CHAPTER 6

Conclusion and Recommendation

6.1 Conclusion

In the last decade food safety crises, revelations of unethical working conditions for farmers, increasing attention to symptoms of imbalance such as pollution and decline of biodiversity have dramatically demonstrated the needs for a sustainable approach to agriculture. In developing countries the right attention and attitude to address the future challenge in agricultural production will be essential to contribute to sustainable development. Because of the importance of sustainable agriculture for all the human beings, this study aims to contribute the knowledge about sustainability in agriculture sector of the country. The objective of the study based on these research questions.

1. What are the management practices of selected cropping systems in the study area?

According to Sustainability Index for each indicator in the cropping systems, we can assess existing management practices of the systems.

In figure 26, we can observe the weakest indicators among the systems. The lowest index for sustainability of the system is found in use of organic fertilizers. In Myanmar, to partial fulfill the requirement of fertilizers for nutrient cycling in the cropping systems, the production and utilization of bio-fertilizers are being encourage and campaigned. But still farmers' perception to use bio-fertilizers is low condition and not enough organic manure and plant residues for nutrient cycling that farmers' usage of organic fertilizer to obtain optimum yield for the crops is low condition. So, we can say that this practice should be improved to be sustainable condition.

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The second weak indicator is usage of chemical control in the systems as observed in figure 26. In this indicator, Rice-Rice system has sustainable condition because cultivation of legumes area in the farm is low. But the other two systems have usage of pesticides or chemical control is non-sustained condition. In Myanmar,

pertaining to plant protection, integrated pest management has been introduced for major crops. Systematic use of pesticides is demonstrated to the farmers by using scouting techniques, setting economic threshold levels and making decision for appropriate spraying. Attempts have been also made for the production and use of organic pesticides, extracted from the neem plants which grow all over the country. A pilot neem pesticide plant was also established in 1988-89. We found that, even though attempts for integrated pest management are continuing, farmers knowledge in this practice is still not fully accepted so that this practice should be improved for sustainability.

We found that other practices such as usage of chemical fertilizers, cultivation of legumes and usage of internal inputs are sustainable. In Myanmar, the level of agro-chemicals use in agriculture is considerable low. The price of chemical fertilizers is high compare with the crop price and farmers are resource poor in some area. So that farmers' usage of chemical fertilizer is sustainable condition but it can be observed that land productivity (yield) could not meet the optimum. We can observe this evidence in indicator if crop yield as non-sustained condition.

2. What is the sustainability level of the three different rice-based cropping systems in the study area?

According to (5) linguistic rules; Very Bad, Bad, Satisfactory, Good and Very Good, Sesame-Rice –Legume system and Rice-Legume system has good level of sustainability and Rice-Rice system has satisfactory level of sustainability.

In general, all the selected cropping systems exceeded 50% of overall assessment in sustainability; we can say that these systems are sustainable.

3. What are the differences among assessment methods in sustainability?

Among (3) assessment methods (SAFE, MCE and SIA), SAFE method appears to be well suited to provide quantitative answers pertaining to sustainability. Fuzzy model admits new parameters according to need and eliminates old ones if they have no effects on the results. Also one can build different fuzzy rules and the choice of sustainability indicators depends on the interest of operator as well as condition of

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the system. Defining appropriate indicators, collecting the relevant data, and choosing adequate fuzzy operators are indispensable steps to achieve a better assessment.

Fuzzy logic operations compensate for the lack of full knowledge of our system. Uncertainty is ubiquitous in sustainability problems since we never have complete knowledge of the ecological systems or the human society. We are not even capable as well of predicting all the effects of human actions on ecological systems and vice-versa. The SAFE model provides a practical tool to manage and to predict, to some extent, the global evolution of the overall system.

The SAFE approach proposed in this research exhibits three important characteristics. First, it permits the combination of various aspects of sustainability with different units of measurement. Second, it overcomes the difficulty of assessing certain attributes or indicators of sustainability without precise quantitative criteria and, third, the methodology is easy to use and interpret. Values of sustainability can be derived and comparisons made over different areas or times. Therefore, this model has the potential to become a practical tool to policymakers and scientists.

The second suitable method for sustainability assessment is MCE (Amoeba approach). This method is useful to graphically integrate and monitor the different indicators by the ‘Amoeba’ or ‘Radar’ diagram.

