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9. ABSTRACT

This is a report of an independent quantitative expert on the multivariate statistical analysis in the Development Alternatives Incorporated (DAI) study entitled: Strategies for Small Farmer Development. Each of three major research steps are reviewed: modeling and establishing hypotheses; collecting the raw data and constructing complex variables; and multivariate analysis and interpretation. For each step, the procedures followed in the original study are summarized and critical commentaries are provided. A number of questions can be raised about each of the steps in the research for the original study. Some questions are extensive because of a too limited technical input into the study and because of the tendency to overstate the significance of the results. Despite such reservations, it is concluded that the original study is quite provocative in regard to the role of local action and participation in determining project success. The intuition of the authors apparently substituted well for more systematic technical procedures. Statistical results are quite robust to the most interesting variations in variable definitions and procedures. A significant impact of local action in the determination of project success is supported although perhaps more in an intermediary role than is indicated in the original study.

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A CRITICAL EVALUATION OF QUANTITATIVE MULTIVARIATE ANALYSIS

IN

STRATEGIES FOR SMALL FARMER DEVELOPMENT

by

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September 1977

^{*} This evaluation was written at the request of AID. I have benefitted from conversations with James A. Brown, Paul Iserman, Donald G. McClelland, E.A. Owens, and H.P. Peterson of AID and with Donald R. Mickelwait, Elliott R. Morss and Roger Swenson of DAI. None of these individuals, however, are responsible for the views expressed in this report.

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ABSTRACT

This is a report of an independent outside quantitative expert on the multivariate statistical analysis in the Development Alternatives Incorporated (DAI) study entitled: Strategies for Small Farmer Development. Each of three major research steps are reviewed: (1) modeling and establishing hypotheses, (2) collecting the raw data and constructing complex variables, and (3) multivariate analysis and interpretation. For each step, the procedures followed in the original study are summarized and critical commentaries are provided .

As with any extensive empirical study, a number of questions can be raised about each of the steps in the research for the original study. Some of the implications of these questions are more extensive than might be reasonable to expect because of a too limited technical input into the study and because of the tendency to overstate the significance of the results. For example, further analysis suggests that ex ante profitability may be quite important in understanding project success and local action partially may be representing such considerations, so it may not have been appropriate to ignore or dismiss such considerations in the original study.

Despite such reservations, I also conclude that the original study is quite provocative in regard to the role of local action and participation in determining project success. The intuition of the authors usually substituted well for more systematic technical procedures. The statistical results often are quite robust to the most interesting variations in variable definitions and procedures. In particular a significant impact of local action in the determination of project success is supported albeit, perhaps more in an intermediary role than is indicated in the original study.

Further data collection and analysis should be conducted to investigate more fully the effects of local action and participation and the cost and mechanism for inducing them in rural developing projects.

A Critical Evaluation of Quantitative Multivariate Analysis
in
Strategies for Small Farmer Development

I have been asked by AID to provide an independent¹ evaluation of the multivariate quantitative analysis in the study by Development Alternatives Incorporated (DAI) entitled: Strategies for Small Farmer Development (hereafter referred to as Strategies). This report constitutes that evaluation.

The Strategies study is on a topic of great importance. It considers the "success" of projects in so far as they contribute to the development of small farmers. Primarily on the bases of multivariate regression analysis of an almost-recursive model involving "success" and "local action," it concludes that the latter is a very important determinant of the former and that a number of variables often emphasized previously are not of significance. The quantitative analysis in Strategies and the question as to what extent it supports the conclusions of the study have generated considerable controversy within AID and elsewhere. Therefore it was decided to arrange for this outside evaluation by an independent quantitative expert with experience in the area of agricultural development.

¹I was approached originally by AID to do this evaluation. After a long delay, the efforts being pursued to identify a suitable contracting mechanism fell through. Therefore it was decided to handle the budgetary aspects of funding this evaluation as part of a contract with DAI. However it was always emphasized that the funding arrangement was for the convenience of AID and was not intended to compromise in any manner my role as an independent outside evaluator.

This evaluation is organized around a set of three idealized research steps: (1) modeling and establishing hypotheses, (2) collecting the raw data and constructing complex variables, and (3) multivariate analysis and interpretation. A section is devoted to each of these steps. In each section the approach taken in Strategies first is summarized; then a commentary is provided. The final section gives concluding remarks.

Section 1. Modeling and Establishing Hypotheses

Much research in the social sciences, and particularly in economics, involves modeling. By modeling I mean the simplification or the abstraction of a phenomenon to represent its essential elements, given a particular question of interest. Modeling implies a set of hypotheses which can be tested against empirical observations to see which support is provided for the theories underlying the model.

Subsection 1.1. Modeling and Establishing Hypotheses in Strategies

The authors of Strategies reviewed the existing literature on rural development, but concluded that it was of limited use for their purposes.¹ Therefore they adopted a more inductive approach. They did not present explicit models of the behavior of small farmers and of other actors within the rural development context. Instead, they posited much looser relations between dependent variables (i.e., success and local action) and sets of variables which seemed plausible on the basis of general wisdom about rural development and their own field experience. In indicating which variables were included in the set of possible determinants, of course, they

¹In the words of Morss (6-11-74): "Considerable discretion will be used in drawing on this...source since we have found that all-too-frequently, reality does not correspond with the written word."

implicitly posited hypotheses about the rough nature of the underlying relations. Their empirical analysis then led to focus on a subset of significant variables in an inductive procedure (see Section 3 below).

Subsection 1.2. Commentary

The lack of a theoretical model underlying the analysis has been criticized (Isenman 6/10/75, Peterson 21/1/76, McClelland 10/3/75, and Tanter 8/3/76). The claim by the authors of Strategies that most existing literature provides little insight into the behavior of small farmers and of other relevant actors indeed does seem too strong. For some aspects of that behavior, there seems to be considerable empirical evidence of consistency with traditional economic analysis. Perhaps the best example is the work on peasant supply response (see Behrman 1968, Lau and Yotopoulos 1971, and Askari and Cummins 1977 and the references therein). Although similar work does not exist for all aspects of important behavior related to rural development, the authors of Strategies do overstate the paucity of prior modeling and empirical testing of behavior relevant to their study.

