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Agricultural project design and evaluation in an island community

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Summary

When an economic project is introduced to a community from outside, all sorts of things can go wrong. One reason is that it is very difficult to design a project specifically to the needs of a particular group. This monograph tells of the experiences of the people of Atiu, an outlying island in the Cook Islands. In the last 30 years many new agricultural projects have been set up there. Atiuans, like other Pacific Islanders, have been very selective about what to participate in and what to ignore. Their responses to these opportunities demonstrates what project characteristics are attractive and why. As a result practical guidelines can be developed on how to design a new project to elicit the most enthusiastic response from a particular community, how the project may be better administered, and the implications for more accurate project design.

Contents

Introduction

I decided to study the problem of grower response to agricultural aid projects for two main reasons. The first was an interest in the pattern of economic change in less developed communities and the reaction to new opportunities there. This is a subject that was studied first by anthropologists and later by sociologists. Economists have not yet formulated a successful general approach to the problem. Analytical work has gone no further than the very basic analyses of the effects of technological change in peasant communities by Mellor (1969) and in more primitive ones by Shand (1965).

Case studies of response to technological change have rarely managed to blend the approach of anthropology with the techniques of economics. One that does so successfully is the study of Epstein (1962, 1973) on the effects of irrigation on two South Indian villages. It was this work that convinced me of the potential of a microeconomic - anthropological approach to the subject.

The second reason for this study was more practical. In my observation of Pacific Island communities, I was interested by the number of development projects that have misfired. Many times administrators have introduced a profitable new technology, only to find that producers are not very keen about using it. Traditional texts on aid (for example, Mikesell 1968) rarely consider the microeconomic response of recipients to projects. Cost-benefit analyses (even the specific adaptations for developing countries by Little and Mirrlees (1968) and their followers) all make the basic assumption of a complete and usually spontaneous producer response to new opportunities. This is despite the work of Berg (1961) and Fisk (1964) in showing the theoretical reasons for a variable labour response and giving practical examples. There seemed a need for an investigation of producer response to different technological characteristics, to allow better design, administration and evaluation of aid projects.

My approach involves the study of a particular community and its experiences with introduced projects. In selecting a community I was aware that the agricultural sector has been the subject of most attempts at structural change, and that farmers have been the most discriminating in responding to this change.

I visited agricultural projects in five countries in the South Pacific before deciding to study the experiences of Atiu, a small island in the Cook group. On Atiu the administration had tried to introduce a number of new agricultural crops of various types over twenty-five years; full records were kept of the results of these projects.

This offered a unique opportunity to study the impact of a whole range of variations on technological change. I returned to the island for six months in 1974-75 to learn about the community, the projects, and growers' reactions. Information came from the administration's historical files, stories of the old projects from growers and administrators involved in them, my observations of current projects and general economic activity, and a survey carried out among sixty growers of crops and labour involvement.

In Part I, I present a case study of the island and life there. In Part II, I construct a model to analyse the effects of the design and administration of agricultural projects on a community. I then test the results obtained for Atiu. This allows me to draw some conclusions and to formulate policy implications in Part III. Constructing a model to explain some observed behaviour and then testing the results according to the original observations is of course at least partly a circular process.

The results are intended to be generally applicable to the analysis of development projects with variable labour response. However, the study was inevitably coloured by those issues that appeared important on Atiu. If the character of a community under study differs from the East Polynesian culture of Atiu, and if the type of project being considered differs from new cash crops, then the relevant aspects of change to be investigated must differ from those studied below.

The case study is at the same time descriptive and quantitative, in the belief that both these approaches are necessary. The model is based on a neoclassical constrained optimization, a method I originally had no intention of using. A number of other methods proved unproductive. I consider mine as a turnpike approach: by making some restricting assumptions I may use all the results of an established method as far as I wish to take them. The problem is getting back to my original destination. The conclusion attempts this by considering the practical policy implications of the theoretical results.

Finally, the whole approach rests on the assumption that farmers in a developing country act just as rationally as perfect competitors in a developed country. If any behaviour appears irrational in the light of some theory, then it is an indication that that theory has not managed to capture the essence of the system.

This work originally appears as my Ph.D. thesis (The Design and Evaluation of Projects with Variable Labour Response, 1977). The main change for the adaptation to monograph form has been that the mathematical model has been omitted and part II relies instead on a brief logical explanation. I wish to thank all those people, both on Atiu and elsewhere, who helped me with the thesis and with the preparation of this monograph.

Alan Bollard
1977

Glossary of Atiuan terms

akaere	administrative tribal head
ariki	paramount tribal chief
atinga	tribute, homage
karakia	master of ceremonies
makatea	old uplifted reef around island
mana	prestige
marae	ceremonial centre of tribal life
mataiapo	chief of major lineage
metua	head of household
orometua	church minister
rangatira	head of minor lineage
raui	prohibition order, e.g. on crops
tapere	subdistricts
tapu	taboo
taunga	old priest
tere	travelling party
tumu korero	tradition-recording body
tupuna	ancestors
tutaka	inspection
umukai	feast
unga	commoner
vaka	tribe
vai rakau	medicine (tree spray)

Glossary of notation

f	grower production function
u	household utility function
ℓ	grower labour input
ℓ_m	minimum maintenance labour
y	grower income
y^e	expected level of income
q	real output
$\bar{q}$	maximum capacity yield
q^*	maturity capacity given current labour level
ε	disturbance term in production
σ^2	variance in production
p	unit product price
C	measure of communal participation
G	extent of Government participation
P	profitability of a project
k	labour productivity parameter
α	rate of growth
λ	rate of adjustment
P°	initial conception of general parameter p
$\hat{P}$	current conception of p
δ	rate of time preference

Part 1
Case study of ATIU

Chapter 1

Atiu the island and the people

The physical environment[1]

The fifteen islands of the Cooks lie 2,600 km northeast of New Zealand, and spread over 2 million square km of ocean. Rarotonga is the main island. Atiu is 180 km northeast of Rarotonga: it is a small island populated by 1,380 (1975) Cook Island Maoris of East Polynesian origin. At a latitude of 20^{o} the climate is warm, moist and tropical in summer, drier and temperate during winter months.

Atiu is a raised coral island, oval-shaped, 6 km long by 5 km wide, and 2,695 ha in area. It is the apex of an old, weathered volcano rising 3,000m from the sea bed. A central cone of basalt has been deeply eroded and a surrounding belt of exposed coral reef either uplifted or left exposed above sea level; a new fringing reef has formed.

In the centre of the island a series of flat-topped ridges radiate out from a maximum height of 70 m. The villages are sited on the highest parts in the very centre of the island. From these ridges deep eroded gullies drain down through bush-covered slopes and into lowland swamps on the inner margins of the *makatea* (the old uplifted reef around the island) and, in one corner, into a lake. The *makatea* itself is about 20m high and a half to one km wide, studded with limestone pinnacles and depressions. Outside this is the steep and rocky coastline, encircled by a close reef that has several natural openings to the ocean (see Fig. 1).

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[1]Menzies (1970) provides a much fuller account of the physical geography and ecological variations found on Atiu.

Table 1

Ecological zones

	Coastal Reef	Makatea	Swamp	Hill slope	Ridge tops	House Sites
Area	-	1,607 ha	119 ha	728 ha	179 ha	62 ha
Geology	Live coral	Elevated, exposed and eroded limestone	Fine alluvium	Basaltic alluvium	Deeply eroded basalt	
Natural vegetation pandanus	Coconut, pandanus, *toa*, etc.	Coconut, pandanus, candlenut, etc.	Native grasses	Fern, guava, coconut, etc.	Fern, guava, casuarina, grasses	
Cultivated	-	Coconut, pawpaw, *Tarua*, *kumara*, yam, banana	*Taro*, *tarua*, banana, coconut, *puraka*, *kape*	*Kumara*, yam, arrowroot	Arrowroot, yam, *kumara*	
Project crops	-	Orange, coffee	*Taro*	Tomato, coffee, orange, vegetables	Forestry, peanuts, pineapples, vegetables	

Map Reference (see Fig. 1)

Source: Adapted from Menzies (1970), Grange and Fox (1953).

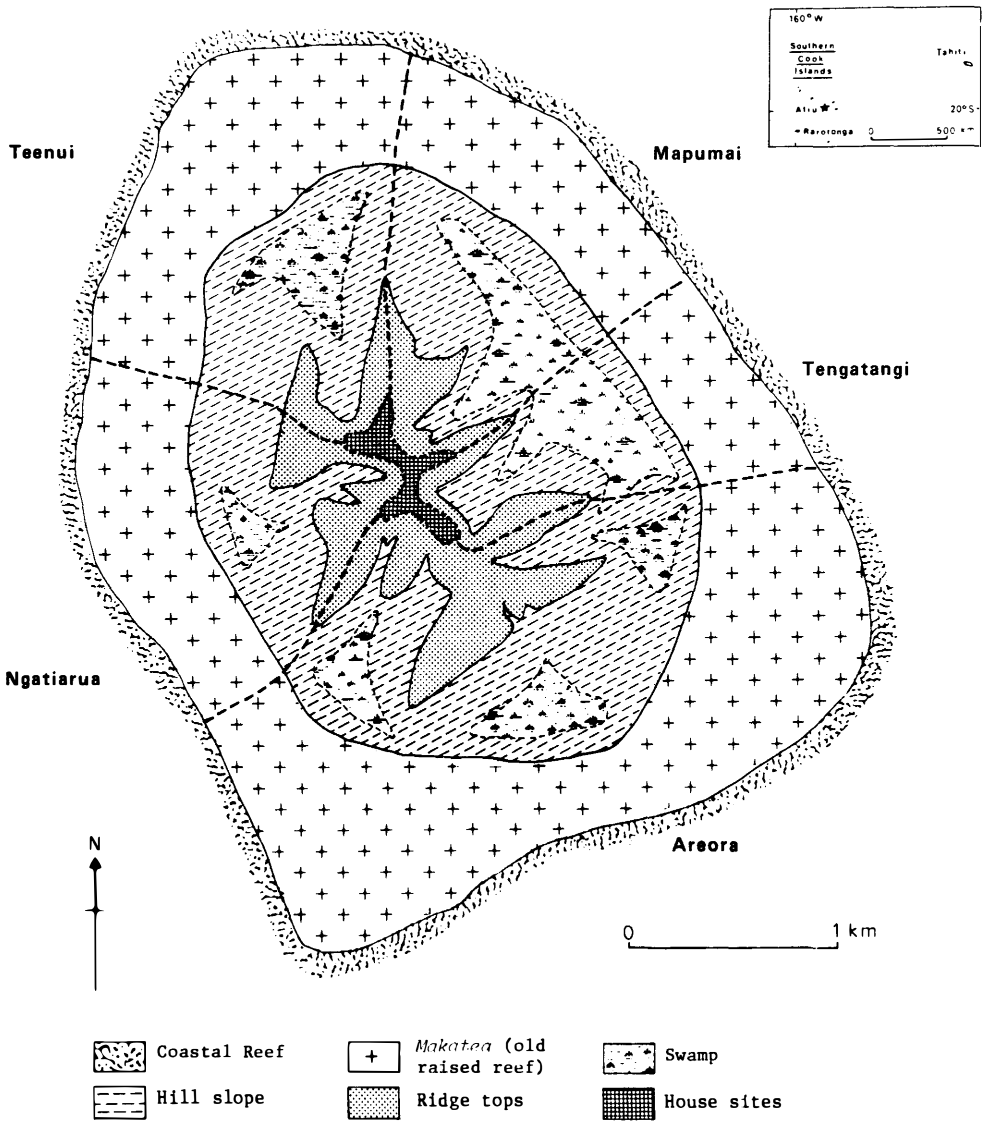

Fig. 1. Map of Atiu

<u>Source</u>: Adapted from Menzies (1970), Grange and Fox (1953).

The distinct geological structures on the island (Marshall 1930; Grange and Fox 1953) affect the zones of economic cultivation and patterns of social organization. The ecological zonation is so distinct that it may be usefully categorized as in Table 1.

- The scrub-covered ridge tops hold leached, infertile soil, long thought to be incapable of good crops. However, pineapples have been grown there recently with heavy fertilizer use.

- Steep slopes running down from the ridges to the valleys cover much of the island; part is in dense bush, part is cleared for planting. Most root crops and tree plantations are here.

- The swamps contain a moist easily cultivated alluvial soil. Swamp grass grows wild, and the carefully irrigated taro patches are constructed here.

- The *makatea* is heavily wooded and contains a few pockets of very fertile loam where a few crops are grown although most is very rocky. Pigs are kept, and people hunt for crabs and honey or gather berries, fruit and leaves.

- The reef is a rocky shelf with large pools containing small fish and seafood.

- In the open sea, the most adventurous spear and hand line for fish.[2]

Demography

Population growth. McArthur (1968) gives an authoritative account of population change in the South Pacific. She quotes several independent early estimates that suggest the population on Atiu may have been as high as 2,000 in the eighteenth century. These were probably exaggerated but they do suggest that the island could

[2] For further detail on identification of vegetation see Barrau (1961); he uses Atiu as an example of a typical Polynesian raised coral atoll.

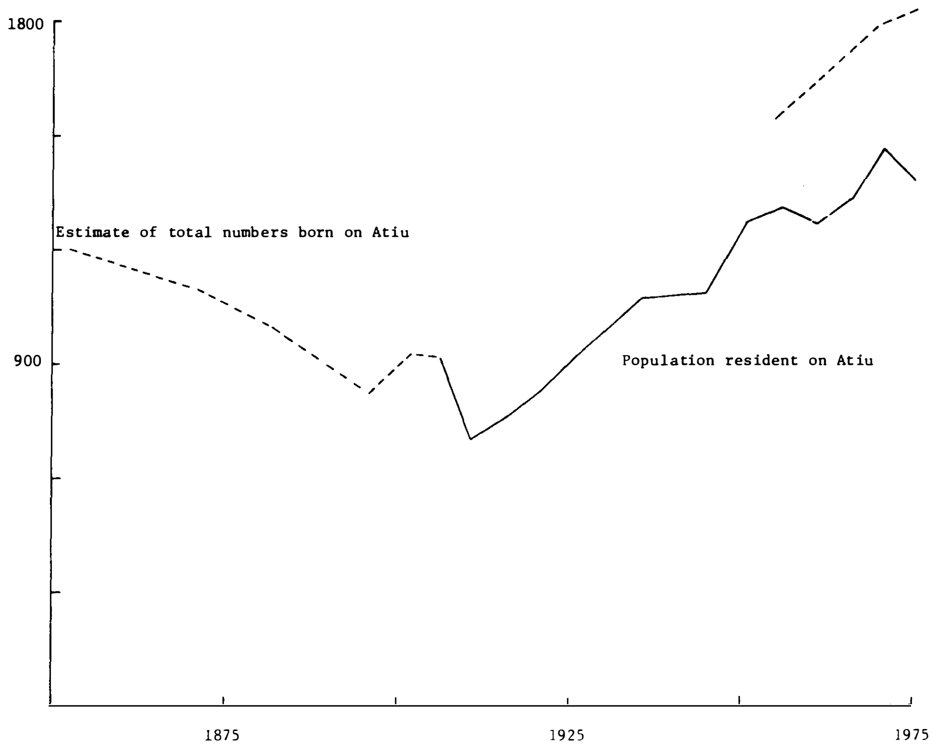

Fig. 2. Population of Atiu, 1850-1975

Sources: Estimates of Atiuan-born from Register of Births and Deaths, Atiu. Resident population from : 1852, 1876 Gill estimates, 1881 Harris estimate, all quoted in McArthur (1968); 1896-1961 Censuses, Appendix 3 to Journal of House of Representatives; 1966 and 1971 Censuses, Cook Islands Government; 1975 Population Count, Atiu Administration.

support at subsistence level a higher population than today's.

In the 1840s missionaries reliably established the population as being between 900 and 1,200. For the next seventy years it dropped slowly but significantly. There was some early migration to Rarotonga and Tahiti, and the population was also adjusting to introduced European diseases that were so virulent in some parts of the Pacific. (There was an outbreak of dysentery in 1891.) The population reached its lowest in 1915 (see Fig. 2). Gradually the birth rate stabilized and the death rate dropped as people received better care, especially in old age. The infant death rate remained very high as late as the 1960s when it too dropped. In the last thirty years the annual rate of natural increase has risen from around 2.4 to 3.6 per cent.

Growing migration has been balancing this natural increase. For a long time Atiuans have travelled freely within the Cook Islands; in 1966 630 Atiuans lived on neighbouring islands and only 208 non-locals lived on Atiu. There is an Atiuan community in Tahiti. Cook Islanders have always had free access to New Zealand; increasingly this is their destination. It is estimated there were about 500 Atiu-born immigrants in New Zealand in 1971. Birth, death, and population data from Atiu suggest that annual population loss from migration was about 50-60 for the last thirty years, providing a safety valve for population pressure.

Population distribution. Total population has not changed very much, but its distribution has. The most obvious effect of growth and migration has been to decrease the labour force and increase the number of dependants too young or too old to work. Table 2 shows a steadily increasing dependency ratio, rising to 62 per cent in 1975.[3] Yet birth and death figures suggest that this ratio was as low as a quarter for all Atiuan-born inhabitants and migrants. Clearly the migrants have been drawn almost exclusively from the work force. The age distribution histograms in Fig. 3 confirm the increasingly top- and bottom-heavy population on Atiu.

Table 2

Dependency ratios (per cent)

1896	1936	1945	1956	1966	1975
35	46	51	54	60	62

Source: Population censuses.

[3] The dependency ratio is here defined as the proportion younger than 15 years or older than 65.

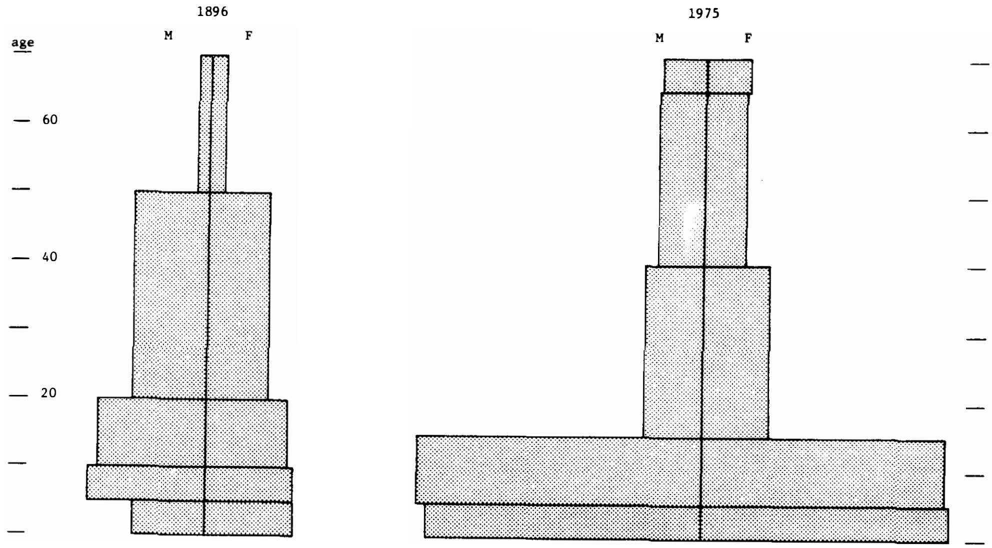

Fig. 3. Age distribution, 1896 and 1975

Sources: 1896 Population Census, 1975 Population Count.

The people live in villages built in the middle of the island, each at the apex of a segment of land constituting a district. As shown by Table 3 population and land area differ considerably between villages. So, for example, land is more closely cultivated in Teenui than in Ngatiarua. But each household holds land in different villages and most have more than they can use, so this is not a pressing problem.

Table 3

Distribution of population, 1975

Village	Household	Population	Land (ha)
Ngatiarua	24	124	675
Tengatangi	38	281	405
Mapumai	28	181	405
Areora	53	391	890
Teenui	57	403	320
Total	200	1,380	2,695

Source: 1975 Population Count.

Political and social history

This section summarises some generally accepted interpretations of Atiuan pre-contact and recent history and the effects this historical experience has had on the social and economic structure of the island. Knowledge of genealogies, local myth and legend are highly regarded on Atiu today; such things are actively researched and recorded by the *tumu korero* group. I have based this section on comments by several expert Atiuans, by early traders, missionaries and administrators, and on Land Court records.[4]

Pre-Contact experience. Genealogical evidence suggests initial settlement of Atiu took place about the thirteenth century A.D. During the sixteenth century a second group arrived and, after fierce warfare, defeated the original inhabitants and established themselves. They created seven titles known as *mataiapo*, one for each of their related descent groups. The island was then divided into seven districts with a *mataiapo* responsible for each, the island to be governed jointly by them. This period (the 'Rule of Mokoero') lasted through twelve chiefly reigns and was far from peaceful.

