The Design and Administration of New Crops: Grower Response to Change

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I. Introduction

In developed countries, an important determinant of a farmer's production is the price he receives for his produce. Neoclassical economics has a well-developed methodology for analysing the response of growers to small price changes in their established crops. This method of analysis has been applied with minor success to the small scale agricultural producers of developing countries.[1]

But for a farmer in the Third World today, changes in crop prices are often of relatively minor influence on production decisions; they are swamped in importance by the disruptive changes in the form of new crops, new ways of growing old ones, and methods of crop organization that have taken place since the Green Revolution.

How can we best approach the general problem of analysing the response of these farmers to such structural and organizational changes? This paper is an attempt to quantitatively investigate likely grower reaction to changes in a much wider range of crop characteristics than is usually considered. We do this by adapting the established neoclassical theory of producer/investor behavior (though we inevitably run up against its limitations).

. The method consists of firstly isolating a number of characteristics of crop design and administration which appear im-

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1 See, for example, Bherman (1968).

portant in determining the interest of a particular community in that crop. The effect of each of these characteristics on grower participation decisions is then separately investigated using simple regression techniques. Taken as a whole the effects of all these characteristics appear to provide a reasonably convincing explanation of grower behaviour.

The importance of such an analysis of grower response is that it may enable us to design, select and administer new crops in the most appropriate way for the very particular requirements of any comunity of growers. We define this "most appropriate way" as that which elicits the maximum response from the community. This has often been a problem when, as in most aid projects, a new crop is offered to a community of growers by an outside body which does not explicitly allow for the cultural differences to be found there compared with producers in their own country. The analysis is also important in cost-benefit analysis: it allows the often unrealistic assumption of complete farmer participation in a project to be replaced by a realistic estimate of the likely partial response.

The analysis is set in the South Pacific. Here, because of a certain natural prosperity and many externally-financed opportunities, growers can afford to be discerning about whether or not they wish to become involved in a new project. In particular, we use a study made on the island of Atiu, where growers have had the chance to join in growing ten new crops over the period 1950-1975.[2]

We will treat crop technology as being contained in a standard production function relating crop revenue to managed inputs (mainly labour) given other structural characteristics of the crop such as its riskiness, timing, information content, and so on. We represent producer preferences by standard utility functions expressing a trade-off between work and income, and also containing elements of time, uncertainty, ignorance and dependence on others. Then our problem is to analyse producer decision making in the face of exogenous changes in each of the structural characteristics in turn.

Atiu is a small (2,600 hectare) raised coral atoll in the Southern Cook Group, lying 190 kilometers north east of Rarotonga the seat of government. The Cook Islands has been administered by New Zealand since the turn of the century, but became internally self-governing in 1965. A prohibition on land sales has meant that the agricultural economy has always remained completely in Atiuan

2 See Bollard (1977).

hands.

Today the population of 1380 belonging to three tribes, work the village lands in accordance with the Maori Land Court's recent interpretations of traditional land tenure. The *ariki* and other chiefs of lesser rank appear to hold declining powers and influence. The Island Council, church groups, village committees and bush beer clubs are all enduring units of social organization.

Until the mid-twentieth century Atiuans spent much of their time on subsistence work: catching fish and other sea foods, gathering plant foods growing wild in the bush, and growing a few root crops, taro being the only one to receive intensive cultivation. They earned small amounts of cash for their casual needs, mainly by picking the fruit of the hardy, uncultivated native orange trees.

In the 1940s these trees became diseased and began to die out. The New Zealand Government tried to provide an alternative source of money on Atiu, by introducing new higher yielding varieties of orange trees in a Citrus Replanting Scheme in 1950. These "improved" trees were labour intensive and rather sensitive, requiring a much more regular commitment to take market economy. Initially oranges were shipped fresh to New Zealand, then later a factory was built on Rarotonga to juice them. In 1965 the Cook Islands Government took over administration of the project.

For a variety of economic and biological reasons, this scheme was not a complete success. Because of this the Atiu Administration introduced a whole series of new short and long term cash crops over the next twenty years. These included forestry trees, tomatoes, peanuts, coffee, pineapples and other vegetables. In most cases an improved variety was introduced; like the Citrus Replanting Scheme, all were based on smallholder agriculture, except for a Pineapple Incorporation Scheme which corporated lands into one large planting block. These projects are summarized in table 1.

