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OPTIMIZING POTATO PRODUCTIVITY
EVALUATING AND UTILIZING RESULTS OF ON-FARM TRIALS

Roger T. Cortbaoui

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INTERNATIONAL POTATO CENTER
Aptdo. 5969 *Lima-Peru*

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R. Cortbaoui**

I. Introduction

In CIP's approach for optimizing potato productivity (OPP), an alternative technology (selected for its potential for improving yields and/or incomes) is tested in farmers' fields in comparison with the farmer's current practice. This testing is conducted at several sites within the target area, in collaboration with several farmers belonging to the target group of on-farm research.

This training document deals with the "segment" of the research process that follows the on-farm testing. It outlines a procedure for the utilization of the information accumulated during one cycle of on-farm research.

This information can be grouped as follows:

a. Agronomic results related to the physical performance of the alternative technology in contrast with the farmer's current practice. They consist mainly in differences in yields and/or quality of the production.

b. Economic results related to costs and returns of the alternative technology in comparison with those of the farmer's current practice.

c. A series of non-quantifiable information concerning the reactions of the farmer to the alternative tested and his views on the possibilities of incorporating the proposed changes into the present crop production system.

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* This paper forms part of a series of training documents related to CIP's approach to Optimizing Potato Productivity. This document, therefore, deals with the evaluation and utilization of results of on-farm trials. Other steps of the OPP strategy are detailed in other training documents.

** Production Specialist at the International Potato Center.

Analysis is based on data and information recorded for each of the experimental sites and eventually for each of the alternatives tested. It will be conducted:

- On a case-by-case basis, evaluating performance of the alternative in each trial.

- On an overall basis, evaluating performance of the alternative across the various test sites.

II. Case-by-Case Analysis of the Trials

For each trial the following questions need to be answered:

a. Did the alternative produce the expected quantitative and/or qualitative improvements in production, compared to what the farmer is currently obtaining? If so, how great were these improvements?

b. Can the alternative increase net farm returns? In other words how big is the change in net returns made possible by the alternative in relation to the change in cost necessary for its adoption?

c. How was the alternative perceived by the farmer? Does it address a problem that he considers to be important? Does its adoption appear to be possible taking in consideration his farming system and the availability of inputs, labor and capital? Are there any sociocultural impediments (obstacles) for this adoption?

The first question is answered relatively easily by comparing physical yields both in quantity and quality. The qualitative criteria used need to be carefully determined so as to allow meaningful comparisons between the different experimental sites included in the testing process. Besides the quality of the production per se, these criteria could relate to agronomic characteristics such as rapidity of emergence, earliness in maturity....

The second question is answered by partial budget analysis of each of the trials.* This is done by calculating:

- The change in production costs incurred while replacing the farmer's technology by the proposed alternative.

- The change in net income that the alternative generates.

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* For more information cf. D. Horton "Partial Budget Analysis for On-Farm Potato Trials," Social Science Department, Training Document 1980-8.

These two figures will be used to determine the rate of return on any additional resources necessary for the application of the alternative technology.

Answering the third question requires information on the socio-cultural characteristics of the target area, gathered through the informal survey and complemented by discussions with the farmer collaborator throughout the on-farm research process.*

The three groups of questions mentioned above should be answered at the end of each cycle of the on-farm research process. Generally clear cut conclusions cannot be made after one single cycle of testing. Extra testing cycles will help clarify the answers by exposing the alternative technology to the farmers' conditions and judgement under different climatic and economic circumstances. At the same time alterations of the proposed alternative will be made from one cycle to another in order to improve its adequacy to the problem it is meant to solve.

Utilizing the results of each trial, the researcher will attempt to draw overall conclusions concerning the performance of his proposed technology across the various experimental sites. The following section outlines a procedure to "pull together" the various answers in order to draw conclusions on the value of the proposed alternative not for the single farmer collaborator but for the whole target group selected.

