

## **Abstract**

A number of questions have been raised on sustainability of agricultural production in Punjab due to growth and modernization of agriculture in the state over the last five decades, which has contributed immensely to the increase in supply of foodgrain in the country. The thesis quantitatively analyzes soil nutrient depletion, which is one of the key issues. The developments in Punjab have led to dominance of rice and wheat in the state, the thesis focuses on the impact of rice-wheat cultivation on changes in availability of soil nutrient and attempted to answer the following questions

1. What are the factors that have led to increase in areas under rice and wheat rotation?
2. What is the extent of nutrient depletion and is there any evidence of its affect on rice and wheat yield?
3. Does farmer's nutrient management strategy mine soils of nutrients? How well do they perform vis-a-vis nutrient strategies recommended by Punjab Agriculture University? Are they irrational in their choice of nutrient management strategies?
4. Is it possible to induce the farmers to adopt more sustainable practices without affecting the profits?

The thesis also presents a computational strategy for using dynamic optimization framework to address the issue of exploding number of soil quality types from year to year, as soil quality is a function of crop grown and crop management practices.

To assess the extent of depletion and analyze its impact on productivity, estimation of nutrient balance and analysis of yield were carried out. To address the last two questions stated above simulations were done using estimated yield-soil nutrient availability function and soil nutrient availability evolution function. The analysis brought out the following points in response to the questions posed

1. A continuous increase in yield coupled with a favourable price policy that provided stability to prices, made rice and wheat the most profitable crops, with a low risk. This led to increase in area under rice and wheat in the state.
2. A low level of potassium fertilizer use resulted in considerable extraction of potassium from soil over the decade of 80s. Limited use of Farmyard Manure and fertilizers that

supply micronutrients led to inadequate replenishment of soil with micronutrients. The analysis of rice and wheat yield indicated that districts with a longer history of intensive agriculture had a lower yield.

3. The farmer's strategy depleted the soil of nutrients but it resulted in better profits over the long-term compared to the nutrient management strategies recommended by PAU. The farmers were not irrational in their choice strategy but lack of adequate resources, cost-effectiveness of organic fertilizers, risk and high discount rate imply that strategies recommended by PAU were not viable.
4. A greater effort in developing better quality seeds for alternative crops, cost-effective organic manure and soil quality test based fertilizer recommendations would increase possibility of the farmers adopting more sustainable nutrient management strategies in the future.

Lack of data restricted the demonstration of the computational strategy developed to analyze the issue of soil nutrient depletion in a dynamic optimization framework. The simulation exercise is a comparative analysis and thus could not be used for analysing the effect of policies in attaining more sustainable production.