Many of these projects were little better designed than the Citrus Replanting Scheme. Consequently growers were discerning about their participation. Good crop records exist and we can use them to investigate the effects of differences in design.

II. The Design of Crops

Profitability

What will be the yield of a new crop, how much money will this

harvest be worth, and how much work will it require? These are usually the first questions (through by no means the only ones) that farmers ask about a new crop. For agricultural administrators, the promise of improved yield and increased total revenue has often been sufficient justification to introduce a new crop. But an "improved" crop often involves a number of other characteristics, not all of them beneficial to growers.

As an example we consider a very simple static production, where extra inputs of labour produce decreasing increments of extra output.[3] Then we can isolate several aspects of increased profitability: the yield of the crop when it has reached full maturity, the fixed amount of work necessary to establish a crop, the productivity of labour as it grows, and the market price of the product.

Now we may analyse more closely what is involved in the various loosely labelled "improved" crop varieties frequently offered through aid projects. Evidence from the Green Revolution[4] suggests that new crops frequently offered much higher capacity yields (at least under controlled conditions) at the cost of much higher inputs of maintenance and materials; labour productivity might or might not be higher.

This was certainly the case on Atiu. The new citrus trees were capable of a higher yield than the old native oranges, but they required a lot more work weeding and pruning just to keep them alive. As an Atiuan grower put it:[5]

> "The (old) haori orange you just pick. No weeding, manure, spary and taking away the dead branches. You just pick the orange and get the money. But the (new) plot orange you pick and get more money. But hard work. You spray, manure, weed . . . . Weeding! Weeding! Weeding! Hard work!"

What is likely to be the attitude of these growers to increased profitability? How much harder they wish to work to earn more money will depend on their trade-off between leisure and labour. On Atiu it appears that extra money may induce extra work effort up to some target income; after that the farmer becomes increasingly insensitive to further inducements. His marginal utility of income is positive though decreasing with extra income, but his marginal disutility of work as positive and increasing.

3 We are here considering the most common type of Pacific agriculture, where unpaid family labour is the main input.

4 See Mellor (1969).

5 Quoted in Menzies (1970).

This suggests that a grower on Atiu might respond positively, if insensitively, to increased crop profitability. What we can observe of the response to the new orange crop there seems to support this hypothesis. But can we test whether profitability is a statistically significant explanatory variable?

Let us postulate that the extent of participation by an average grower in a particular crop in a particular year depends on some measure of the profitability of the crop at that time as well as on a number of other characteristics of crop design and crop administration yet to be developed.

We measure profitability (P) by the marginal revenue product of labour (engaged on its most useful role on a crop), adjusted for the current level of production in a steady state situation.[6] A second explanatory variable is the fixed labour (L) required to establish the crop.

The dependent variables that we use to reflect grower participation in a crop are the average labour time spent, working on it (L), and the average income earned from it (Y). So far our explanation of grower participation takes the form:

$$Y, L = f(P, L_0, \text{other crop characteristics})$$

we wait to develop these other characteristics in the following section before reporting on statistical results.

Timing

The timing of the yield is another important aspect of a project, especially with a tree crop. A crop that may be harvested in one season or less will be viewed differently from one that takes a long time to reach maturity. A tree crop has no fixed gestation period. An orange tree, for example, may begin to bear uneconomic quantities of fruit after a year or so, then these will increase for up to a decade before reaching maturity; it may be 5 years before it is worth picking the fruit.

By describing the pattern of growth algebraically, we can use a functional parameter to characterize the crop timing. Biological evidence suggests that plant growth is roughly logistic (S-shaped); as this function is easily estimated it is convenient to use the logistic

6 Note that this involves three crop parameters: maturity yield, single period labour productivity, and market price. For a fuller explanation of the underlying production fucntion, see Bollard, 1977.

constant to describe crop growth rates.

The importance of this crop characteristic in a particular community depends on the growers rates of time preference that is how they regard work and consumption in the present as opposed to its prospect in the future. On Atiu, as on many Pacific Islands, it seems that people display very long term views of some traditional types of economic activity such as subsistence crop management on customary lands.[7] But at the same time in commercial agriculture growers have preferred fast maturing crops. This behaviour is characteristic of much of the Third World. One reason for it is the absence of adequate capital markets to handle new commercial investment. A classic example occurred on Atiu in 1964: having grown peanuts that year, they were all eaten and none saved for the next year's planting!

