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Partial Budget Analysis for On-Farm Potato Research

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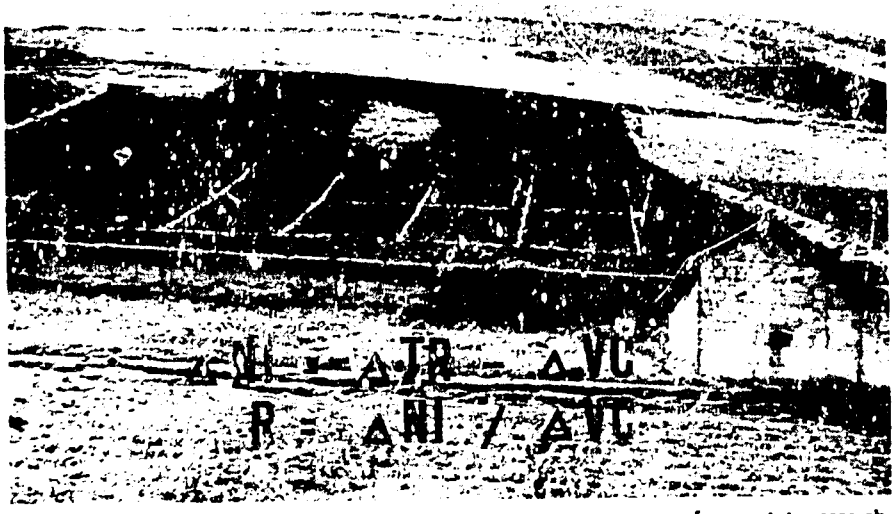

on-farm potato research

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Partial Budget Analysis for On-Farm Potato Research

Objectives. Study of this bulletin should enable you to:

- discuss application of partial budget analysis,
- identify types of data required,
- explain the partial budget approach,
- carry out partial budget analysis and draw conclusions.

Study materials.

- Examples of limiting factors in local potato production.
- Suggestions of alternative technologies to overcome these limiting factors.
- Local prices to calculate costs of alternative technologies.

Practicum.

- Calculate costs of some simple alternative technologies which may be promising in your region.

Questionnaire.

1. What is the objective of *farm budgeting*?
2. Apart of costs and returns, what other factors are involved in farmer's decision making?
3. Why is the partial budget approach called *partial*?
4. Aside from partial budget analysis, what other considerations should be used in developing recommendations for farmers?
5. What are *variable costs*?
6. Define *change in net income* (ΔNI).
7. Define and explain *rate of return* (R).
8. What are three important criteria in partial budget analysis?
9. How should cost and return data for partial budget analysis be expressed?
10. How should interest rate on capital be determined?

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Partial Budget Analysis for On-Farm Potato Research

1 Introduction.
2 Application of partial budget analysis (PBA).
3 Example: potato seed technology.
4 Partial budget approach.
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7 Additional reading.

1 INTRODUCTION

Agricultural growth requires continuous improvement of crop production technology at the farm level. Agricultural research and extension help develop and transfer appropriate new technologies to farmers. Some new technologies developed on experiment stations are not adopted by farmers because of lack of economic advantage over current production methods.

Partial budget analysis (PBA) provides useful information for making decisions in the potato research-extension-adoption process, but decisions should be based also on good knowledge of potato technology and local farming systems.

2 APPLICATION OF PARTIAL BUDGET ANALYSIS (PBA)

When a farmer decides on a change in his production system – buying improved seed, growing a new variety, using more, or less, fertilizer – he usually thinks of the economics involved and does an exercise called *farm budgeting*. The actual budgeting may be done only in the farmer's head or, for more complex decisions, items may be written down on paper following a formal budgeting procedure. In either case, the farmer tries to judge the impact his decision will have on:

- input use and costs, on one hand, and
- returns, on the other.

He will also consider such factors as seasonal availability of labor, cash flow and the risks of changing his time-tested production practices.

Partial budget analysis can be used for comparing the impact of a technological change on farm costs and returns. This budgeting approach is called *partial* because it does not include all production costs, but only those which change or vary between the farmer's current production practices and the proposed one(s). PBA allows us to assess the impact of a change in the production system on a farmer's net income without knowing all his costs of production.

Partial budget analysis is useful at each stage in the research-transfer-adoption process. First, it can help researchers focus attention on problematic aspects of technologies they are developing, where costs need to be cut or returns increased. Later, it can help extensionists develop sound recommendations with a high potential for adoption. Finally, it can help farmers improve their decision making.