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[4]Crocombe (1960, 1964, 1967, 1972) has done the authoritative recording.

Eventually two factions developed: the three northern districts rallied against the four southern. About the mid-eighteenth century the original settlers, who had been living in caves, tried and failed to resume control. The victorious southerners elevated their senior *mataiapo* to the new high chiefly rank of *ariki* (entitled Ngamaru). Soon afterwards the northern districts demanded their paramount *mataiapo* be made an *ariki* (Rongomatane), and this was done. To avoid a split or a confrontation several lesser *mataiapo* were created so that each *ariki* had control of his own group of districts and had at least one *mataiapo* in every other village. This system of checks and balances in allegiance remains today. Some years later a second northern district also elevated its senior *mataiapo* (Parua) to the rank of *ariki*, making three on the island. These three (interrelated) lineages still hold the titles today, and the order in which they were created reflects their status and the precedence of their villages.

Each *ariki* had his own *akaere* (an intermediary between chief and community) who organized day-to-day business. At the island level a chief *akaere* acted as liaison between the *ariki*; at the village level, lesser *akaere* carried out chiefly commands. A *karakia*, or master of ceremonies, was a dignitary important in ceremonies such as the installation of the *ariki*. Below these were the *rangatira*, each the head of a minor segment of his chief's lineage.

This tribal arrangements has continued until today. It has never been a stable unified structure, but rather a collection of three small hierarchies in a state of continual change and readjustment to one another and to outsiders.

Atiu maintained a tradition of conquest and colonization among the surrounding islands. At one period Atiuans controlled the 100 km-distant atoll of Manuae. They used the nearby uninhabited island of Takutea as a fish and bird reservoir. They are known to have travelled as far south as Rarotonga. By the early nineteenth century they were in possession of the neighbouring islands of Mauke and Mitiaro, controlling political life there, and preying on them for food and women. Occasional revolts were repressed savagely; reprisals continued until the 1840s when they were stopped by the influence of missionaries and the arming of the Mauke people. Yet Atiu *ariki* continued to exert influence over these islands throughout the nineteenth century.

Early European contact 1820-1900. In 1777 Captain Cook briefly visited the island; he was followed by infrequent explorers. Because there were neither harbour nor obvious resources, there were few traders. More important were the missionaries of the London Missionary Society who arrived in the 1820s and soon converted the island to Christianity. This had two consequences:

(i) The people lived in scattered groups mostly on the lower slopes of bush near their gardens. Missionaries resettled them in five adjoining villages at the centre of the island, each still in its own district. This unified island life as never before.

(ii) In contrast to other islands, Atiu was left to the care of Tahitian or Cook Island pastors. They wielded less prestige and political influence than Europeans and most came under the influence of an *ariki*; this was the only way for them to get land.

New contact with outside had given the *ariki* new ideas of chiefly rights they might exploit. They began to exert influence over the church, which offered them direct and strong control over a centralized population unified by religion. In earlier times chiefly acquisitions from commoners (*atinga*) were a basis for economic redistribution and immediate consumption. There was no accumulation of wealth for its own sake. But trade offered opportunities for this. The chiefs became the middlemen in the export of produce such as arrowroot, coconut oil, and fresh provisions, even running market houses. They did this by using their traditional roles as trustees of the land and mobilizers of labour and by controlling (through land and marriage) the operations of the few European and Chinese traders to live on the island.

This economic activity climaxed with the reign of Ngamaru Rongotini Ariki who, for a variety of personal reasons, wielded more power than any one previous chief. He clashed with the church in collecting tithes and trying to assume a religious role for himself. He organized and encouraged production of copra and other produce for many years, and in 1895 bought an 87-ton trading vessel on behalf of the island. While Atiuans respected his power and position, they found his increasing demands for cash and labour oppressive, especially in his later years.

These chiefs also exercised the only administrative and judicial power through *ariki* courts which levied fines. Until the British Protectorate came to Atiu in 1888 they were the only civil authority. The British declared they would not interfere with *ariki* government. From 1892 Atiu received a small subsidy for administration from the Rarotonga Federal Parliament. All government posts (judge, postmaster, police) were *ariki* nominees.

The period of transition, 1900-50. Atiu became part of New Zealand in 1901. Crocombe (1967) calls this a watershed in Atiuan history: annexation changed Atiu from the dominant member in the surrounding group into a small part of a small colony of a small nation. At the same time internal chiefly power and leadership diminished: the Rarotonga-based Resident Commissioner made a deliberate attempt to curb the power of the *ariki* and eliminate *atinga*.

New Zealand law now applied to the island. Tariffs, trade and revenue were put under New Zealand control. Positions held by Atiuans through the chief were taken over by outsiders. A European trader was appointed resident agent to take over responsibility for administration and for the *ariki* courts; in 1906 he was also made magistrate. The Native Land Court was set up, and by 1919 it had begun investigation into Atiuan lands. This struck at the very roots of chiefly power, because it awarded to lineages a title to planting lands that was held independently of the will of the *ariki*. This eventually eroded customary food and labour tribute paid to him.

With few chiefs of high calibre, limits on their power, and no attempts to train islanders in administration, Atiu was left without effective local leadership. The resident agent could wield a lot of personal influence over the island; but islanders held no sanctions over him as they had over their own chiefs, and they tended to withdraw from European economic life. Atiu was governed in this way until 1965 in a system Crocombe (1967:11) calls 'a passive but benevolent paternalism, the authoritarian government of a leaderless people'.[5]

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[5]In 1965 the Cook Islands achieved internal self-government, and today Atiu elects two members to the Legislative Assembly in Rarotonga.

Religious schism and economic recession aggravated the social climate. The Roman Catholic Church gained a foothold in one village in 1919 as part of a protest movement. When a Seventh Day Adventist Church was set up later, interdominational antagonism was rife.[6] Economic production declined to a single cash crop (oranges), and when these orange trees began to die mysteriously in the late 1940s, a movement of political discontent arose which Crocombe interprets as a cargo cult. This was a transitional period of social withdrawal and readjustment. The aid projects introduced over the next twenty-five years were intended to appease it.

[6]Today approximately three-quarters of the population belong to the Cook Islands Christian Church (London Missionary Society) and a sixth are Catholics.

Chapter 2

Socio-economic organization

The household

The household has been a basic unit of economic and social organization for some time, especially since European contact. It is currently in transition between an extended and a nuclear family. This loose grouping, based on kinship, often includes temporary or permanent visitors, guests, distant relatives and adopted children. It is a flexible grouping and very mobile.[1]

This poses a problem of definition: the same group of people frequently do not eat and sleep together. The more significant economic grouping - those who grow crops together - is not always based on kinship or neighbourhood. A household is arbitrarily defined here as that group of people who regularly eat together.

By this measure there were 190 households averaging 7.3 persons on Atiu in 1975. This number has hardly changed over the last twenty-five years. What has changed is the composition: there are more older people and many more children, but fewer working age adults. The dependency ratio has risen significantly.

It is always possible to identify a household head who makes decisions, usually the oldest active male who holds the land rights. He plans and directs planting by the family. Since an extended family may plant the same crops on scattered plots of land, the head must ensure sufficient of each is grown.

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[1] During my six months fieldwork household composition changed significantly, though each household retained the identity of its head.

Several branches of a family may work together only on certain occasions, for example to cultivate a jointly-owned orange plot. Then a respected senior member will organize and co-ordinate the work. Several households may plant together. This is often a useful arrangement between friends or neighbours with adjoining lands, rather than a formalized kin relationship. An elderly childless grower may gain security this way.

Clearly household grouping is an arrangement of convenience rather than of strict convention. An extended household may appear loosely-knit, but it can combine for economic strength. The family of Iva provides an example.

Iva is a 70-year-old Atiuan, the head of a large extended family household typical of household size and organization in the past. Eighteen people live in three family houses built round a compound. Iva lives with his wife and an elderly woman friend. They do little economic work, though Iva has the right to control planting decisions and affairs of the land. They receive old age pensions worth $800 yearly and a small rent from the government for land it uses as a planting nursery.

In the same house live the last of his sons to remain on Atiu, and his wife; they are childless. The 30-year-old son is a casual labourer on the government pineapple scheme earning $800 in 1974, and he also sells a few vegetables. He co-ordinates the family planting to ensure enough of each crop is grown on the scattered plots. He grows subsistence crops and raises the family pigs. His wife is a teacher earning a salary of $1,270 per year. They regularly buy foods which are pooled with the rest of the household and cooked by the women for the collective meals.

In another of the houses lives Iva's 45-year-old daughter with her husband who has a permanent labouring job with the Agriculture Department. He earns $600 annually. He does a minimum of subsistence planting which causes ill-feeling with Iva's son, but he looks after his own pigs and grows coffee on his own land ($250 worth in 1974). He also receives some money from relatives in New Zealand. They have nine children.

The third house is still being built and is occupied by two of Iva's grandsons aged 20 and 17. The older one was working recently in New Zealand and he brought back $400 to pay for building materials; he now does occasional labouring on Atiu. The younger one earned about $550 labouring for the government in 1974. The two boys spend a lot of time working on subsistence crops on their own land under their uncle's general direction. They have no pigs or tree crops. They too buy food and eat with the others.

When some urgent work (such as picking oranges for a shipment) arises, all the family including children may help. They may also all work together in village work parties, except for the son-in-law whose allegiances lie in another village. The total income of this extended household in 1974 was $4,830, a relatively large amount and secure because it came from many sources.

The household work force. Everyone in an Atiuan household does some work: young children help around the house and feed animals as they play. They are very useful in fruit picking.[2] Frequently on holidays the whole family works together, the children learning the rudiments of agriculture. While of school age, a boy helps his father in most plantation work, and at about 15 years he is given his own taro plot on a separate piece of land, to be cultivated under direction if necessary. This is symbolic of attaining manhood.

Retirement from work is gradual, depending on health rather than age. A man over 60 may hand over everyday management to his son, but continue to do light tasks on the plantation, and continue an active interest in all land affairs. When he is too old to work he will be supported by his children or other kin.

There is a defined division of work by sex but it is not a rigid one. Women do some of the lighter and more tedious time-intensive agricultural jobs and also most of the cooking and housework. Half the teachers on the island are women and there are a few nurses, but there is not much more opportunity for them to earn money. Most women spend a lot of time working at community tasks, especially the regular sewing circles. Table 4 specifies the role of women and the time they spend working.

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[2] My field survey showed children contributed significantly to gardening work in about 20 per cent of households in an average week.

Table 4

Division of labour by sex, and female work patterns, 1975

	Male role	Female role	Female work (av.) Hours weekly	% Women involved
Cultivation	Most agricultural work	Weeding and harvesting,	1.0	20
		feeding animals	1.5	50
Hunting and gathering	Collecting firewood, hunting crabs, honey, reef and sea fishing	Fruits and nuts, handicraft materials, reef foods	1.2	50
Employment	Most wage work	Few teachers, nurses, shopkeepers	2.6	8
Home	Heavy cooking and food preparation	Most cooking, cleaning and child care	n.a.	100

Source: Field notes, field survey, 1975.

These roles are flexible and this compensates for the large variation in household size caused by extensive migration. Some households have four or five adult males living in adjoining dwellings and planting large areas; they can afford to specialize in planting, fishing or wage work. At the other extreme, thirteen households have no economically active male at all. Many of these received large remittances from emigrant husbands and children who feel obliged to save and send whatever they can. At least one woman does all her own planting; and several men, husbands of teachers, sit at home all day ostensibly baby-sitting. Children may be borrowed or adopted to help with work. Old couples and a few cripples on the island are supplied food by relatives and neighbours.

A son wanting to migrate first asks permission of his family. Permission might be withheld because the son is the last adult male left at home. A temporary migrant works very hard and saves regularly. A permanent one sends back money especially at Christmas, birthdays, funerals, but these remittances may decline over time. His family in Atiu is free to write to him requesting money or gifts.[3]

How do Atiuan men spend their day? Most rise early to take advantage of daylight. Many have taken on regular wage jobs in the last few years and these are disrupting established work patterns. These labourers work from 7 a.m. to 3 p.m. on the government agricultural schemes; only then can they walk or ride down to their planting lands to do regular chores like feeding animals and gathering food crops. They may then choose to work on their own, or work with a group, rest or drink. Those without regular employment, especially the older men, follow more traditional work habits: they spend much of their day on the plantations, working early and late but resting through the hottest hours. The field survey showed that in an average week a grower would spend 22 hours working for wages, 14 hours planting and fishing on his own, and another 5 hours engaged on communal work.

Household capital. Despite differences in earning ability, Atiuans own very similar houses. Most built a standard block house with a loan from a government rehousing scheme that began in 1962. To build a house a man asks his relatives for their help. He pays for materials and kills several pigs for a large *umukai* (feast) on completion. He feeds the builders; the master builder, who is paid by the government to supervise the scheme, receives the biggest pig as well as gifts such as woven mats and shirts. Informants comment that today it is increasingly necessary to hire workers from outside the family to build a house.

Houses are simply furnished with furniture built at home to a standard design, with local handicrafts, and with a few

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[3]These may be sizeable: one informant enthusiastically told me he had written to his daughter in New Zealand asking for a small boat with an outboard motor, and next he intended to ask for a truck to carry it.

store goods - a transistor radio, a kerosene cooker, sometimes a sewing machine. Cheap motorbikes are increasingly popular for leisure and for transport to the planting lands; there were about fifty in 1974. Several returning migrants have brought back lawnmowers and three people had small electricity generators. A few men have built water tanks for their homes and purchase of a kerosene refrigerator may be tolerated. However, there are derogatory comments about people who are too acquisitive.

Land on Atiu

In early days land meant power. Today land tenure is still a sensitive and complex issue difficult for an outsider to probe. Land remains a source of prestige and non-monetary wealth. Land tenure in Atiu has been thoroughly researched by Crocombe (see Crocombe 1960a, 1964, 1967, 1972). For these reasons this section is mainly a summary of published knowledge.

Land tenure and the Land Court. Lands on Atiu are divided into different blocks, each controlled by a lineage. The three *ariki* with the four senior *mataiapo* each head a land district containing a village (one large village sprawls over three districts). Each district is divided into several *tapere* (subdistricts) controlled by a separate lineage under a *mataiapo*. Each *tapere* is based on a valley and ideally radiates out in a segment shape from the centre of the island to the coast, containing a cross-section of the different ecological zones of planting and gathering lands.

Control over land is the basis of social hierarchy. Table 5 shows the correlation between tribal rank and land rights.

In 1902 a Maori Land Court was established in Rarotonga. The Court has since surveyed Atiuan lands (mostly since 1951), and has vested ownership of each block in one or more family heads in proportion to their accepted claim. Each family has rights in several blocks. Crocombe (1960a) estimated the average commoner was at that time a right-holder in six blocks of land in his own village and five blocks outside. Members of *ariki* families held rights in twenty-nine blocks on average.

Table 5

Tribal rank and land rights on Atiu

Title	No.	Rank	Land rights	Land sections
Ariki	3	Paramount tribal chief	District (incl. 4 *mataiapo*)	7
Mataiapo	c.30	Chief of major lineage	*Tapere*	25
Rangatira	c.80	Head of minor lineage)	Unspecified rights in various blocks (on av. 11)	504
Metua	c.110	Head of household)		
Unga	c.1150	Commoner)		

Source: Crocombe (1960a, 1964).

Several factors have complicated the workings of the Land Court over time. Awarding legal rights to all natural and adopted heirs irrespective of their need, their present abode, or their intentions to use the land, has led to a multiplication of owners. Individual shares have become smaller. In 1959 the average block of planting land (2.5 ha) had eighty shareholders; today this fragmentation is worse.

The decisions of the Maori Land Court lacked the flexibility of pre-contact custom; traditional practice had been to inherit from only one parent. Also absenteeism or ineffective cultivation meant a grower lost his land rights. Some informants claimed that the European surveyors of the Land Court were misled over boundaries by the few English speakers among the Atiuans.[4]

[4] One informant told me his family lost land rights because his grandmother, the title-holder, was too drunk on the day of the survey!

It is only because migration has eased pressure on land resources that this clumsy system has survived. A landowner who migrates may lend his rights to others in the block. Another shareholder who takes over an emigrant's land without permission risks a dispute. In principle a landowner should obtain the permission of all others before he plants on that block. The many scattered shareholders makes this impossible. In 1959 a quarter of land rights were held by residents of the local village, a quarter by other villagers, and the rest by migrants. Today absentee ownership is even worse.

Land rights. In this setting, land 'ownership' has never been a rigid concept. Rather it is an expression of the varying rights of different people to use different types of land for different purposes. For example, Crocombe differentiates between the rights of the tribe, of the major and minor lineages, and of the household, all over one piece of land. Again rights in a house site differ in nature to rights over planting lands, swamp rights, and reef rights.

Furthermore, there are differences, in short-term cropping rights, rights to hunt and gather, rights to fish, rights to extract tribute or payment, and rights to travel. The Land Court vested all these rights in the landowners. But in practice such rights are determined by the shadow prices of resources: crops growing wild and plentifully (passionfruit, nuts, guava, pawpaw, breadfruit) may be occasionally picked by anyone for family consumption but not to sell. Anyone can refresh themselves but not collect and store crops that grow wild but are scarce or commercially valuable (coconuts, wild coffee, native oranges); crops that have been planted and cultivated (oranges, root crops) should not be touched. Today anyone may gather foods off the reef or fish the sea anywhere, though passages through the reef belong to the *ariki*. Certain resources occur only in particular places and they belong to the local landowners. A special spring containing fibre-strengthening chemicals is more than enough for the whole island and there is free access. But a cave containing coveted freshwater eels which could easily be overfished is jealously guarded by the right-holders.[5]

[5] Access to a special resource may require payment; a minute of the Maori Land Court reads: 'When anyone wants timber or lime from this land, they make their request to us

Even the final use of land is relevant; rights to exploit a block to raise funds for the church are more likely to be granted than rights to exploit it for private gain, for example.

The changing nature of land 'ownership' may induce unusual economic behaviour. For example, planting a tree crop like oranges or coconuts may be used to establish or confirm an individual's long-term claim over a plot of land. It would be antisocial for another right-holder to interplant his crops among these trees unless they have been abandoned. There are cases of competitive planting among orange growers: one branch of a family plants a plot of oranges on a piece of land. Another branch immediately plants another plot next to it, to reassert their claims and interest. Such plots are poorly maintained.

Traditional rights do not guarantee that other landowners will not claim a share of a grower's harvest. To avoid this the Court introduced the 'occupation right' - the agreement of all owners that one person should have sole right to the proceeds of a tree crop.

Distribution of land. Clearly land distribution was and still is far from equitable. It was formerly based on a stratified rank system, and has since been affected by luck of inheritance and the arbitrary rulings of the Land Court. But every grower has sufficient land to raise his crops. Only one case was observed where a shortage of a particular class of land actually constrained production.

Land is considered to have a pedigree; to treat it as a traded good in the European style would be sacrilege for many Polynesians. Land may not be bought or sold, and is rarely rented. Crocombe (1960a:15) comments:

> Due to the large numbers of right-holders, almost half of whom have migrated to Rarotonga, New Zealand and elsewhere, it is virtually impossible to negotiate a lease, which is the only legally recognised form of transfer of land rights. This leads

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5 (Continued)
today as they did to our *tupuna* (ancestors) in the past. Such persons used to bring pigs to pay my *tupuna*' (Minute Book 2, p.14, 1950).

> to informal arrangements about the use of land for cash cropping which are not only short-term and insecure, but also conducive to exhaustive techniques of land use.

Flexible land customs, traditions of hospitality, and wide kinship ties mean those who lack them can usually borrow lands, so that in practice land distribution is reasonably efficient. Several cases where growers borrowed specified pieces of land from kin for short-term cropping were noted. In most cases the borrower would give a few kits of produce on harvesting in acknowledgment. Worst off were the 200 islanders born outside Atiu: they had to plant on their wives' lands or borrow from friends. It was common to lend tree crops to a less well-off relative. It was also common for two men, often brothers, to plant a crop together and then split the proceeds in proportion either to the work done, or their relative needs.

Restraints can be exercised over Atiuans who tried to take advantage of land customs. Any grower showing too keen an entrepreneurial skill in amassing undistributed wealth could find other title holders making it hard for him to increase his land holdings.

> The exploitation and control of the land is at present still generally workable because of the respect accorded to the elder resident members of the family, but this respect is fading and there is already a noticeable trend for the most acquisitive right-holder to take control of the land. This trend is just emerging on Atiu (Crocombe 1964:128).

The Village

The village also provides a basis for work and co-operation. Atiuans bear deep allegiance to their village of birth as a social unit. This allegiance continues despite considerable intermarriage, with some men living and planting on their spouses' land in other villages. The five villages are joined geographically but they are socially distinct entities.