Atiuan growers were initially keen to plant several different tree crops, but then tired waiting for them to mature. One of the things that most attracted growers to work for wages in the new Pineapple Incorporation Scheme was that they received first payments after only a fortnight rather than waiting 18 months for the first crop to mature. All this evidence suggests that speedy crop yields are an important inducement to Atiuans.

We can test this observation more systematically by including the logistic constant of the plant growth rate (G) as another explanatory variable in our estimation of grower participation. Our regression now becomes: $Y, L = f(P, L_0, G,$ other crop characteristics)'

Risk

Another important element of a production process is the risk involved. Here we are talking about the full information objective risk where the grower knows perfectly well the proability distribution of outcomes. (In the next section we extend this to the problems of subjective risk.) We are mainly concerned with biological variations in yields, and market variations in prices. These are particularly important for new crops in under-developed countries, because they are usually sold on volatile world markets, and because they usually offer their higher yields at the cost of much greater yield variances. Bred under laboratory conditions often in a temperate country,

7 For example, by such conservationist customes as the *rau'i* a chief could prohibit the use of certain crops to conseve supplies or certain pieces of land to give them time to recover.

"improved" crops may be very sensitive to the extremes of a tropical island environment, and they can have no natural immunity to the posts and disesses to be found there.

This inbred biological variability was very prounced in orange-growing on Atiu. Old native orange trees, well adapted to the conditions, had given low but consistent yields. Improved orange varieties growing under controlled conditions in Australia at that time recorded approximately twice as great a yield variance. When similar improved varieties were introduced to Atiu, their yields fluctuated even more. The fluctuations can be traced to several hurricanes, a bad drought, biennial bearing, outbreaks of scab disease, white moth infrestations, and occasional shipping shortages.

Farmers in less developed countries generally display positive risk premiums; because they have low incomes they cannot afford the consequences of bad luck, and may try to insure themselves against it. This behaviour can still be consistent with enjoying small gambles. Indeed, Atiuan growers are avoid small-time betters on horse races. But they avoid taking risks where the costs of failure are high. For example, when a slight shipping delay spoiled most of a tomato harvest, people suddenly realized how risky this project was and abandoned it.

The evidence clearly points to Atiuan growers as being active risk averters. To test this hypothesis statistically requires a measure of the objective risk involved in growing a crop. For this we use the variance of returns (V) from each crop over its lifetime, normalized about an estimated labour trend in order to compensate for planned variations in inputs.[8] Now our participation regression becomes:

$$Y, L = f(P, L_0, G, V, \text{other crop characteristics}) \quad (1)$$

Knowledge

A related structural element in a production function is the state of the user's knowledge about the process. The information content determines how efficiently a technical process will be operated. This has been shown by many industrial studies. This should be an important consideration in the introduction of new crops. In this context of community farming knowledge becomes a public good: it is non-tradeable and observed by all.

The learning pattern of a grower is basically repetitive: his

8 This measure is clearly only a very approximate one.

knowledge of a crop at any time enables him to estimate with some degree of confidence the likely outcome of a particular planting policy. Learning from repeated trials or from observation of other people's allows him to revise his earlier estimates if new evidence suggests they are wrong, and also to improve his confidence about them. In this way subjective uncertainty gradually becomes objective risk.

The difficulty in agriculture is that there are likely to be highly variable returns due to changing management and uncontrollable distubances. Therefore learning may require a long time, many trials, and considerable skill in isolating the effect of a new technique from other changes.

Like all subsistence cultivators, Atiuans had built up an extensive knowledge of horticultural practice for their limited range of crops before European contact. This was based on the more earily observed input-output correlations, and contained in traditional handed-down folk lore in such forms as the tidallunar planting calendar.[9] Where outcomes could not so easily be accounted for, magical belief was strongest.

Introduction of new crops backed by Western scientific techniques inevitably challenged much indigenous knowledge on Atiu. Farmers had to go through a painful adjustment period deciding what to accept or reject. Where extension agents managed to relate new practices like artificial fertilizing to age-old traditional ones like mulching, this was made easier.

