Tropentag 2013, Stuttgart, Germany
September 17-19, 2013

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the University of Hohenheim

Impacts of Climate Variation on Land Use Change in Major Fruit Production Area of Thailand

Potchanasin, Chakrit

Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University
50 Ngamwongwan, Rd. Chatujak, Bangkok, Thailand 10900. Email: fecocrp@ku.ac.th

The present study was prepared among several efforts to depict impacts of climate variability on crop production and land use change especially in tropical and sub-tropical agricultural area. The paper will direct through an introduction of the research question and the significant of the study area following by research methodology and details of data collection. After that, main results of this study will be presented and, in the end, recommendations based on the findings will be proposed.

Introduction

The study aims at analysing impacts of land use change due to climate variability in Thailand's major fruit production area —Tha Mai district, Chan Tha Buri province. The study area is located on the east part of Thailand and has been selected as a major fruit production area especially for durian, mangosteen, rambutan and Lansium domesticum (longkong). In 2010, planted area of these crops was reported around 6,172.96 ha which was accounted for around 1% of the country's planted area or around 10% of Chan Tha Buri province (Land Development Department, 2010). These fruit productions could generate income to the area 102.49 mil US$ or 14,732.39 US$ $hh^{-1}year^{-1}$ while province and country average were 2,977.04 and 1,670.94 US$ $hh^{-1}year^{-1}$, respectively (Office of Tha Mai District Agricultural Extension, 2011). However, due to climate variability, fruit production in this area might be affected and, consequently, induce the change on land use and economic situation of the area. Therefore, this study was focused on the questions about how impacts of climate variability on cost-benefit of fruit production and land use change.

Material and Methods

Data – The analysis used secondary data which consists of GIS land use data of 2010, climate data from 1951–2010, crop production data surveyed in 2010 from 292 farm samples by the Office of Agricultural Economics, and crop coefficients required for CropWat model (Smith, 1992) from FAO and published literatures.

Analysis – The study used the CropWat model to estimate impacts of weather variables - which consist of rainfall (mm.), maximum temperature (°C), minimum temperature (°C), relative humidity (%), wind speed (ms^{-1}), sunshine (hrs)- on actual crop yield and comparative cost-benefit of crop production. The study calibrated the positive quadratic programming model (Howitt, 1995) to land use of the study area in 2010 which the model consists of 154 variables determined for 11 major crops including rubber, dragon fruit, pepper, salacca, rambutan, mangosteen, durian,

Lansium domesticum, pineapple, rice and cassava in 14 sub-districts. In addition, the model consists of 224 constraints which comprise 42 the area's resource constraints of available land, labor and cash for 14 sub-districts and 154 technical calibrated constraints. The results of this model under production conditions in 2010 was considered as baseline scenario results. Scenario analysis regarding climate variability was, later, conducted by implementing the changes on cost-benefit of crops to the model to examine how land use change due to climate variability.

Scenarios of climate variability – This study had conducted scenario analysis concerning to climate variability. 2 scenarios of climate variability whereby 6 significant climate variables had been defined through empirical cumulative distribution function concerning to probability of climate variability varied like the climate in La Niña and El Niño years (Figure 1). For the scenario that climate variables are varied in term like La Niña years, dominant characteristics of the weather were having higher total rainfall around the year, earlier coming of rainy season starting, late coming of rainy season ending, having higher relative humidity and wind speed while having lower average temperature and sun shine hour. For scenario that climate variables are varied like El Niño years, characteristic of weather variation is in the other way around to La Niña year case (Figure1).

