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

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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. Those studies failed to conduct a proper analysis of the natural resource management problem. To fill such a knowledge gap, this paper applies an integrated approach, which combines both spatial and temporal dimensions of agricultural resource management. Using farm level data in Western Guatemala, this 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 remain at a low level. In addition, both socio-economic and spatial characteristics play a significant role in determining technical efficiency.

IV. Methods

- **Data Collection: F**ace to face interviews and downloads
- The data collection occurred in 2017-2018 with randomly selected 108 households. The survey instrument consists of four sections: socio-demographic of the farmers, production data, marketing data and farming practices.
- Geo-spatial data such as slope, elevation, precipitation and soil carbon stock for GIS based mapping was extracted from the following sources
- https://www.mapzen.com/blog/long-term-support-mapzen-maps/ https://github.com/tilezen/joerd/blob/master/docs/data-sources.md, https://soilgrids.org

- **Data Analysis: Frontier Production Function & Inefficiency model**
  - TE = Actual output/Potential output
  - TI = 1-TE (TE refers technical efficiency)

$$TI = \mu + \sum_{i=1}^{n} \delta_i w_i + e_i$$

  - Where i=1……n; TI=technical inefficiency
  - w =socio-economic, management & locational factors
  - δ_i = co-efficients
  - e = random error term

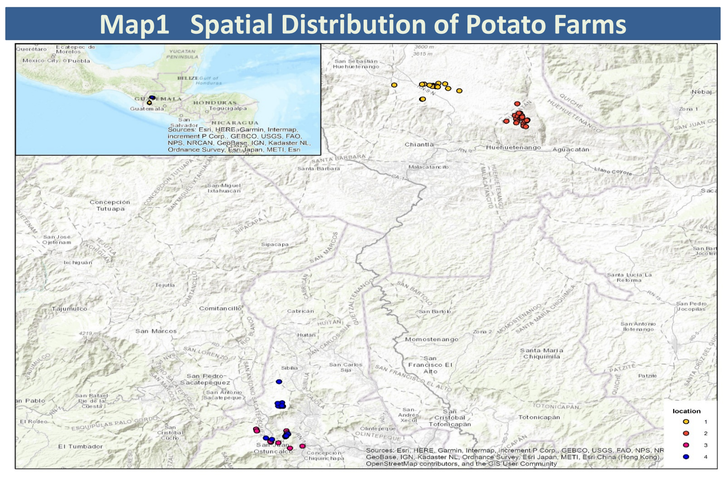
Study Area:

- Seventy percent of potato production is found in Western Guatemala in the department of Huehuetenango and Quezaltanago. Two sites from each department were selected. They are Climentoro and Paquix from Huehuetanango and San Juan and Palastina from Quezaltanago.

- The review of secondary data and key informant interviews revealed that the widespread poverty (range 73.8% - 86%), income inequality (range 0.49 -0.58), malnutrition among school children (range 48.8% - 68.8%), small farm size (range 0.27-0.78ha) and low productivity in potato farming (range 20.20 -27.18 MT/h) are some of the major socio-economic problems in these areas.

- Many of these socio-economic problems are linked to the stagnation of agricultural sector. Therefore, it is imperative to examine the factors that influence technical inefficiency in potato farming.

Map1 Spatial Distribution of Potato Farms



1 Paquix 2. Climentoro 3. San Juan 4. Palastina

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 a staple food crop
- Guatemalan potato productivity is 40% lower than (25 ton/ha) the world productivity (35ton/ha) and 220% lower than European and North American productivity (80ton/ha).
- Our focus group interview revealed that 50% of yield reduction due to crop diseases called ***"Nematodes".*** Among others invasive weeds and pets are crucial problems.
- USAID funded a project to look at potato productivity