How might they better have proceeded? First they need to have elaborated on the nature of the goals of the donor. From the point of view of actual (or potential) donors, success presumably depends on the level and distribution of economic and noneconomic outcomes induced by the project. The level of economic benefits should be measured by the present discounted value of the past, present and future income streams generated by the project, net of costs incurred by outsiders and by participants. Noneconomic outcomes include health, nutrition, political power, etc.

For the most part in the analysis of Strategies, these noneconomic considerations implicitly are assumed to be separable from the strictly economic ones and thus are put aside. This may be a strong assumption. Some of the noneconomic results may alter significantly the strictly economic outcomes (e.g., good health and good nutrition may improve productivity, see Selowsky and Taylor 1973). Separability between economic and noneconomic benefits may have been convenient or almost necessary to keep the study of manageable size, but the authors of Strategies at least should have acknowledged explicitly that they are making this assumption.

What determines success? Succinctly, the answer is the response of individuals, families and of larger collectives or groups of individuals to their perceptions of the economic, natural, technological, social, political and institutional environment in which they operate, given their existing resources, technologies, and preferences. For individuals and families who are small farmers, there exists considerable evidence that such responses are consistent with economic maximizing behavior as is mentioned above. These responses may be not only to expected levels of outcomes, but to higher moments of their subjective probability distributions which are related to risk (although Roumasset's, 1976, careful recent study raises some questions about the degree of importance of this factor). For other collectives and institutions in such communities I am not aware of similar studies, although it seems to be thought widely that political and social power play relatively large roles in determining their responses.

Conceptually, one could precisely model the behavior of small farmers and of various collectives given their resources, preferences, and the overall environmental in which they operate. Then one could estimate the parameters of the implied structural relations and explore what would happen with various

project designs.

There is much to be said for such an approach. To the extent that theory provides guidance for specifying relations, it is generally on the level of such structural relations. For many of the relations (e.g., supply relations and production functions) moreover, a considerable number of empirical studies exist which would provide some basis for evaluating the reasonableness of the magnitudes of the estimated parameters which are obtained. Ideally, the authors of Strategies would have been much better off to have taken such an approach.

However I think that there are two good reasons why they did not do so. The first is the lack of good tested models of the determinants of some possibly important aspects of behavior related to rural development, such as those related to collective behavior and the determinants of political power and its distribution. As noted above, they overstate the lack of previous relevant tested models for rural development, but there is merit to their claim for some such aspects of behavior. The second is that the estimation of all of the relevant structural relations would have required data, computer and analytical resources beyond those available for the project.

The approach therefore adopted in Strategies can be considered to be equivalent to the implicit derivation of reduced forms from the underlying structural relations within an almost recursive framework. The framework is almost recursive in that local action is posited to be one of the possible determinants of success, but only one of the components of success (i.e., increased agricultural knowledge) is included in the eligible set of right-hand side variables for local action. The reasons for this almost recursive structure should be given, but are not. In fact if the one component of

success is dropped from the set of possible determinate for the local action variables to make a truly recursive structure, the estimates change considerably for two of the components of local action (Behrman, 1977). The other right-hand side variable included in the sets of possible determinants can be considered to reflect the nature of resource availability, the economic-political-institutional environment in which small farmers operate, and the impact of projects --all as suggested by the underlying structural relations.

The general strategy of focusing on what can be considered to be reduced forms instead of on the underlying structural relations seems warranted for the two reasons which are indicated above. The failure to be explicit about as many of the underlying relations as is possible, however, has had two costs. First, some readers have not seen that the approach taken can be considered to be the examination of reduced form relations which could be derived from such a set of underlying structural relations. Second, the authors of Strategies did not include in their analysis some possibly important considerations which probably would have occurred to them had they more explicitly thought about the underlying structural relations: ex ante expected profitability, ex ante risk,¹ dynamic aspects of project development, climatic conditions, market product and factor prices, the distribution of power and of assets, the legitimacy of authority, prestige, and status and social distance. Subsequent analysis of the Strategies data in a report which is complementary

¹The exclusion of risk in the multivariate statistical analysis is peculiar because the text of Strategies places considerable emphasis on the importance of risk.

to this one (Behrman 1977) suggests that some of these variables, in particular the ex ante profitability and risk ones, probably have significant roles in determining success directly or through local action. This result casts a somewhat different light on the claim in Strategies that previous studies tended to emphasize the wrong variables.

Section 2. Data Collection and Variable Construction

Subsection 2.1 Procedures in Strategies

First, a definition of small farmers was required. The authors established a lower limit by requiring that small farmers be cultivators of at least enough land to provide subsistence for their families. At the upper limit farmers who used different techniques than subsistence-level farmers, had substantially more capacity to bear risk than subsistence level farmers, or cultivated significantly more land than the average in the area were characterized as large farmers (Strategies, p. 21).

Next, raw data had to be obtained. Secondary sources revealed little in the way of consistent data for many important variables across case studies. Therefore original data were collected from 22 projects and 29 subprojects in Africa and 14 projects and 16 subprojects in Latin America. The criteria for selection of projects were orientation towards small farmer development and the feasibility of obtaining information. Already existing documentation offered little useful data. Censuses or surveys would have required more resources than were available for the study. Therefore the major data source was a set of individual field interviews with key informants for each project. Such informants included from 0 to 7 representatives of foreign donors, from 0 to 14 project staff

members, from 0 to 2 non project representations of the host government, and from 0 to 11 small farmer participants (plus some groups of co-op leaders and of small farmer participants). The data for a particular project represented the weighted average of responses from a variety of key respondents, with the weights developed by the judgment of the interviewers. To increase accuracy, the results of the interviews were sent back to the interviewees with a request for comments on any inaccuracies. To facilitate comparison across projects, only a few interviewers were utilized. After all of the interviews had been completed, the entire team of interviewers checked all of the variables across projects and within projects in a further effort to eliminate anomalies and to assure consistency. This process was followed both with the raw data and with the constructed variables utilized in the subsequent analysis.

Finally, the raw data were used to construct composite variables which better fit the desired underlying theoretical constructs. The key such variables are overall success and overall local action.