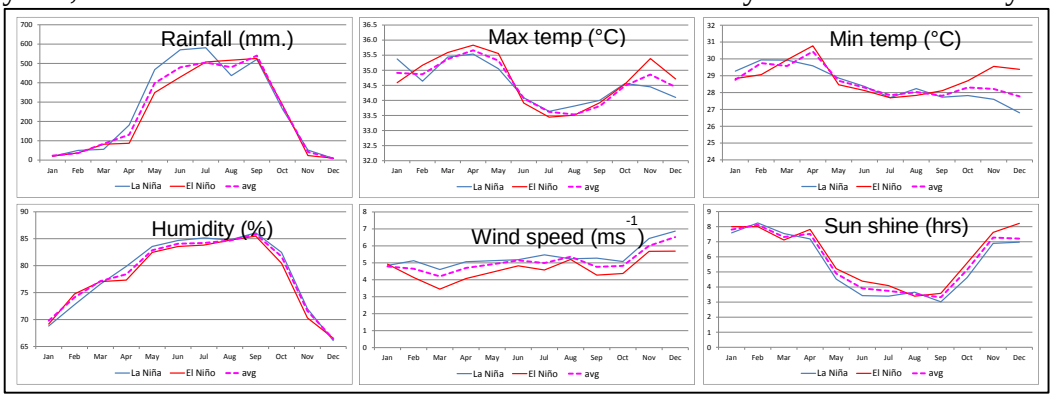

Figure 1: Climate variability scenarios

Main Results

Impacts on average crop revenue - The results showed that climate variability in term of La Niña years induced a reduction of the crop revenue of 131.57 US$ ha^{-1} on average from baseline which the most of negative impacts were found in dragon fruit reduced by 554 US$ ha^{-1} and pepper reduced by 425 US$ ha^{-1}. For El Niño case, crop average revenue would be reduced 155.86 US$ ha^{-1} while the most reductions were found in pepper and dragon fruit (Figure 2).

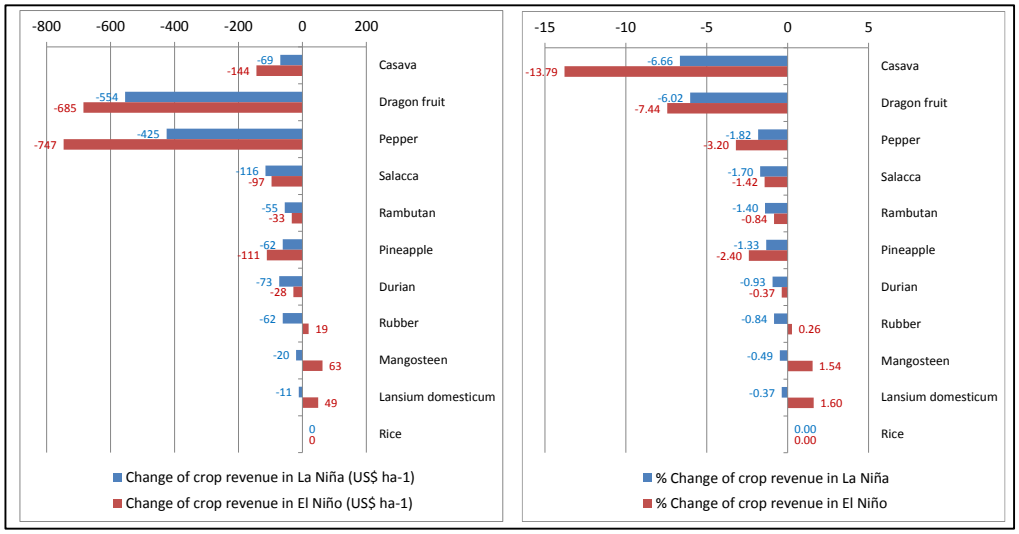

Figure 2: Impacts of climate variability on average crop revenue

Impacts on land use – For the case of La Niña, planted area would be reduced by 524.38 ha on average which cassava, durian and rubber were the most three crops with high reduction (Figure 3). In addition, pepper, Lansium domesticum and durian were the first three crops with high sensitive response to climate variation indicated by percent of planted area change when average net income changed by 1%. The results under El Niño climate variability showed that crop area would be reduced 504.44 ha and Lansium domesticum, mangosteen and rubber crop area would have positive responses under El Niño climate variability. However, pepper and durian were under El Niño still counted as the most sensitive crops to the climate variation.