Village meeting houses. Each village is wedge-shaped, sprawling down a ridge away from the centre of the island. At the apex of each stands the meeting house on a grassy section. These large verandah-sided halls are the focal point for village life. They are owned by the church and controlled by the deacons, but are used mainly for secular activities. Here take place weddings and funerals, men hold church and village meetings, women sew and talk, children play. They are frequently in need of maintenance and it is a continuing job to raise funds for them.

The meeting houses were originally built by the Cook Islands Christian Church around the turn of the century. In 1952 a young deacon returning from overseas found them badly dilapidated and suggested rebuilding them. He encountered opposition from the elders in Teenui, his own village, but he used his prestige (he was heir to an important island title) to enlist a group of forty young men of the village to help him. They cut timber from the bush. They earned money clearing sites for citrus plots; building materials cost them $40. The deacon used his rudimentary drawing knowledge to redesign the building. Then, donating their labour, the group substantially rebuilt the heavy hall. Teenui village was very proud of the result. Other villages were also impressed and organized local groups to rebuild their own meeting houses. The Teenui deacon agreed to supervise work on these too.

In early 1975 the Teenui village fund raising committee decided their meeting house needed new seats. They ordered the men of the village to help with contract taro patch making at a time that would not interfere with normal work. The next Saturday at 4 a.m. deacons blew conches around the village to wake everyone up. About thirty-five men (half the local population) assembled with tools at the meeting house in the dark. A truck drove them down to the taro swamp. There they worked in two gangs digging and slashing. By 7.30 a.m. they had made three taro patches for which the owners paid them $37. It was generally agreed that this was a good effort. This work was repeated for the next three Saturday mornings, by which time people were becoming tired of it.

On Easter Saturday a dance was to be held. The young unmarried girls of Teenui spent a week practising song and dancing items for it. The older women tutored them, and much of the village turned out to watch the evening practices in the meeting houses and to gossip. The items brought contributions from the audience of $20 to $30: not very profitable but enjoyable for all, and an important way of passing on traditional culture. With all the money earned wood was bought from New Zealand, and proper seats made for the meeting house.

Village committees. The formal body that organizes village life is the village committee. This comprises a number of locally elected representatives plus the village *mataiapo*. They have the power to organize village labour for public works and have done so extensively in the past.

In the 1950s every adult male was required to do public work organized by the village committees without payment each Monday morning. They made communal rubbish tips, bathing holes, water tanks and village roads; the government paid for materials. After lapsing for a period the committees were revived in the late 1960s for another period of intensive work: they made concrete blocks for housebuilding, maintained main roads, cleared plantation tracks, lined new washing holes, built large holding tanks in each village, improved the landings, and built drains through the village taro swamps.[6] In 1974 village committees were still active, though they were tainted by political intrigue and this earned them disrepute.

An active village always needs money for one project or another; fund-raising efforts and communal work parties organized by the village committees, by the *akaere*, and by energetic individuals are important unifying forces in village life. In 1975 one village was raising money for four different funds at once: for their meeting house, their roads, the church, and a travelling cultural party.

The bush beer schools. Next to the households the most important work groups are undoubtedly the bush beer schools. There are six of these on Atiu, and they correspond roughly to village boundaries, with drinking habits strengthening

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[6] Remaining records show this involved considerable effort: in 1971 village work took place roughly once a fortnight, when about 30 workers would turn out for each village. In only 6 months they worked a total of 16,000 man hours, volunteering labour then worth $5,000.

village allegiances. Each school is approximately centred on a taro swamp and most of its members plant there, though men may visit other schools.

Home-brewing is illegal, and at one time all drinking was done covertly deep in the bush. Drinking groups were informally organized, usually friends or neighbours who liked to work together. They made an orange brew fermented with hops, and this used a lot of oranges.[7]

By the 1960s drinking had become much more open. The schools formalized past patterns of allegiance and work, and today they are well organixed to cope with the high level of social drinking. Each school offers relaxation among a sympathetic group of men; it presents opportunity and incentive for communal work; it allows drunkenness and escape from economic reality.

A school contains twenty to forty members, elects officers and keeps accounts. One or more times a week members mix a brew of beer in a large tree trunk, combining purchased hops and sugar with local fruit (malt is an increasingly popular substitute). After a few days the brew is ready to drink. To pay for it members work as a group once or twice weekly, making taro patches for one another: this is a heavy, dirty, arduous job and it is made more pleasant by company. The plot owner is charged for the work, depending on its size and difficulty and also on his ability to pay. Any member absent from the work is fined.

For example, in the Mapumai-Tengatangi area a bush beer school was operating in 1975. For the three weeks after Christmas they had not worked, and their funds dropped to $5. So the chairman organized them into making taro patches every Tuesday and Thursday afternoon; they earned $63 over the next three weeks. They brewed two 30-gallon tree trunks of beer a week, and they would drink it on Thursday and Friday evenings and all day on Sunday. A typical brew (30 lb of sugar, 10lb of malt and a half packet of hops) cost $24.

When money is not needed, the men may work on one another's plots unpaid. Or they may agree to be paid in food:

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[7] I estimate up to 3,000 cases per year were used this way, a significant part of production.

there is always plenty of work to do. The field survey shows the economic importance of this work: 70 per cent of all growers hired bush beer gangs at some time. The gangs built 40 per cent of all taro patches in 1974. On average growers spent 1.5 hours per week working in these gangs, constituting 10 per cent of their subsistence work.

They earned money working on members' taro plots, rotating between the Mapumai and Tengatangi ends of the swamp. For example at one work party: the first of the workers strolled down to the taro swamp when their government work finished at 3.30 p.m. Nine men started to work on the appointed patch. After a while the number rose to twenty-three. The men worked systematically: about ten worked at any one time while the others rested. Two of the older men slashed the weeds and two others carried them to be dug under as compost. Then came six young men doing the heavy digging. It was hard and hot work, but a fairly large taro patch of 400 shoots was dug over ready for planting in an hour. Everybody washed in the swamp. Men adjourned to a nearby shelter and began to drink the brew made two days previously. Prayers were said, thanks given, and accounts read out. The plot owner paid $15 for the work, and those who had arrived too late to work were fined $1.50. Drinking continued till after dark.

Drinking takes place in the evenings and weekends especially on Sundays. Most members finish drunk. The field survey suggests three-quarters of adult males drank in the schools, and in an average week in 1974 each spent about ten hours there drinking or drunk.[8] While drinking, men gossip, philosophize, pray, and pass on economic and political news. Each school has some older men who no longer participate in the work, but who supervise the drinking; they may withhold beer to censure bad behaviour. There is also opportunity for them to pass on the old stories of the island.

Government schemes have recently induced changes in work behaviour: time is more precious and money more easily obtained. Faced by this the bush beer schools have altered; the drinking role is increasingly more important than the work organization. As units of social organization they are stronger than ever today.

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[8] And many more hours recovering from what was described as an 'overhang'.

Informal work groups. In past years groups of young boys or teenagers in a village would form themselves into a company and offer to work on taro patches in return for payment. Sometimes they would accept food or alcohol instead of money. Usually such groups are formed for a limited time with a specific purpose in mind: to earn money for the Boys Brigade, to earn fares for a trip, to buy instruments for a band. They would usually work in the early morning or late afternoon several days a week.

It is difficult to be precise but informants suggest about half a dozen such companies were operating in 1974, most of them school-leavers. There are fewer today because of the availability of regular wage employment. The field survey showed nearly 10 per cent of growers hired companies to work on their taro in 1974.

Women's groups. The bush beer schools and work companies are strictly for men. The women group together at village level in the sewing and handicraft circles: they gather at the meeting house or on a verandah and spend an enjoyable afternoon talking and working on assigned projects. Most will attend classes on public health and child care. They form committees which carry out the health and handicraft inspections. During shortages they may declare certain foods should be preserved and they can arbitrarily impose penalty fines. They may also try to influence the men when they feel that excessive drinking is going on, or too many oranges are being used.[9]

The co-operatives. Though now largely defunct, co-operatives were at one time very active on Atiu. They were first set up in 1956 at the instigation of a co-operatives officer on Rarotonga. He picked out Atiu because of the strong communal spirit there. After several village meetings and a training course for officers, a thrift and loan co-operative was established in each village. Members invested a small amount and undertook to save 4 shillings per month. After one year these savings could be withdrawn: alternatively members might request small short-term loans out of the assets.

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[9] The story is gleefully told of the day the women marched down to the bush beer schools, tipped all the beer out, and then threw garlands of flowers over the mortified drinkers.

Interest in the co-operatives was keen and most families soon joined. The co-operatives offered the first source of credit available to most Atiuans. Members used the loans of $10 to $20 mainly to buy basic agricultural tools or household furniture. They borrowed $1,600 over the next 14 years, not a large amount, but enough to teach the principles of a repayable loan. Loans were not secured but since others could not borrow until they had been repaid, social pressures discouraged defaulting. This was the main achievement of the co-operatives.

The co-operatives assumed other functions too: they dug fishponds in the swamps and stocked them with fish for a future food source. Over the next decade they tried to raise breeding pigs, they opened a bulk purchase store for members, dried copra, made handicrafts, purchased seeds and encouraged planting programs. All these schemes met with initial enthusiasm but ultimate failure, usually because of their poor design and administrative difficulties. In 1966 the village co-operatives were formally liquidated. Membership and assets at that time are recorded in Table 6.

Table 6

Village co-operatives, 1966

	Members	Assets ($)
Ngatiarua	41	240
Tengatangi	41	376
Mapumai	58	178
Areora	80	664
Teenui	48	892
Atiu total	268	$2,350

Source: Co-operative files.

In 1957 175 members of the five village co-operatives jointly subscribed $660 in shares to set up the Atiu

Co-operative Marketing Society. It aimed to introduce, encourage and market producer crops. It exported small quantities of tomatoes, peanuts, and later taro and coconuts to Rarotonga, Tahiti and New Zealand. It organized almost all copra production, building kilns, paying members to bring in nuts, and employing labour to cut and dry them. Later, a committee was set up to organize copra making on the uninhabited offshore islet of Takutea. A gang of men would work there several months a year cutting copra and planting palms. Other ventures were tried: the co-operative operated a bakery for several years, and bought pigs to butcher and sell. A co-operative retail store was set up: in 1970 it had 269 shareholders with $1,780 in shares.

In 1971 another thrift and loan co-operative was set up, this time only for regular wage earners: its thirty-seven members deposit 50 cents per month and may withdraw this at any time. Salary earners have a similar scheme where they deposit regular amounts into the Co-operative Bank in Rarotonga.

Co-operatives on Atiu have been much more successful than on most Pacific Islands. This suggests unusually strong communal feeling and unity of purpose. Today the store is the only surviving outward evidence of co-operative activity. The rest have been victims of mismanagement and waivering enthusiasm. But they did provide experience to learn the European concepts of money savings and loans and the impersonal sale of surplus crop production.

The tribe

There are three tribes (*vaka*) on Atiu. Each is headed by an *ariki* and associated with one district, though its members are scattered all over the island by intermarriage.[10] Every Atiuan recognizes primary allegiance to one or more tribes (ideally the tribe of his parents, the tribe associated with his village and with his planting lands). It is difficult for an outsider to gauge the precise role of the

[10] The 3 *ariki* titles are Ngamaru of Ngatiarua, Rongomatane of Tengatangi and Parua of Mapumai. In addition the 4 senior *mataiapo* titles each heading a district are Paerangi, Aumai and Tinokura of Areora, and Makopi of Teenui.

tribe in a society changing with migration and monetization. Some Atiuans appear confused themselves.

The basis of chiefly power lay in *ariki* control over lands. The Land Court eroded this power. Recognition of *ariki* status today is reflected in tribute payments. Attitudes to these vary considerably according to how each individual feels he stands to gain or lose by them. Generally, however, when a pig is killed the head is given to the *ariki*,[11] and so is the first bunch of bananas harvested and sometimes other first fruits and vegetables. Part of unusually large fishing catches and prestige items such as conger eels are given too.

The personalities of ranking tribal members has also been important in the decline in chiefly status. Today one *ariki* is a young girl married to a non-Atiuan and absent from the island; another is an elderly woman; a third is criticized for his acquisitive attitude and political stance. It is said that the *ariki* should not concern himself with such mundane things as earning money.

The *akaere*, the administrative head of the tribe, retains the crucial role. He calls tribal meetings, passes on news, and imposes tribal decisions about planting ordinances, crop preservation orders, wandering animal prohibitions. Most important, he organizes the ceremony and feasting involved in the investiture or funeral of an *ariki*, extracting the necessary pigs and labour. The ability of this person to mobilize resources and handle day-to-day business of the tribe has determined its effectiveness as a contemporary unit of social organization.

An ineffective *akaere* has no recourse against a recalcitrant tribe today. One *akaere* was observed to call on his tribe to help put up a fence round the *marae*, the ceremonial centre of tribal life. Only a few people turned up to help: he finished the job himself late in the day. He later bemoaned that such a thing could not have happened in his father's day. It may be symbolic of declining tribal influence that the three *marae* are rarely used, and their buildings are unoccupied and ill-kept.

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[11] And, one informant joked, the testicles go to the local government representative.

Since 1950, many high ranking tribal members have felt it their social responsibility to participate in the new introduced agricultural projects. For example, a disproportionate number of *ariki* and *mataiapo* hold citrus plots. But having planted the crops their ability to maintain them has been unimpressive. The tribe as a unit has only rarely been used in cash cropping.

For example, one of the economically most active tribes is the Ngati Te Aka. The *ariki* of the Ngati Te Aka tribe is Ngamaru, the first created and most powerful title. Accordingly this tribe and Ngatiarua, its associated village, are always awarded precedence in Atiu ceremony. The tribe has an *akaere*, six *mataiapo* and sixty-four *rangatira* titles. The current *ariki* is an elderly woman who appears to be popular but not powerful. The tribe's strength comes from the personality of other senior title holders. For example, the *akaere* is a keen planter, has a prestigious job in the Agriculture Department, and holds other titles in his own village. His power was seen when the previous *ariki* (Paora) died recently and he organized a large funeral, extracting sixty pigs for the feast.

The tribe holds valuable land in the centre of the island. The government rents some of it. On the ceremonial *marae* the tribe built a large and expensive *ariki* house. It was never finished and the *ariki* prefers to live elsewhere. The tribe agreed to join in the first two agricultural aid projects. On tribal lands they planted a forestry plot (now dead) and a citrus plot. It was intended that each *rangatira* would be responsible for the upkeep of two orange trees. The tribe would hire labour to pick the oranges; two-thirds of the proceeds would go into a bank account for tribal use. The system worked poorly: today that plot has deteriorated badly, and it is lent out to tribesmen without their own plot.

Crocombe (1967) concludes that the tribe has not been a strong unit since the 1900s: most commoners today would not support an increase in its powers.

The church

The church continues to play an important role in Atiuan life. Missionaries brought the gospel in the 1820s and Christianity has spread rapidly, bringing changes in cultural outlook and village organization. But in social rank the *orometua* (minister) has been subordinated to the wishes of the *ariki*; and in economic habit the church reinforces the traditional importance of working together for spiritual salvation.

The oldest and the established dominant denomination is the Cook Islands Christian Church (originally London Missionary Society). In 1919 a Roman Catholic church and school were built and they now have about 250 members, mostly in one village. More recently the Seventh Day Adventist Church was founded by about 100 discontents. The Morman Church tried but failed to gain a foothold. The churches today do not actively compete for parishioners (indeed they co-operate as far as helping to maintain one another's churches). And they do not encourage the active competition for fund-raising that occurs in Western Polynesia.

Atiuans take services seriously, and spend a lot of time preparing for, attending, and later discussing church. There are five hours of services per week. Most women and children and about half the men attend church regularly. On average men spent one and a half hours per week there in 1974.

The church has an organized hierarchy of members; minister, elder, deacon, assistant deacon, Sunday school teacher. The *orometua* is accorded much respect. He is an important participant in most village activities. Parishioners take turns to provide him with food, and if necessary they will lend him land or tend his garden. His home may be a refuge for destitute people or orphans.

The deacons are the main policymakers. There are about a dozen and they hold regular meetings on religious and social issues. They are elected for their high standing in the community, and they appear to lead opinion in economic matters too, though they show no special expertise there. They organize work for the church and can if necessary mobilize vast resources. For example, in 1967 one of the deacons decided to redesign and rebuild the Cook Islands Christian Church building, the largest in the Cook Islands. This was a massive job. The deacons arranged for each village to provide forty volunteers to work in rotation one day a week. They hired twelve permanent tradesmen, supervised by the designer. They raised $6,000 locally to pay for materials and another $200 was sent from relatives in New Zealand. The whole job was finished in three months.

The churches run most of the youth activities: Sunday schools, Girls' and Boys' Brigade, Boy Scouts. These organizations are taken very seriously and occupy a lot of time for children and adults. They are often used to raise funds. On holidays the church is the centre of social festivities. It is also the body around which are organized the popular *tere* parties for cultural, sporting, and social exchange between islands. For example in 1971, forty-four members of the Cook Islands Christian Church raised a total of $6,000 and travelled as a choir to Tahiti for three weeks.

The internal hierarchy of the church is open and mobile compared with the rigidity of tribal rank. This offers hope and reward to a hardworking, conformist Atiuan.

The island

In early history the island faced internal division and it held little identity except in times of war with other islands; but today it serves increasingly as a unit of socio-economic organization. This is partly due to the formation of the Cook Islands as a self-governing group, and to the political opposition that unites most Atiuans against the Rarotonga-based government (although politics have at times divided the island). Atiu elects two representatives to the Cook Islands Legislative Assembly. These are respected men but they are too frequently absent in Rarotonga to influence Atiuan life much.

The administrative head of the island is the resident agent, for a long time a New Zealander but now an Atiuan. Crocombe (1967:110) comments:

> Despite the drawbacks of the chiefly system the chiefs had obligations to, as well as rights over, their followers, and the people could to some extent exert sanctions against them. But they had no sanctions against the Resident and no access to him. Their only power lay in refusing to act.

The resident agent still wields much potential power but his effective position depends on his personal ability. Recent poor holders have cheapened the office and today other more dominant personalities have emerged in Atiuan life.

A locally elected Island Council, with one member per village and the resident agent and *ariki ex officio,* fills the role of a local authority. It employs people on public works, receiving a grant from central government and raising a small revenue from local taxes. It organizes the boating and reefing crews that service the off-shore ships. It administers the health and planting inspections. Whenever the whole island is involved in some work project, the Island Council co-ordinates it.

For example during 1974-75 a contingent of New Zealand Army engineers built a large harbour on Atiu, as part of the pineapple scheme there. At a stage during concrete pouring the army requested a few local labourers to help on a Saturday. The Island Council met and decided that all island men should turn out to help. The island councillors announced this decision around the villages: in at least one village the men had to cancel other voluntary communal work they had planned for that day.

At 5 a.m. on Saturday 150 men assembled at the meeting houses and trucks carried them to the beach. For four hours they worked enthusiastically in groups, collecting rocks, crushing gravel, and carrying heavy concrete at a run. Laughter and the urging of onlookers maintained a pace that would have been impossible otherwise. The army supervised the work, each island councillor urged on the men from his village, and certain dominant individuals - a deacon, an agricultural officer, an *ariki* shouted commands at whoever would listen. The final result was considered a triumph for the island as a whole. For the next four weeks the work continued, each village providing 50-60 men.

Other institutions such as the primary and junior high schools and the hospital call on island support. The kindergarten relies totally on voluntary donations; it was set up in 1969 on several hundred dollars raised by the villages. The sports clubs and a weekly drinking club[12] also encourage an island spirit.

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[12] With the grandiose title "The Enuamanu Cosmopolitan Men's Drinking Club'.

Chapter 3

The Atiuan economy

During the period of first European contact on Atiu subsistence (non-monetary) production prevailed. Gradually cash cropping became a major occupation. Today however, this has been superseded by the non-agricultural sector: wage labour and injections of money from abroad.

The subsistence sector

Untitled Atiuans worked lands at the discretion of chiefs and in return for tribute payments. They grew a small range of reliable short-term crops that had been known and grown for many generations. They used a simple technology based on wooden planting tools.[1] Sometimes their planting was directed by the chiefs; it was also constrained by social norms and there was little opportunity for individual variation. The arrival of missionaries, traders, and western administration including the Maori Land Court, inevitably altered subsistence life. In an undocumented sector it is hard to be sure what these changes were; the comments of older growers suggest the following, although the changes were gradual.