Third suitable method for sustainability assessment is SIA method. It simply aggregates and integrates diverse information into a meaningful form. In this method less data and analytical skills is required. Comparison among the assessment methods are presented in Table 27.

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Table 27. Comparison among the assessment methods in sustainability

Attributes	SAFE	MCE	SIA
1. Handling uncertainty in the problems	By fuzzification	By probability	By scoring
2. Overall assessments	Permits the combination of various aspects of sustainability	Apply weights and integration	computation
3. Assessing attributes	By normalization (overcome the problem of more is better or less is better)	By normalization (overcome the problem of more is better or less is better)	By scoring
4. Interpretation	Assess by intermediate levels between yes and no	By visualization with amoeba diagram	comparing
5. Comparison among alternatives	comparing	visualization	comparing
6. Decision making	Comparing	Allow compromise solution	comparing
7. handling	Need fuzzy logic and to apply analytical skill	Need to apply reasonable weights	Simple calculation

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6.2 Recommendation

Rice-based cropping systems are important for food security and promote rural income in the study area. S-R-L system plays an important role for family food requirement as mainly source of nutrient as rice, cooking oil and protein. Farmers grow sesame, rice and legumes for daily food requirement and for cash income. They can sell to the market when they have more than daily requirement. So, this system is important for family food security, for cash income for the farmers and nutrient

management by applying crop residues as organic sources for the land. For the country, it is important for local consumption and for export.

R-R system is important for food sufficiency and for export. Being Myanmar is rice exporting country, rice production is promoted by irrigation facilities. The main objective of Ministry of Agriculture and Irrigation is to achieve surplus in rice production. The agricultural development of the study area is based on progress in irrigation works. Rice is staple food for the country and considered as vital role in setting the agricultural policy. So, this system is important for implementing agricultural policy of the country.

R-L system is important for farmers' food sufficiency and extra income. Where soil moisture availability is less and risky for sesame, farmers grow rice and legumes for basic food requirement and cash income when they have extra produces. This system is important for nutrient availability for family, cash income and nutrient management for organic sources by applying crop residues to the land. This system is important for the country as local consumption and export.

In this situation, to overcome the unsustainable manner for each system, recommendations are as follows:

1. balanced and integrated use of mineral fertilizers together with organic fertilizers on the basis of soil tests, promise long-term productivity with sufficient economic returns are needed to manage,
2. to encourage to include legume crops in the cropping systems to supplement N requirement and increase the organic material content in soil,
3. to enhance the efficiency of fertilizers applied by controlling nutrient leaching through appropriate methods of irrigation and fertilizer application,
4. In order to reduce farmers' dependency on harmful chemical control measures, it is necessary to promote non-conventional measures of insects and pest control, including herbal insecticides and promotion of insect and pest predators,
5. Crop production in the study area is financially viable, but economically not viable. The profitability of crops is affected by changes of input costs and output prices. So, reliable and efficient market system is recommended,

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6. The current extension services are not adequate to encourage the farmers to adopt resource-conservation services. So, agricultural extension workers should receive adequate motivation so as to provide efficient services to farmers. One of the primary responsibilities of the extension service should be to make farmers aware of the long-term environmental and economic implications of the over and inappropriate use of resources including external inputs and usage of irrigation water,
7. New technology, information and news concern about sustainable agriculture should be transmitted by TV program, Radio, newspaper and journals to the farmers,
8. Sustainable crop management practices, land suitability analysis, risk management analysis and updated soil/ land databases are needed for further study,
9. Incentives to promote nutrient management in appropriate ways are required.

Policy incentives for selected cropping systems are suggested as follows:

Cropping systems	Condition	Incentives
1. Sesame-Rice-Legume	Area under more water availability	-efficient water distribution -stable market situation -quality seed production -distribution of fertilizers(organic & inorganic) and pesticides (herbal) in subsidized price
2. Rice-Rice	Under irrigation projects	-efficient water distribution -arrangement of water schedule to include legume crop in cropping system -stable market situation -distribution of quality seeds for early mature varieties -distribution of fertilizers(organic & inorganic) and pesticides (herbal) in subsidized price
3. Rice-Legume	Area under	-efficient water management

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	less water availability	-supporting of technology for crop management practices -stable market condition -distribution of quality seeds for drought resistance varieties -distribution of fertilizers(organic & inorganic) and pesticides (herbal) in subsidized price

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