5. CONCLUSIONS

The land use in 1992 in Phrao district area indicated that about 60% of agricultural area were used for cultivation. Most of those cultivated area were lowland area with permanent paddy fields and the infrastructure was well-developed (Wangchuk, 1992). The remainings are the forest land especially dry dipterocarp area (see Table 12).

Land evaluation by the DLD method can be used for general physical evaluation purpose in the small-scale planning since they were developed for the national level use. The land qualities used to assess specific crop for particular area were restricted to the permanent land qualities or the qualities that rarely change over time such as climatic limitations and soil physical limitations. The results of this method were sometimes inappropriate whereas other limitations that are also important for crop production were ignored particularly the soil chemical limitations or any socio-economic constraints. Hence, they need to be modified for use in the more detailed level.

The manual land evaluation is time-consuming while the computerized method is relatively easy and efficient for reclassifying the suitability classes. The construction of the decision trees through the ALES was relatively easy. Although, the major problem with decision tree is their sizes that grow exponentially with the number of factors considered. There are many ways in ALES to reduce this problem i.e., the determination of the severity level land quality and the maximum limitation method. The results can be presented in

the straightforward manner that are easily understood by the users. ALES computes physical evaluation by traversing the decision trees and then estimates gross margin for the economic evaluation. The evaluation results can be displayed either as physical suitability classes or economic suitability classes (Figures 8-18 and Figures 26-31). The ALES database can be directly used to reclassify the existing raster image in IDRISI program when the ALES map units database is correspondent to the integer code in document file of IDRISI. IDRISI can be used to produce interpretative maps of those evaluation results and available for further image processing such as to overlay with the other spatial information.

The results of current physical suitability ratings revealed that:

- In the study area, most severe limitations were nutrient availability for most crop and the flood hazard for field crops. Some areas were limited by steep slope.

- If maximum limitation method was used for land evaluation in FAO framework, most land will be rated as non suitable for growing crops. This method is not suitable for rating the lands in the study area.

When nutrient availability and terrain were treated as the LQ that can be improved by management, potential physical suitability could be assessed. Significant amount of lands were moved from subclass 4 to subclass 3 and the economic suitability of each LMU can be evaluated.

Land evaluation using the ALES and those classified by DLD were compared by Kappa statistics. The results indicated good agreement ($\hat{K}$ = 0.82) between the two methods of evaluation for corn, peanut and soybean but poor agreement ($\hat{K}$ = 0.19) for paddy rice. However, most paddy field in 1992 were located in the suitable areas suggested by the ALES model.

For economic suitability classification:

- The "optimal" yield for a specified LMU could be estimated from DSSAT crop models and was found to be in the range of the published data in the study area.
- About 63% of agricultural area can be used to grow field crop, 22.6% was highly suitable for growing peanut and 10.0% was also highly suitable for soybean production.
- Almost 60 % of agricultural area was defined as moderately suitable for rice production while only 15.1% was the permanently not suitable area.

ALES can also be used to evaluate the multiple cropping systems either in rainfed condition or in the irrigated area. which can not be handle by the DLD method at present. This improvement is significant in terms of evaluating land in northern Thailand where climatic and soil characteristics allow double cropping to be feasible on certain land mapping unit. Land evaluation by ALES will help identifying the potential land for enhancing productivity and income of the farmers.

Data availability for land evaluation process at present are not complete particularly quantitative data for rating land qualities of individual crops. Although, there are many experimental data generated by the experiment stations and those recorded from the farmer fields by various agencies, the records on crop requirements and optimum yield for particular crop in the specific agroecosystem are still lacking. The model for predicting crop yields can help solve those problems. This study utilize DSSAT model to estimate yields of the specified conditions in order to calculate the proportional yields. The results corresponded well with those existing data.

The results of the land evaluation can be displayed as images in IDRISI, a raster GIS, and they were very attractive to the users. They can be queried on screen and results can be printed out effectively. ALES model can be used as a tool to assess the area that have potential in producing some crops in the currently not suitable area through the economic suitability evaluation. Extension workers can use them to guide the selection of the most suitable area for specific crop production. These can be useful in identifying the area to implement the Agricultural Restructuring Project which is currently one of the top priority project undertaken by the Ministry of Agriculture and Cooperative. In that project, the aim is to reduce the cultivated area of dry season rice, coffee, pepper, and cassava. Automated land evaluation such as described in this study can be efficiently used to identify the targeted area by identifying the non-suitable area for those crops and overlaying on the present land use. The recommended crops can be evaluated on those land until final selection can be made based on the economic suitability level of the alternative crops.