Growers used to spend a lot more time away from the village working on their lands; often the whole family lived in temporary huts on the plantations and worked together. Frequently groups of friends, neighbours, relatives worked together in informal companies on one another's land in rotation, and then drank together. Western institutions such as school and regular wage labour changed these work habits. More work is now done individually: the 1974 survey revealed that men spent 4.5 hours per week, on average, working by themselves in their gardens and another three hours in communal subsistence labour, most of it on *taro* plots. It

[1] See Allen (1969) for a full description of indigeneous and introduced technologies on a neighbouring island.

also appears that people work more intensively today when they are faced with more demands on their time.

Technical change accompanied organizational change. Cultivators used techniques requiring minimum labour effort. For example, arrowroot, which requires a large cleared area, used to be less popular than it is today and was grown mainly to make starch. Many crops, especially less sought-after roots, were not cultivated at all, but were left to grow wild, providing a reservoir of food for an emergency. *Taro*, the staple root crop, was grown in a different way. Instead of building up composted patches, *taro* shoots were planted straight into the swamp. This was easier, for growers lacked tools to dig up the swamp and shoots could be automatically replanted as they were harvested; but smaller tubers resulted.

The availability of basic iron hand tools (especially the machete and spade) altered cultivation techniques making it easier to clear bush, eliminate weeds and contour and ditch the *taro* swamp. The introduction of the horse meant produce could be transported from distant planting lands. In the last few years it in turn has been superseded by the motorbike. Table 7 indicates the possession of iron tools.

When the administration introduced the project crops in the 1950s, they imported several tractors with hoes, ploughs and slashers. These were available for private hire. The hope was that use of machinery together with other techniques of modern plant culture would diffuse through the subsistence sector. Machinery could be easily observed at work and was welcomed as a labour substitute. The survey showed that 60 per cent of growers hired some mechanical equipment in 1974. This was mainly to clear ridge-top plantations, and resulted in a big increase in arrowroot planting.

However, the advantages of other techniques were less obvious. Conservative growers feared to experiment with unknown practices on a vital food supply. In 1974 no growers used fertilizer on their subsistence crops, most relying on plot rotation and composting to overcome fertility deficiencies; only a few sprayed against disease, the rest having no way to combat such recent problems as the *taro* blight.

Table 7

Possession of agricultural hand tools

	Number per household 1950	1975
Axe	1.2	1.0
Machete	1.7	2.8
Hoe and rake	0.1	1.3
Fork	-	0.7
Shovel and spade	1.5	1.8
Pruning saw	-	1.4
Reaphook	1.0	1.4
Value at 1974 prices[a]	$20	$37

[a]In addition each household had on average $17 invested in heavy equipment: wheelbarrows, knapsack sprayers, citrus ladders, mowers, etc.

Source: FAO survey, 1950; field survey, 1975.

There is little variation in choice of crops grown. In 1974 everyone grew *taro* and bananas, most grew *taro tarua*, arrowroot and either yams or *kumara*. Only a third of growers planted anything else, usually tomatoes or other introduced vegetables. Table 8 gives estimates of areas under crops compared with an earlier survey for confirmation.[2]

The season allocation of work is determined by the warm wet summer months and the dry cooler winter. *Taro* and arrowroot may be planted in any season and mature in nine months and a year respectively. *Taro tarua*, bananas and yams are all planted during the second part of the year and are harvested a year later, though the yam crop may be left

[2]Data such as these are very prone to error. Crop areas are difficult to estimate and the accuracy of some earlier measures is doubtful. With these qualifications in mind the data may still be useful.

Table 8

Subsistence crops (in hectares)

	1966	1974
Taro	21	19
Taro tarua	10	12
Kumara	6	4
Yam	4	1
Tomatoes	2	3
Arrowroot	9	18
Bananas[a]	9	41

[a]The 1966 figure for bananas covers new plantings only; the 1974 figure includes all bearing banana shoots.

Source: Agricultural Census, 1966; field survey, 1974.

in the ground for up to three years in storage. Vegetable crops and *kumara* are planted earlier in the year and mature in six months or less; consequently *kumara* is the first crop to be replanted after a hurricane. The result is that the work load is spread over the seasons, but the food supply may be shorter during the first half of the year.

There is less reliance today on the wild crops that used to be an important part of the diet. Some of these have been relegated to inferior emergency foods. But a lot of time is still spent in seeking out and gathering native foods, fuels and raw materials for handicrafts and medicines, most of it in the wilds of the *makatea*. There are fruits (coconuts, breadfruit, pawpaw, mango, capsicum, guava), berries (coffee), nuts (chestnuts, cashews), stems (sugar cane), leaves (flax, pandanus, young *kumara* leaves), young fern fronds, and roots (*puraka*, *kape*, *tii*). Men hunt for honey or crabs, and catch eels in the swamps. Women and children collect firewood, or shells and seafoods on the reef.

Fishing is done by the men: methods include rod fishing off the edge of the reef, netting in the rocky pools of the lagoon, or handlining from a canoe in the open sea. Fish are an important source of protein in the diet and are considered a delicacy. But the work is time consuming, risky, and sometimes dangerous. Because of this it is a declining activity. On average two to three hours per week are spent fishing. It appears that the number of canoes has declined from one per two households in 1950 to about one per four in 1974. However, most households still have access to one.

All Atiuan households keep fowls and a few pigs. About half keep goats for special occasions. Pigs are usually penned in the far off *makatea*, and they must be fed daily. Consequently a family spends about eight hours a week caring for pigs. This appears likely to make pig raising a more specialized occupation although at present there is little trade in livestock. Table 9 presents a livestock census data.

Table 9

Livestock

	1950	1955	1960	1966	1975
Poultry[a]	5,188	2,867	n.a.	4,777	4,535
Pigs	1,871	1,328	1,822	1,870	1,359
Goats	454	397	452	598	763
Horses	95	72	74	59	22
Cattle	1	3	5	-	1

[a]Numbers are estimates only and depend on the season during which the census is taken.

Source: Agricultural Censuses.

Evidence suggests subsistence production has declined slowly in the past owing to the pressures of cash cropping, and continues to decline because of the attraction of wage labour. The evidence of Table 10 supports this view (with the qualifications of footnote 2).

However, subsistence production remains important in Atiuan economic life today. A rough estimate of its value at current market prices is $900 per household per year or 40 per cent of total income (see Table 11). Note that this

Table 10

Area planted in taro (hectares)

1954	1966	1970	1974
26	21	20	19

Sources: FAO Survey, 1954; Agricultural Census, 1966; Agricultural Survey, 1970; field survey, 1974.

Table 11

Estimate of subsistence income, 1974

		$ per household
1.	*Taro*	192
2.	*Tarua*, arrowroot, *kumara*, yam	114
3.	Bananas	44
4.	European vegetables	18
5.	Fruit, seafood, firewood, nuts	29
6.	Fish	29
7.	Livestock	480
		$906

Note: 1-4 are calculated from crop production survey, estimated at market prices, even though not all the produce is fully traded;
5 and 6 are calculated at factor cost from labour survey;
7 is valued at likely market price, given probable turnover of stock of animals.

All values given here and afterwards are in New Zealand dollars, corrected to 1974 values unless otherwise specified.

estimate is somewhat hypothetical as not all components are commonly traded.

Cash cropping

Traders arrived late on Atiu and held little sway over the populace. Opportunities to earn money were controlled by the *ariki* and were usually for communal benefit. In the late nineteenth century non-perishable indigeneous crops were sold through the few Chinese and European traders. For example, Findlay (1884) records Atiuan exports of 10 tons of coconut oil, a ton of cotton and a ton of arrowroot.

For a long time official reports told of the potential production of the island but the inability of the administration to extract it.[3] It took the dominance and *mana* of one *ariki*, Ngamaru Rongotini, to organize any sizeable surplus for trade. For example in 1902 Atiuans exported 118 tons of copra, 5 tons of coffee, 1,000 gallons of limejuice, and 1,962 cases of oranges, under his direction.[4] Over the next few years, bananas, candlenuts, *kumara* and pineapples were also exported. Records of export volumes in the early twentieth century appear in Table 12. Reliable price data to estimate incomes are not available.

For the first decade of the twentieth century exports were high though fluctuating. Money earned was mainly spent on communal projects. The goods traders offered made little difference to permanent consumption patterns. In 1910 Ngamaru died and a European resident agent was appointed; *ariki* influence decreased. Atiuan growers realized they could now earn money on their own account, and that the best way to do this was to concentrate on the oranges and copra, the most profitable crops. Over the next decade erratic but often considerable effort was spent in producing these. (Orange production per capita was as high as in the best years of the recent Citrus Replanting Scheme.) Atiuan growers had their first personal experience of external produce markets, and they suffered some learning pains. World War I brought sharp movements in price and shipping shortages. In 1919 growers complained of traders forming

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[3] e.g. see Appendix 3 to *Journal of House of Representatives*, 1902, p.49; 1908, p.11.

[4] *Report of New Zealand Department of Agriculture*, 1903, p.426.

Table 12

Volume of exports, 1900-1930

	Oranges (cases)	Copra (tons)	Coffee (lb)	Limejuice (gal.)	Kumara (cases)	Coconuts (no.)	Bananas (cases)	Candlenut (tons)	Pineapples (cases)
1901	n.a.	n.a.	n.a.	n.a.	-	-	-	-	-
1902	1,962	118	11,000	1,000	-	-	-	-	-
1903	4,000	n.a.	n.a.	n.a.	-	-	-	-	-
1904	n.a.	n.a.	n.a.	n.a.	-	-	-	-	-
1905	3,141	144	2,073	3,150	-	1,200	-	-	-
1906	9,333	30	10,900	3,780	-	-	-	2	-
1907	13,762	41	5,160	540	-	-	-	-	-
1908	10,974	145	5,900	100	-	-	21	-	31
1909	4,614	204	-	-	-	-	-	-	-
1910	13,566	203	3,300	-	-	-	198	900	-
1911	14,072	170	11,000	-	-	-	-	-	-
1912	14,722	149	900	-	-	-	28	620	-
1913	8,975	260	2,000	-	2,000	-	4	-	-
1914	2,196	43	-	-	-	-	-	-	-
1915	5,604	1	2,600	-	-	-	-	-	-
1916	5,716	27	-	-	-	-	-	-	-
1917	2,258	150	-	-	-	-	27	-	-
1918	2,240	106	3,000	-	-	-	-	-	-
1919	n.a.	n.a.							
1920	n.a.	n.a.							
1921	n.a.	n.a.							
1922	n.a.	n.a.							
1923	n.a.	n.a.							
1924	n.a.	n.a.							
1925	n.a.	n.a.							
1926	9,102	n.a.							
1927	14,509	n.a.							
1928	9,217	n.a.							
1929	13,200	n.a.							
1930	9,261	157							

Source: *Report of New Zealand Department of Agriculture*, 1903; Appendix 3 to the *Journal of the House of Representatives*, 1905-1930.

monopolies to set artificially low produce prices;[5] for a period oranges were shipped through a Rarotongan co-operative.

During the 1930s depression hit the New Zealand market; in 1932 the orange price dropped to a quarter its previous level. Growers were perplexed; suspecting injustice they slashed their production and received very low returns. Complaints of poverty were made to the New Zealand government. In 1937 they set up the Fruit Control Scheme; the government would buy and market all Atiuan oranges. Growers responded to the higher and more stable prices, and by the end of the decade oranges had entered a new boom.

Then, in the late 1940s, a second crisis struck: the native orange trees became badly diseased and yields fell mysteriously. This caused economic distress and social discontent. Growers switched to copra which they produced individually and in bulk through the co-operatives for the next twenty years.

To meet this situation a series of new crops were introduced as aid projects starting in 1950. This marked a watershed: the end of the trade in wild-growing native produce and the beginning of scientifically cultivated introduced cash crops. No longer could an Atiuan go out into the bush and be sure of finding a crop that had self-seeded and grown wild there, then gather it, and with a minimum of processing, sell it to the trader for a reasonably assured and immediate return on his labour. The generations of accumulated experience and knowledge built up about indigeneous crops were no longer relevant and sometimes misleading. The newly introduced crops required much more planning and cultivation than the old, and they were very sensitive to the new Atiuan environment. Inevitably the period was marked by uncertainty and confusion, as described in Chapter 4.

Over the next twenty-five years most growers earned some money from a variety of project crops. Most important were the oranges planted by three-quarters of households under the Citrus Replanting Scheme. The story of cash cropping on Atiu is largely the story of orange production.

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[5] See Merchants, Planters and Traders of the Cook Islands, 1920.

For a few years in the 1950s most growers cultivated tomatoes. In the late 1960s and early 1970s a few growers harvested and sold coffee. For a couple of years many growers exported their *taro* to Rarotonga, and a few planted pineapples. More recently a few growers have earned high incomes growing vegetables. Figure 4 and Table 13 record the composition of cash crop income since 1930 in money terms. It has been subject to violent fluctuations, a moderate increase in the 1950s and 1960s, then a recent fall as opportunities for wage income become available in the 1970s.

The non-agricultural activities

The public sector. The administration on Atiu, inspired by New Zealand concepts of government paternalism, has always been pervasive; it has grown to the level where today it provides 70 per cent of Atiuan income.

The administration has employed a number of Atiuans on salaries for some time. Half of them are teachers, the rest administrators, agricultural, health and public works staff. This reflects the range of services made available to Atiuans. Today there is a wide gap between the wage of a labourer (about $16 per week) and a government salary (averaging $1,400 per annum). For example in 1973 the 50 salary-earners grossed more than did the 170 regular and casual labourers.

In the past, few wage jobs were available. In the 1940s groups of men travelled to work for a period on a phosphate island in French Polynesia. The only other work was loading the occasional ships. Then in the 1960s a series of projects boosted job opportunities. First the revamped citrus scheme needed labourers to prune and spray. Then in 1964 labourers were employed to set up the coffee project. In 1965 the government housing scheme began. And from 1970 the pineapple incorporation started to absorb workers. This last project is so large and labour intensive that it is the major employer today; today all who want wage work can get it and the pineapples suffer from a labour shortage. In 1974-75 this was temporarily aggravated by the men working for the New Zealand Army building a harbour on Atiu. About a third of households now have a regular wage or salary earner and most others have at least one casual wage earner.

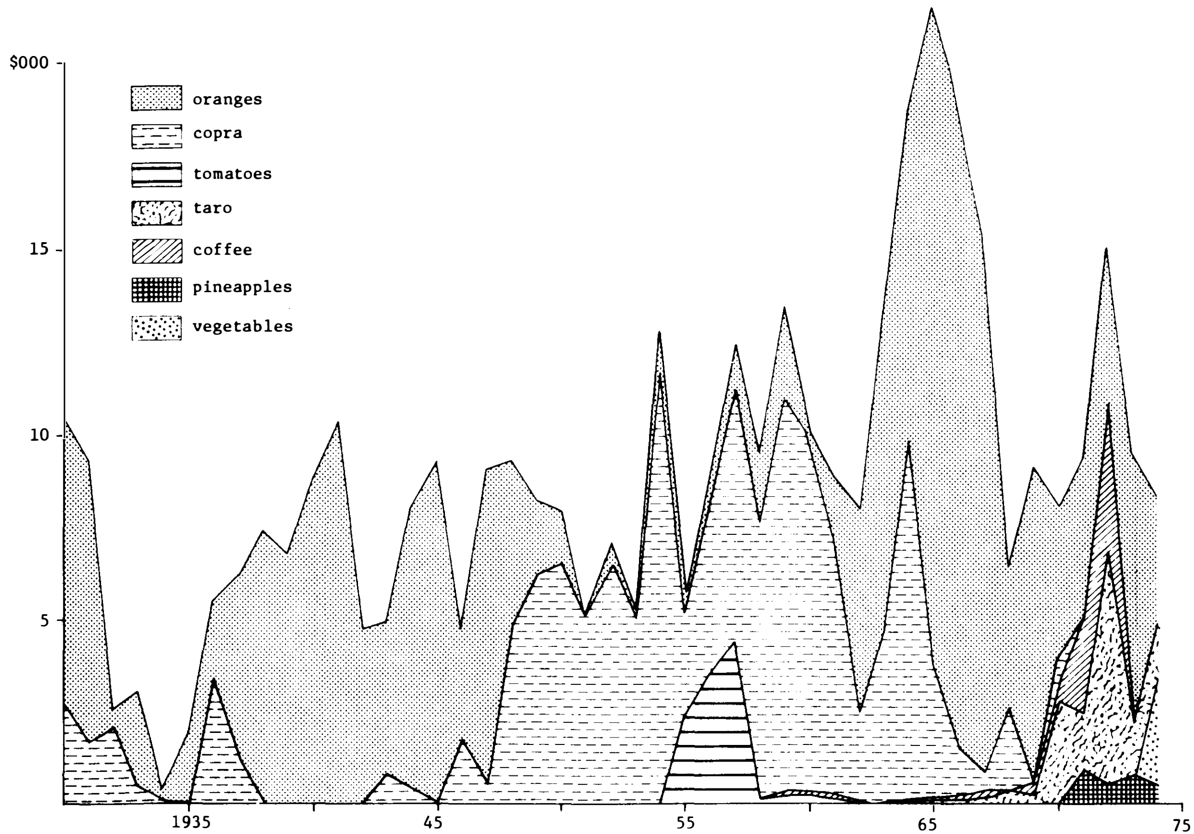

Fig. 4. Agricultural incomes, 1930-74

Note: Net money income received by growers (not total export receipts). Revenue from each crop is the area between the lines. Area under the top line represents total agricultural income.

Source: Table 13.

Table 13

Agricultural production and income, 1930-74

	Oranges		Copra		Tomatoes		Coffee		Taro		Pineapples		Vegetables	Other produce	Total Ag. income
	Cases	($)	Tons	($)	lb.	($)	lb.	($)	Cases	($)	Cases	($)	($)	($)	($)
1930	9,261	7,779	157	2,662										36	10,477
1931	10,028	7,621	177	1,702											9,323
1932	2,724	545	129	2,064											2,609
1933	12,903	2,581	28	448											3,029
1934	2,983	448	1	19											467
1935	7,831	1,958	-	-											1,958
1936	9,664	1,933	217	3,472											5,405
1937	16,287	4,886	81	1,296											6,182
1938	21,196	7,418	-	-											7,418
1939	17,114	6,846	-	-											6,846
1940	22,136	8,854	-	-											8,854
1941	29,437	10,303	-	-											10,303
1942	11,176	4,688	-	-											4,688
1943	7,841	4,088	48	864											4,952
1944	11,801	7,627	14	420											8,047
1945	12,916	9,307	-	-											9,307
1946	3,987	2,939	44	1,760											4,699
1947	8,077	8,438	15	600										34	9,072
1948	3,236	4,426	61	4,880											9,306
1949	1,731	1,982	59	6,254										150	8,386
1950	1,267	1,450	59	6,490											7,940
1951	-	-	42	5,040										246	5,286

1952	505	530	50	6,500											7,030
1953	-	-	40	5,120											5,120
1954	700	910	95	11,780											12,690
1955	327	211	24	2,880	1,995	2,394									5,485
1956	989	400	42	4,872	2,988	3,586									8,858
1957	2,579	1,294	66	6,864	3,510	4,388									12,546
1958	7,356	1,845	75	7,500	104	94									9,439
1959	6,792	2,380	71	10,650	234	187			140	140					13,357
1960	98	36	82	9,840	338	237			-	-					10,113
1961	4,140	1,739	70	7,000	71	43			77	80				85	8,947
1962	9,838	5,509	24	2,400					-	-				76	7,985
1963	10,480	8,803	41	4,592					-	-				156	13,551
1964	10,758	9,037	82	9,676					18	27				365	19,105
1965	24,334	17,886	30	3,660			111	28	-	-				-	21,574
1966	23,800	17,493	12	1,392			213	47	69	68				60	19,060
1967	19,570	14,384	4	456			1,040	280	106	128					15,248
1968	7,474	3,872	13	2,145			1,347	377	-	-					6,394
1969	23,227	8,455	-	-			1,197	323	190	243					9,021
1970	12,758	4,197	3	540			13,881	2,776	245	490					8,003
1971	13,936	4,292					6,176	1,420	1,194	2,675	1,058	943			9,330
1972	11,301	4,351					38,735	6,198	1,596	3,910	704	592			15,051
1973	13,413	7,323					10,892	1,307	-	-	710	768			9,398
1974	5,839	3,352					8,584	1,373	-	-	41	50	3,434		8,209

Note: Crop income refers to net revenue paid to grower, not to total crop value.
Other produce includes intermittent exports of arrowroot, *kumara*, coconuts, *taro tarua*, passionfruit.

Source: Files of Atiu administration.

The New Zealand Government established a scheme of minor social transfers: old age, destitution, and war pensions. The Cook Islands Government boosted these into an important source of income, especially for old people whose children have migrated. This compensates for the loss of security from the breaking up of the extended family unit.

