ECONOMIC ANALYSIS FOR POST-HARVEST TECHNOLOGY

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INTRODUCTION

Economic analysis of the post-harvest systems in most developing countries has not been as intensive or extensive as in crop production. Most post-harvest (PH) economic analysis has been limited to macro studies of loss estimation. This has a limited role but is not by itself helpful in evaluating location specific PH problems or in evaluation new PH technology. Economic analysis is important in the development and evaluation of new PH technology because the user of that new technology, i.e. farmer or small-scale processor, uses the technology to achieve specific socio-economic objectives, i.e. better income, more and better food, more economic resource use. Therefore, economics studies of PH technology, whether it is done by economists or technical scientists, should provide the intended user of the technology with preliminary results of the potential economic benefits from investing in and using the technology.

PH TECHNOLOGY PROBLEM IDENTIFICATION

Economic analysis is important in PH even before the technology is developed. In his research plan, the scientist must first decide what is his PH research strategy: i.e. commodity based (rice, oilseeds, legumes); technology based (dryer, thresher, storage); or user based (farmer, rural processor, transporter, retailer). Once this is decided, the scientist must identify and evaluate both technically and economically the PH problems. Depending on the research strategy selected, the economic study of the problems will be somewhat different. For example,

(i) if commodity based:
- What are values of both quantitative and qualitative losses in the major points of the commodity PH system?
- What is the value added resulting from different processes in the PH system?
- Does the market recognize and pay for different levels or standards of quality for processed crops? What are the price discounts for different grades?
- What are the seasonal and locational differences for unprocessed and processed crops?
- What are the economic values for alternative uses of processed crop by-products? How does these values compare to value of the main processed crops.

(ii) if technology based:
- What are the costs and benefits of different existing methods of a specific process?
- What are costs and benefits of different scales of a technology for a specific process?
- What are the relative costs and benefits of the technology for processing different crops?
- What are the costs and benefits of processing crops of different grades?
- How many customers does it serve? Does its market require batch i.e. custom or continuous operations?
- Is it operated by one farmer, one processor, cooperative?
- What specialized technical and management labour requirements (and costs) does it demand?
- Does it have high or low fixed and variable costs?

(iii) if user based:
- What are the range of crops, and relative quantities for any specific processing? What are the location specific grades and prices?
- What are the relative market prices for different processed crops?
- At the time required for processing, what are the alternative benefits or opportunity costs for the investment - fixed or variable costs required for processing?
- For any specific user, how does the use of a PH technology affect his cash-flow and his demand for labour?
- Is the processor one or many or one of a few, i.e. is he a price "taker" or price "setter"?

Key Points:

1. Characterize your benefits into either
   (i) input into farming system
   or
   (ii) Value Added Activity.

2. If the nature of benefit is a value added activity, what additional marketing costs must the farmer incur to achieve the benefit?

The above socio-economic information has two uses:

1. Deciding on priorities for PH technology research by using the information on estimated benefits from - loss reduction, improved quality, improved efficiency, and identifying what group would benefit.

2. Placing parameters on technology design by using the information on - benefits from loss reduction and/or improved quality, benefits from different size of operation, benefits from processing alternative crop and costs to process raw crops of different grades, and constraints or limitations to cash and labour.

This data is not useful for evaluating new technology developed through research. As will be explained later, economic evaluations of new technology is not a "before or after" question, but is a "with and without" question.

EVALUATION OF NEW PH TECHNOLOGY

Economics can assist in technology evaluation by comparing:

1. costs and benefits of alternative designs of new technology, and
2. comparing costs and benefits of a new technology with the traditional practice.
(a) What level of technical efficiency (how much technical output)?

In the development of new technology, be it PH or any other, one "rule" usually applies - "maximizing technical efficiency does not maximize economic benefit. The point of maximum technical efficiency means the marginal rate of increase of technical efficiency is zero and that the average rate of increase in technical efficiency is positive but declining. The optimum economic level of efficient operations is when the marginal benefits from improved technical efficiency equal the marginal costs of achieving that level of efficiency. In other words, when the productivity ratio \( \frac{AY}{AX} = \) the inverse price ratio \( \frac{PX}{PY} \) in this and the following two examples;

\*  \( AY = \) change in output  
   \( AX = \) change in input  
   \( PY = \) unit price of output  
   \( PX = \) unit price of input.