The following example which is based on actual results of farm-level trials illustrates the application of PBA.

Precaution. It may be risky to recommend a new technology to farmers only on the basis of one or a few successful on-farm trials. Wherever possible, on-farm trials should be continued over several years, and careful evaluation of farmer acceptance or rejection of the technology should be undertaken.

Even when a technology looks promising on a wider practical scale, it may still not be adopted by farmers, for example, because there is no reliable supply of a recommended input, or because credit is not available when needed. Factors such as these need to be taken into account in planning on-farm research and in the interpretation of PBA results. An obvious, but often forgotten, rule is that only readily available inputs should be recommended to farmers.

3 EXAMPLE: POTATO SEED TECHNOLOGY

A potato farmer has to decide whether to use his own seed tubers, or to buy recommended, *improved seed.* The recommended seed potatoes are expensive. In addition, the improved seed is, on average, larger in size than the farmer's own seed. Thus, use of improved seed increases both the seed price and the seed quantity.

The farmer wants his potato crop to be high-yielding. But his main concern is income. So, in deciding whether or not to purchase the recommended seed he wants to know:

- will the recommended seed technology increase his net income? and, if so,
- by how much?

An on-farm trial was set up to evaluate the recommended seed, as compared with the farmer's own seed. The quantities and prices used in this example are the actual figures of this on-farm trial. Quantities and prices of seed tubers and harvested potatoes are given in Table 1. For convenience, a theoretical monetary unit (MU) is used.

Seed rate. The farmer's own seed rate was 1 500 kg/ha compared with a recommended seed rate of 2 000 kg/ha improved seed. (Standardization of the seed rate to 2 000 kg – that of the recommended seed – would have modified the *farmer's own seed technology*). So the trial, in fact, evaluates a simple *technological package* made up of seed quality and seed rate.

Seed price. The farmer's own seed does not have a direct cost to him in money, but it is still valuable, since he could have eaten it or sold it. In this case he estimates that he could have sold these potatoes for 0.10 MU per kg. At 0.15 MU per kg, the improved seed was considerably more expensive.

Seed cost. Seed cost is the result of seed rate x seed price. Because of increased seed rate and seed price, seed cost of the recommended seed technology is twice (300 MU/ha) as that of farmer's seed technology.

Table 1. Quantities and prices of seed tubers and harvested potatoes of the example.

	farmer's seed technology (a)	recommended seed technology (b)
inputs		
1 seed rate (kg/ha)	1 500	2 000
2 seed price (MU/kg)	0.10	0.15
3 seed cost (MU/ha) = = seed rate x seed price (= 1 x 2)	150	300
4 interest rate per 4 month cultivation period (%)	10	10 *
5 capital cost (MU/ha) = = seed cost x interest rate (= 3 x 4)	15	30
6 variable costs (MU/ha) = = seed cost + capital cost (= 3 + 5)	165	330
returns		
7 yield (t/ha)	10	20
8 harvest price (MU/t)	100	100
9 Total return (MU/ha) = = yield x harvest price (= 7 x 8)	1 000	2 000

* Interest rate per year = 30 %

Capital cost. If the farmer buys seed, he needs money (capital), and if he uses his own seed he forgoes income by not selling it. Capital has a cost which depends on two factors:

- the annual interest rate and
- the period over which capital is used.

This is true whether the source of capital is credit or the farmer's own resources. In this example, the interest rate is estimated to be 30 % per year and capital is used over a cultivation period of four months (1/3 of the year). So, for the cultivation period the cost of capital is 10 % the investment (1/3 of 30 %).

Variable costs. PBA considers only those costs which change or vary between the alternative practices. In the example they include only seed cost and capital cost. Thus variable costs are 165 MU/ha for farmer's seed technology and 330 MU/ha for the recommended seed technology.

Yield. The farmer's seed produced a yield of 10 tons of potatoes per hectare; the improved seed produced 20 tons per hectare.

Price of potatoes harvested. The quality of tubers harvested from both seed sources was similar. The farmer may have sold half the crop for a price of 100 MU per ton and kept the other half for home consumption. Nevertheless, we assume that the part he kept also was worth 100 MU per ton.

Total return. The agronomic success of the improved seed technology was clearly evident – it doubled yield and returns – but we are still not sure which of the two seed sources produced a higher net income, since the improved seed technology was considerably more expensive (higher seed price and higher seed rate).

