In Chapter I, I discussed the general status of rice cultivation in the Philippines. I explained the effect of rice in the lives of Filipino people and its contribution to the economy. The methods and practices of rice cultivation were discussed. The challenges in attainment of self-sufficiency in rice in relation to the environmental impact of rice cultivation were also explained. The importance of fertilizer application and the utilization of “carabao” (water buffalo) as draft animal during land preparation and hauling were discussed. The mechanization of rice production was explained, including the rice straw and husk management in the field. The general objective of the dissertation was mentioned.

In Chapter II, the energy input-output for different rice production systems in the Philippines was analyzed. Energy input-output of rice production considering the power source (manual, semi-mechanized, and mechanized) were analyzed using the Philippine national statistical data of 2006-2007 based on life cycle viewpoints. The differences on growing season (wet and dry season) and irrigation methods (irrigated and rain-fed) were also reflected in the data. The results discussed separately for the dry and wet season data. The results were compared to previous studies on rice energy input-output analysis in other countries.

In Chapter III, the greenhouse gas emission of rice production system in the Philippines was evaluated based on life cycle inventory analysis. The GHG emissions of rice farming inputs (fertilizer, pesticide, fuel for machines, and irrigation) and carabao were comprehensively quantified. Methane (CH4) and nitrous oxide (N2O) emissions from soil processes during rice production were estimated based on 2006 IPCC guidelines. The difference in rice straw management (burning or incorporation) and method of irrigation (irrigated and rain-fed) were also taken into account. All data were based on national surveys conducted in 2006-2007. The result discussed the GHG emission of rice production in the Philippines. The emission of rain-fed and irrigated area was compared towards the discussions. The detailed GHG emission of sources of emission was also discussed here. Several mitigation processes were identified to reduce GHG emission during rice cultivation. The result was compared to the emission of different countries, such as Japan and Italy. The conclusion was discussed by stating some possible mitigation technologies based on the viewpoint of an agricultural engineer.

In Chapter IV, as a mitigation technology, the technical and socioeconomic evaluation of a ride-on tillage implement for the hand tractor was conducted in actual field operation. The status of rice production mechanization was discussed in the introduction. Technical evaluation covered the speed of travel, draw bar pull, rolling resistance, and turning radius of the hand tractor during plowing and harrowing, depth of cut, width of cut, and field efficiency. All data
were analyzed using the descriptive statistical analysis. The socioeconomic impact and feedbacks from the farmers who used and observed the ride-on attachment were gathered through structured questionnaire. The economic analysis of the handtractor using a straight line method was also evaluated. The result showed the actual performance of the handtractor with ride-on attachment. The advantages of using the ride-on attachment in relation to field performance, economics were compared to the conventional attachment. The mitigation effect of using the handtractor as replacement of carabao during levee-side plowing was discussed.

In Chapter V, as a mitigation technology, the potential evaluation of a locally-designed wind-pump system for water pumping to irrigate rice crop based on 10-year weather in the Philippines was studied. The weather data were gathered from PhilRice weather monitoring station. A previously installed wind-pump system in Tarlac, Philippines, was used for the study. The actual performance of the wind-pump by measuring the water discharge together with the actual wind speed in the area was monitored and analyzed. The 10-year wind speed and rainfall data of the area was analyzed in relationship with the actual data. The result showed that the wind-pump is not capable of irrigating one hectare rice crop. However, it can support rice crop during the rainy season (June-November) if it is combined with the rainfall. The mitigation effect of using the wind-pump system during dry season was also compared to water pumping using diesel engine-pump system.

In Chapter VI, as a mitigation technology, the evaluation of an up-draft rice husk gasifier system for powering rice mills in the Philippines was conducted. The study was aimed to ameliorate the effect of rice husk disposal by small rice mills. Performance of the gasifier was discussed. The study concluded that the gasifier output was not enough to power a small rice mill. However, by improving the performance of the system, this could be done. If improved and adopted, the gasifier will help rice millers in reducing rice husk waste and at the same time, power their mills. The mitigation effect of using the gasifier was discussed in this chapter.

In chapter VII, the general discussion and conclusion were discussed. The concluding remarks in each chapter were discussed. The final message of the dissertation was stated.

Photos

Visit to Tohoku Agricultural Research Center, NARO, in Morioka city (2012).

Poster presentation at 11th International Ecobalance Conference in Tsukuba city. The gold poster prize was awarded (2014).