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# An Introduction to Economic Analysis of Pest Management: Concepts of Partial Budgeting Analysis[1]

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## Introduction

Pests have long posed a serious challenge in agroecosystems, inflicting substantial economic losses on a global scale (Alphey and Bonsall 2018). In the realm of agricultural production, pests are often associated with crop yield losses, leading to a reduction in farm profits (Naranjo et al. 2002; Zalucki et al. 2012; Furlong et al. 2013).

This initial publication in the *An Introduction to Economic Analysis of Pest Management* series aims to educate agricultural producers, Extension agents, and researchers in non-economic disciplines regarding the concepts of partial budgeting analysis. This fundamental tool is widely used to analyze the economic viability of adopting various pest management strategies. Subsequent articles will present specific case studies on pest management, demonstrating the practical application of the analytical tool and examining potential environmental implications.

## Pest Management and Partial Budgeting Analysis

Agricultural producers often face the question of whether to adopt a specific production or management practice. In agricultural decision-making, evaluating the cost-effectiveness of various practices and techniques is vital. While certain techniques may enhance crop yields, they often come with increased costs, necessitating a careful analysis of their overall economic feasibility. For example, Nian et al. (2022) found that the increased grafted organic tomato yields in high tunnels (a disease control method) did not necessarily lead to an increase in net profit.

Partial budgeting analysis is an economic analysis tool enabling agricultural producers to make more informed decisions by assessing cost-effectiveness (Kay et al. 2016). Unlike studies that focus on maximizing yield, this tool evaluates the dual impact of a management practice on both crop yields and production costs, thereby facilitating sound decision-making.

## Revenue and Costs: Two Sides of Partial Budgeting Analysis

Partial budgeting analysis requires both revenue and cost information. The adoption of pest management practices can lead to both positive and negative effects in terms of economic outcomes. Positive effects might include increased revenue and decreased costs, while negative effects could encompass decreased revenue and increased costs. The aggregation of these positive and negative impacts produces the net effect, showing the cost-effectiveness of different pest management strategies. Both revenues and

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costs of treatments in experiments are usually converted to per acre revenues and costs in partial budgeting analysis.

On the revenue side, implementing pest management strategies can result in higher yields and improved product quality, thereby increasing revenues. Conversely, certain strategies may lead to reduced yields and, correspondingly, lower revenues. The cost side of the analysis is more complex; a pest management practice can involve multiple inputs, such as labor and different types of materials, and can affect costs in several ways, such as through decreased use of inputs or the adoption of less expensive alternatives. Pesticides, for example, are a common input for agricultural production. Costs can vary depending on the amount applied, application frequency, and pesticide types. A standard cost analysis must consider various inputs, including land, labor, machinery, materials, and energy, among others.

In practice, conducting a partial budgeting analysis does not require the examination of all inputs and outputs. Instead, it focuses on input and output *changes*, analyzing the differences in the types and quantity of inputs between the treatment (which receives the change or intervention in the experiment) and control groups (which do not receive the change or intervention). Unchanged elements, such as land rent, fixed asset depreciation of the farm, and other costs unaffected, are not considered. This selective approach is why the analysis is termed "*partial budgeting*."

## Necessary Details for Conducting Partial Budgeting Analysis

In this section, we provide essential details and practical guidelines for partial budgeting analysis.

Interdisciplinary collaborations play a crucial role in the economic analysis of pest management. Thus, it is important for economists and other analysts to understand the experiment trials conducted by scientists. A trial often involves the treatment group and the control group. The treatment group employs a specific pest management practice, which is compared with the control group, which either does not use any treatments or employs a historically standard technique. It is common to include and compare multiple treatment groups. For example, Cao et al. (2019) compared five treatment groups in their study on the cost-effectiveness of different fumigation methods in tomato production (Figure 1).

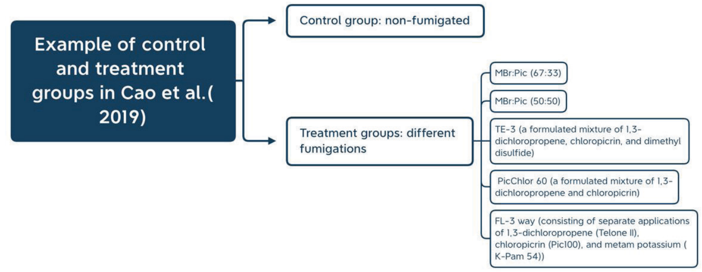


Figure 1. Example of control and treatment groups adapted from Cao et al. (2019). The control group is non-fumigated; the treatment group involves different fumigation methods.

As previously mentioned, the cost aspect of partial budgeting analysis is more complex. We illustrate the affected cost categories in Cao et al. (2019) in Figure 2.

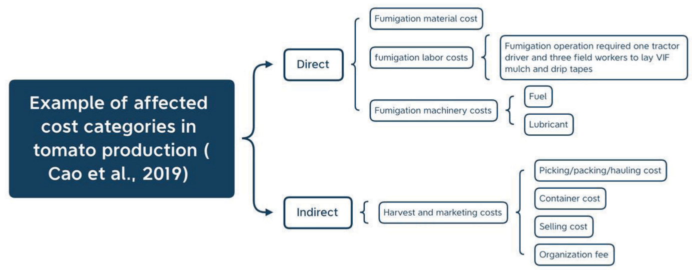


Figure 2. Example of affected cost categories in tomato production adapted from Cao et al. (2019). Direct costs include the cost of fumigation materials, fumigation labor costs, and fumigation machinery costs. Indirect costs include harvest and marketing costs.

Direct costs, including materials, labor, and machinery, are the expenses directly involved in performing the treatment. For example, in tomato production, as reflected in Cao et al. (2019), material costs vary based on the amount of chemicals used. Labor costs should consider the frequency of treatment applications per season, the time needed to spray an acre, and the hourly wage of the tractor driver. Machinery costs encompass expenses for fuel and lubricants.

Indirect costs are not costs of performing the treatment but those related to the treatment indirectly. In Cao et al. (2019), indirect costs include changes in harvest and marketing expenses due to yield differences between treatments. Indirect costs include variations in picking, packing, hauling, container costs, selling expenses, and organization fees.

The calculation of costs involves both input quantity, such as labor hours, and the unit price of input, such as hourly wages. Input quantities are typically collected from field trials, while the input prices are usually obtained from suppliers of inputs or farmers purchasing those inputs.

Finally, the calculation of changes in revenues considers market prices, yield, and product quality. Market price data for many crops can be obtained from the United States

Department of Agriculture Agricultural Marketing Service (USDA-AMS) website. Prices can vary significantly over the season. The multiplication of weekly prices by corresponding weekly yields can be used to calculate weekly revenues, which could then be summed up over the season for comparisons across treatments. Data on yield and input use are typically collected from field trials conducted by research institutions. For instance, in Cao et al. (2019), yield data were collected from a UF/IFAS trial conducted in the fall of 2013, while product quality was based on the grading results. However, obtaining precise measurements can sometimes be challenging, which presents an opportunity for further research in this area.

## Summary

This article outlines the general framework and key concepts of the partial budgeting method. While our focus has been on pest management, it is important to recognize that the method is versatile and can be applied in various agricultural production contexts. For example, it could be used to evaluate the profitability of adopting a new crop variety or using a new nutrient management practice.

In the next article, we will present a case of nematode management in Florida tomato production to illustrate how to apply this tool. Given the increasing awareness of environmental concerns, our third article will focus on the environmental implications of pest management practices.

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