The private sector. The private sector on Atiu is small and static. There are two branches of large Rarotongan stores. The co-operative runs a store; in the past it also ran village bulk stores and employed men to make copra. Private individuals have made short-lived attempts to open stores of their own. These have failed because of low turnover, low legal profit margins, and requests by relatives for credit. In the 1960s the police decided to open private stores in several villages: only one survives.

In 1972 one enterprising grower formed a small company with Rarotongan friends and set up his own store. He was strict in emphasizing that he would not give relatives goods and that debts must be settled weekly. At the same time an Atiuan living in Rarotonga raised a large commercial loan there and re-lent $400 to each of several Atiuans, to open small stores in the front of their houses and buy their goods through him. Currently there are five private stores operating.

In 1974 a tiny growers' market was built, and half a dozen vegetable growers occasionally sell produce there. Other growers report misgivings about such buying and selling, for it conflicts with traditional views of gift-giving and requests.

In the past up to six bakers have been turning out a few loaves on tiny back-yard ovens made out of old oil drums. Today there is only one: a much larger mechanized unit, with a staff of four. Run by a returned Atiuan migrant, it produces over 1000 small loaves of bread a day fairly regularly. With an average weekly turnover of about $400, it makes a good profit.

The only other private businesses are two bands that play at dances and special occasions. One consists of eleven growers who formed a work group and raised $400 to buy instruments. Later, one of the shopkeepers bought electrified instruments and a generator to run them, then taught

Table 14

Total incomes, 1961-74 (dollars)

	Remitt-ances	Pensions	Salaries	Regular wages	Casual wages[e]	Private sector[e]	Total non-Ag.	Agricul-tural income	Total income
1961	14,754	1,600	12,100	6,000	6,000	1,000	41,454	8,947	50,401
1962	18,396	1,600	14,520	5,760	3,720	1,300	45,296	7,985	53,281
1963	21,230	1,750	17,850	5,400	3,000	1,500	50,730	13,551	64,281
1964	22,838	1,750	18,000	6,400	3,000	1,700	53,688	19,105	72,793
1965	29,524	2,330	24,760	8,400	5,700	2,000	72,714	21,574	94,288
1966	32,430	2,730	26,150	9,120	7,600	3,000	81,030	19,060	100,090
1967	31,852	6,570	37,400	11,880	7,200	4,300	99,202	15,248	114,450
1968	35,762	5,540	37,300	13,440	2,030	4,800	98,872	6,394	105,266
1969	37,020[e]	6,040	35,900	10,800	2,050	5,300	97,110	9,021	106,131
1970	33,800[e]	7,140	46,160	13,000[e]	9,300	5,800	115,200	8,003	123,203
1971	25,800[e]	7,190	52,000	13,250	9,600	6,100	113,940	9,330	123,270
1972	23,090[e]	7,940	51,480	17,000	22,600	7,000	129,110	15,051	144,161
1973	34,741	9,490	57,000	13,000	25,850	9,000	149,081	9,398	158,479
1974	59,708[e]	22,870	73,025	16,200	66,274	12,270	250,347	8,209	258,556

Sources: Files of Atiu administration, field notes.

Note:
1. Most of these figures are calculated from payment vouchers; where some component had to be estimated because of lost records, the figure is marked 'e'.
2. Most remittances are traceable from money orders not cheques; a small amount is carried home and cannot be traced because Atiu uses New Zealand currency. Hence the figures quoted are underestimates.
3. Casual wages were paid out mainly for work on the Citrus Scheme 1961-64, the Housing Scheme 1965-67, and the Pineapple Incorporation 1970 on; in 1974 a lot of men worked on the harbour project.
4. Pensions include $3,270 paid out to land-owners in 1974 as rent for incorporated lands.

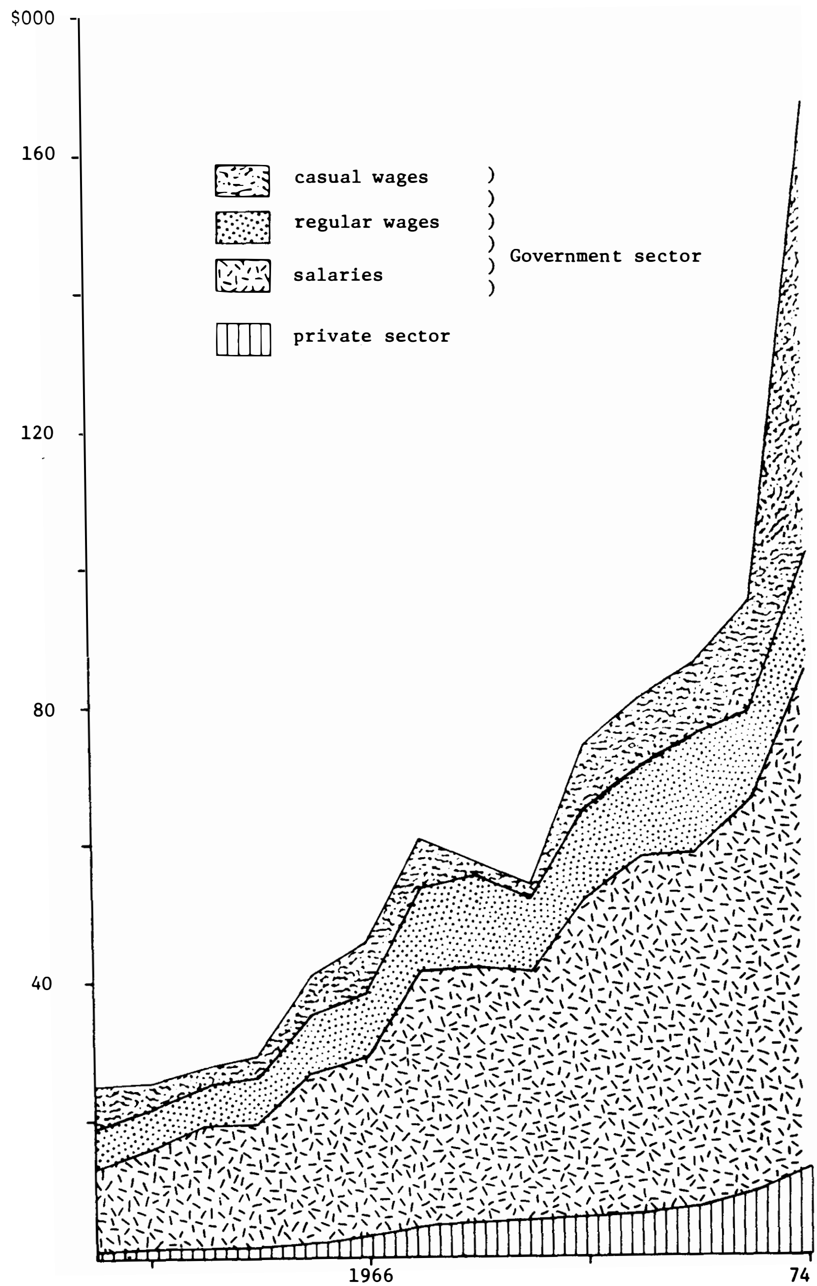

Fig. 5. Salaries and wages, 1961-75

Note: Income from each source is represented by area between the lines. Area under top line is cumulative wage and salary income.

Source: Table 14.

his wife to sing and his daughters to play. Little money but a certain prestige is to be had this way.

There is little entrepreneurial talent and initiative on Atiu compared to many Pacific islands. Even in a small isolated Polynesian community such as Tonga, there is a continuous supply of men with small savings setting up new businesses, albeit suffering a high failure rate (Bollard 1976). One reason is that the paternal public sector on Atiu dulls initiative and rewards conformity.

Another reason is that many potential entrepreuneurs have migrated to Rarotonga or New Zealand after encountering social resistance to their ideas on Atiu. But they still play a part in the Atiuan economy through the money they remit. When a person migrates he usually sends or brings back savings to his parent or wife: the amount depends on their needs and the length of absence. About 80 per cent of households receive remittances, and today they constitute one-quarter of total money income.

Figure 5 and Table 14 show the rapidly rising value of non-agricultural incomes. (They increased six-fold from 1961 to 1974 in money terms.) There has clearly been a structural shift in the monetized economy away from self-employed cash cropping towards wage labour for the government. This is demonstrated by table 15 which records the principal occupations of Atiuans.

Table 15

Principal occupations

	1956		1975	
	Male	Female	Male	Female
Full time planter	266	-	76	-
Wage labourer	17	11	120	9
Private sector	8	1	10	7
Salaried	32	5	34	17
Total	323	17	240	33

Source: Population Census, 1956; Population Count, 1975.

Table 16

Comparison of money incomes, 1900-74

1902		1930		1950		1970		1974	
Oranges	655	Oranges	7,779	Oranges	1,450	Oranges	4,197	Oranges	3,352
Copra	2,400	Copra	2,662	Copra	6,490	Copra	540	Pineapples	50
Coffee	370	Lemons, etc.	36	Wages	4,200	Coffee	2,776	Coffee	1,373
Limejuice	70	Wages (est.)	2,000	Salaries	4,040	Taro	490	Vegetables	3,434
				Remitts, etc.[a]	14,900	Wages	28,100	Wages	94,744
						Salaries	46,160	Salaries	73,025
						Remitts, etc.	40,940	Remitts, etc.	82,578
Total income (money prices)	$3,495		$12,477		$31,080		$123,203		$258,556
Real income per capita (at 1974 prices)	$34		$51		$71		$120		$188

[a]This figure includes wages of men temporarily working on a phosphate island.

Sources: Miscellaneous records of Cook Islands and New Zealand governments.

Changes in income composition

The pattern of money earning has changed since first monetization. For example in 1902 most production was still non-monetized but cash cropping was beginning to realize a small income. By 1930 a handful of people were receiving a little in casual wages though cash cropping was established as the main activity. Non-agricultural incomes had increased significantly by 1950. In the next twenty years real money incomes nearly doubled, though cash cropping contributed only a small part. This trend continues. By 1974 total incomes had risen dramatically but cash crops earned only 3 per cent of this.[6] This pattern may be seen in Table 16. Subsistence incomes cannot be documented but have apparently fallen only gradually over this period.

By 1974 the average Atiuan household contained one or two income earners who were part-time subsistence farmers and part-time wage earners working for the government. In addition most collected a little casual income from orange plots and substantial unearned income in pensions and remittances.

Table 17

Average household income, 1974

Regular wages and salaries	$470	36%
Casual wages	349	27
Cash crop income	73	6
Pensions	120	9
Remittances	292	22
Total	$1,304	100%

Source: Field survey, 1974.

Analysis of disaggregated incomes by households shows that income distribution is significantly skewed: the most common range of income is less than $400. Almost every

[6] 1974 was an atypical year because of the Army Harbour Project.

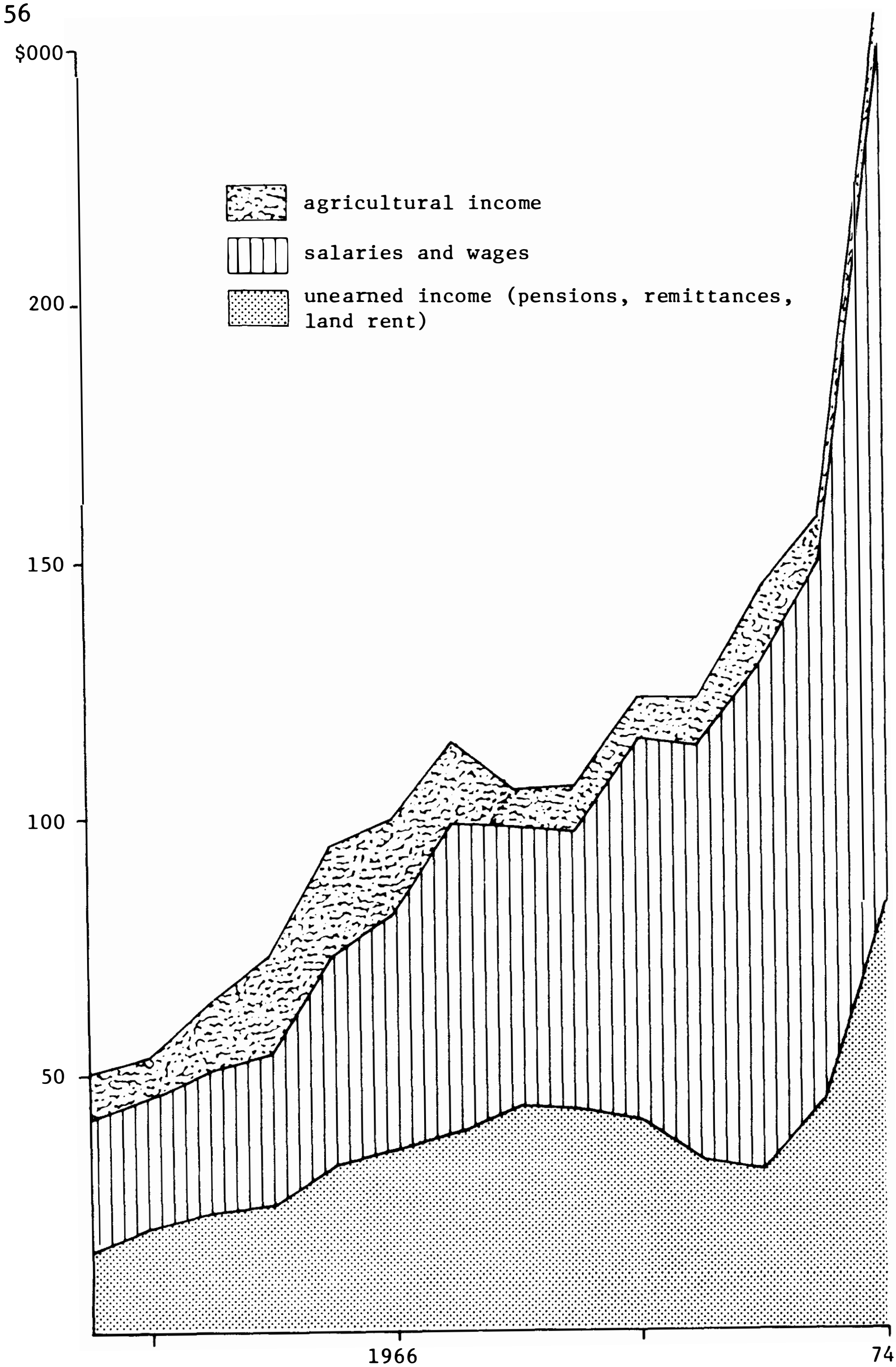

Fig. 6. Total incomes, 1961-74

Note: Area under top line represents cumulative total incomes.

Source: Table 14.

household earns under $1,600. A small number earn over $2,400. Figure 7 shows this. Income disparity may increase with increasing opportunities for specialization. At the same time incomes may become more equitable as there is less regard for traditional rank and privilege.[7]

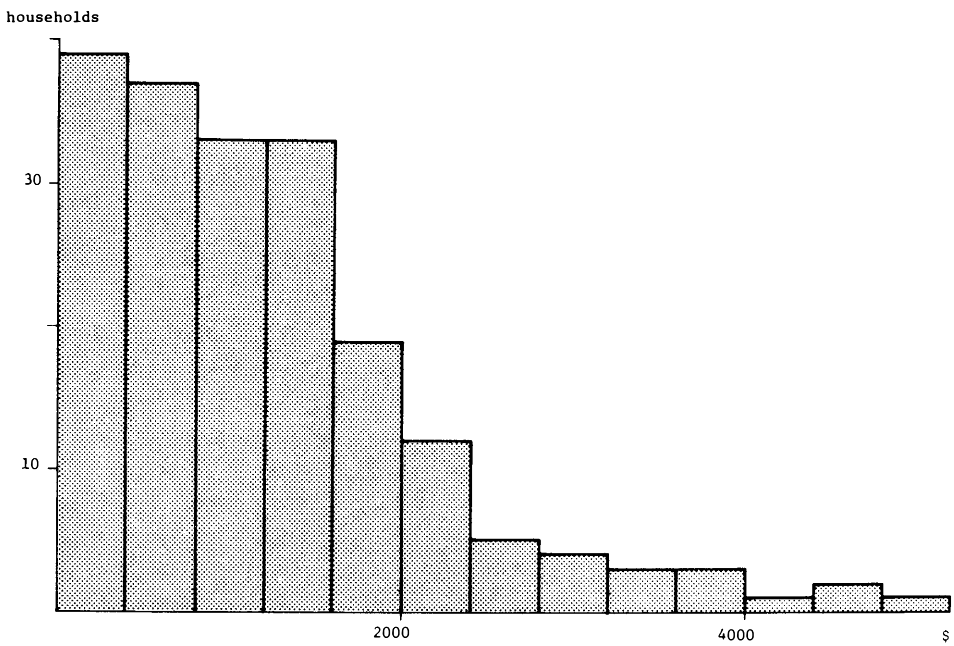

Fig. 7. Distribution of incomes, 1974

Note: Histogram of distribution of money incomes only.

Sources: Field survey, Administration payment vouchers, other files of Atiu administration.

[7] The coefficient of variation, a normalized measure of dispersion (= standard error/mean) was .98 for incomes in 1974 and .97 for incomes in a small and biased survey in 1966 (Menzies 1970). This does not suggest any marked change in the recent distribution of income.

Chapter 4

The agricultural aid projects

Native orange production

Since the nineteenth century orange trees have grown wild on Atiu. They seem to have originated from sweet naval orange seeds from either the Mediterranean or Chile, left by the early missionaries and traders. They spread naturally and prolifically through the bush, growing very tall (10 metres and more, with high-spreading canopies). They yielded heavy crops of low quality, seedy, thin-skinned, fungus-covered oranges.

Each household held picking rights over two or three groves containing perhaps thirty or forty trees. They did not cultivate these at all. A former Director of Agriculture wrote 'citrus production was looked upon as one of the gifts of nature which did not require the aid or labour of man' (Baker 1952:185). The trees grew hardy, adapting themselves to weed competition, water shortages, and the few indigeneous pests. In this respect, orange trees were similar to the coconut palms, native coffee and other wild fruit trees which grew on Atiu; they fitted usefully into a gathering economy.

The day before a ship was due to arrive, a family would walk down to one of their orange groves and roughly clear the undergrowth from the mature trees. The oranges could be shaken off the small trees; young children had to climb up the big ones, and pick into kerosene tins or throw the fruit down. No niceties of modern citrus handling here. The men laboriously carried the cases of fruit up the gullies and through the bush to the nearest road access. From there the local traders trucked them down to the beach. Here they were repacked and weighed by the family, and then boated out to the ship lying offshore. Oranges were consigned to New Zealand, so harvesting was dependent on the irregular and infrequent shipping links.

For half the twentieth century native oranges dominated the cash economy. At first they brought high returns; then prices began to drop. Traders allegedly formed a monopoly to keep the price down. They encouraged islanders to buy from them on credit so they would be forced to consign them their oranges to pay off this debt. When cargo space was limited each trader allocated each grower a quota based on the money the latter owed him. Prices to the grower dropped to a fraction of the fruits' resale value in New Zealand. Occasionally shipments would net no payment at all. Agitated growers threatened to withhold oranges.

With the start of the Great Depression prices plummetted again. Growers became increasingly indebted to traders, and reacted by shipping less and less. By 1934 they received on average a twentieth of 1930 incomes. Allegations of poverty and profiteering prompted the New Zealand Government to send a parliamentary delegation to investigate the fruit growing industry.[1] As a result, the Fruit Control Scheme was set up in 1937. The administration undertook to buy, transport, and market produce; they also employed a citrus expert on Rarotonga to improve the crop. Over the next few years, prices tripled and so did Atiuan production.

During the 1940s production again declined, this time more seriously. The native trees started to die off mysteriously. Many theories have been advanced. Most trees were over seventy years old, near the end of their life. No one had transplanted seedlings and natural regeneration had been too slow. Death had been hastened by two recent hurricanes, by the clearing of orange groves for other crops, and by the increasing rat population eating fallen seed oranges. Also several European growers on Rarotonga, in importing new strains of citrus stock from overseas, had unwittingly introduced new pests and diseases to which native trees had no natural immunity.

The Agriculture Department advised growers to prune their trees down to a stump a few feet high. Growers received this advice suspiciously, but from 1947 to 1949 most of them did so. It appears that the number of trees bearing fruit halved from forty per household in 1940 to twenty in 1950. Despite rapidly rising prices production dropped from 30,000 cases to 1,000. Rumour was rife: Europeans were trying to take over Maori lands; a mysterious poison had spread through

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[1] See *Report on the Cook Islands Fruit Industry*, 1936.

the soil and no crops could be grown. Economic instability threatened political instability. Agitation led to the protest Cook Island Progressive Association being set up in Rarotonga.