The before mentioned questions are still open:

- Did the application of the recommended seed technology increase the farmer's net income?
- If so, by how much?

In this example, the farmer's cost (variable costs) increase by 165 MU and his returns (total returns) by 1 000, (Table 1), thus resulting in an increase in net income of 835 MU. This implies that for each additional MU spent on improved seed technology the additional return was 5.1 MU (835 MU divided by 165 MU = 5.1). With these results, the farmer should be highly motivated to buy improved seed.

Before analyzing these results in more detail, the partial budget approach and its data requirements will be explained more fully.

4 PARTIAL BUDGET APPROACH

This section outlines the formal logic of PBA, using symbols and formulae. Some readers may find this treatment of the subject too technical, but covering the material will be useful for correct application of the approach.

For more convenient expression of economic concepts and relationships, the following abbreviations of terms are used:

NI = net income,
TR = total return,
TC = total costs,
FC = fixed costs,
VC = variable costs,
Δ = change in any of the above, for example
ΔNI = change in net income,
R = rate of return

For the sake of simplicity, we assume that the main objective of a potato grower is to maximize the net income derived from his crop.

Net income (NI), generated by a potato crop, is the amount of money which is left when total costs (TC) are subtracted from the total return (TR):

$$NI = TR - TC. \qquad (4.1)$$

Total returns (TR) correspond to the value of harvested potatoes.

Total costs (TC) include the costs of all inputs, such as seed potatoes, fertilizer, pesticides, labor and capital.

For purposes of PBA, total costs can be separated into two groups: fixed costs (FC) and variable costs (VC):

$$TC = FC + VC. \qquad (4.2)$$

Fixed costs (FC). When a new technology is compared against a farmer's present technology, fixed costs (FC) are those that *do not vary* between the two technologies. For example, in an experiment that compared different potato seed qualities (as the example), costs for fertilizer, tillage and weeding are the same.

Variable costs (VC), on the other hand, are those that *do vary* between the technologies being evaluated. In the example, the variable costs are those associated with the two seed technologies being evaluated (seed cost and capital cost).

Combining formulae 4.1 and 4.2 results in the following:

$$NI = TR - (FC + VC) \qquad (4.3)$$

Change in net income (ΔNI). In deciding whether or not to adopt a new technology, a farmer wants to know if it will increase his net income. The increase of change in net income (ΔNI) is the difference between the change in total returns (ΔTR) and the change in fixed costs (ΔFC) and variable costs (ΔVC), according to formula 4.3:

$$\Delta NI = \Delta TR - (\Delta FC + \Delta VC). \qquad (4.4)$$

Fixed costs are, by definition, the same for both technologies:

$$\Delta FC = 0.$$

Thus formula 4.4 can be simplified to:

$$\Delta NI = \Delta TR - \Delta VC. \qquad (4.5)$$

By application of a new technology a farmer expects an increase in net income.

Rate of return (R). In addition to change in net income, another criterion, the rate of return (R) is useful for evaluating the economics of adopting a new technology. R measures the increase in net income (ΔNI) which is generated by each additional unit of expenditure (ΔVC):

$$R = \Delta NI/\Delta VC. \qquad (4.6)$$

In other words, R measures the net return on additional capital invested in a new technology, compared to the farmer's present one. If the new technology costs less than the farmer's present technology, it is not necessary to calculate the rate of return (R). If the alternative technology is more costly, the rate of return (R) must be

- higher than those of other possible investments, and
- high enough to cover risks associated with adoption.

As a general rule, we are not optimistic about the adoption of a new potato technology unless it has a minimum rate of return (R) of 1.0. This means, in our on-farm research we look for a rate of return which is at least 100 % above the change in variable costs (ΔVC).

Criteria for partial budget analysis. To summarize, in the partial budget analysis three criteria can be applied:

- If net income remains the same or decreases the new technology should be rejected because it is not more profitable than the farmer's present technology.
- If net income increases and variable costs remain the same or decrease, the new technology should be accepted because it is clearly more profitable than the farmer's technology.
- If both net income and variable costs increase, the rate of return (R) should be looked at. The greater the increase in net income and the higher rate of return, the more economically attractive an alternative technology is. The new technology should be accepted only if its rate of return is higher than 1.0.

5 DATA REQUIRED FOR PARTIAL BUDGET ANALYSIS

Partial budget analysis is simple in principle, but collecting necessary data may not be easy. Using poor data may lead to wrong conclusions.