III. Overall Evaluation of a Series of Trials

The objective of this evaluation is to judge the performance of the proposed technology across the different sites utilizing the case-by-case analysis outlined in the preceeding section. It can be divided in two sections:

- Agroeconomic Evaluation
- Farmer Evaluation

1. Agroeconomic Evaluation

The overall agroeconomic evaluation can be done by fixing a minimum improvement (quantitative or qualitative) in yield and a minimum rate of return that the proposed technology should achieve in comparison with the

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* For more information cf. R. Rhoades: "Understanding Small Farmers: Sociocultural Perspectives on Experimental Farm Trials," Social Science Department Training Document 1982-3.

farmer's current practice. Once these minima fixed, the scientist will score the number of trials where:

a. the minimum improvement in production has been achieved,

b. the minimum rate of return has been attained,

c. the two above mentioned minima have been attained simultaneously.

This scoring will allow the scientist to appraise the stability of performance of the proposed technology throughout the different experimental sites. Because of heterogeneity of yields and costs of the farmers' present practice (to which those of the alternative technology are being compared) the scientist can seldomly expect clear cut results of the comparison. In very few cases will the scientist obtain one hundred percent positive (or negative) scoring for the proposed alternative. Nevertheless this scoring exercise will certainly indicate the pattern of performance of the technology being tested. For example a 70% positive scoring is a clear indication of the potential carried by the technology and should encourage the scientist to re-examine those cases where the technology did not follow the general pattern in order to determine the reasons for the "failure" of the technology. These reasons might help refine the technology or re-define the target group for future on-farm research.

On the other hand and since not all alternatives will produce simultaneously the required improvement in yield and the desired rate of return, the scoring described above will help determine whether the technology tested:

- improves yields but is not profitable under the present circumstance, or,

- increases profit, through cost reduction, without affecting significantly the physical yield, or

- improves both production and profits.

The calculated rate of return should not be considered as the <u>only</u> indicator of acceptability of a proposed alternative: a technology with a high rate of return may not be acceptable to farmers because it requires a large increase in cash inputs, generates only a small increase in farm income, increases risks or is socially unacceptable to the producer.

Our experience with the overall agroeconomic evaluation of on-farm trials shows that it is difficult to establish clear-cut criteria for determining the minimum improvement in yields and the minimum rate of return that a technology should achieve, during the testing process, in order to be considered potentially acceptable to producers. These minima

will vary over locations and technologies but should reflect what is locally acceptable taking into account actual yield levels, precision of data gathering during the trial phase, rates of interest and inflation, existing investment opportunities and risk associated with the adoption of the new technology. In most cases it is advisable to perform the scoring using two (or more) levels for these minima, thus performing a "sensitivity analysis" of the proposed technology.

2. Farmer Evaluation

Pulling together the opinions of farmers collaborators (or their neighbors) concerning the alternative technology tested, is less mechanical than the agroeconomic evaluation. Here again the scientist will be looking for general patterns in reactions and judgements. Each farmer judges the proposed technology from his very personal point of view and probably based on the more recent production problems that he faced. As for the figures on yields costs and returns used in the previous section, the pool of opinions expressed by farmers should be firstly considered as reactions at a "given time" and following a given set of circumstances. The time dimension is an important element of the evaluation and should consequently be reflected by the overall analysis of the different individual evaluations expressed by collaborators.

From all this diffuse, personalised and time frozen information, the scientist will extract elements of answers to a series of questions related to the potential acceptability of the proposed alternative in the target area. These questions will vary between technologies and sites but in most cases they will consist in finding out:

a. Whether the farmer understands the trial and believes it addresses a problem he considers to be important?

b. Whether the technology conflicts with other activities in the present farming system?

c. How important is the risk inherent to its adoption?

d. If the inputs required for its adoption are easily and readily available to the producers (physical inputs, labor, credit,...)

e. Whether the technology or its products conflict with the preferences, customs or beliefs of the target group?