The origin of the Citrus Replanting Scheme

The New Zealand Government acted to defuse the situation by revitalizing the orange growing industry through the whole lower Cook Group. First they offered to assist, in replanting oranges, any grower who could arrange a clear individual title to his land. This was impossible for most, and the scheme was dropped. Then the administration proposed to lease a large area of growers' land, bring it into orange production, and then pay the landowners half the proceeds. Distrust of government motives led growers to reject this too.

Eventually the provisions of the Citrus Replanting Scheme were settled. An individual grower could obtain secure tenure over customary land by the consent of all owners to this sole right to proceeds from a plot. This was formalized through an occupation right through the Land Court. A condition was that the land be used 'in a husband-like manner'. Then the government would provide trees, with advice and services to grow them. The scheme aimed to standardize plots at 90 trees (0.4 ha) on Rarotonga and 45 trees (0.2 ha) on the outer islands; this implicitly assumed individualistic and competitive smallholder farming. It was to be financed by the New Zealand Government.[2]

Operations began on Rarotonga in 1946. In 1948 the Director of Agriculture travelled to Atiu to introduce the scheme there. The resident agent held a meeting of all interested growers, and they listened to the details. Members of the Cook Islands Progressive Association also travelled to Atiu, agitating against the scheme. They warned growers that the government's first move on Rarotonga had been to chop down all the old trees. Many older Atiuans opposed the scheme, fearing they would lose not only their trees but also their lands to the government. The Resident Commissioner on Rarotonga wrote to the New Zealand Secretary

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[2] Finance totalled $1,000,000 from tied loans, $250,000 from tied grants, and roughly $500,000 from general grants for the first 20 years, for the whole Cook Islands.

of Island Territories (1949):

> There has been considerable opposition on the part of growers to the inauguration of any scheme of citrus replanting on Atiu; until this year the growers were firmly of the opinion that their deteriorated trees would recover naturally and that no effort on their part was necessary. During the Director of Agriculture's visit in May last, the growers professed to see that pruning existing trees and replanting are necessary, but it is still doubtful whether there has really been a change of heart.

Another visit the following year eventually convinced most growers to join the scheme. But at least half a dozen of the most respected older men still opposed it, and refused to join. The administration planted eight demonstration plots in the only village that had been surveyed so far by the Land Court, mainly on the lands of influential middle-aged growers.

Project services

Having obtained an occupation right over a piece of land, the plot owner had to clear it. This was done either by contract gangs raising funds or by work groups taking turns to break in one another's land. The administration supplied trees, fertilizer and sprays, gave technical advice, and sprayed the trees. A tractor could be hired to help cultivation. Materials were charged at cost to an individual account held for each grower. Interest was charged at 5 per cent on the balance 6-monthly. When the fruit was sold, the administration automatically deducted three-quarters to pay off the debt; the grower received the rest.

Over the years the scheme became more and more lax. As the growers neglected weeding, pruning, spreading fertilizer, and even picking, the Agriculture Department took over these duties. Increasingly, costs were subsidized: by 1975 trees still cost only 30 cents (the 1950 price), fertilizer had a 50 per cent subsidy, and spray was free. The interest rate dropped to 0.5 per cent, and the repayment rate to 50 per cent of proceeds.

The government undertook to buy, grade, pick, fumigate, and ship the oranges to New Zealand, where they assured an open market. In 1961, the Greggs Company of New Zealand built a juicing and canning factory in Rarotonga (Island Foods Limited) to process orange juice. From 1962 all Atiuan fruit was consigned there. This meant lower quality, less ripe fruit was marketable, and shipping costs were lower.

Ostensibly, the project involved only new orange varieties - the locally developed Rarotonga Seedless grafted on to lemon rootstock, and the imported Late Valencia orange intended to lengthen the harvesting season. However, these new varities brought with them a whole collection of new citricultural practices that amounted to a revolution in farm management.

This was not made clear in the early meetings, and most growers did not anticipate it. Whereas the old trees had borne fruit without any cultivation the new varieties depended crucially on how they were cared for. Being much smaller, the new trees were easier to pick, but they were very easily smothered by surrounding bush. They needed 3-monthly weeding, annual fertilizer and pruning, and spraying against an increasing range of diseases and insects. Furthermore, it only needed a few seasons of neglect to damage them permanently. Atiuan growers had never experienced an input-intensive crop like this before; even if they had been prepared to work as hard as required, they were not convinced of the usefulness of fertilizers and sprays.

In the meetings, owners were told they could expect their trees to start bearing in the fifth year and reach a maximum yield of five (70-pound) cases in the tenth year. Yields this high may now be possible with proper management. But in the 1940s it was a wildly optimistic estimate to make to Atiuan growers, even higher than controlled field trials in developed countries had yielded. They talked of these yields without suggestion of the likely variations between years from climate, shipping, disease and administrative mismanagement. In fact, trees on Atiu turned out to be more slow growing and more variable than predicted, yielding on average only two cases per tree.

The administration overestimated financial returns too: they predicted a net return to the grower of $20 after five years and $160 debt-free after eleven years. In fact most growers received no returns for about eight years, and today

80 per cent of plots still owe money. Figure 8 contrasts advertised and actual net returns to the grower. As a result growers had to decide their strategies on incorrect information.

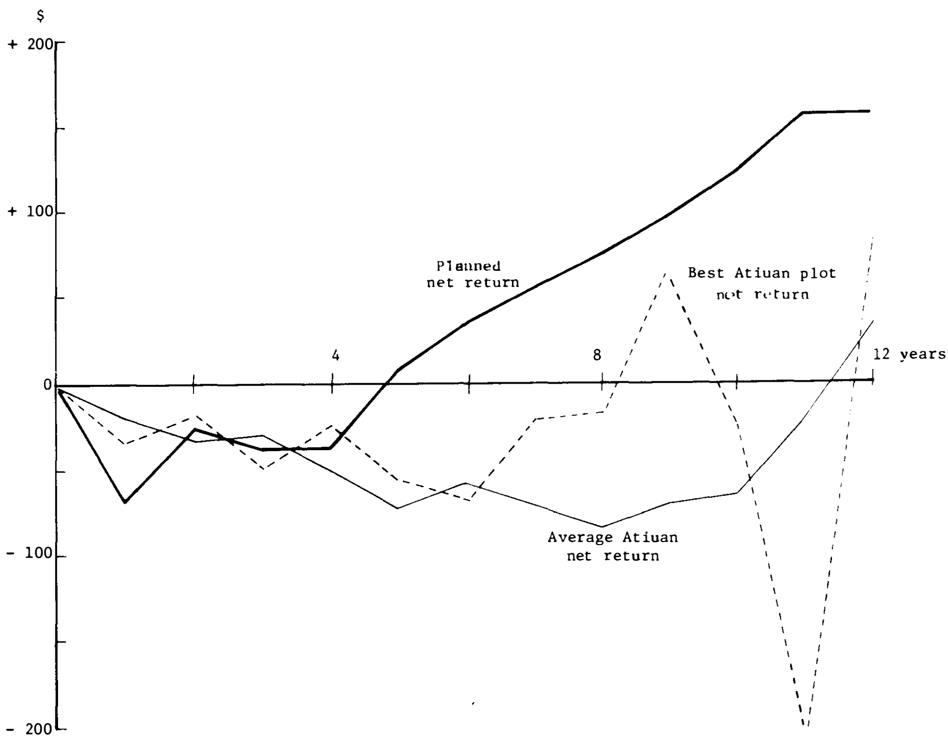

Fig. 8. Net return from oranges

Note: Returns received for first 12 years from the Citrus Replanting Scheme, weighted for different age plots, in money, not real terms

Source: Table 18.

Grower response

After the first eight plots had been planted in oranges the reluctance and suspicion towards the scheme weakened. More and more growers joined in until after five years the numbers tailed off as only the more reactionary ones were left. In all, 80 per cent of households planted plots. The

Table 18

Performance of Citrus Replanting Scheme

	Planned			Actual		
Year	Value of Inputs ($)	Value of Output ($)	Net Return ($)	Value of Inputs ($)	Value of Output ($)	Net Return ($)
1	71	-	- 71	25	-	-25
2	27	-	- 27	31	-	-31
3	29	-	- 29	33	-	-33
4	31	-	- 31	54	-	-54
5	41	41	0	71	-	-71
6	41	81	+ 40	80	18	-62
7	45	101	+ 56	99	25	-74
8	46	122	+ 76	113	24	-89
9	46	141	+ 95	118	34	-74
10	46	162	+116	111	45	-66
11	46	203	+157	84	63	-21
12	46	203	+157	57	95	+38

Note: Planned figures are 1946 estimates. Actual figures are weighted for different plot ages, and are in money, not real terms.

Taking 1967 as a typical year, the average mature plot yielded 7,970 lb. After the administration had deducted expenses, the grower received $87.70 for about 15 days' work: an average revenue product of labour of $1.00 per hour.

Source: Files of Atiu Administration.

rapid rate of tree planting and the way this compensated for the demise of old trees is seen in Fig. 9. The most outspoken early opponents did not join, but many of their children did. Most people joined before they had had time to assess yields from the demonstration plots: they were influenced more strongly by other community members than by financial inducements.

Most growers worked hard on their plots for the first year or so, then the surge of community enthusiasm began to fade. Growers had never experienced this type of intensive cultivation before: realizing the cost on their time they started to let plots deteriorate. The trees had not yet begun to fruit, so the effect of this neglect was not obvious.

Then in 1955 the first oranges were sent off to market. But where was the money that had been promised? Even the best growers took home only about $5. Neglected during their crucial early years, the trees bore far less than

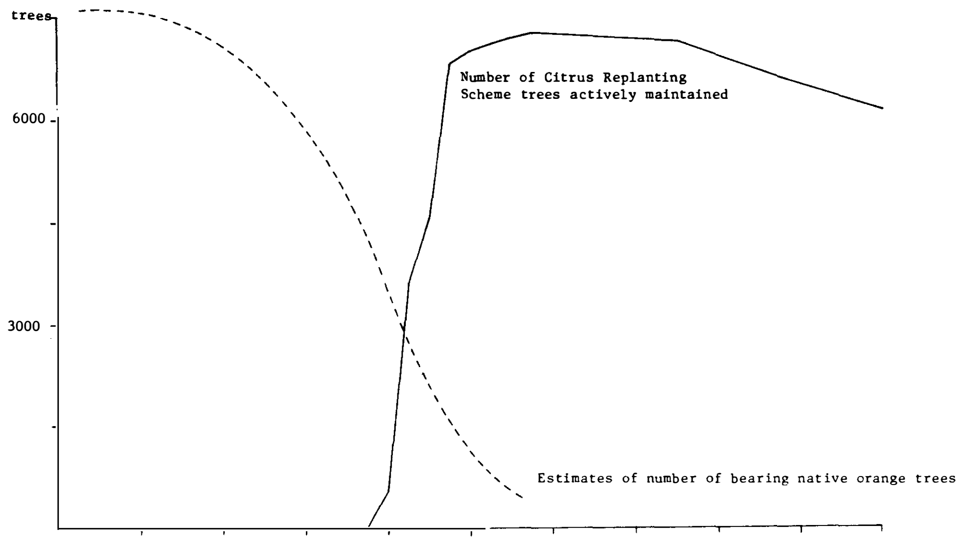

Fig. 9. Maintained orange trees

Source: Table 19.

Table 19

Grower participation in Citrus Replanting Scheme

Year	No. of trees	Maintained plots	Price to grower (¢/lb)	Value of inputs ($)	Exports f.o.b. ($)	Accum. debt ($)
1950	1,017	22	-	1,290	-	1,290
1951	3,671	81	-	3,340	-	4,634
1952	4,587	102	-	4,814	-	10,458
1953	6,839	155	-	5,804	-	16,260
1954	6,980	158	-	5,704	-	22,764
1955	7,067	160	0.3	11,978	137	34,654
1956	7,155	162	0.3	12,330	763	45,962
1957	7,245	164	0.3	13,258	1,329	56,910
1958	n.a.	164	0.4	14,302	7,158	65,774
1959	n.a.	164	0.5	22,076	7,120	81,146
1960	n.a.	164	0.5	23,924	110	104,964
1961	n.a.	164	0.6	16,284	5,216	115,786
1962	n.a.	164	0.8	10,900	16,528	118,620
1963	n.a.	164	1.2	9,714	17,606	122,492
1964	7,131	164	1.2	4,464	18,073	119,328
1965	n.a.	164	1.1	1,040	45,993	104,342
1966	n.a.	164	1.1	1,056	44,982	90,988
1967	n.a.	164	1.1	9,923	36,987	86,741
1968	n.a.	164	0.7	9,938	10,830	81,599
1969	6,582	162	0.5	7,260	33,006	78,958
1970	n.a.	150	0.5	10,980	17,325	81,990
1971	n.a.	137	0.4	4,119	18,222	76,925
1972	n.a.	135	0.6	10,162	16,441	78,994
1973	n.a.	135	0.8	10,476	21,825	71,776
1974	6,085	131	0.8	5,358	9,862	72,607

Price paid to grower = f.o.b. price - debt repayment - administrative levies.

Sources: Files of Atiu Administration, field notes.

the administration had predicted. With the true production information just beginning to accumulate, growers took stock of their position. It was not worth working too hard for this sort of money: better to accept low yields off poorly-kept trees.

As real prices received by the grower rose over the next decade, so output lagged several years. As they fell after the mid-1960s, so did production (allowing for climatic variation), as Fig. 10 shows. It is not clear how far price and production response were connected. But the level of market intelligence was not high: the survey found only one man who could give even a rough idea of the current price per pound of oranges, and no one understood how the complicated and changing deductions and repayments worked. Nevertheless, growers did have a general impression of real price changes.

Similarly, paying interest did not deter growers from accumulating high levels of debt. Most people interviewed did not know how their plot debt stood nor how interest operated. Consequently, materials charged to them appeared artifically cheap (as in effect they have been since many growers have never paid off their debts). Some plots have now accumulated massive debts, several over $1,000. The very best plots took seventeen years to become debt-free instead of nine as predicted.

As new more glamorous crops became available, grower interest faded. In particular, the lure of wage jobs with the new Pineapple Incorporation drew men away. In such cases, growers worked a bare minimum on their orange trees, sometimes only picking the fruit for home consumption or to make bush beer.

Growers who migrated usually left their plots to relatives who often already owned other plots. Under absentee ownership, such trees yielded significantly less (see Menzies 1970). By 1961 a quarter of plot owners had left for Rarotonga or New Zealand. By 1975 only 20 per cent of plots were still cultivated by their original owners. On average, each plot had had two owners ratified through the Maori Land Court and at least one other unofficial one. The effect was less commitment and less continuity in a crop where commitment and continuity were all-important.

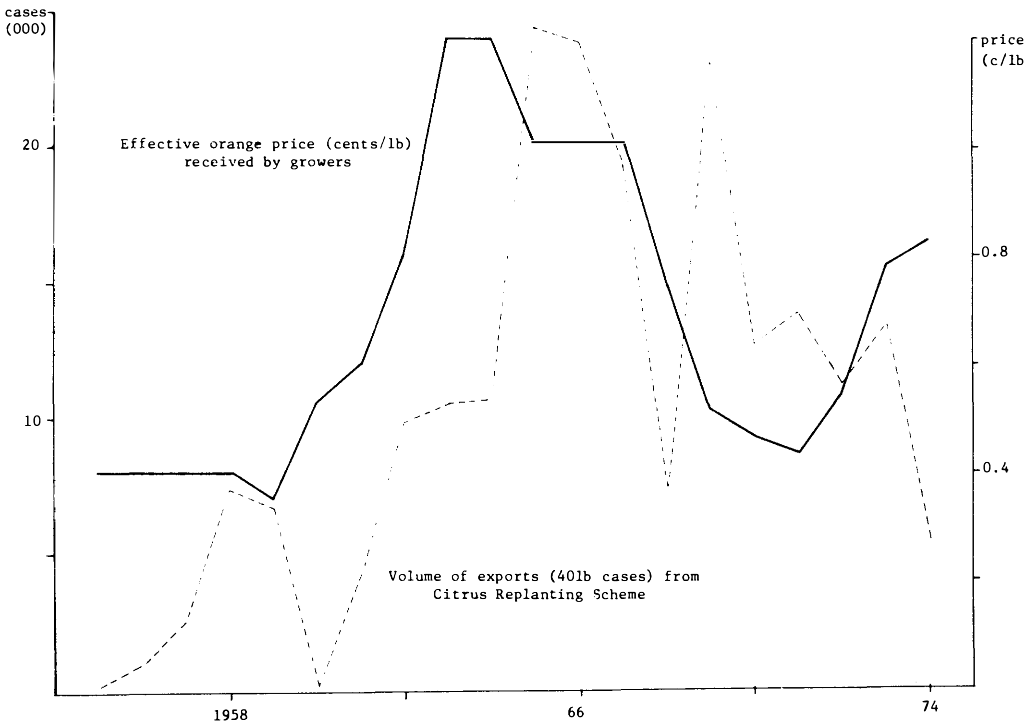

Fig. 10. Prices and volumes of orange exports

Source: Tables 13, 19.

Faced with this fading enthusiasm, the government responded by assuming a more active role, first cajoling and then taking over duties themselves. In 1964 a new resident agent organized the Island Council and village committees to exhort orange growers to work harder, using planting inspections, competitions and increased grower prices. These resulted in several years of high productions which were ended by the hurricane of 1968.

By 1975, the Agriculture Department had progressively taken over spraying and spreading fertilizer, then slashing weeds and pruning trees, and they even ring-weeded several plots manually. Most growers seemed to prefer to work for wages, then pay for these jobs to be done.[3] A couple of owners even paid labourers to pick the crop. There were also half a dozen plots whose owners had grown old or migrated, which had been taken over completely by the Agriculture Department.

Only about a dozen men continued to take orange cultivation seriously. Most of these were full-time growers who needed the money and managed all their crops knowledgeably. They received a net return of around $100 to $200 per year from their trees. There is no evidence that growers of higher tribal rank produced more, though they were statistically more likely to be participants.

The gradual decline in production over the last decade is probably irrevocable. Trees are now 20 to 25 years old, neglected, and incapable of responding to new inputs. Surveys show that the rate of depreciation of the stock of trees has been equivalent to 100 bearing trees falling out of production each year for the last ten years, mainly precipitated by weed strangulation. The decision to withdraw from the project is not made suddenly; a grower gradually gives up weeding his crop and then picks it less regularly, sometimes not bothering to sell it. Weeds take their toll. Soon there is nothing worth looking after. By 1975 nearly a quarter of the plots were in this state, although well below the advertised tree life of 45 years.[4] Figure 11 shows this decline.

The Citrus Replanting Scheme appears near its end. How successful has it been? It has been a financial failure, though in a wider economic sense it generated important knowledge for growers on the problems of modern crop cultivation and for administration on the problems of project design.

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[3] Evidence of this recent decline of grower involvement comes from my field survey of orange growers (results of a 1969 survey by Menzies in brackets). Growers ring-weeding own plot, 57 per cent (100 per cent); cultivating own plot, 10 per cent (60 per cent); pruning own plot, 15 per cent (90 per cent).

[4] I arbitrarily define the withdrawal date as the year returns fall below 20 per cent of the average level for at least two successive years and never again reach 50 per cent of the average.