The overall success measure, SUCCESS (599), is an equally weighted average of four standardized¹ variables:²

¹The standardization procedure is to subtract the sample mean and to divide by the sample standard deviation. Thus the standardized variables indicate how many sample standard deviations a particular project is above or below the mean for the sample for that variable. Standardized variables are indicated by asterisks.

²These definitions are paraphrased or quoted from Strategies, pp. 243-361.

- 1) **INCOME/COST RATIO (519*)**: The ratio of total additions in constant prices received by project participants from the most important technological packages associated with the project over the period from the inception of the project to date divided by the total costs of the project paid by the sponsors.
- 2) **SELF-SUSTAINING INDEX (566*)**: An index of the likelihood that the benefits generated by the project will become self sustaining, as indicated by the ability of the project to draw upon increased income from project participants to pay for necessary services and supplies, the probability that it will be possible to maintain or expand the level of project benefits at reduced cost in the future, and the percentage of project costs paid for by domestic sources.
- 3) **AGRICULTURAL KNOWLEDGE INDEX (567*)**: An index of the agricultural practices adopted by small farmers as a result of their acquisition of new agricultural knowledge based on the number of the following eleven indicators for which a majority of the participants in the project made "significant" changes from previous agricultural practices: credit (if repaid); participation in an effective local organization; use of fertilizer as recommended; use of improved seeds; use of insecticides, herbicides or pesticides, treatment for animal diseases; use of substantially changed harvesting procedures or adoption of quality control measures for marketing; construction of on-farm infrastructive; maintenance of on-farm infrastructive; processing of agricultural produce; diversification of agricultural cash crops; expansion of land under cash crop cultivation; storage of agricultural cash crops; improved resource management (conservation, grazing, etc.).
- 4) **SELF-HELP INDEX (572*)**: An index of the increased capacity of local organization or groups to raise the income and improve the welfare of small farmers resulting from the project, as measured by the following six characteristics: creation of group decision-making capabilities; mobilization of resources from the local population under the auspices of a local group; mobilization of resources from outside the local area; provision of services by local groups; creation of new non-traditional leadership positions and specializations; and viability of local organization system.

The overall LOCAL ACTION variable (619*) also is the sum of four standardized variables, the first two of which relate to the involvement of small farmers in project decisions and the next two of which refer to small

farmer relative resource commitments.¹

- 1) INVOLVEMENT IN INITIAL PHASE (528*): Small farmer involvement in dialogue, decision making and local area project control in the idea generation and project design phases.
- 2) INVOLVEMENT IN IMPLEMENTATION (530*): Small farmer involvement in dialogue, decision-making and local area project control in the implementation phase.
- 3) LABOR COMMITMENT (606*): Ratio of additional small farmer unpaid family labor commitment required to complement the technology introduced by the project evaluated at local wage rates to the average of pre- and post-project on-farm income.
- 4) CASH COMMITMENT (608*): Ratio of small farmer additional cash commitment required by technology introduced by project (i.e., out-of-pocket or locally borrowed payments for additional market inputs evaluated at 30 percent annual interest rate plus repaid institutional credit valued at actual interest rate) to the average of pre- and post-project on-farm income.

Subsection 2.2 Commentary on Data Collection and Variable Construction

Questions arise in respect to each of the three steps indicated above.

First, in regard to the definition of the largest allowable small farmer, it is not clear why the use of a different technique than used by the subsistence-level farmers should disqualify farmers from this category. Conceivably even different subsistence - level farmers could use different techniques. Likewise it is not clear that larger than average farm sizes necessarily should disqualify farmers. If the land is heterogeneous and the larger plots are poorer in quality, the larger farmers by such a criterion may be worse off than the smaller ones. Instead of such criteria, it would seem preferable to use one related to income per family member. Of

¹These definitions are paraphrased from Strategies, pp. 277-287.

course such distinctions are somewhat academic in any case since, as the authors acknowledge, the definition in Strategies is not really an operational one.

Second, in respect to the collection of raw data there are several weaknesses. The projects were not selected in a random fashion from any population, but merely were those that were accessible. This undoubtedly creates biases. For example, no projects which already had failed were included. Given the need to collect original data under fairly severe resource constraints due to the inadequacy of existing data, however, it is hard to see that DAI had much choice in this matter.

For the same reason the use of key informants rather than survey or census data probably was warranted. However it should have been justified on these grounds as a second-best alternative, and not claimed to be superior without qualification. Moreover rules for identifying key informants, for scaling qualitative variables, and for correcting anomalies should have been made explicit. The use of a very few interviewers with intensive communication among them in my judgment probably did limit the extent to which inaccuracies entered into the raw data because of the failure to establish more precise rules a priori. I have the feeling from my conversations with the interviewers that a consistent set of such guidelines indeed was established implicitly. Nevertheless, one could have more confidence in the consistency of the raw data and in the possibility of replication if such guidelines had been made more explicit a priori.

One final problem in the data collection is that most data were obtained only for a year or two. This precludes the examination of dynamic processes except under the strong assumptions required to approximate them with cross-section evidence. That different projects were at different points

of disequilibrium when the data was selected a priori would seem to confound the analysis considerably. It would have been preferable to attempt to obtain more time series data, even though the limited record keeping of the projects probably severely restricted the possibility of obtaining all the desirable time series data. On the other hand, if a variable related to the gestation period or degree of disequilibrium is added to those included in the original Strategies study, it has significantly nonzero coefficients estimates only in a few cases, and its inclusion does not seem to alter substantially other coefficient estimates (Behrman 1977).

Third, in respect to the construction of variables, a number of questions arise, the most implicit of which now are considered in turn.

1) Construction of aggregate variables from components - In Strategies aggregate variables are constructed from standardized components by summing the components. Generally equal weight is given to each of the underlying items. If, instead, the weights are estimated as part of the multivariate analysis, they often are not equal. For example, I have estimated such weights for the components of local action in the determination of success and found that more than equal weight should be given to overall resource commitment/average income and to small farmer participation in decision-making during implementation (Behrman 1977). Such alternative weighting schemes do not, however, alter radically the general thrusts of the results.

