to mitigate adverse effects of acidity and manganese on nodule number.

Unfortunately, in this experiment, soil aluminum, manganese and calcium were not analyzed. The available phosphorus was 17 ppm and 17.5 ppm at the first and the second seasons, respectively. Such level was not considered to be favorable for promoting rhizobial activity.

The rhizobium strain used to inoculate the seed was *R. legumenosarum bv phaseoli*, which is not indigenous. The local strain KN6 which was later isolated by Dr. Ampan Bromsiri, Department of Soil Science and Conservation, Faculty of Agriculture, Chiang Mai University could be one factor contributing to inoculation failure due to the competition from the local, adapted strain (Velazquez *et al.*, 1988).

Under the non-fertilized treatments, the introduced rhizobial strain had similar nitrogen fixing ability as the local strain (uninoculated seed), expressing RUI-N% about 59.7 percent at pod forming stage (R_4). The ability to fix nitrogen was reduced by fertilizer application either one time at 7 DAP (F_1) or twice at 7 and 30 DAP (F_3). However the data (Table 5.9) indicated that delayed application of fertilizer at 30 DAP would not suppress the rhizobial activity, giving RUI-N% of 61.4 percent.

Other study of rhizobial activity at Kae Noi showed that the non-fertilized and uninoculated sample provided RUI-N% of 30 percent (Intasan, 1997).

However at present and the Intasan (1997) studies did not show the positive effect of rhizobial inoculation on final seed yield of red kidney bean.

6.3.4 Effect of nitrogen fertilizer

There was no significant evidence that nitrogen fertilizer had improved seed yield in the May planting. However in the September planting, when the soil condition was much improved (pH = 5.9), there was a significant response to two applications of nitrogen fertilizer, averaging 1546 kg ha^{-1}, an increment of 300 kg ha^{-1} over the other treatment. At this level, a few farmers would be willing to accept the fertilizer risk by applying twice.

In this experiment, the May and September plantings produced overall similar yields, averaging 1219 and 1319 kg ha^{-1}, respectively, which was different from what had been observed in the farmer fields. This is indicative that red kidney bean in September planting could be improved to produce seed yield similar to that of May planting if soil conditions and weed control measure could be better managed.

Furthermore, seed damage by disease is one factor that decreases seed yield. It was commonly occurred more occur in red kidney bean grew in early rainy season (17 percent) than red kidney bean in late rainy season planting (4 percent) (Table 5.17). Wallace (1980) concluded that, excessive rain caused flower drop and increased the incidence of diseases.

However it was evident that the May planting provided favourable growing environment for red kidney bean. The crop took 68 days to mature while it would take 86 days to mature when planted in September. The May planting provided faster crop growth rate than the September planting averaging 54 kg $ha^{-1}day^{-1}$ and 34 kg $ha^{-1}day^{-1}$, respectively. Similar result reported by Wallace (1980) that, plants with a greater total dry weight were produced at constant temperature. After emergence, bean would grow slowly if day time temperature were below 20 °C. After flowering, 15/12 °C day/night temperatures would damage tissues and delay maturity.

At Kae Noi, to improve farm yield through management practices, the September planting would require immediate attention and receive high priority, as 80 percent of households produced yield less than 1500 kg ha^{-1}.

6.3.5 Economic benefit

In the May planting, as the treatment effects were not different, producing average seed yield of 1220 kg ha^{-1}, thus it was obvious that the uninoculated and non-fertilized treatment (R_0F_0) would provide the highest net return.

On the contrary, the September planting showed the significant effect of two-applications of fertilizer (F_3), while the rest was not significantly different, the treatment of uninoculated and two application of fertilizer would provide the highest return. The practice is currently adopted by the Chinese Haw. However the non-fertilized treatment and without rhizobial inoculation showed promising return. This has been practised by the resource-poor Lahu families.

Using the average planted area of red kidney bean in the May planting (7.76 rai or 1.24 ha) and in late August planting (6.81 rai or 1.09 ha) as obtained from the farmers survey, an annual net return from growing two seasons of red kidney bean could be estimated. It turned out that the low input, low risk systems of R_0F_0 treatment (Table 6.1) provided 10825 baht per household. Therefore growing red kidney bean under rainfed conditions where yield risk is inevitable, farmers will be skeptical about fertilizer application. It is also indicated that management of plant nutrient is the most important production strategy to increase farm income.

Table 6.1 Net return (baht per household) at Ban Kae Noi, 1995.

Treatments	May planting		September planting		Net benefit (baht/hh)
	benefit (baht/hh)	Area (rai)	benefit (baht/hh)	Area (rai)	
1 R_0F_0	917.69	7.76	543.98	6.81	10825
2 R_1F_0	829.65	7.76	518.94	6.81	10460
3 R_0F_1/R_0F_2	710.65	7.76	336.94	6.81	7809
4 R_1F_1/R_1F_2	685.65	7.76	311.94	6.81	7445
5 R_0F_3	503.54	7.76	669.07	6.81	8465
6 R_1F_3	478.65	7.76	664.07	6.81	8100