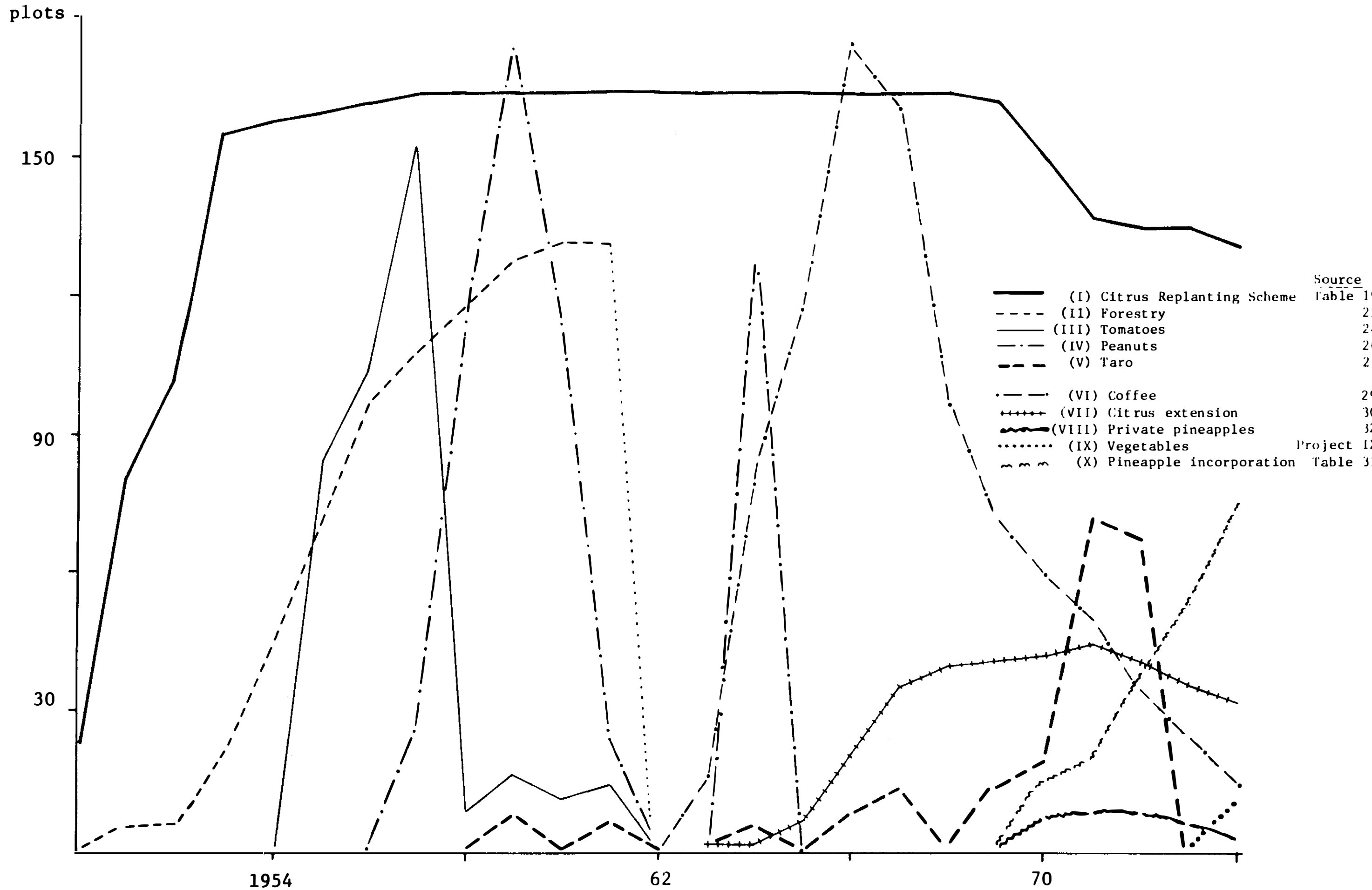

Fig. 11. Number of maintained project plots

Table 20

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

Subsequent economic projects

The Citrus Replanting Scheme was only the first (though a major one) of a diverse range of ten agricultural projects involving new or improved crops and crop practices that were implemented over the period 1950-75 (and another two were planned but not implemented). Table 20 summarizes the technical characteristics of each of them.

This section describes each project in turn. The technical details provide the data on which the models of Part Two are tested.

Project II: Forestry. When it appeared the Cook Islands would become a large citrus producer the resident agent on Atiu, an ex-New Zealand forester, suggested planting forestry trees on the leached unused fernlands. This would conserve the soil and yield a soft wood for milling into fruit cases.

The resident agent set up a two hectare experimental farm, then imported and planted a variety of fast-growing seedlings. From these, he selected the leguminous albizzia tree. With the support of teachers on the island, he outlined a scheme to growers, to plant seedlings on land with settled ownership. The administration would disc the plot. The owner had to dig holes, plant and stake the trees under supervision, maintain a firebreak, and weed the plot several times a year for the first two years. After several more years the administration would help prune the trees. At age 10 they could be thinned to yield the first timber. Another five years and they could be milled. Table 21 reconstructs the expected returns to a grower from an average plot of 0.5 ha (470 trees).

Five Atiuans, all keen growers and large landowners, agreed to plant trial plots. Seeing this, the others grew keen. In the next year 250 growers applied to join the scheme putting forward 134 hectares, a considerable part of the island ridge-tops. Many lost interest, however, as they had to wait for seedlings. Over the next eight years 131 plots were planted (see Table 22).

Table 21

Expected returns to labour from forestry, 1960

Revenue:	royalty on thinnings	(year 10)	$ 60.00	
	royalty on timber	(year 15)	$150.00	
	total			$210.00
Costs:	establishment		$ 33.60	
	maintenance	(for 15 years)	$ 18.00	
	total			$ 51.60
Net annual returns to labour				$ 10.60

Note: Assumes no interest paid.

Source: Report on Atiu Forestry Project, 1960.

Once established, the trees grew well, even though they were rarely weeded, and neither pruned nor thinned. Several plots were accidently burnt each year. When the resident agent left, plantings stopped. By 1960 a report suggested that there were 40,000 trees still in reasonable condition, some 25 to 30 metres high, and they should be ready for milling in the early 1980s.

But no succeeding resident agents were interested in the project. No one encouraged growers; no one provided the promised sawmill. Trees were cut down for firewood and canoes, and cleared for crops. The Pineapple Incorporation cut down most of what remained. As an estimate, perhaps 10 per cent of trees are left, symbols of false expectations and short-sightedness.

The project was cheap, costing about $8,000 for the nursery and $800 for tractor work in a decade (excluding wages and salaries). It probably increased soil fertility and halted erosion. And it taught growers to be wary of administration claims. Otherwise it was a failure.

Table 22

Grower participation in forestry project

	No. of trees	No. of plots
1951	1,000	5
1952	4,447	6
1953	12,639	21
1954	22,237	44
1955	28,100	n.a.
1956	n.a.	97
1957	54,301	108
1958	57,200	n.a.
1959	n.a.	128
1960	60,418	131
1961	61,129	131
1970	30,000[e]	-
1971	11,000[e]	-
1974	6,000[e]	-

Sources: Department of Agriculture Files; field notes. 1970, 1971 figures are estimates of trees cut for pineapple scheme.

Project III: Tomatoes. Tomatoes had been grown for years in Rarotonga but apparently not on Atiu. The resident agent grew them in his nursery in the 1950s, and he offered seed to those interested. Growers could hire machinery to clear the land. The crop required constant weeding, and improved with fertilizer. As interest grew the administration deducted a small levy from each case of tomatoes and credited it to the grower; when he had sufficient credit to buy a bag of fertilizer, this was issued to him. However, in practice issues were irregular and did not meet the different crop requirements. Table 23 estimates actual returns to labour from an average (0.1 ha) plot in 1955, a typical year.

Table 23

Estimated returns to labour from tomatoes, 1955

Revenue:	518 lb at 5.5 cents		$28.50
Costs:	clearing and seeding	$ 3.00	
	harvesting	$ 2.30	
	total		$ 5.30
Net annual return to labour			$23.20
Approximate labour required			8 days
Average revenue product of labour on average plot			$0.48/hour

Note: This assumes all produce reaches market and that the grower works a six-hour day.

Sources: Files of Atiu Administration; Atiu co-operatives; field notes.

By 1956 most growers had a small tomato plot, and they sold their crop through private traders. In 1958 the co-operatives took on an active role. They sold seeds, then supervised planting and inspected crops. They arranged shipping and marketed the crop directly in New Zealand and Tahiti. Because it could last only a week without refrigeration it was dependent on frequent direct shipping. Fruit that ripened between ships was wasted. Several informants estimated half of production rotted. After the Rarotonga fruit processing factory was opened in 1961, New Zealand-owned shipping became much less frequent. The price to the tomato grower dropped. Growers lost interest; after the 1960 hurricane, exports ceased. Table 24 shows grower involvement.

The tomato project was less planned than others, growing from a need for a short-term grower income before orange trees matured. It cost the administration little. Some growers received good returns, but the fluctuations in climate, prices and shipping, made it extremely risky.

Table 24

Grower participation in tomato project

	No. of growers
1955	84
1956	104
1957	152
1958	9
1959	16
1960	12
1961	4

Sources: Files of Atiu Administration; Co-operatives.

Project IV: Peanuts.[5] In 1953 the resident agent imported seed from Fiji, and established a peanut crop in the government nursery for several years; this was the first time peanuts had been grown in the Cook Islands. Public meetings were held to interest growers in a home plot.

The seeds were distributed free to growers. They were planted in small plots on the unused fernland plateau. Discs could be hired to break in the land. But sowing, weeding and harvesting had to be done by hand. The latter was especially tedious: after five to nine months the plants were dug, dried and stooked, often by children. Although originally intended as an export crop, they were grown by many families only for their own use. It is estimated a third dried their own nuts and sent them to Rarotonga at some time. This was a risky proposition. More reliable was the small market for selling small bags of roasted peanuts outside dances on Atiu itself. Table 25 estimates net returns to the grower from peanuts off an average plot of 0.2 ha sold in Rarotonga in 1959.

[5] Few records remain from the peanut scheme. My knowledge is limited to informants' comments and grower surveys. Consequently the data of this section are less reliable than for other projects.

Table 25

Estimated returns to labour from peanuts, 1959

Revenue:	127 lb at 16 cents		$20.30
Costs:	establishment	$6.00	
	freight and marketing	$2.00	
	total		$ 8.00
Net annual return to labour			$12.30
Approximate labour required			8 days
Average revenue product of labour on average plot			$0.26/hour

Note: This assumes only 10 per cent of production marketed.

Sources: Files of Atiu Administration; field survey.

Table 26

Grower participation in peanut project

	Estimated no. of growers
1957	26
1958	113
1959	174
1960	113
1961	25
1962	-
1963	-
1964	126

Sources: 1957-61, field surveys; 1964, files of Atiu Administration.

After several years' interest, growers abandoned the crop. The original resident agent had left, returns were risky, and the job was tedious. Then, in 1964 a new resident agent tried to revive the scheme. New seeds were sold to growers. Loans of up to $20 were offered through the Economic Development Fund to hire equipment and buy fertilizer. The Island Council bought special peanut lifting equipment. Many growers applied for loans and established plots. But there was poor seed germination and rats proved troublesome eating nuts off the plants. It is said that in 1964 planters neglected to hold over any seed for the following year, when only one planter repeated the experiment. The sample estimate of planter involvement from grower surveys presented in Table 26 is very rough.

Project V: Taro. A growing urban market for *taro* in Rarotonga in the early 1960s encouraged a few younger growers to export their surplus *taro* there privately. Most growers had misgivings about the ethics of selling a traditional subsistence crop to other Cook Islanders.

Then, as Rarotongan plants were hit by a *taro* blight, the Rarotongan market became suddenly very lucrative. In 1970 the price almost doubled to $2.00 per kit. In 1968-69 for the first time a few of the more respected older growers had sold their crops. This appears to have convinced others of the legality of the practice. In 1970, seventy-two growers joined in. The Agriculture Department arranged shipments to Rarotonga, and sold the crop there, remitting the profit to the grower. By 1971, each grower was exporting on average 660 lb of *taro*, and his labour earned an average revenue product of about $0.94 per hour.

This project arose spontaneously in response to a disequilibrium market. The innovation involved was the break with tradition to market a subsistence crop in the Maori economy. For this reason the initial response was slow (see Table 27). The end of the project was sudden: the Rarotonga blight struck Atiuan *taro*. In one season the island lost its surplus, and no more was exported. Today growers are still experimenting to try and beat this disease.

Table 27

Grower participation in taro project

	Number of exporters
1960	-
1961	6
1962	-
1963	-
1964	4
1965	0
1966	7
1967	13
1968	0
1969	13
1970	19
1971	72
1972	68
1973	0

Note: Early numbers may be under-estimates owing to incomplete records.

Source: Files of Atiu Administration.

Project VI: Coffee. Native coffee bushes have grown wild for a long time on Atiu. They are said to be self-sown from stock planted by early traders. Growers cultivated them only by hacking back undergrowth to help harvesting. The coffee berries were used for a strong bitter local brew. In the 1950s several growers privately obtained seeds of some improved strains from a neighbouring island and grew coffee commercially. Also, a range of imported coffee varieties was planted in the local government nursery.

In 1963, the New Zealand Government directed the resident agent on Atiu to improve commercial coffee growing. A New Zealand coffee expert selected a suitable arabica variety, and plants were established in the Atiu nursery to provide free seedlings for growers. Applicants had to have obtained the agreement of landowners to plant some land, then clear it, dig holes, cut stakes, and plant shade and shelter belts. The Agriculture Department supervised planting. Fertilizer was free for the first two years, and 3-year Economic Development Fund loans were available for hiring machinery.

The bushes had to be weeded, mulched and fertilized several times and pruned once a year. Atiu was free of most coffee diseases so no spraying was necessary. The first berries appeared after two years and full production was achieved at five, harvested from February to May. Picking by hand was a tedious and time-consuming task.

Until 1967, the berries were pulped in a government machine and then sold to local traders. In 1967 a small factory was built on Atiu to husk the berries. The dried beans were then sold on contract to Greggs (New Zealand), the parent company of the Rarotonga orange processing firm. They paid a small fraction of the price immediately, and the rest nearly a year later when they had worked out profits on their coffee operations. Real prices have been falling in recent years. Table 28 records approximate returns to labour from an average-sized coffee plot of 225 5-year-old trees planted on 0.15 ha at 1970 prices.

Table 28

Estimated returns to labour from coffee, 1970

Revenue:	309 lb at 20 cents	$61.70
Costs:	Share of establishment costs	$ 3.80
Net annual return to labour		$57.90
Approximate labour required		11 days
Average revenue product of labour on av. plot		$0.88 / hour

Note: Average plot yields approximately 100 lb in 3rd year, 200 lb in 4th, 300 lb in 5th. Establishment costs include clearing ($18), holing ($5), planting and manuring ($3), spread over 7 years.

Source: Files of Atiu Administration.

The scheme was introduced with grower meetings. The whole community was keen: the administration planted a large area, and the school and the Catholic Church both planted plots; so did 177 growers, with the largest private plot containing 1,300 trees. Many plots were planted by contract work gangs or by communal work parties.

It was the story of the Citrus Replanting Scheme all over again. Initially enthusiastic growers grew reluctant to cultivate and market crops. Most preferred to let them compete with the bush, growing long and straggling, as did the tougher native coffee; they preferred to pick them infrequently for home use, rather than sell them regularly. Furthermore, a hurricane in 1968 damaged most plantations with salt spray; the resident agent who had organized the coffee left the island the same year. As a result many neglected young bushes died. Of a total of 40,000 plantings, 10,000 had died by 1967; today less than 10,000 remain, mostly in poor condition (see Table 29).

Table 29

Grower participation in coffee project

	No. of maintained private trees	No. of private plots	No. of exporters
1963	1,585	15	-
1964	14,743	84	-
1965	19,662	118	1
1966	34,576	173	1
1967	30,162	163	10
1968	18,045	97	3
1969	n.a.	72	10
1970	11,210[e]	60[e]	23
1971	n.a.	50[e]	9
1972	n.a.	35[e]	34
1973	n.a.	25[e]	10
1974	2,800[e]	15	15

[e] means estimate.

Sources: Files of Atiu Administration, field notes.

Project VII: Citrus extension scheme. An extension to the earlier Citrus replanting Scheme was implemented on Atiu in 1965. It was hoped it would stimulate flagging orange production among growers who had had the chance to learn about modern tree cultivation from the first scheme. The government aimed to make the grower play a larger role. The scheme offered new strains of orange tree on a sturdier rootstock, and also a new jaffa variety. They were to be bought, planted and maintained at the grower's initiative. As the trees reached maturity, the grower had the choice between maintaining a private plot, or buying fertilizer and spray through the administration, then paying from crop proceeds.

There was a slightly more cautious approach by growers: 58 applied to join, but over the next six years only forty four actually planted plots, on average 0.5 ha (twice the size of earlier plots). Three thousand trees were planted, though a quarter had to be replaced because of poor stock and poor care. Most of the participants were growing oranges for the first time - either younger planters or a few older ones who had objected to the original scheme but since decided their fears were unjustified.

Despite better services and information, plot maintenance did not improve. The field survey showed only half the trees still survived by 1975 and many of these were in poor condition. Plot debts have risen faster than anticipated and yields are low: by 1974 forty plots should have been bearing but only eight were picked. A quarter of the plots have been abandoned by their emigrant owners. The rest receive even less attention than the original citrus trees did.

Island Foods Limited suggested an incorporation of lands might provide a larger more efficient citrus plantation. In 1971, a block of land owned mainly by two families was offered. Although it still has not been formally incorporated, men from these families are employed by the Agriculture Department to plant orange trees on 40 ha. Until they mature, vegetable crops are being interplanted to reduce costs. By 1974 only 200 of an eventual 8000 trees had been planted, but the incorporation was already encountering severe management problems.

Table 30

Grower participation in citrus extension scheme

	Maintained trees	Maintained plots	No. of exporters	Value of inputs ($)	Value of production ($)
1963	73	1	-		
1964	73	1	-		
1965	686	7	-		
1966	1556	21	-		
1967	2211	35	-		
1968	2122	40	-		
1969	n.a.	41	-		
1970	n.a.	42	-	70	
1971	n.a.	45	1	110	20
1972	n.a.	41[e]	4	87	171
1973	n.a.	36[e]	6	200	334
1974	1513	32	6	70	111

Sources: Files of Atiu Administration; field survey.

Project VIII: Private pineapple project. About 1969 Island Foods Limited indicated to the Cook Islands Government that they needed more fruit to keep their Rarotonga factory running economically. They suggested pineapples could be grown on the unused barren fernlands there.

Families were to apply for court occupation rights in small plots of unused plateau fernland. The government offered free technical advice and pineapple shoots. Other materials could be bought from the local Agriculture Department, which also marketed the crop. All the work had to be done by the growers. By Atiuan standards, this was considerable. Land had to be cleared, contoured, and drained. Pineapples were planted in rows, heavily fertilized, weeded twice yearly, and sprayed. They fruited after the second year, then 6-monthly for another two years:

picking was by hand. After this, plants were uprooted and the land left fallow.

Well maintained, the pineapples could bring good returns although far less than those advertised. Table 31 estimates the annual net returns to labour from the average 2-year-old plot of 0.25 ha in 1971.

By 1970 twenty-seven families had applied for occupation rights to plant up to one hectare in pineapples. However, in the meantime the government decided the crop might be better produced using skilled management and hired labour in a land incorporation.

Only eight private growers eventually tried growing pineapples on their own. These were the most active innovative men on the island, and they used considerable skill and initiative with this difficult crop. Nevertheless, they only obtained about a quarter the crop they had hoped for; a mealy bug infestation was a major reason. Most gave up their plots and joined the incorporation. By 1975 only two growers stubbornly continued on their own.

Table 31

Estimated returns to labour from pineapples, 1971

Revenue:	8400 lb at 1.8 cents		$151.10
Costs:	Share of establishment	$19.00	
	Weedicide	$ 6.00	
	Fertilizer	$13.00	
	Total		$ 38.00
Net annual return to labour			$113.10
Approximate labour required			14 days
Average revenue product of labour on av. plot			$1.35/hour

Note: Average plot yields approximately 8000 lb in 2nd year, 4000 in 3rd. Establishment costs include tractor ($38), contouring ($11), planting ($8), spread over 3 years.

Source: Files of Atiu Administration.

Table 32

Grower participation in private pineapple scheme

	No. of plots	No. of exporters
1970	7	-
1971	8	7
1972	8	7
1973	6	5
1974	2	1

Sources: Files of Atiu Administration; field survey.

among Atiuans. In 1974, twenty-five growers sold crops worth over $3,000, mostly in the local market or to the army. Shipments to Rarotonga occasionally proved very profitable but were risky. In addition, green vegetables were a welcome supplement to some home diets. But the drought in 1974

Project IX: Vegetables. The Cook Islands Governments decided the visit of New Zealand army engineers to Atiu in 1974 and the growing Rarotongan market for fresh vegetables presented opportunities for vegetable growing on Atiu. An agricultural officer was sent from Rarotonga to set up a small vegetable plot in the government nursery, growing selected seeds and selling these to growers. (For political reasons, the Atiu Administration did not continue this nursery work.)

Having seen the dismal record of past projects, the officer tried a new approach: instead of organizing public meetings and exhorting the populace, he picked a dozen of the best growers and supplied them with free seeds, hoping others would copy them.

These and other growers set up the Growers' Association with representatives from each village to act as a pressure group. They arranged to ship bulk produce to Rarotonga and sell it there. They also built a tiny market place on Atiu - the first formal institution to sell local produce ruined a lot of planting and dissuaded many growers. Half of them appeared to have given up planting by the following year.

These vegetable growers were the entrepreneurial cream of Atiu. With hard work and careful planning a few of them earned a lot of money this way: one man earned $800 from part-time growing in 1974, and two others grossed over $400. The average return per grower was $132; but with high costs of fertilizer, spray and equipment, and the heavy work required, the average revenue product of labour on a typical vegetable plot in 1974 is estimated at about $1.17 per hour. Several growers experimented with new varieties of vegetable. However, the real innovation was the break with tradition in selling crops to fellow Atiuans.