The following data are required for PBA:

- quantities of inputs which vary between alternative technologies,
- prices of these variable inputs,
- yields resulting from the two technologies (the farmer's and the new one)
- prices of harvested potatoes.

All data should be expressed on a *per hectare* basis. Relevant are the *farm-gate* prices which the farmer pays for inputs or receives for his harvest (out-put). Thus, all input prices should include transport costs to the farmer's place. If potatoes are sold off the farm, transport costs to market should be subtracted from the market price to arrive at a new farm-gate price.

If an alternative technology affects the quality of the harvested potatoes (e.g., better control of nematodes may improve market value of tubers) different market prices should be applied for the different qualities. The same is applicable when different qualities of inputs are utilized (e.g., in the example, the recommended seed costs more than the farmer's seed). Prices for the different qualities should correspond to actual market values.

In addition to the variable costs of such inputs as pesticides, fertilizer, and labor, PBA also accounts for the cost of capital used. The interest rate on capital should be the interest rate that the farmer actually pays for a loan, (including service charges and related costs) or the prevailing market rate (the *opportunity cost* for use of his own capital).

6 CALCULATION EXAMPLE

In Table 1, the recommended technology (b) increased yield by 10 tons per hectare over the farmer's technology (a). At a price of 100 MU/t this corresponds to an increase in total return (ΔTR) of 1 000 MU per hectare.

Due to the increased seed price (seed rate and associated capital cost) the variable costs also increased by 165 MU. To decide whether the alternative technology increases net income the two formulae 4.5 and 4.6 of section 4 are used.

Calculation of rate of return and variable costs are presented in Table 2. Refer also to Table 1.

Result. The result of partial budget analysis for the example is:

change in total return (ΔTR)	(Table 2)		1 000 MU
change in variable costs (ΔVC)	(Table 2)	150 + 15	165 MU
change in net income (ΔNI)	(form. 4.5)	1 000 − 165	**835 MU**
rate of return (R)	(form. 4.6)	835 / 165	**5.1**

Conclusions. The change in net income amounts to +835 MU. The rate of return is 5.1, which means that the rate of return is 510 % above the cost for additional investments (ΔVC). This turns out to be very high in comparison to the farmer's other investment opportunities. Hence, use of improved seed technology can be considered to have an economic advantage over use of the farmer's own seed technology. It seems quite likely that this technology would be adopted, in spite of its relatively high cost.

Table 2. Return and variable costs of the example.

	farmer's seed technology (a)	recommended seed technology (b)	change (b-a)
Total return (TR) TR = yield x harvest price	TR = 10 t x 100 MU/t = 1 000 MU	TR = 20 t x 100 MU/t = 2 000 MU	**+ 1 000 MU**
Variable costs (VC) SC* = seed rate x seed price	SC = 1 500 kg x 0.10 MU/kg = 150 MU	SC = 2 000 kg x 0.15 MU/kg = 300 MU	+ 150 MU
CC* = SC x interest rate	CC = 150 MU x 10 % = 15 MU	CC = 300 MU x 10 % = 30 MU	+ 15 MU
Total VC			+ **165 MU**

* SC = seed cost; CC = capital cost

7 ADDITIONAL READING

Castle, E.N. and M.H. Beeker. 1972. Farm business management: the decision making process. Mac Millan and Co., New York.

Cortbaoui, R. and R.H. Booth. 1980. On-farm evaluation of seed stores. Social Science Department Training Documents 7. International Potato Center, Lima, Peru. 10 pp.

International Potato Center. 1978. Optimizing potato productivity in developing countries. Planning Conference Report. International Potato Center, Lima, Peru. 172 pp.

Monares, A. 1980. Análisis económico de la producción y uso de semilla de papa. Documentos de Entrenamiento 4, Departamento de Ciencias Sociales. Centro Internacional de la Papa, Lima, Perú. 9 pp.

Perrin, R.K. et al. 1976. From agronomic data to farmer recommendations. An economics training manual. Centro Internacional de Mejoramiento de Maíz y Trigo, México D.F., México. 51 pp.

Stanton, B.F. 1973. Farm budgeting for project analysis. Economic Development Institute. International Bank for Reconstruction and Development, New York, USA. 139 pp.

NOTES

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Technical Information Bulletin — Evaluation.

CIP's Technical Information Bulletins contain relevant information for potato production and research. Although written for intermediate professional levels, most of the information is easily adaptable to the farmers' level. It may be utilized in:

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