A more fundamental question is how best to go from the underlying components to the overall indices. The Strategies' procedure is simply to add up the standardized components, similar to the adding of the components of national income. To get the total "product" the number of units of component A is added to those from component B, with the various components

made comparable in terms of units by the standardization procedure.

Implicitly there is an underlying production process in which each of the standardized components may be provided independently and each contributes equally to the overall aggregate.

Some critics have in mind a quite different way of combining information from the components to obtain the overall aggregates which they presume was used or should have been used (e.g., Tanter 8/3/76, Soos 10/3/75, Freeman and Lowdermilk 4/4/75). Instead of summing the components, they have in mind the use of some principal components or factor analysis procedure to obtain the common dimension(s) of a number of components of success. In such a case it would be appropriate to undertake reliability (i.e. consistency) and validity tests to see if the constructed indices are internally consistent and if they represent the construct under investigation (see Bohrnstedt 1970).

I have constructed alternative indices based on the first principal components for all of the major aggregate variables which are constructed from a number of components in Strategies (Behrman 1977). The use of these variables instead of the original ones in the multivariate statistical analysis sometimes makes a considerable difference. The results obtained are less supportive of the conclusions in Strategies than are those using the original variables.

However, to conclude that the means by which one goes from the components to the overall index is important is not to say that the authors of Strategies erred in their construction of aggregate indices. The choice they made is more appropriate if a priori one thinks that the different components add to the overall index by representing different dimensions which are not necessarily interrelated across the sample. The alternative choice is preferable if a priori one thinks that the underlying components are all

representing different facets of the same phenomenon so that the best representation is a measure of the commonness or interrelatedness among the components. In my judgment the former choice which is the one made in Strategies is more justifiable than the latter given the way in which DAI was considering the underlying components.

2) Logical overlap among indices. Although various indices are not constructed from the same underlying series, the verbal descriptions of the variables suggest that they may be measuring the same phenomenon in what Tanter (8/3/76) calls "logical overlap." Some of the subcomponents of the self-help, self-sustaining, and increased agricultural knowledge components of success may be logically measuring the same characteristics as the local action variables, and thus result in a high correlation without any very useful meaning. Particularly suspect is the relation between the self-help component of success and the local action variables.

Elsewhere I discuss the bivariate correlation between the sub-components of these variables (Behrman 1977). In fact the subcomponents of the self-help index of success are about as highly correlated with the small farmer involvement in decision making components of local action (but not with the resource commitment variables) as they are with each other. This bivariate evidence is consistent with a problem of logical overlap, but is not conclusive. In other contexts variables which measure different constructs (e.g., consumption and income) are even more highly correlated because of casuality, not logical overlap. Ultimately it seems that the decision regarding the possibility of such logical overlap has to be made not on the basis of mechanical correlations, but on the basis of a priori understanding of what constructs variables are attempting to represent. On such a basis in my judgement there is a problem with the self-help

component of success being too related definitionally to the involvement in decision-making aspects of local action. Therefore I have estimated regressions for an alternative definition of overall success in which the self-help component is deleted (see Behrman 1977). The results are quite robust in general terms to the question of whether or not the self-help index is included in overall success. This, although legitimate questions can be raised about the wisdom of including the self-help index in overall success in the original Strategies study, the estimates presented therein are not terribly sensitive to that decision.

3) Net income/project cost component of success. This is the only component of success which directly represents the purely economic aspect of success. One interpretation of the success measure which reconciles it with the discussion of goals above in Subsection 1.2 is that this variable represents the strictly economic benefits to date, and the other three components of success relate to the probability of sustaining such benefits in the future.

However the definition of this variable raises a host of problems:

(i) There is no discounting. (ii) Only increases in income to date are included without any estimate of future benefits, so there is a bias towards older projects - and the projects in the sample ranged considerably in duration, from 1 to 22 years.¹ (iii) The cost measure includes the total pool

¹ Assume that the total cost to outsiders of a project is \$100 all in the first year, and that the net on-farm income generated is \$10 per year for a quarter century. The Strategies' calculation of this variable would give a value of 0.1 if the project happened to be included in the sample during its first year, 0.5 if it happened to be included during its fifth year, etc. The authors of Strategies realize that their procedure of not discounting and of counting only benefits to date implies what some may consider a bias towards older projects, but argue that the procedure is warranted since it puts an emphasis on proved, sustained projects (p. 248).

of credit made available through the project, not just the opportunity cost of alternative uses (i.e., the subsidy through below-market interest rates and through any default), which implies a bias against projects with a large credit component. (iv) The cost measure does not include additional costs borne by participants due to the project (e.g., reductions in off-farm labor by the farm family due to increased labor demands from the project¹), but only those incurred by outsiders. (v) The preferable form of relating benefits to costs is not to form the ratio, but to subtract the latter from the former (although in this respect the authors of Strategies are in good company with many practitioners of cost/benefit analysis). (vi) The raw data cover adequately only a few recent years and only the three most important technological packages (although as many as 20 were included in some projects), so the data base for calculating this variable is somewhat weak -- especially for the older projects. Considering only the three most important technological packages also implies a bias towards those projects with benefits concentrated in a few technological packages in comparison to those with more dispersed benefits.

To explore the sensitivity of the statistical estimates in Strategies to the peculiar definition of this major representation of the strictly economic component of success, it was decided to define an alternative variable. Collecting new raw data was outside of the scope of this effort, so some attractive possibilities could not be pursued. Finally it was decided that the best alternative was to follow a suggestion of Paul Isenman

¹ According to Strategies (p. 245), "...in a number of projects, off-farm income was a key component of total farm income." Therefore ignoring possible changes in off-farm income may have introduced substantial distortions.

and to ask the DAI interviewers to construct an index of their best estimate of the long-run strictly economic success of each project. The resulting variable ranges from 1 ("economic failure") to 5 ("economic success"). When this variable is used as a dependent variable instead of the original income/cost measure, the estimates differ substantially from those in Strategies. On the level of determining the components of success, therefore, the statistical estimates are quite sensitive to the peculiarities of the definition of the strictly economic benefits. When a new overall success measure is constructed with this new alternative as one of the components instead of the original income/cost variable, however, the basic thrust of the regression estimates is not changed radically (see Behman 1977). Thus the results are somewhat paradoxical in regard to the sensitivity to changes in the definition of the strictly economic component of success.