Cost of farmer adaptation – To alleviate crop yield change under La Niña conditions, adaptation of farmers would cost 1,697 US$ ha^{-1} on average which consists of 577 US$ ha^{-1} for input cost, 704 US$ ha^{-1} for labor cost and 544 US$ ha^{-1} for irrigation cost. Adaptation costs to alleviate the impacts on El Niño weather conditions were lower and consisted of 501 US$ ha^{-1} for irrigation on average. The first three crops that have relative high adaptation cost were salacca, rubber, and Lansium domesticum (Figure 4).

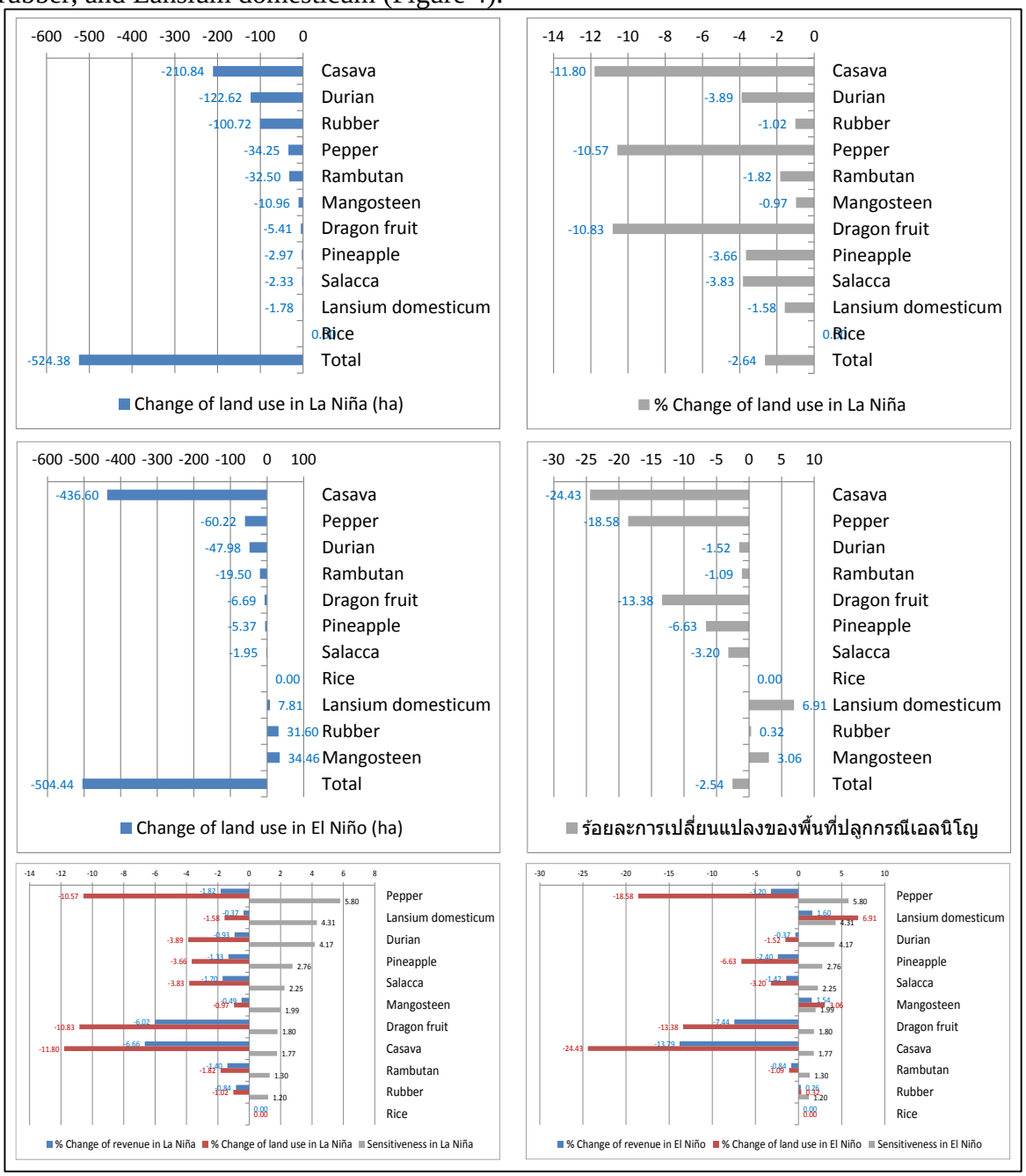

Figure 3: Impacts of climate variability on land use change

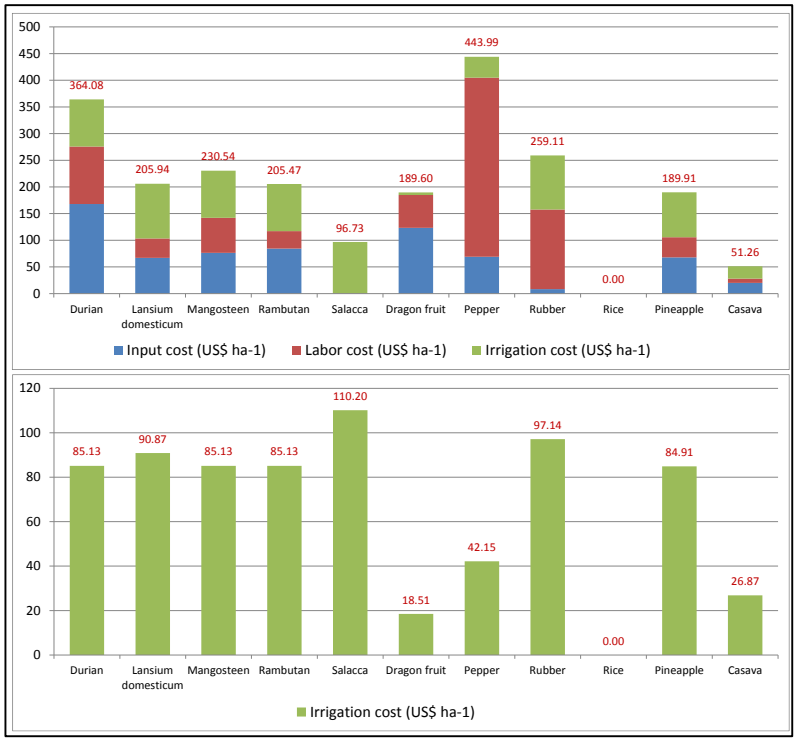

Figure 4: Cost of farmer adaptation

Recommendations

Based on the results, this study could recommend that policies to mitigate climate variability should be pursued in pepper and durian as first priority while further fund support will be needed when the climate variability tend to be more in the direction of La Niña weather conditions because in such condition (high total rainfall, early coming and late ending of rainy season) the farmers have to do more orchard management in order to smooth impacts to their fruit yield. In addition, for the case that if there will be irrigation support policy the policy makers should consider priority of crops to be supported based on water requirement which can be ranked as Lansium domesticum, rubber, salacca durian, mangosteen, rambutan, pineapple, pepper and dragon fruit, respectively. Furthermore, in the case of climate variability in term like La Niña years, farmers will need labor for orchard management especially for pepper, rubber, durian, mangosteen dragon fruit, respectively. Thus, labor saving technologies for production processes should be developed and improved. Also, as the weather condition in the study area tend to be in the way that having high total rainfall, early coming and late ending of rainy season which this will highly impacts to fruit production especially at the initial stage to get flowering and at the period of harvesting, thus, the research concerning production management in such significant periods should be pursued and transferred to the farmers.

References

Howitt, R. E. 1995. "Positive Mathematical Programming." Agricultural & Applied Economics Association, 77 (2): pp. 329-342.

Land Development Department. 2010. Geographic Information System of Chan Tha Buri province. Ministry of Agriculture and Cooperatives, Thailand.

Office of Tha Mai District Agricultural Extension. 2011. Agricultural Statistics of Tha Mai district in production year 2010 (Online). http://www.chanthaburi.doae.go.th/data/static_planting2.htm, October 23, 2011.

Smith, M. 1992. CROPWAT A computer program for irrigation planning and management. FAO Irrigation and Drainage Paper, no. 46. Food and Agriculture Organization of the United Nations.