V. Results- Inefficiency Model***

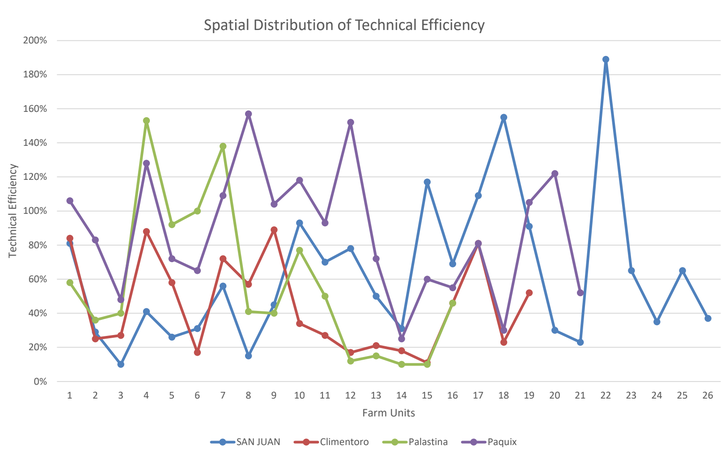
Explanatory Variables	Parameters	Standard Error	"P" Value
Constant	-5.38	45	0.905
DL3	-30.91	9.61	0.001*
ELEV	0.034	0.041	0.023*
FSZ	-0.172	0.081	0.037**
CARST5	-0.224	0.359	0.535

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

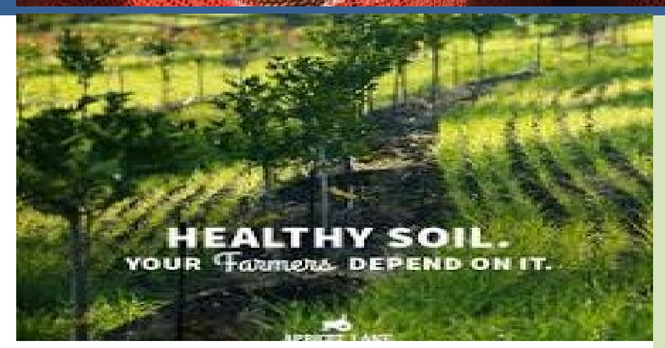
Interpretation of Inefficiency Model Results

- San Juan (DL3) contributes to decrease technical inefficiency in potato farming due to rich 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

Figure 1



- Average technical efficiency is 64% in Western Guatemala. Thus, the actual output is 36% below the level of potential output
- Large fluctuations in technical efficiency between and within regions
- Map 2 shows approximately a uniform variation in soil carbon stock across individual potato farms.
- Map 3 shows spatial variation in elevation across individual potato farms



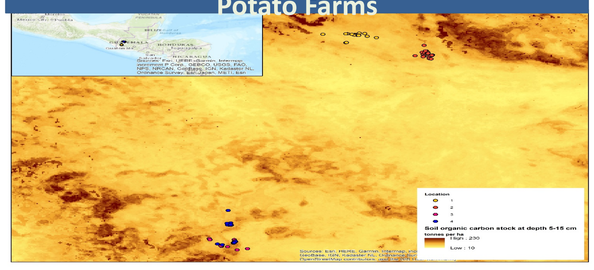
II. Objectives of the Study

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

III. Research Questions

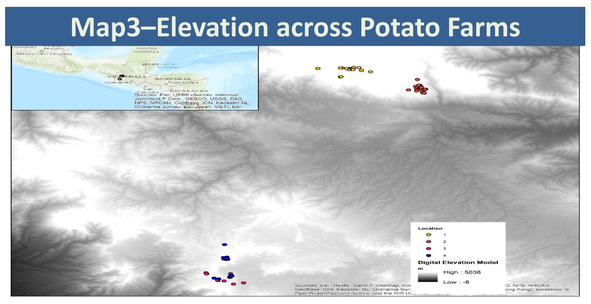
- What are the socio-economic & spatial factors that determine technical inefficiency?
- What is the spatial pattern of the concentration of the technical efficiency of potato farming in Western Guatemala?
- What are the policy implications of this study in formulating best agricultural practices in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

Map2 –Distribution of Soil Carbon Stock across Potato Farms



1 Paquix 2. Climentoro 3. San Juan 4. Palastina

Map3–Elevation across Potato Farms



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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

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