Unlike the overall agroeconomic evaluation, it is not possible to score positive or negative answers to the preceeding questions. In other words the farmer evaluation will not be expressed in percentages and numbers but in general patterns extracted from the information gathered during the informal survey and complemented by discussions with the collaborators throughout the on-farm testing phase.

IV. Utilizing Results of On-Farm Trials

Ideally, a series of on-farm trials, comparing a given alternative to the present crop production system of a target group in a target area, should lead to the confirmation or rejection of the potentialities of the alternative as a way of improving yields and incomes.

Technologies passing the three evaluations described above do certainly represent a potential solution for the production problem under study. But it should be stressed that these evaluations represent only part of the complex decision making process of a farming community. In other words, a positive evaluation does not necessarily mean automatic adoption. Nevertheless, those technologies selected through the on-farm testing process can be passed to the diffusion channels (demonstrations, extension programs, ...) with better prospects of adoption than those who come directly from the experimental stations to the diffusion channels.

From another point of view it must be stressed that one single cycle of on-farm testing is seldomly sufficient for the confirmation or rejection of an alternative production technology. This is especially true in situations where on-farm research is relatively new and where production specialists and social scientists have limited experience with the area under study.

This shows the second utilization of results of a series of on-farm trials: they constitute an excellent opportunity for refinement of knowledge that the scientist has of a given area and the crop related problems. This refinement will lead to a better definition of problems and consequently to a better selection of potential solutions to be tested.

The third utilization deals with feedback to the research agencies. This feedback might relate to production problems encountered during on-farm research and for which no practical solution has been found so far. Thus on-farm research could play a role in generation of production technologies aimed at solving actual problems. One other aspect of the feedback deals with those technologies which could solve a given problem but which for some socioeconomic reason have little prospect of adoption. On-farm testing of these technologies will help indicate the improvements that might be needed to adapt these potential solution to the specific situations encountered. Here again on-farm research can be a stimulator for experimental station research geared to solving farmers' problems.

In summary, results of on-farm trials may be used:

a. To confirm or reject the potential of an alternative technology for solving a production problem in the target area, thus allowing a better selection of technologies to channel to the diffusion and extension systems.

b. To improve the efficiency of future on-farm research through better understanding of problems and socioeconomic conditions of the target area.

c. To stimulate research for solving unforseen problems or for adapting existing solutions to special socioeconomic environments.

V. Conclusion

The procedures outlined above must be considered as one possible way of analyzing and utilizing results of on-farm trials. They are mainly based on "common sense" and do certainly have their own limitations. Nevertheless, our experience shows that these procedures constitute a valuable tool for drawing conclusions from on-farm trials, this mainly because of their simplicity and closeness to the farmer's way of thinking. Needless to say that these procedures do not simulate the complex decision making process of a farmer, which means that technologies selected by these procedures will not necessarily be adopted by farmers. Their selection means that they carry a good potential for adoption which makes them eligible for transfer to the diffusion channels available.

VI. Example

In this example we analyze the results of the trials described in R. Cortbaoui "Planning and Implementing on-farm Trials." (Social Science Department Training Document 1982-1).

These trials consisted in comparing seed produced by a national seed program to that of the same variety normally utilized by farmers. Two target groups were identified: (a) farmers possessing a tube well (group I), and (b) farmers depending only on public irrigation (group II).

The economic analysis of these trials was done following the first example given in D. Horton "Partial Budget Analysis for On-Farm Potato Trials." Social Science Department Training Document 1980-8.

1. Background Information

A small valley situated within an irrigation development project area was selected for on-farm potato research. The potato program and the extension service of the Ministry of Agriculture were given the mandate to select and extend improved potato technology for the valley.