4) Other peculiarities of variable definitions. Other problems in definitions are less important. Nevertheless it is useful to mention two examples in order to give the flavor of these more minor problems: (i) In measuring the labor commitment of small farmers only unpaid labor was included (p. 282), which leads to a peculiar situation in which the labor commitment variable would decrease in value if two farmers decided to hire each other instead of working on their own farms. (ii) In the cost per participant variable only the cost in the most recent year was included (p. 250), which causes substantial problems of interpretation given that the projects had different time profiles of costs and were at different points on those profiles at the time of data collection — and which causes considerable doubts about the Strategies' conclusions regarding the lack of advantages of concentrated projects (see Subsection 3.1 below).

Section 3. Multivariate Analysis and Interpretation

Subsection 3.1 Procedures and Interpretation in Strategies

Multivariate regressions are presented in Strategies for the almost - recursive system comprising success and local action and the components of each. Therefore estimates are available about the determinants of success and local action both from the overall aggregate relations and from summing the relations for the relevant components. In each case a set of plausible possible determinants was identified on the basis of implicit theorizing and field experience as is described above in Subsection 1.1. Then the subset of determinants was selected which is most consistent with the variance in the dependent variable subject to the constraints that: (i) each coefficient estimate is significantly nonzero at least at the ten percent level (i.e., has a t-statistic at least 1.8 in absolute value) and (ii) no more than 6 right-hand-side variables enter into the relationship in order to have sufficient degrees of freedom.¹ For the success variable and its components, in addition regressions were estimated with alternative measures of the small farmer resource commitment/average income and with only the overall local action variable. For all of the regressions ordinary least squares techniques are used. The authors of Strategies defend this choice of a relatively simple technique because of the experimental nature of the study and because of a desire to keep the technical analysis as simple as possible in order that it be understandable to a wide readership. Analysis

¹This maximum was reduced to as low as 4 in some cases in which observations had to be dropped because of the lack of data. A stepwise regression program was used, but the procedure is equivalent to that described in the text. In cases in which a right-hand-side variable entered in an early step but not in the final one the earlier step estimates also were presented.

of the residuals was presented in a supplementary report (Morss, Swenson, and Riegelman, 1975).

Table 1 summarizes these regressions. It includes the following information for each of the dependent variables: (i) the coefficient estimates and the coefficient of determination¹ for the "best" regression in the sense of being most consistent with the variations in the dependent variable subject to the constraints that all coefficient estimates are significantly nonzero at the 10 percent level² and that a maximum of 4 to 6 right-hand-side variables (depending on the number of observations) are included; (ii) an indication of the variables (and of their signs) which are not significantly nonzero in the best regression, but which enter into the other regressions presented in Strategies, subject to the same two constraints mentioned above; (iii) an indication of variables which neither entered the best regression nor the alternatives with significantly nonzero coefficient estimations, but which were in the a priori specified set of candidates; and (iv) (for success and its components) the coefficient of determination (\bar{R}^2) in the bivariate relation in which the only right-hand-side variable is the overall local action measure.

¹The coefficient of determination (\bar{R}^2) is corrected for degrees of freedom. It indicates the extent to which the estimated relation is consistent with variations in the dependent variable. The maximum possible value, thus, is 1.0. See further discussion of this statistic in Subsection 3.2 below.

²The standard errors or t-values are not included in this table in order to keep it from being too messy. In all cases, however, the t-statistics are at least 1.8 in absolute value.

Table 1 Summary of Multivariate Regression Estimates for SUCCESS, LOCAL ACTION, and Components of Each in Strategies^a

Right-Hand Side Variables and Numbers										Dependent Variables											
										SUCCESS					LOCAL ACTION						
										Over-	Components			Over-	Components						
										all	Income/	Self-	Increased Ag-	Self-Help	all	Involvement	Involvement	Resource	Commitment		
										599	Wide Costs	Sufficiency	ricultural Knowledge	Capability	619	In Initial Phases	In Implemen-	Average	Income	Cash	
													567 ^a	574 ^a		528 ^a	530 ^a	Total	Labor	Cash	
																		621 ^a	606 ^a	604 ^a	
19	Literacy rate									b-	-.01								.01	-	.02
20	Percentage of output in cash crops									.01		.01	.01	.01							
RAV24	Pre-project per capita income									.01	b	.01	.02	.01					-.02	-.02	
34	Farm units per extension worker																				
36	Extension emphasis (general=1, crop-specific=2)																			.71	
4640	Percentage with reasonable land security									.01		.01									
57	Average farm size																		-.01		
79	Past experience with organizations																			-.16	-.26
80	Level of social services prior to project																			-.35	.27
81	Level of social services early in project																				
82	Level of social services late in project									b											
164	Percentage within 5 km. of all weather road (market access)									-.01 ^b	b		-.01								
484	Subsidization required to induce acceptance of technology																				
531	Individual (-1) vs groups (=5) in providing inputs																				
532 ^a	Technical inputs (extension, research, etc.)																				
534	External project costs per farm family																				
537	Individual (-1) vs groups (=5) in resource commitment																				
565	Importance of two-way information flow																				
573	Percentage change, pre- to post-project, in on-farm income																				
613	Labor commitment/project costs per participant																				
614	Cash commitment/project costs per participant																				
615	Total commitment/project costs per participant																				
Local Action																					
619	Overall									.28	b	.26	b	.43							
528 ^a	Small farmer involvement in initial decisions																				
530 ^a	Small farmer involvement in implementation phase									b											
621 ^a	Total small farmer resource commitment/income									b											
606 ^a	Total small farmer labor commitment/income										.41		.78								
608 ^a	Total small farmer cash commitment/income									b			b								
Success																					
567 ^a	Increased agricultural knowledge																			.80	.84
Coefficient of Determination, corrected for degrees of freedom (R ²) ^c										.73	.49	.64	.66	.67	.68	.31	.78	.70			
"Best" regression										.49	.08	.46	.40	.50							
With only overall LOCAL ACTION variable																					