Peasant farmers are said to dislike experimenting with new techniques or growing crops about which they feel that they do not know enough. The reason, as with objective risk, is that they cannot afford to be wrong. It is difficult for us to be quite sure of the Atiuan attitude to agricultural learning: growers refused to experiment in established areas such as subsistence root crops, even in such circumstances as a mysterious new taro disease. Yet the very same growers took up several completely new cash crops with only a limited idea of what they involved.

We should like to investigate growers' perceptions of each of the structural parameters of production rather than the absolute value of the parameters themselves. But agricultural learning theory is poorly developed, and it is very difficult to measure empirically the

9 This calendar sets out a list of guidelines for the most appropriate time to plant many traditional crops, depending on the phase of the moon and the state of the tides. In many aspects this coincides with modern planting recommendations.

extent of a grower's knowledge. For this reason we do not statistically test the effect of information content on crop participation, though we suspect it is important on Atiu.

We can now attempt a statistical regression of grower participation using all the above characteristics of structural crop design (except information content) as explanatory variables. We wish to test whether each element of design will affect participation as hypothesized above, and whether taken together they will offer a reasonable explanation of grower decision making.

We use equation(1), and assume it is roughly linear and that we may for the moment ignore the importance of crop organization to be developed in part III:

$$Y, L = \beta_0 + \beta_1 P + \beta_2 G + \beta_3 L_0 + \beta_4 V$$

Each regression uses data for the 20 years 1955 to 1974, corrected for price movements, and grouped into periods long enough to provide sufficient observations but not so long as to allow intertemporal distortions.[10]

The results of the regression are presented in table 2. We note that as anticipated, β_1 is positive; this suggests the profitablilty of a crop is generally a significant inducement to its acceptance. β_2 is generally both positive and significant; again as expected, growers appear to prefer fast maturing crops and to regard this as a relatively important aspect of design. Unexpectedly, β_3 the coefficient of establishment labour is also positive, suggesting that growers prefer crops requiring a lot of work planting. It is difficult to account for this result. β_4 is negative as expected, though not often significant; the sign suggests that growers do try to avoid very risky crops.

The statistical fits obtained are reasonably good. Given the poor quality of data and the small samples used, it would be dangerous to try to draw too many conclusions from the regression. However we do seem to have captured some of the design characteristics that growers consider important in these crops.

III. The Organization of Crops

Role of the Community

So far, the *ex ante* design of a new crop has been our only con-

10 Data for 1968 is omitted as a hurricane in that year completely disrupted production.

cern. Now we consider how to introduce and administer one that has already been designed.

A very noticeable characteristic of decision making in many small communities is the social interdependence of economic action: people copy each other, especially when they are faced with a new and confusing choice. When a new crop is introduced they may be suspicious at first, but then participation tends to follow a bandwagon effect. This has been well documented[11] There are many reasons for this. Following one's neighbour may be a way to insure against localized risk, an easier way to learn, a chance for economic of scale, or simply a more pleasant way to work.

This interdependence is most pronounced in isolated tight societies. Here any experiment made by a grower is closely and critically observed by others. But all growers are not equally influential in swaying their neighbours: the rank and personality of some people make them natural leaders in the adoption of new processes.

This tight social interdependence is important to Atiuan growers. An example is the exporting of taro: everyone had grown this staple for generations. Then in the mid-1960s a few younger innovative growers seized the opportunity to send taro to the growing Rarotonga market. But there was something in this new practice of selling a traditional crop to fellow Cook Islanders that worried most growers, and they would not join in. Then in 1969 and 1970 several respected influential community leaders, title-holders, and government officials took up the idea. Quite suddenly it became respectable. Within the next 2 years half the Atiuan farmers began to export taro too.

We can investigate statistically the effect of this communal decision making on participation. As a measure of an individual grower's perception of the value of company in a project (C), we use the proportion of growers involved in that project at any time.[12] This now becomes an explanatory variable of crop organization.

Role of the Administration

Faced with a new crop opportunity, growers may decide for quite rational private economic reasons that it is not worth their

11 See for example Rogers (1962).

12 This assumes that each grower is equally influential in his participation. There is a simultaneity problem inherent in regressing individual participation on an independent variable of group participation. We assume this is not distorting here.

while to join in them. However, it may be in the community interests that they should participate. Then the administration (in its many possible guises) may decide to intervene to cushion the impact of the crop's undesirable features. It is the role of the administration to pull together the diverging public and private interests in the community.