Rearrange the equation so that \( AY \cdot PY = AX \cdot PX \). This applies analysis on the use of variable inputs i.e. fuel for a dryer, labour and fuel for a rice mill or groundnut decorticator. It ignores the level of fixed costs as these do not affect variable input use.

(b) How to produce technical efficiency or output (input use)?

Inputs combine in 3 ways

(i) fixed proportions: A thresher and a man. A thresher without a man will not affect level of threshing done.

(ii) constant rate: Male or female labour; electricity or diesel.

(iii) decreasing rates of substitution: Sun-drying and artificial drying.

The ratio of \( \frac{AX_2}{AX_1} \) is a technical relationship known as the marginal rate of substitution at which \( X_1 \) substitutes for \( X_2 \) for a given level of technical output. This rate alone cannot be used to make a decision; prices are needed. The economic choice indicator for input-output decisions is:

\* (Adapted from: "Asian Cropping Systems Research - Microeconomic Evaluation Procedures" by Dr G R Banta, IDRC, 1982)
\[ \frac{AX_2}{AX_1} = \frac{PX_1}{PX_2} \]

Rearrange equation

\[ AX_2P_2 = AX_1PX_1 \]

[reduced costs] = [added costs]

When the MRTS is constant, the equation will tell which input to use, and if decreasing MRTS, what level of combined inputs minimizes costs to produce a given level of output.

(c) What to process, i.e. what combination of output?

For many PH technologies, different crops can be processed but not at the same time and the technology processes different crops at different rates of technical efficiency. If more \( Y_1 \) is processed, less \( Y_2 \) is processed, i.e. \( AY_2/AY_1 \) = marginal rates of product transformation (MRPT). The economic optimum level of \( Y_2 \) and \( Y_1 \) processing is when \( AY_2PY_2 = AY_1PY_1 \) [reduced returns] = [added returns].

**NOTE:** If MRPT constant, equation tells you what crop to process.
If MRPT decreasing, equation tells you what combination of crops to process.

Once a technology is designed by considering - what level of technical efficiency, what combination of inputs and what combination of crops to process; it must be evaluated with regards to specific criteria i.e. returns to labour, returns to capital, profit and finally it must be evaluated against the existing processing method.

**ECONOMIC INDICATORS**

(1) Productivity (or Value of Production) per unit of major input: i.e. output per unit of capital/labour/energy etc. These indicators measure efficiency in terms of resource utilization. They measure relationships of one input to one output but ignore quality and quantity of other inputs (assumed constant).
(2) Amount (or cost) of input per unit of output: i.e. Rs/kg, man-hours/kg, energy/kg. These measure capital intensity, labour intensity and energy intensity respectively. Again, these ignore quantity and quality of other inputs.

(3) **Profit:** Revenues - Costs.

(4) **Payback Period:** number of years required to pay back investment.

(5) **Breakeven Analysis:** the level of price or production at which the technology covers total costs.

**METHODOLOGY FOR EVALUATION OF NEW PH TECHNOLOGY**

**Rule to remember:** Demonstration alone is not research!!

**Step 1:** Initial site description of PH technology/system analysis and problem identification and selection of priorities (before technology design) based on technical and economic assessment of potential costs/benefits.

**Step 2:** Selection of existing alternative (to existing PH technology) technology or design of new technology. Keeping in mind technology and economic resource availabilities in the existing PH system.

**Step 3:** Researcher-managed experimental station evaluation of technology and economic performance.

**Step 4:** Researcher-managed on-site evaluation of technology and economic performance. This is the most difficult aspect. It is expensive but necessary. It must be scientific in its experimental design i.e. a control, treatments and use standard statistical analysis and economic analysis. It must compare on-site researcher-managed trial results with researcher-managed experimental station results and with existing user technology.
There are two key issues here:

1. What is difference and reason for difference between researcher station and on-site results, and between researcher and user on-site results?

2. What is the net benefit of new technology - on site compared to existing system. Here one can use Partial Budget Analysis, i.e. need to identify:

   (a) What costs will be increased?   ) COSTS
   (b) What income will be foregone?  ) COSTS
   (c) What costs will be reduced?    ) BENEFITS
   (d) What income will be increased? ) BENEFITS

Add (c+d) minus (a+b) = Net Incremental Benefit!
Is it positive or negative?

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