^a See appendix and text of Section 2 for more extensive variable definitions. * implies that variable is standardized to be in units of sample standard deviations from sample mean. Regression results are from Strategies pp. 302-4, 306-7, except for corrections for typographical errors for some of the coefficient estimates and for some of the coefficients of determination (that changes the apparent "best" regression for overall success).
^b Significantly nonzero coefficient estimates in "best" regression (i.e., that which maximizes consistency with variation in dependent variable subject to constraint that coefficients are all significantly nonzero at 10% level and there is a maximum of 4-6 variables) are given.
^c Not significantly nonzero in "best" regression (as defined in a), but significantly nonzero in one of other multivariate regressions presented Strategies. Minus sign after b means that coefficient is negative; otherwise, it is positive. Included in set of eligible variables but not significantly nonzero in "best" regression (as defined in a) nor in other presented multivariate regressions (as defined in b).
^d The coefficient of determination gives the proportion of variance in the dependent variable with which the right-hand side variables are consistent within the sample. See note a for the definition of the "best" regression.

The interpretations of these results by the authors of Strategies perhaps is best summarized by a long quotation from their Executive Summary (pp. 10-15, 50):¹

...We found that overall success ratings were most affected by: The Local Action taken by small farmers to complement outside development management and resources. By itself, this factor explained 49 percent of the variation in the overall success rankings.

When the components of Local Action were examined, two proved to be most important in promoting overall success:

- Small farmer involvement in decision-making in the implementation phase of a development project; [note deleted] and
- Small farmer resource commitment (labor and cash) to a development project...

These conclusions imply that project success is dependent on a set of positive actions by small farmers:

- Their participation in project decision-making (which appears more significant in the implementation stage than in the design phase);
- Their willingness to contribute labor and money to the development effort.

Those development projects which took the time and effort to build in an active and cooperating role for small farmers were significantly more successful than those projects which followed more traditional (externally-dominated) development approaches.

Of course, project success was also affected by a number of other factors. As might be guessed, the chances for project success are greater if one works with more progressive farmers as measured by per capita income and the percent of output sold for cash. Somewhat surprisingly, greater project success appeared to occur in projects located a considerable distance from all-weather roads and in projects where the literacy rates of participants were low. We believe this is a reflection of a deliberate decision by leaders of some of the most successful projects in the sample to work in remote areas and not the influence of these

¹This summary refers to the interpretation of the multivariate regression analysis as supplemented by other analysis in the report, but the multivariate quantitative analysis is the core of the study, and thus, the basis for most of the major conclusions.

factors as such.¹

Many factors thought to be important in project success did not turn out to be so in this analysis. Cost per participant was not, which suggested that large outlays spread over few people will not necessarily improve chances for success. The degree of subsidization offered for adoption of new technology was not, suggesting that small farmers will adopt new technologies without further incentive if it appears in their interest to do so. In addition, the growth rate in the number of project participants showed no relation to project success, thereby raising obvious questions concerning the frequent use of this measure as a success indicator. And finally, the quality of the physical environment did not appear to be of overriding importance, as successful projects were launched under good as well as poor farming conditions.

The policy implications of the analysis are clear. Project designs can most strongly influence potential success in rural development projects by deliberately working to generate various types of small farmer involvement and resource commitment to project activities...

Through study of overall local action..., three variables were found to be positively associated with the level of local action:

- The specificity of the agricultural information offered by the extension service;
- The importance of local organizations in the project; and
- An effective two-way communications flow between project participants and project management and staff.

The size of the subsidy offered to farmers by the project appeared to have a negative impact on the overall level of local action. Perhaps most importantly, the following variables did not appear to have a significant impact:

- Farm units per extension worker;
- Reasonable security over landholdings;
- Average size of farm in project;
- Past experience (good or bad) with development efforts;
- Provision of social services;
- Increase in agricultural knowledge generated by the project;
- Percent change in farm family income resulting from the project.

When the involvement components of local action were examined individually, the most important variables were the existence of effective two-way communications systems and functioning local organizations or groups. The analysis showed that poor small holders with less security over the land they farmed are more likely to become involved in decision-making during project design and implementation than are wealthier, larger farmers. This finding should signal the policymakers that small farmers will contribute if given an opportunity.

¹While literacy did not appear necessary for project success, it was significant in bringing about a small farmer resource commitment.

A review of the variables which influenced small farmer resource commitments of additional labor and money revealed again that poor small farmers are more likely to make greater relative resource commitments than are larger, wealthier farmers. Our quantitative work suggests further that small farmer resource commitments would be higher if project planners focused on increasing rural functional literacy, improving land tenure security, offering crop-specific extension instruction and promoting small farmer involvement in project decision-making at the local level. Large subsidies for adoption or the provision of social services appeared to have a negative impact on the willingness of small farmers to make a resource commitment. Income increases, in absolute or percentage measures, did not bring forth larger commitments, suggesting the decision-making calculus for farmers near subsistence is complex and involves far more than the size of net income gains...

Our general conclusion...is that getting the benefits of development to the small rural producer will require fundamental changes in the project identification, design and implementation procedures of AID and other external assistance agencies...

Subsection 3.2: Commentary on Multivariate Statistical Analysis and Interpretation in Strategies

The choice of multivariate regression analysis was a reasonable one. Alternatives might include canonical correlations and the other approaches included in what-Wold (1977) terms "soft modeling", but many of these approaches are quite new, they have some uncertain properties, and they would be less familiar to the readers. Ordinary least square procedures are fairly robust and relatively widely understood. The rule for excluding variables which are not significantly nonzero at least at the 10 percent also is consistent with widespread practice, although it is not unquestionable.

On the other hand, the rule for limiting the number of right-hand-side variables to 4-6 is arbitrary and does not reflect standard practice. However the imposition of this rule does not seem in itself to have been very misleading. Only for the regression with overall local action as the dependent variable was this constraint effective, and even in that case it did not radically alter the coefficient estimates for most of the variables

included in the relevant regression in Strategies (Behrman 1977).