How far an administration should intervene in a project depends partly on the attitude of growers. If they are fiercely independent and mistrusting of official interference then economic incentives may bring no response. On the other hand many traditionally ranked societies, for example Polynesian, are used to working under direction for the public good, and can be expected to respond well. Firth[13] provides a good example in the economic duties of chiefly classes in Tikopia. There chiefs insured against insured against local risk, encouraged investment for the future, disseminated agricultural knowledge, and coordinated important communal work.

From our study of Atiu, we provide some examples of how an administration may attempt to modify what it sees to be the constraining elements in the operation of a crop.

(i) Administration as Profit Increaser: There are several ways an administration may use its superior bargaining power to increase the profitability of a crop for small-holders. It can provide necessary inputs more cheaply by bulk buying of fertilizers and sprays, by providing large mechanized implements for hire, and by building infrastructure such as roads and wharves. It can also obtain a better selling price for growers by acting as a marketing board with sole selling rights outside the community. The Atiu Administration attempted to fill most of these roles by using a rather unwieldy government institution, the Fruit Control Scheme.

(ii) Administration as Banker Providing Credit: A second major role of an Administration is the provision of credit to help growers participate in new crops where there are long gaps between planting and harvesting and between harvesting and receiving returns. It may be inthe public interest for individual planters to invest in long term projects. Indigenous kinship-based lending and sharing arrangements rarely prove adequate for this new situation. There are several ways an administration can provide credit to encourage investment: a development bank, a cost-sharing arrangement, or a

13 See Firth (1965).

forward selling agreement.

On Atiu a basic scheme was devised to provide growers with all their non-labour inputs on credit, to be repaid by a fixed percentage of proceeds when the oranges began to fruit. This simple pay-back mechanism is less flexible than a full commercial capital market; however, it is easily administered and requires no special grower security. It does appear to have encouraged early investment in tree crops on Atiu.

(iii) Administration as Insurer Sharing Risk: Again, an administration has the resources to cushion the riskiness of crops for samll-holders, and there may be good social reaons for it to do this. Commercial institutions will not insure small farmers; informal traditional arrangements within a community are of limited use where new cash crops involve extensive risk, and private money-lenders or share cropping arrangements often become exploiting. An administration may intervene through a price stabilization scheme, a profit sharing arrangement, or a farm insurance institution.

On Atiu the credit scheme outlined above also provides limited insurance for orange growers by smoothing out their net returns to labour. In a good year, when they can afford to, they pay more for their fertilizer than they would on the open market; in a bad year when they are short of money, they pay less. Again this scheme has encouraged growers into riskier production than they would otherwise have ventured.

(iv) Administration as Teacher Sharing Knowledge: Information about any new technical process is crucial for decision making. The administration should help this learning problem because there is generally a gap between private and social optimum levels of learning. They can do so in several ways. They may bear the cost of the earliest most risky series of experiments even if it means holding back the introduction of a new crop for a few years. They can collect, record and publicize the results of other relevant experiments that growers may not otherwise hear about. And they can keep them informed of continuing technical progress.

At the same time they must avoid feeding exaggeratedly optimistic information in the hope of encouraging growers, for this can lead to future mistrust. On Atiu the Citrus Replanting Scheme was originally advertized as likely to yield 16,000 lb or $NZ310 net per plot. In fact the best plot only ever reached 11,000 lb and $NZ115 (at 1950 prices).

(v) Administration as Coordinato: Because growers in closed

communities may feel uneasy unless others are involved in a project, there is a clear role for an administration to act as a group coordinator. By artificially encouraging a few growers (typically the most respected community leaders rather than the best growers) they may be able to induce others to follow in a bandwagon effect.

For example, no Atiuans voluntered to join the Citrus Replanting Scheme for several years. Then in 1951 the Administration planted out 8 demonstration plots on the lands of some of the more influential men. this encouraged another 16 bolder growers to plant their own crops later that year, and nearly all households followed in the next 3 years.

There are other possible administrative roles. The principle is the smae: to encourage participation and production by reconciling private and social aims. Our observation is that this has been relatively important and successful on Atiu.

How can we test this statistically? The Administration fills several roles in different projects, so we denote its intervention by a dummy explanatory variable (A). This assumes a different value depending on whether projects have no administrative support, whether they have one of the above schemes operating, or whether they hae been effectively taken over by the administration producing on its own account and employing landowners on wages.

