Economic and Spatial Analysis of Concentration of Technical Efficiency: A Case Study of Potato Farming in Western Guatemala

Rupananda Widanage*, Catherine Chan*, Yin-Phan T. Sang*, Brent Sipes**, Haddish Melakeherhan***, Amilcar Sanchez****, and Alfredo Mejia****

*Department of Natural Resources & Environmental Management, College of Tropical Agriculture and Human Resources, University of Hāna, USA
**Department of Plant & Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawai‘i at Mānoa, USA.
***Department of Horticulture, College of Agriculture & Natural Resources, Michigan State University, Michigan State, USA
****University of San Carlos, Guatemala

ABSTRACT

Agricultural resource management problems are associated with both temporal and spatial dimensions. Many previous resource management studies focused only one dimension of the problem which, is based on a single disciplinary approach. These studies failed to conduct a proper analysis of the natural resource management problem. Only in the last couple of years, the paper represents an integrated approach, which combines both spatial and temporal dimensions of agricultural resource management. Using high level data in Western Guatemala, the paper employs frontier production function and GIS based spatial mapping to examine the concentration of technical efficiency of potato farming. The estimated frontier production function shows that technical efficiency in potato farming remains at a low level. In addition, both socio-economic and spatial characteristics play a significant role in determining technical efficiency.

I. Introduction

• Guatemala is a country with stagnant growth in agricultural productivity. Guatemalan agricultural sector contributed to 13.2% of GDP and it provided employment opportunities for 32% of labor force in 2014.
• Potato is important to Guatemalan economy as it is one of the major cash crops as well as staple food crop.
• Guatemalan potato productivity is 40% lower than (25 ton/ha) the world productivity (50 ton/ha) and 225% lower than European and North-American productivity (80 ton/ha).
• Our focus group interview revealed that 50% of yield reduction due to crop diseases called “Nematodes”. Among others invasive weeds and pests are crucial problems.
• USAID funded a project to look at potato productivity

II. Objectives of the Study

• To measure productivity in potato farming
• To provide policy implications for improving efficiency in potato farming

III. Research Questions

• What are the socio-economic & spatial factors that determine technical inefficiency?
• What is the spatial pattern of the concentration of the technical efficiency of potato farming in Western Guatemala?
• What are the policy implications of this study in formulating best agricultural practices in Western Guatemala?

IV. Methods

• Data Collection: Face to face interviews and a desktop study.
• The data collection occurred in 2017-2018 with randomly selected 100 households. The survey instrument consists of four sections: socio-demographics of the farmers, production data, marketing data and farming practices.
• Geospatial data such as slope, elevation, soil carbon stock and soil carbon stock for GIS based spatial mapping was extracted from the following sources
  - https://soilgrids.org
  - https://www.mapzen.com/blog/long-term-support-mapzen-maps/

V. Results: Inefficiency Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEV</td>
<td>-30.91</td>
<td>9.61</td>
<td>0.001*</td>
</tr>
<tr>
<td>CARST5</td>
<td>0.172</td>
<td>0.081</td>
<td>0.037**</td>
</tr>
<tr>
<td>FSZ</td>
<td>-0.224</td>
<td>0.359</td>
<td>0.535</td>
</tr>
<tr>
<td>W</td>
<td>-0.224</td>
<td>0.359</td>
<td>0.535</td>
</tr>
<tr>
<td>DLU</td>
<td>0.172</td>
<td>0.081</td>
<td>0.037**</td>
</tr>
</tbody>
</table>

• Significant at the 1% & **significant at the 5% levels of significance
• Frontier model was used to derive technical inefficiency in the frontier model plot, cost of labor, cost of labor square, & cost of land control are significant at 5% level of significance.

Interpretation of Inefficiency Model Results

• San Juan (DL3) contributes to decrease technical inefficiency in potato farming due to high socio-economic infrastructure
• An increase in elevation (ELEV) increases technical inefficiency due to soil erosion
• Large farm size (FSZ) reduces technical inefficiency due to economies of scale
• Soil carbon stock (CARST5) reduces technical inefficiency due to increasing soil fertility

VI. Policy Implications

• Formulate policies plus extension activities by integrating optimal input uses with optimal locational centric factors to enhance productivity
• More soil erosion control methods for potato farms located in elevated lands
• Workshops on agricultural best practices for Climentoro, Palastina, & Paquix
• Just using land is not enough. There are other factors such as education, extension services, and market access that positively influence efficiency in potato farming
• We do not consider those factors due to the unavailability of data.

VII. Conclusion

• Technical inefficiency in potato farming in Western Guatemala remains at a high level
• Both socio-economic and spatial factors are important determinants of technical inefficiency
• Increase in farm size & erosion control enhance technical efficiency
• Focus more on Climentoro in conducting workshops
• Provide policy insights to formulate best agricultural practices which enhance productivity through improving technical efficiency
• Such a strategy would help to establish an economically efficient and environmentally sustainable potato farming in Western Guatemala

Acknowledgements

• We do not consider those factors due to the unavailability of data.
• Workshops on agricultural best practices for Climentoro, Palastina, & Paquix
• Just using land is not enough. There are other factors such as education, extension services, and market access that positively influence efficiency in potato farming

References