CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Shifting cultivation, with upland rice as the main crop, was the predominant land use in the Xieng Ngeun district, Luang Prabang province, practicing about 4,500 families (over 80% of the total families). The practice consists of cutting the vegetation (trees, shrubs) during the dry season (January, February), allowing it to dry and burning shortly before the onset of the rainy season (April, May). Seeds are dibbled in untilled soil in May or early June. Rice (mostly glutinous variety) is the most important crop. However, a large variety of non-rice crops are also planted on the same field.

The prevailing environmental conditions made the shifting cultivation be the best option for the farmers. Areas under permanent agriculture that were currently used for rice cultivation occupied only 0.1% (231 ha), meanwhile the areas that could be possibly involved in shifting cultivation were over 70% of the district area. Almost areas used for agriculture were concentrated on sloping land. Over 90% of the total area of 185,600 ha had a slope gradient greater than 30%.

Upland rice production was totally dependent on natural environment. In a year of good rain and fewer pest damages could bring good harvest. However, rice shortage of 1 to 4 months was common. The most important reasons for rice shortages cited were drought, pest damage, and too much weeds.

Animal raising was an important component of the upland rice farming systems in the area surveyed, which was the most important source of cash income. Pigs and

poultry were the most common animals raised by the farmers. Although livestock could bring in a desirable income because of high market demand, there were some constraints to raising more animals, depending on the type of animals. Limitation of grazing area, diseases epidemic and management were the main constraints to raising more cattle, while diseases epidemic, fodder shortage, and lack of capital were the main constraints to raising more pigs and poultry.

Fallow periods have been shortening during the past few years because of the government regulation on land use in the uplands, and rapid population growth, causing more and more people who lived in the lowland had to practice upland rice. At present, the average farm size in the surveyed area was 3.3 ha per household, while the average planted rice area was 1.0 ha per household. The natural fallow periods of 2-3 years cannot be sufficient to restore soil fertility for favorable growth and development of subsequent rice crops, compared with traditional systems which have fallow periods of about 20 years. Shorter fallow cycles combined with inappropriate cultural practices caused soil degradation, and weed infestation. Almost farmers in the surveyed areas reported that they had weeded their rice field up to 6 times during the rice season. Comparing to the past (2-3 weeding per year), it could be profitable for the upland farmers to change to a more effective cultural practices that optimize returns to their labor.

In an effort to develop effective and productive technologies for Lao upland farmers, a field experiment was carried. The new technology tested was the introduction of pigeon pea into upland rice based production systems, with an anticipation that pigeon

pea could help increase aggregate production output without much reduction in rice yields and facilitate long term production.

The experimental results have shown that there was highly significant difference ($P < 0.01$) between the treatments tested for both yield and biomass. Sole rice cropping treatment gave the highest yield, about 1,200 kg per hectare. Intercropping pigeon pea into rice reduced rice yield as well as biomass production. Rice grain yield was reduced by 84%, and by 100% for strip intercropping, and row intercropping, respectively. Intercropping pigeon pea into rice increased pigeon pea grain yield by 10% and biomass by 3%, even though some planted areas were occupied by rice crops. However, There was statistically deferent from sole pigeon pea sole cropping.

Productivity of the technologies tested was evaluated using Land Equivalent Ratio (LER). Treatments 4, 5, and 8 were found to be more efficient for intercropping pigeon pea into rice in terms of yields and biomass production.

The intercropping technologies tested actually satisfied the general concept of the research that is the output per unit of land area had been improved. Treatment 4, 5, and 8 were shown to be more productive, compared to sole cropping (LER greater than 1). Therefore, treatments 4, 5, and 8 were shown to be a promising technology, in terms of agronomic advantages. However, the increased output per unit of land in which the yield of the main crop was substantially reduced might not be accepted by farmers. That LER alone, based on my study, would not be an adequate indicator for effective technologies.

Therefore, further studies on rice/pigeon pea intercropping systems, either on station or on farmer's field, should be done, before recommending them to farmers. That

should improve chances of adoption of recommended technologies by farmers and help to avoid wasting farmer's time and resources. The recommendation for further studies on rice/pigeon pea intercropping systems has to focus on the following issues:

a) Pruning regimes

Rice is the staple food for Lao people. The strong preference for rice may be the main constraint for Lao upland farmers to shift to more intensive non-rice production systems. Any new technology that substantially reduces rice yields is unlikely to be accepted by farmers. Appropriate pruning regimes may provides favorable condition for rice to grow and develop in pigeon pea intercropping systems, therefore improve rice yield.

b) Weed and soil fertility management

Lao upland farmers consider weed to be the main constraint to upland rice production. About 4-6 hand weedings are required per cropping season, utilizing about 50% (about 300 man day^{-1} ha^{-1}) of the total labor input or more. Lao farmers are less likely to accept any recommended technologies that cannot alleviate the weed problem. Therefore, careful studies on rice-pigeon pea intercropping systems (strip or row intercropping) for weed control is certainly an important research priority which should receive support from government agencies. Fewer weeds mean reduced labor input, hence reduced cost of production.

Soil fertility is another important constraint to upland rice production. Soil fertility plays a significant role in sustaining crop yield. Therefore, long-term experiments should be established to monitor changes in both soil fertility and weed populations in rice-pigeon pea intercropping systems.

c) Soil erosion control

Land is a principal input for agriculture. Good land means good soil, and healthy crops. Over 90% of the land in the Xieng Ngeun district has a slope gradient exceeding 30%. Appropriate rice-pigeon pea intercropping systems (strip or row intercropping) for a given slope gradient could help reduce soil erosion and facilitate long-term production. Efficient and productive rice-pigeon pea intercropping may also help alleviate nutrient deficiencies in the upland, especially phosphorus.

d) Economic study

Although, pigeon pea has no market presently, the cost and benefit of intercropping pigeon pea into rice must be evaluated. Preferably, opportunity cost can be used for this purpose. For example, the cost of intercropping pigeon pea into rice can be estimated from the cost of plant nutrient loss through soil erosion and run off in sole crop. The economic results can provide a very important information for policy makers to be incorporated in their strategic planning.

e) Crop modeling

Although LER was used to evaluate the productivity of intercropping against sole cropping, it cannot tell that the systems will be sustainable or not because it ignores time periods. Crop modeling may help answer this problem and many others "what if" questions. Crop modeling may also be a useful tool to explore hypothesis for further research. The use of reliable crop model can be time and resources saving and provide quick answers.