Almost no mention is made of the traditional problems of multivariate regression analysis and their implications for the results in Strategies: errors in variables, heteroskedasticity, identification, simultaneity, specification error, serial correlation, etc. This is a shortcoming in that almost all of these problems exist in the Strategies' estimates. As is noted above, for example, the inclusion of the increased agricultural knowledge component of success in the regression for the components of local action results in a simultaneity bias. The defense of the authors of Strategies for not being more concerned with such questions, however, does have considerable merit: In this experimental venture they are concerned only with the directions of effects, not the magnitudes, so biases or inconsistencies in the coefficient estimates are not of great moment. Nevertheless, such biases could be substantial and even reverse the estimated signs. Moreover the use of simple procedures does not make the nature of the biases clearer to readers, as is claimed by the authors of Strategies. Therefore it would have been preferable to devote some effort to considering these traditional econometric problems.

These also are some problems in their interpretation of the coefficients of determination. First of all, the statement is made that: "by itself... [local action] explained 49 percent of the variation in the overall success rankings." In a sense this is quite misleading since local action is correlated with other right-hand-side variables in the preferred relation, and thus is representing in part these excluded variables in the bivariate regression. Since local action is not orthogonal with all of the other variables, the bivariate coefficient of determination probably gives an upper bound for its effect. Secondly, there is some

question as to what the coefficient of determination means when the variables are ordinal. Almost any value could be obtained by altering the underlying scale without changing the ordering. I am in no way suggesting that the DAI team in fact did attempt to choose scaling of the key variables in order to maximize the multiple correlations. But I am saying that the statements about "explaining" the variance in the dependent variables are all conditional on the particular scales which were used for the ordinal variables. Once again, however, DAI is not alone in attempting to interpret coefficients of determination for ordinal based variables. Many economists and sociologists have done so, for example, for occupational status measures.

A final point in respect to statistical procedure is that it would have seemed quite natural to explore the question of whether or not the estimated relations were the same for Africa and Latin America. The authors of Strategies incorrectly claim that they had insufficient degrees of freedom to do so. Some simple explorations in Behrman (1977) suggest that there is some evidence of a difference between the continents in regard to the success regressions.

Turning now to the question of interpretation, the basic problem is a pervasive tendency to overstate their results. I suspect that the authors of Strategies might defend this style by arguing that too many qualifications would confuse the general reader towards which, in part, the study is directed. However the lack of such qualifications may be very misleading. In a sense the authors of Strategies try to "have their cake and eat too." They claim that the data will not support more sophisticated analysis, but draw very strong conclusions from it. The more their analysis is inductive rather than deductive, the more it only suggests hypotheses to

be tested with other data instead of testing a priori hypotheses. They also never note the problems of giving a dynamic interpretation to their cross-section analysis.

As in any empirical work, there are a number of problems or at least questions in each major step underlying Strategies. Many of these have been mentioned above. Although the basic thrust of the results in regard to the consistency of variation in local action with that of success seems fairly robust under most alternations which I have explored in Behrman (1977), there are some significant changes in details. Ex ante profitability and risk variables, for example, seem quite important. Local action, in fact, may be serving as an intermediary in substantial part for ex ante profitability. Moreover the other intervention points to encourage local action are not so clear. Exactly what does a project director do to create a good environment for the development of local action? Even if local action is important in itself, moreover, there is no evidence in Strategies that the expected cost of developing it is less than the expected benefits. Furthermore it is not at all clear that already existing elites will not capture a disproportionate share of those gains due to the projects. Such considerations as these call for considerably more care, qualifications and humility in interpreting the results of Strategies. I expect that the style of overstating without qualification has generated considerable and not always warranted doubts among more sophisticated readers.

Section 4: Conclusion

Empirical work in new areas is difficult. Choices made at an early stage sometimes come back to haunt you at a later stage. I have yet to see an extensive empirical study, including those with which I have been

associated, which is not open to legitimate questioning about some of the steps in the analysis.

Strategies, too, is open to such questioning. I have indicated a number of respects in which I have questions above. All in all there are more such questions than I would like. In part this reflects a tendency to substitute good judgment and intuition for systematic technique a little too much. A stronger technical input at all stages of the project would have been useful in avoiding many of these problems. More care also should have been taken to not overstate the implications of the analysis.

Nevertheless, I find the study to be provocative and innovative in an important area. The result that local action is an important determinant of a reasonable measure of success seems fairly robust, even though its role may be much more intermediary for ex ante profitability than is suggested in the original study. Numerous qualifications need to be made, but the suggestive results should be followed up with further data collection and analysis so that the role of local action and participation and the cost and mechanism for inducing them can be understood better. It also would be desirable if ongoing and future AID projects automatically had a systematic and automatic data gathering and recording procedure so that at some future date further analysis could be made of the determinants of success and failure on the basis of existing consistent project records.

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Appendix: Variables in Strategies

<u>Variable Number</u>	<u>Definition of Variable and, When Applicable, Coding Instructions</u>
x ₁₉	Literacy rate; percentage of project participants who have the ability to read a basic farm manual
x ₂₀	Cash crop output; for project participants, percentage of output in cash crops
x _{RAV24}	Per capita income; for project participants, pre-project per capita income in current dollars
x ₃₄	Extension workers; on the project level, average number of farm units per extension worker
x ₃₆	Primary extension responsibility; for those extension workers that interact with the population. Code: General or combination =1; Crop-specific extension work = 2.
x ₄₆₄₀	Land security; percentage of project participants with reasonable security (those with titles plus those with reasonable security)
x ₅₇	Average farm size; for project participants, in acres. In Africa includes both cultivated acreage (of which little was recorded). In Latin America included cultivated land only.
x ₇₉	Past experience with organizations; average score of projects participants' perceptions of similar development projects, government organizations, community organizations and other organizations
x ₈₀ , x ₈₁ , x ₈₂	Level of social services: prior to project (x ₈₀), early in project (x ₈₁), and late in project (x ₈₂) level of social services. Code as significant, moderate or none.
x ₁₆₄	Market access; for the project, percentage of communities within five km. of an all weather road
x ₄₈₄	Degree of subsidization; required in getting farmer to accept technological change. Code: Significant=4; Moderate=3; Little=2; None=1

