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【論文の内容の要約】

Introduction

The rapid world population growth was projected in the developing country such as Indonesia. This condition will be followed by the increase of rice demand as a staple food. On the other side, agriculture sector will withdrawal more freshwater to provide sufficient affordable food for growing and urbanizing populations. The government of Indonesia has done several investment programs such as development adequate irrigation system, agriculture machinery, fertilizer subsidies in order to increase rice production. However, they need to prioritize the implementation due to budget limitation. Fully comprehending the complicated current condition of rice production system is necessary for decision making for rural development.

The improvement in rice production can be determined by several integrated factors such as climatological and hydrological factors, technology, agricultural input, social/economic conditions, the market, and agricultural infrastructures. Determining agricultural productivity based on only one of these factors may be disingenuous to provide of the relative contribution of the different factors that can influence the production level. Hence, the objectives of the study are to identify the various factors that affect rice production and to estimate water demand, supply and productivity for sustainable rice production.

Methods

There were two analysis in this study. First, Structural Equation Modelling

analysis on agricultural system (natural condition, agricultural input and socio-economic condition) in major rice production area. Second, water supply, demand and productivity analysis under current irrigation facilities and the improvement of irrigation efficiency scenarios for future investment of irrigation system. Specifically, Artificial Neural Networks (ANN), a biologically inspired computer programs designed to simulate the way in which the human brain processes information was used to analyze the hydrological and water resources condition, and F.J. Mock tank model was used to analyze water balance in the study area. The Water Evaluation and Planning System (WEAP) a forecasting tool for maintaining water demand and supply information was applied to analyze the future condition of water demand and supply based on several scenarios.

Analysis

SEM analysis of various factors that affect cropping intensity and land productivity in the central rice production region of Solok Regency showed that not only the development of adequate irrigated area such as semi-technical and simple irrigation systems was the only government subsidy that contributed to rice production, increased evaporation also significantly affected the cropping intensity, while an increase in farmers income through increased rice exports mediated by the presence of rice milling units and farmers' organizations affected both the cropping intensity and the average yield.

Available water supply in the Sumani watershed is approximately 40 % of annual rainfall. Since the study area is rice production region, irrigation water requirement is much higher than domestic water requirement. Based on the current condition of irrigation system, net irrigation requirement approximately 50 % of the total irrigation requirement. Annual available water supply can cover the annual water demand. However, insufficient water availability occurred in the dry season. Water productivity in the study area are influence by yield and irrigated area. Further analysis regarding supply and demand is conducted based on several scenarios of population growth, improvement on irrigation efficiency and development of irrigation system. The findings of the scenario simulation are if there is no increase in the population growth rate and there is no improvement on irrigation efficiency, Sumani watershed will require

37 % more water in 2050. On the other side, irrigation water requirement will decrease approximately 35% if all of rice field in the area only occupy by technical irrigation system with 80% of irrigation efficiency. However, the annual water requirement coverage is 100% only occurred in the very wet season with monthly unmet water requirement in the dry season.

Conclusions

Four key findings are of particular importance for future decision making: (1) an increase in farmer's income through increased rice exports was the most significant factor that affected rice production in the study area. (2) The existence of a farmer's organization had the most significant effect on a farmer's income. (3) Although there was no water use competition in the study area due to population growth, water availability was insufficient during the dry season due to the increase in evaporation, threatening the ability to harvest rice three times per year. (4) The development of areas with semi-technical and simple irrigation systems was the only government subsidy that contributed to rice production, and the modernization of both irrigation systems is required to increase water productivity.

The average water productivity in this central production was relatively higher than average water productivity in the developing country. Sumani watershed had sufficient water supply for irrigation in the wet season with average irrigation efficiency approximately 50 %. Based on scenarios simulation, annual water requirement is covered in the very wet year with the lowest irrigation requirement (irrigation efficiency of 80%). However, there is monthly unmet water requirement in the dry season where the coverage demand is only 65%.