We can now include these 2 elements of crop organization, the role of the communityh (C), and the role of the administration (A), as additional explanatory variables of grower participation in various crops.[14] Using the same data base as previously, we now estimate, in table 3, a final function of the form:

$$Y, L = \beta_0 + \beta_1 A + \beta_2 C + \beta_3 P + \beta_4 G + \beta_5 L_0 + \beta_6 V$$

We note that β_1 the coefficient of A is highly and significantly positive, implying that at least in recent times, growers do respond to inceased administrative involvement in projects. β_2 the coefficient of C, is also highly positive: it appears too that growers respond in general to the company of other growers in a project. The inclusion of these organizational details as explanatory variables of grower involvement improves the goodness of fit.

IV. Conclusion and Policy Implications

First, we must recall the limitations of this analysis. We have us-

14 We should note that there may be some multicollinearly between administrative involvement and the other explanatory variables.

ed a quantitative approach based on a neoclassical equilibrium model, that takes no account of the non-Western institutional and cultural rigidities found in the Atiuan economy. Within this framework we have made some particular assumption: that growers regard participation in each project independently of other projects at any time; that the subsistence sector may be approximately treated as being in a steady state for short periods; and that we may treat the explanatory regressions as roughly linear. Furthermore, some of the data used is poor quality.

In view of these qualifications, only a very loose signed hypothesis test is applied; the good statistical fits obtained cannot be taken to mean a complete understanding of Atiuan grower behaviour. But within these limitations most of our expectations have been upheld. It does seem reasonable to expect that grower response to a range of different crops does depend on the crop design and its organization, at least in the *direction* hypothesized. It is more difficult to say anything vey useful about the *magnitude* of response.[15]

Some obvious policy implications may be drawn from this:

(i) *Ex Ante* Crop Design: Introduced projects usually rise from some perceived need and some potential production capability of a community. However, rarely are they explicitly designed to marry the two. Knowledge of the physical and social environment of a particular community makes it possible to lay down guidelines for a scientist to breed a crop to grower tastes, or a planner to select a suitable variety.

(ii) *Ex Poste* Project Organization: More usually a particular crop breed must be accepted. Then the administration may be able firstly to speed its introduction by manipulating existing patterns of communal interdependence; and secondly increase its popularity by using its resources to cushion any undesirable features.

(iii) *Ex Ante* Project Evaluation: A criticism made of most agricultural cost-benefit analyses is their assumption of total grower participation, especially in communities where there are cultural reservations to involvement in the cash economy. In these circumstances an evaluator must appraise the possible range of grower response to various crops, and by sensitivity analysis, determine the effects of these varying commitments on project profitability.

Perhaps more important than these direct policy implications

15 This of course is a common problem throughout economics.

however, is the insight that this type of analysis offers into just what new crops have meant for many Third World farmers, and how they hae reacted to the quite disruptive changes involved. It is this potential framework for the analysis of the interaction of crop and community under change that should be advanced.

References

Behrman, J.R., *Supply Response in Under-Developed Agriculture,* North Holland, Amsterdam, 1968.

Bollard, A.E., *Design and Evaluation of Projects with Variable Labour Response: Case Study of Agricultural Aid on Atiu,* Ph.D. thesis, University of Auckland, 1977.

Firth, R., *Primitive Polynesian Economy, 2d ed.,* Routledge & Kegan Paul, London, 1965.

Meller, J.W., "The Economic Behaviour of Subsistence Farmers," in *Subistence Agriculture and Economic Developmen,* ed. C. Wharton, Aldine, Chicago, 1969.

Menzies, B.J., *A Study of a Development Scheme in a Polynesian Community,* M.A. thesis, Massey University of Manawatu, New Zealand, 1970.

Rogers, E.M., *Diffusion of Innovations,* Free Press, New York, 1962.