Variable Number

Definition of Variable and, Where Applicable,
Coding Instructions

x519*

Adjusted total project income over the life of the project to ratio of total project costs, standardized (a component of x₅₉₉)

x528*

Small farmer involvement in idea generation and initial project design. Code: Scale 1-5; None = 1; High involvement = 5

x530*

Small farmer involvement in the implementation phase. Code scale 1-5; Dialogue = 1; Dialogue, decision-making and project control=5

x531

Relative importance of individual or groups to provide small farmer inputs into the implementation phase. Code 1-5 scale; Individual inputs = 1; Group inputs = 5

x532

Small farmer technical inputs (extension, research, etc.). Code 1-5 scale; None = 1; High = 5

x534

Externally provided project costs divided by the number of farm family participants, most recent year

x537

Relative importance of individuals or groups to provide small farmer resource commitment. Code same as x₅₃₁

x565

Importance of two-way information flow in the project. Code 1-5 scale; Nonexistent = 1; Information flow functioned to change both project design and behavior of local participants = 5

x566*

Scale of self-sufficiency (a component of x₅₉₉)

x567*

Scale of increased agricultural knowledge (a component of x₅₉₉)

x572*

Scale of self-help capability (a component of x₅₉₉)

x573

Percent change, pre-project and post-project, in on-farm family income

x598

Credit commitment; that portion of small farmer resource commitment which comes from actual credit repayment

x599

Overall SUCCESS

Variable Number

Definition of Variable, and Where Applicable
Coding Instructions

x602

Dollar value of labor; resource commitment increase or decrease of man-days as a result of the project times the prevailing wage rate in the area

x603

Actual money resource commitments (in dollars), increase or decrease in dollar commitment of small farmer

x604

Total farmer resource commitment; addition of x603 and x602

x606*

Value of labor resource commitment (x602) divided by the average of pre-project and post-project on-farm income, standardized.

x608*

Value of money resource commitment (x603) divided by the average of pre-project and post-project on-farm income, standardized

x613

Value of labor resource commitment (x602) divided by project costs per participant most recent year

x614

Value of money resource commitment (x603) divided by projects costs per participant most recent year

x615

Value of total resource commitment (x604) divided by project costs per participant most recent year

x619

Overall LQCAI ACTION scale

x621*

Total small farmer resource commitment (x604) divided by the average of pre-project and post-project on-farm income, standardized

Appendix: Variables in Strategies

Variable Number	Definition of Variable and, When Applicable, Coding Instructions
x19	Literacy rate; percentage of project participants who have the ability to read a basic farm manual
x20	Cash crop output; for project participants, percentage of output in cash crops
xRAV24	Per capita income; for project participants, pre-project per capita income in current dollars
x34	Extension workers; on the project level, average number of farm units per extension worker
x36	Primary extension responsibility; for those extension workers that interact with the population. Code: General or combination =1; Crop-specific extension work = 2.
x4640	Land security; percentage of project participants with reasonable security (those with titles plus those with reasonable security)
x57	Average farm size; for project participants, in acres. In Africa includes both cultivated acreage (of which little was recorded). In Latin America included cultivated land only.
x79	Past experience with organizations; average score of projects participants' perceptions of similar development projects, government organizations, community organizations and other organizations
x80,x81,x82	Level of social services: prior to project (x ₈₀), early in project (x ₈₁), and late in project (x ₈₂) level of social services. Code as significant, moderate or none.
x164	Market access; for the project, percentage of communities within five km. of an all weather road
x184	Degree of subsidization; required in getting farmer to accept technological change. Code: Significant=1; Moderate=3; Little=2; None=1

Variable Number

Definition of Variable and, Where Applicable,
Coding Instructions

x519*

Adjusted total project income over the life of the project to ratio of total project costs, standardized (a component of x₅₉₉)

x528*

Small farmer involvement in idea generation and initial project design. Code: Scale 1-5; None = 1; High involvement = 5

x530*

Small farmer involvement in the implementation phase. Code scale 1-5; Dialogue = 1; Dialogue, decision-making and project control=5

x531

Relative importance of individual or groups to provide small farmer inputs into the implementation phase. Code 1-5 scale; Individual inputs = 1; Group inputs = 5

x532

Small farmer technical inputs (extension, research, etc.). Code 1-5 scale; None = 1; High = 5

x534

Externally provided project costs divided by the number of farm family participants, most recent year

x537

Relative importance of individuals or groups to provide small farmer resource commitment. Code same as x₅₃₁

x565

Importance of two-way information flow in the project. Code 1-5 scale; Nonexistent = 1; Information flow functioned to change both project design and behavior of local participants = 5

x566*

Scale of self-sufficiency (a component of x₅₉₉)

x567*

Scale of increased agricultural knowledge (a component of x₅₉₉)

x572*

Scale of self-help capability (a component of x₅₉₉)

x573

Percent change, pre-project and post-project, in on-farm family income

x598

Credit commitment; that portion of small farmer resource commitment which comes from actual credit repayment

x599

Overall SUCCESS

Variable Number	Definition of Variable, and Where Applicable Coding Instructions
x ₆₀₂	Dollar value of labor; resource commitment increase or decrease of man-days as a result of the project times the prevailing wage rate in the area
x ₆₀₃	Actual money resource commitments (in dollars), increase or decrease in dollar commitment of small farmer
x ₆₀₄	Total farmer resource commitment; addition of x ₆₀₃ and x ₆₀₂
x ₆₀₆ *	Value of labor resource commitment (x ₆₀₂) divided by the average of pre-project and post-project on-farm income, standardized.
x ₆₀₈ *	Value of money resource commitment (x ₆₀₃) divided by the average of pre-project and post-project on-farm income, standardized
x ₆₁₃	Value of labor resource commitment (x ₆₀₂) divided by project costs per participant most recent year
x ₆₁₄	Value of money resource commitment (x ₆₀₃) divided by projects costs per participant most recent year
x ₆₁₅	Value of total resource commitment (x ₆₀₄) divided by project costs per participant most recent year
x ₆₁₉	Overall LOCAL ACTION scale
x ₆₂₁ *	Total small farmer resource commitment (x ₆₀₄) divided by the average of pre-project and post-project on-farm income, standardized