From a quick informal survey supplemented by interviews with extension agents and credit cooperative managers we have selected the following information because of its relevance to the example:

a. Potatoes are grown in the valley in two seasons:

- Planting March/harvest in June, using imported certified seed.
- Planting early September/harvest in December, using seed saved from the preceeding crop.

b. The two groups are irrigated (except the few weeks in March and November when rainfall is sufficient). The farmers have strong ties with the market (90% of the crop is sold in urban markets) and with the credit cooperative (75% of the farmers have used credit to purchase seed and fertilizers for the preceeding campaign).

c. Farmers interviewed indicated that yields of their second crop represent about 50% of the yields of the first crop. That same second crop was limited by scarcity of public irrigation water during September and by frost in late November-December.

d. The quality of seed used in the second crop was mentioned by farmers as a limiting factor but was not perceived as something they should (or could) improve.

e. Information from the irrigation development project showed that farmers owning more than 7 hectares are installing tube wells using facilities provided by the irrigation project. Small holders and tenants were very rarely interested in digging their own wells and were exclusively depending on the public water distribution system.

A survey of the crop in late September showed insufficient emergence in the majority of the fields and lack of moisture in the soil except for a few farmers equiped with tuber wells.

Based on this information the potato program suggested that a possible way to improve productivity in the second crop would be to replace the farmer's seed with that of the multiplication program grown in a different zone, harvested early May and could be made available to the farmers through the credit cooperative. Procedures to be followed would be those established for the imported seed (sold in February).

The alternative, consisting of adding to this variable (seed source) a second one (extra irrigation in September), was discarded first because it would complicate the trial and second because the public water distribution system had few chances of providing this extra amount of water.

Nevertheless and in order to tackle this water stress problem it was decided to work with two target groups:

- large farmers who owned tube wells, and,
- small farmers depending on the public water system only.

For these two groups it was decided to keep track of the irrigation dates especially during the 4 or 5 weeks following the planting.

2. Definition of the Trials and Basic Design

The trials were to compare performance of "improved seed" and the farmers seed. As a consequence the basic experimental design consisted of two adjacent plots:

plot A: Planted with improved seed.

plot F: Planted with the farmer's seed.

All operations from planting through crop care to harvest were carried out by the farmer following his normal practice.

3. Proposed Evaluation of the Trial

The scientists proposed an alternative consisting of replacing the farmer's seed with that provided by the national program. Even if the two lots of seed belong to the same variety, they differ in several aspects:

- Different physiological age and phytosanitary status,

- Difference in size (thus the seed rates of the two plots will be different),

- Difference in price.

So, in reality, the trial was comparing two different "packages" dealing with a single production factor: seed.

The evaluation of the trial was based on:

- Rapidity and uniformity of emergence (which will probably allow a maturity before the frosts of December).

- Yields and their breakdown into the different marketing and pricing categories.

The "expression" of the package depended highly on the moisutre status of the fields during the difficult month of September. This is why the trial was directed towards two distinct target groups and the evaluation done accordingly.

Finally, because of the scarcity of water in September and frosts in November-December, the potato crop in the area carries considerable risks. Because of this risk factor a technology that requires important increases in the production costs has very few chances of success. The evaluation must take this aspect into consideration.

4. Major Results

The following tables give the calculated yields of farmer and improved seed and the estimated net rate of return on extra money spent for the adoption of the alternative.

Trial N°	Farmer Seed	Improved Seed	Net Rate of Return
	Yield (t/ha)		
		Group I	
1.1	10.3	16.3 (+)	1.31
1.2	14.6	25.8 (+)	3.32 (**)
1.3	10.6	20.9 (+)	2.73 (**)
1.4	12.6	18.2 (+)	1.03
1.5	16.7	32.1 (+)	4.58 (**)
1.6	13.6	23.2 (+)	2.47 (**)
Average	13.1	22.8	2.58
		Group II	
2.1	14.6	17.1	(*)
2.2	14.6	20.3 (+)	1.20
2.3	11.4	14.2 (+)	(*)
2.4	14.7	17.3	(*)
2.5	9.6	15.9 (+)	1.28
2.6	5.6	14.4 (+)	2.21 (**)
Average	11.8	16.5	0.76

* In these case the alternative was less profitable than the farmer's current practice (decrease in net returns).