Table 1

SUMMARY OF ECONOMIC PROJECTS

		Type of Innovation	Risk	Short or Long Term	Expected Productivity	Maintenance Required	Government Role
I	Oranges	new variety	medium	long	high	medium	high
II	Forestry	new genus	low	long	low	low	low
III	Tomatoes	new crop	high	short	medium	—	high for period
IV	Peanuts	new crop	high	short	low	—	low
V	Taro	marketing of traditional crop	low	short	high	—	low
VI	Coffee	new variety	high	long	high	medium	high
VII	Orange Extn.	new strains	medium	long	high	medium	high
VIII	Private Pineapples	new crop	medium	medium	high	high	low
IX	Vegetables	new crops	high	short	high	—	medium
X	Pineapple Incorporation	wage labour	zero	very short	medium	—	complete

Table 2

$$Y, L = \beta_0 + \beta_1 P + \beta_2 G + \beta_3 L_3 + \beta_4 V$$

	β_0	β_1	β_2	β_3	β_4	R^2
Y55-59 (n=19)	1425.9	4.5 (1.00)	77.0 (1.14)	87.0* (1.45)	−7755.9 (1.13)	.45
Y60-64 (n=20)	−660.4	4.2** (2.19)	−28.8 (0.02)	291.0*** (3.74)	2153.3 (0.40)	.84
Y65-69 (n=24)	4941.2	7.2** (1.81)	182.2*** (2.81)	646.0*** (3.86)	−25116.7*** (4.07)	.80
Y70-71 (n=16)	725.8	4.7** (2.50)	15.5*** (3.50)	46.4* (1.63)	−2824.2* (1.66)	.80
Y72-73 (n=18)	211.9	10.7*** (3.25)	39.4*** (6.21)	49.2* (1.38)	−2843.0 (1.19)	.89
Y74 (n=10)	130.2	4.5 (0.58)	61.5*** (7.20)	53.3 (1.14)	−4040.7 (1.21)	.96
L74 (n=10)	25.2	0.0 (0.13)	1.6*** (6.03)	0.8 (0.52)	−136.6 (1.26)	.97

Note: *, **, ***, imply significantly > 0 at 90%, 95%, and 99% confidence levels.

Source of Data:

L : a measure of grower participation, labour time in hours spent on each crop by an average grower, from a grower survey for one year (1974) only, and unavoidably rough.

Y : a second measure of grower participation, revenue in cents received from each crop by an average grower, from administration records.

P : measure of crop profitability, in cents per hour, derived from both experimental data and Agriculture Department estimates.

G : measure of crop growth rate, a constant, derived from experimental data and Agriculture Department predictions.

L : measure of labour required to initially establish a crop, in hours, from Agriculture Department figures.

V : measure of the riskiness of returns associated with each crop over its lifetime, in cents, derived from administration records.
(Returns are calculated in New Zealand currency.)

Table 3

$$Y, L = \beta_0 + \beta_1 A + \beta_2 C + \beta_3 P + \beta_4 G + \beta_5 L_0 + \beta_6 V$$

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	R^2
Y55-59 (n=19)	-23,516.7	18,906.1*** (6.5)	16,758.5*** (2.86)	27.4*** (7.83)	-1276.5*** (6.07)	-1716.9*** (6.48)	115,795.8*** (6.02)	.95
Y60-64 (n=20)	- 386.5	-524.1 (0.07)	8,973.5 (0.16)	4.3** (2.16)	-20.7 (0.37)	219.9 (0.96)	769.6 (0.11)	.84
Y65-69 (n=24)	3,339.0	1,851.7 (0.60)	57,104.5 (1.25)	9.2** (1.90)	78.8 (1.31)	-115.2 (0.26)	-14,928.7** (2.41)	.78
Y70-71 (n=16)	-137.4	218.7 (0.59)	11,015.7*** (3.98)	1.4 (1.23)	17.8*** (4.69)	18.9 (1.14)	-1,023.5 (1.11)	.95
Y72-73 (n=18)	-645.8	1,349.0** (1.81)	5,495.1 (0.74)	6.5* (1.56)	32.8*** (4.52)	24.9 (0.86)	-1,034.2 (0.51)	.94
Y74 (n=10)	31.4	1.366.4* (1.61)	3,237.6 (0.63)	-4.7 (0.52)	52.9*** (7.18)	18.8 (0.55)	-3,280.4 (1.42)	.99
L74 (n=10)	6.0	33.1* (1.68)	235.6** (2.37)	-0.6** (2.91)	1.44*** (8.89)	0.4 (0.51)	- 83.5 (1.34)	.99

Source of Data:

C: measure of the value of company in a crop, a constant, from administrative records of participation.

A: measure of the impact of the administration, a dummy variable, with value of 0 for crop with no administrative assistance, 1 for crop with any of the administrative schemes outlined above operating; 2 for crop where the administration has taken over the whole management, employing landowners as labour.