(+) Indicate trials where the alternative outyielded the farmer's practice by 20% or more.

(**) Indicate trials where the net rate of return was bigger than 1.5

5. Agroeconomic Analysis

a. Given the yield levels in the area under study, the size of the experimental plots based on discussions with the collaborators it was decided that the alternative tested will be considered as potentially acceptable from the agronomic point of view if it yields at least twenty percent more than the farmer's seed.

b. Considering the cost of the alternative, the rates of interest and inflation, it was decided that the alternative could be considered attractive from the economic point of view if it's net rate of return was higher than 1.5 or 150%

c. The scoring of the trials where these minima were achieved gave the following:

- Number of trials where the alternative outyielded the farmer's practice by 20% or more:

  Group I: six cases out of six (all trials)

  Group II: four cases out of six (trials 2.2, 2.3, 2.5, 2.6)

- Number of trials where the alternative had a rate of return higher than 1.5 or 150%:

  Group I: four cases out of six (trials 1.2, 1.3, 1.5, 1.6)

  Group II: one case out of six (trial 2.6)

- Number of cases where the alternative outyielded the farmer's practice by 20% or more and had at the same time a rate of return higher than 1.5:

  Group I: four cases out of six (trials 1.2, 1.3, 1.5, 1.6)

  Group II: one case out of six (trial 2.6)

This can be expressed as follows:

Percentage of Cases where the Alternative was Considered Acceptable

	Group I	Group II
Agronomically	100	65
Economically	66	17
Agro-economically	66	17

d. The data on uniformity and rapidity of emergence showed that the alternative seed had an advantage over the farmer's seed only for the Group I: in which case an average of 14 days was gained for the dates of full emergence and maturity.

e. The comparison between the costs of the alternative seed and those of the farmer's seed on per hectare basis showed that the adoption of the improved seed represented an average increase of 400 and 450% in seed cost/ha respectively for group I and II. This was done by calculating the ratio of seed costs for each of the experiments and subsequently calculating the average ratio.

f. Farmers of group I gave two to three irrigations during September. The average for group II was one irrigation.

6. Farmer Evaluation

The two groups perceived clearly the advantages of the improved seed mainly because it showed numerous strong sprouts at planting but group I was the only one to perceive clearly its yield and economic potential.

Both groups expressed concern in relation to the increase in cost due to the price of the improved seed. While group II indicated clearly that this extra cost was beyond its financial capabilities, group I expressed concern about the reliability of the "credit cooperative" for distribution of improved seed. This concern was based on past (bad) experience with the distribution of the imported seed (February).

The risk of frost in late November was mentioned as a reason for minimizing production costs. Nevertheless, some farmers of group I indicated that this risk could be minimized by an earlier planting of the seed and by proper irrigation during September.

All farmers expressed interest in early maturity of the crop in order to hit the high market prices of late November. These results confirm the value of the selection of the two target groups, performed while planning the trials and based on information gathered during the initial informal survey.

7. Conclusion

From the agroeconomic analysis outlined previously it is clear that the proposed alternative carries more potentialities for those farmers who can rely on their own source of water for irrigation (Group I). Because of availability of cash for purchasing seed and because they are not facing the hazards related to the public water distribution system, farmers of group I might be willing to accept the extra investment required for use of the improved seed. Nevertheless, a decrease in the price of the improved seed or a reliable credit source would enhance the acceptability of the proposed alternative. The organization of the credit cooperative and its reliability as a seed supplier need to be reviewed unless other distribution channels are found.

Under the present circumstances (hazards due to water supply, limited credit facilities) group II cannot be considered as a potential user of the improved seed. In spite of the good quality and hypothetical potential of production of that improved seed.