Project X: Pineapple Incorporation. It was suggested that one way to overcome Atiuan problems of land fragmentation, hesitant project response, and communal interdependence would be for owners to pool land into an incorporation and jointly grow a crop like pineapples, using economies of scale. This project required some communal consensus on the sensitive issue of land control, and it introduced a new form of labour organization and control.

A long series of meetings was held with Atiuan landowners: they were keen to participate but wary of disadvantages. At last they agreed to set up a formal corporation under a managing committee of five elected landowners who would appoint a farm manager responsible to them. They would plant pineapples using modern mechanical methods on the 200 to 300 ha of fernland unused in the centre of the island.

Several simple cost-benefit analyses were carried out. The incorporation would plant 80 ha per year, covering costs after the third year. Then profits would be distributed to landowners on the basis of their shares in the lands. Assuming a regular annual yield of 7000 tons, good profits and a social rate of return of 30 per cent were anticipated.

By 1975 the Cook Islands Government had not yet managed to incorporate the land, partly for political reasons. In the meantime the Agriculture Department rents it from landowners who are then employed as wage labourers to work on it. It debits production costs to its current account - in effect an interest-free loan. In 1970 a pineapple nursery of 16 ha was planted as a trial plot. The next year, work began on the main plantation. This covered only 70 ha by 1974, far below the planned planting rate.

By then many cultivation problems had arisen. The land had to be well-prepared, heavily fertilized, hand-planted and weeded frequently. After two years the pineapples could be picked 6-monthly. Labour was a major constraint on production. It was intended to mechanize the breaking in of land, as well as spraying, fertilizing, and possibly harvesting. The UNDP donated a boom sprayer (of the wrong type) and a mechanic (used by the Cook Islands Government on other islands). A long awaited experienced pineapple manager did not arrive until late in 1975.

More problems arose in shipping fruit to the processing factory in Rarotonga. Up to 1974 about a half of crop yield had been wasted owing to the poor scheduling of ships and the problems of manhandling cases of pineapples over a treacherous reef. In 1974 the New Zealand Government sent a contingent of army engineers to the island to build a harbour. This took one year and cost $526,000 by 1976, far greater than pineapple returns. In 1976 two motorized barges costing $80,000 were donated by New Zealand to use the harbour.

By the end of 1975 direct development costs totalled $168,000 or $1,500 per hectare (compared with an expected $350), while total capital costs were far greater. Anticipated yields in developed countries are over 2,400 cases per hectare, and those achieved on the small holdings of neighbouring Mangaia are around 1,600. So far Atiu has produced only about 500 cases, and only half these have been shipped. These low yields are due to mismanagement, lack of machinery, insect damage, and drainage problems. This unqualified financial disaster is shown in Table 33.

Because of the losses and mismanagement, dividends have not been paid to landowners as planned. In 1974 it was decided to pay out half the previous year's proceeds as rent to the owners of the nursery. This showed the problem of fragmentation, unequal ownership and absenteeism that bug the scheme. Of a total of $5,891, $3,084 went to twenty-four landowners still resident on Atiu; one elderly woman received $1,430. Landowners are currently dissatisfied at haphazard payouts, and their inability to influence pineapple growing decisions.

Table 33

Performance of Pineapple Incorporation

	Planned			Actual			
	Costs ($)	Revenue ($)	Area (ha)	Costs ($)	Revenue ($)	Area (ha)	Employees
1970	20,000	-	16	10,900	-	16	15
1971	22,000	-	61	13,000	-	36	20
1972	21,300	-	105	23,200	6,900	53	37
1973	45,600	153,200	150	33,500	7,000	70	55
1974	65,400	245,100	178	44,000[e]	16,300	70	75
1975	74,400	303,200	178	44,000[e]	8,800	71	n.a.

Source: Files of Atiu Administration.

The greatest impact has been the opportunity for wage employment for every man who wants it. Many have been keen to work in the scheme with its attractions of a certain regular wage and communal work groups. Most wage earners and over a third of the labour force work regularly about 20 hours a week: they are unwilling to work longer hours, for other activities are being curtailed. Most of these wage workers have given up their project cash crops, and find it hard even to maintain their subsistence crops. Cash cropping has become more of a specialist occupation for full-time growers in recent years.

In addition to the ten projects implemented on Atiu, another two crops were seriously proposed but did not eventuate. In 1962-63 the administration suggested growing pepper under the forestry trees; fifty seven growers were interested. Eventually, it was decided to grow the crop on a neighbouring island. In 1967-68 a scheme was put forward to grow soya beans in an incorporation; forty-six households wanted to join. The Pineapple Incorporation Scheme ended this.

Chapter 5

Cultural attitudes to economic opportunity

This chapter offers some generalized value judgments about the cultural attitudes that colour the Atiuan response to economic opportunity. It contains material about the existence and magnitude of the cultural parameters used in the theoretical model. Each of the sections relates specifically to one of the following six chapters.

Consumption and work preferences

Material items of consumption are important to Atiuans but their tastes for them seem easily satiated, as is common in relatively closed societies. Great emphasis is put on 'body needs': food, drink, sex, and entertainment in the form of song and dance. The only important item of expenditure is food. The field survey showed that two-thirds of spending on Atiu was on a very small range of basic foods - bread, sugar, tinned meat and fish. Alcohol accounted for another 10 to 15 per cent and cloth was another major purchase. Most homes boasted a few durables: a transistor radio, and perhaps a motor-scooter and a sewing machine.

The starchy root and fruit crops provide the bulk of the diet. No meal would be considered complete without *taro*, bananas and coconut. The scarcer fresh seafoods are specially desirable. It is not easy to buy these subsistence items on Atiu. The western practice of impersonal buying and selling among friends clashes with traditional customs. Although a small vegetable market has begun recently on the island, many are hesitant about using it.[1]

[1] One grower told me that he planted 3,000 cabbage plants in 1974, and when they all grew he gave the surplus away rather than sell it.

Despite levels of income that are very low by western standards ($188 per capita in 1974) Atiuans do not like to spend long hours earning money. Their tastes for many western items are constrained by socially imposed limits and are easily met. The unusual economic and social conformity on Atiu means there is little variation between consumers' experiences and tastes. By 1974 the real value of expenditure was more than twice that of 1950. Much of the increase has been spent on durable goods. Innovation in such products takes place quickly through a powerful bandwagon effect. For example, ten years ago there were no motor-cycles, but today more than half of households own them. Because such expenditure is lumpy, growers who wish to buy motor-cycles and sewing machines work very hard for a short burst to pay for them, then return to earlier leisure levels.

Atiuan concepts of labour and leisure do not follow the two extremes of western economies. For this reason attempts to separate and quantify them can be deceptive. Productive labour is often enjoyable: men like to go fishing; less intensive work such as sewing or gathering berries offers relaxation and company for women. Conversely, leisure occasions are an opportunity for serious work - a picnic at the beach may end up with the men fishing and the women gathering seafoods.

Work is often unintensive and slow-paced, as is fitting in the heat. A full-time planter may spend much of the time on his land resting and talking to neighbours. Indeed, he would be considered unsociable if he did not. Consequently, even routine jobs like pig-feeding may take several hours.[2] The western concept of leisure has no exact parallel. There are no 'holidays' from free labour, only sacred days on which work may not be done. (On Saturdays most men work on their lands or go fishing.)

Atiuans are attuned to work by the task rather than by the time. Few people have watches, and the day is ordered by the passage of the sun and by natural 'body clocks'.[3]

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[2] I went on a netting expedition where half a dozen men took three hours to net half a bucket of small fish; this was not helped by the fact that most of them were drunk.

[3] Teachers complained that children would arrive late for school on cloudy days.

Working by oneself is not much fun, and, if done excessively, will be considered antisocial. Most people on Atiu prefer to work in groups and probably work much harder that way. The only consistent loners in the society were one or two hardworking unpopular growers and several partly crippled or deformed men who sought the seclusion of the bush. All bush beer work and all fund-raising work is organized communally (as was much private cultivation in the past). There are good technical reasons for this: heavy work requiring a lot of muscle power may be done with a gang more efficiently. Also psychological reinforcement means a bush beer gang of ten men can dig ten *taro* patches in less time than one man takes to dig his own.

The end result of work is most important; working for some impersonal organization (such as the government) does not inspire uncommitted workers. There is a world of difference between the half-hearted work of labourers on the pineapple plantation, and the cheerful enthusiasm that goes into building a house for a relative or digging a taro patch to raise funds for the church. Money is not always sufficient reward to overcome these prejudices. Private growers wishing to employ labourers for a small job sometimes offer a bottle of whisky or several cooked fowls in return, without worrying about monetary equivalence. Such 'gifts' seem to be more acceptable than a money payment.

An aspect of work especially distasteful to Atiuans is a regular commitment to labour. When social obligations arise and require attention, work should not be allowed to stand in the way. The Pineapple Incorporation was for many the first opportunity for regular wage labour; records show nobody works a regular 40-hour 5-day week. Instead work is preferred in short bursts of high intensity.

In summary, relatively low levels of income are enjoyed by Atiuans, but they consider they do not have much to gain from extra income (although occasionally people find they want to buy something that requires a lot more money). Private labour is not enjoyed at all, and few people are interested in working harder simply to earn more money. Finally, it is relatively easy to live comfortably on Atiu, and some people do very little work. But in the long run it is not possible to live off the goodwill of others.

Attitudes to risk

Atiuans have shown enthusiasm for gambling in some activities, and at the same time conservative dislike for risk in others. This may be rationalized: risky choices are justified only if the cost of failure is relatively small or if the reward from success is relatively high; risk is avoided in any way a person can insure himself when the cost of failure is high.

Instances of the first case are the small bets placed on horse racing at the government betting agency in Rarotonga; this is very popular among visiting Atiuans. An example of a high payoff inducing a gamble is the classically risky occupation of fishing - yields from a night's fishing in a tiny canoe in the open sea are totally unpredictable and the work is uncomfortable and dangerous. But on a good night the rewards are considerable and this justifies the continuing commitments to fishing.

When new opportunities arise, the true risks involved may not be known until growers have experimented with them. Economic losses soon bring corrective action. For example, tomatoes were grown for the New Zealand market. To get them there ripe but not rotten, a ship had to call at Atiu several weeks before they matured and then connect with another New Zealand boat at Rarotonga. Consequently up to half the tomato crops were lost without compensation; after a few years growers gave up growing them.[4]

Risks are avoided when the costs of failure are high. Typically this concerns the subsistence sector. Atiuans are not willing to experiment with risky new techniques on their traditional crops. They insure themselves with root crops like *puraka*, *kape*, and *tii*, low status foods that are allowed to grow semi-wild in the knowledge that they last for years in the soil; if a hurricane should destroy normal crops they would provide emergency foods until fast maturing crops like *kumara* and banana could be ready in a few months.

In the old days the other insurance against risk was the magic of crop protection: rituals to following in planting

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[4] Another example: a grower told me that in 1956 he grew peanuts and marketed them in Rarotonga; but he never received the money. This was too risky. In future years he sold them himself at a lower price on Atiu.

according to the traditional calendar, in harvesting according to first fruits customs, and in obeying the prohibition of the *tapu*. Crop failures were interpreted as incorrect application of this magic. Christianity and science now challenge some of these procedures, though belief in and adherence to some of them continues.[5]

This fear of the consequences of crop failure is slightly less today because of the existence of a paternal administration. Impressed by the wealth and benevolence of the government, Atiuans realize that in the event of a disaster they would no longer be left to starve, and hence need not take such precautions. The administration also provides other forms of insurance. Their schemes to allow repayment of crop inputs in proportion to receipts guard against high fertilizer or spray payments in a bad year. Without this the Citrus Replanting Schemes would not have survived the hurricanes of 1960 and 1968. The most recent project offers absolutely certain returns to labour in the form of wage employment. The popularity of working for the Pineapple Incorporation shows the Atiuan preference for certainty over the potentially higher but highly variable returns to be had from cash cropping.

In summary, Atiuan attitudes to risk do not differ markedly from those of western economies. Where costs of failure are high, people do their best to insure themselves. Where costs are low, they enjoy a gamble.

Attitudes to the present and the future

This section investigates the relative preferences that Atiuans have for using a factor now against investing it for later consumption. This depends on the sort of resource being allocated - whether it is economic or cultural, traded or inherited. For example, people do have a particularly long (though imprecise) view of the future where land rights are involved. Coconuts are commonly planted to consolidate long-term rights in a price of land. It is felt that this part of the economic heritage should be preserved intact for future generations.

Similarly, the length of past time horizons - the limit of remembered time on which experiences and knowledge are

[5]Often the magical connotation of such procedures is denied today.

based - may be very long, although imprecise. Many Atiuans can quote genealogies for a dozen or more generations in the past, though they cannot date them precisely. The coming of the gospel marks a watershed in Atiuan memory. More recent times are dated by the office of different resident agents.

In everyday economic affairs, this regard for the future is less obvious. The temptation is to prefer immediate leisure over future higher yields, that is, present consumption over future consumption. A classic illustration of this choice came at the end of 1964. Having grown peanuts, apparently no one on the island saved any seeds for the next season: that was the last time peanuts were grown.

This is not to suggest there is no regard for the future. Many planning principles are inherent in traditional subsistence production. Some root crops may be planted then left in the ground for several years as a store against future need. The principle of the *ra'ui* custom is to put a *tapu* on a crop to preserve it for later use. The method can also be used to conserve fish or bird supplies. The uninhabited off-shore atoll of Takutea has for a long time been used as a carefully managed reservoir of birds and fishes.

Planning over time has become an increasingly important issue with the introduction of new tree crops that require several years of cultivation before the tree yields fruit. Where this investment relationship is a sensitive one (for example with coffee trees) Atiuans have a record of failure. Only where the trees can still survive through a jungle of weeds (for example coconuts) are crops grown successfully.[6]

The administration has tried to encourage successful production of such crops by offering loans tied to crop investment: the Citrus Replanting Scheme allowed growers to borrow to finance early inputs against expected future returns. Economic Development Fund loans were established to encourage the peanut and coffee projects but were later used for any crops.[7] Legally these are unsecured, but a

[6] Mechanical equipment like motor-bikes and tractors are generally poorly maintained, further evidence of disregard for the future.

[7] And now mainly used to pay bush beer gangs working on *taro* patches.

Table 34

Loans on Atiu, 1950-74

	CRS loans ($)	(No.)	Co-op. loans ($)	(No.)	Housing ($)	(No.)	EDF loans ($)	(No.)	Total ($)
1950	200	(22)							200
1951	2,000	(81)							2,000
1952	4,500	(102)							4,500
1953	5,500	(155)							5,500
1954	6,000	(158)							6,000
1955	10,000	(160)							10,000
1956	9,500	(162)							9,500
1957	8,500	(164)	68	(30)					8,568
1958	6,000	(164)	124	(27)					6,124
1959	12,500	(164)	124	(27)					12,624
1960	20,000	(164)	142	(19)					20,142
1961	4,500	(164)	162	(29)					4,662
1962	500	(164)	36	(2)	35,200	(88)			35,736
1963	300	(164)	38	(3)	2,800	(7)			3,138
1964	-		240	(10)	3,600	(9)	3,260	(179)	8,100
1965	-		144	(2)	1,600	(3)	170	(3)	1,914
1966	-		362	(4)	1,600	(4)	490	(7)	2,432
1967	-		20	(1)	400	(1)	160	(2)	580
1968	200	(160)	124	(3)	400	(1)	3,025	(39)	3,749
1969	-		20	(1)	-		560	(6)	580
1970	300	(143)	2	(1)	1,200	(3)	3,250	(27)	4,752
1971	-		-		-		3,640	(39)	3,640
1972	200	(125)	-		1,200	(3)	3,480	(25)	4,880
1973	250	(115)	-		1,200	(3)	1,230	(9)	2,680
1974	650	(111)	-		-		1,800	(11)	2,450

Note: CRS means Citrus Replanting Scheme: EDF means Economic Development Fund.

Sources: Files of Atiu Administration and co-operatives.

bad repayment record prohibits a grower from future loans. Interest is paid at 5 per cent though many Atiuan growers do not understand this phenomenon. Demand for these loans is very high.

Land is not permitted as security on a loan and most Atiuans can provide no other security. Consequently negligible commercial lending takes place. In the past some traders permitted short-term credit on purchases on condition that exported produce be consigned through them. Small family stores may also allow credit but often only to kin and only over a short period. For ten years the co-operatives provided an erratic, small, untied source of finance. Documented loans are recorded in Table 34.

To summarize, Atiuans show a consistent preference for consuming the return on traded produce and for leisure in the present rather than for investing labour in future consumption.

Attitudes to knowledge and learning

Pre-European production was based on a small range of crops, well known through generations of experience. Production techniques were simple and efficient given existing technology, consisting mainly of cursory ground preparation of small plots of land, correct timing of planting, sometimes a little weeding, and harvesting.

Knowledge about crop husbandry was contained in folklore accumulated over years of experience and deeply rooted in tradition. For example, before the introduction of the Roman calendar, Atiuans knew what time of the year to plant crops by the arrival of certain constellations in the sky, the flowering of certain bushes, and the changes in behaviour of birds and insects; these last had the advantage of being sensitive to a climatically unusual season. Best (1922) cites similar practices used by the New Zealand Maori.

In principle, knowledge was confined to the easily observed correlations between plant yields and horticultural practice or climatic variation, without any scientific understanding of the biological relationships. For example, I was told of instances from the past where growers had carefully selected nuts from tall healthy coconut trees as the best to germinate and plant in new plantations. They did this knowing healthy trees yield healthy offspring, but not understanding why.

Where outcomes could not be accounted for, magical belief took over. Bad weather, insect infestations, disease, enemy destruction were all dangerous forces. It took the specialized knowledge of a *taunga* (priest) to wield the magic in suitable ritual form to control them. There was a narrow distinction between scientific knowledge and magical knowledge, both based on past observation. For example, the rising of certain stars was known to mark the seasons, but they were also believed to control them and foretell what they would be like.

The Maori lunar planting calendar

The significance of the lunar calendar is that it provided a way of telling the time in the pre-contact period: days all looked the same, but nights were different, each being characterized by the phase of the moon, its time of rising, and the quarter it rose from. The Maori planting and fishing calendar is based on this. Broadly it states that there are naturally advantageous times to plant certain crops and catch different types of fish. It exists in various forms in many parts of Eastern Polynesia (e.g. see Best 1922).

On Atiu the basic calendar is known by all planters, although there are many individual interpretations. Best claims the New Zealand Maori no longer planted according to the calendar by the twentieth century, but the Atiuan calendar is still used by almost all. Its form, reproduced in Table 35 with some loose translations, is very similar to calendars recorded on the neighbouring islands of Rarotonga and Mangaia a century ago (Gill 1876).

The time of day to plant crops is determined by the state of the tide. Crops are said to grow best if planted at low tide. Because Atiu is near the equator, low tide occurs in the morning and evening during a full moon (the most favoured planting time), and at noon and midnight during a new moon.

Table 35

The Atiuan lunar month

1st Quarter	Nights	Loose translation	Planting instructions
1	Itiroa	'The beginning'	Plant root crops
2	Iro	'A bad time'	Plant root crops
3	Oata	'Moon is born'	Plant root crops
4	Amiama	'Time of Amiama'	Plant root crops and 1 banana
5	Akaoti Amiama	'End of Amiama phase'	Stop planting
6	Tamatea Tai	'Tamatea phase'	Planting yields only 1 fruit
7	Akaoti Tamatea	'End of Tamatea phase'	Bad planting times
8	Korekore Tai	'Korekore phase'	Bad planting times
9	Akaoti Korekore	'End of Korekore'	Bad planting times
10	Vari	'Menstruation period'	Bad days
11	Una	'Hidden phase of moon'	Fish are in hiding
12	Maaru	'Faint,shadowy phase of moon'	Plant another banana type
13	Una	'Fruit and flower phase'	Planting brings good flowering
14	Maitu	'Surprise phase'	Plant root crops
15	Otu	'The full moon'	Plant all crops
3rd Quarter			
16	Marangi	'Time of full moon'	Plant all crops
17	Turu	'Foundation centre'	Plant all crops
18	Rakau Tai	'Start of Rakau phase'	Plant all crops
19	Roto te Rakau	'Middle of Rakau'	Crops start to ripen inside
20	Akaoti te Rakau	'End of Rakau'	Crops are finished
21	Korekore Tai	'Start of Korekore phase'	No planting
22	Roto te Korekore	'Middle of Korekore'	No Planting
23	Akaoti Korekore	'End of Korekore'	No Planting
24	Tangaroa Tai	'Start of Tangaroa phase'	Planting yields 1 big fruit
25	Roto te Tangaroa	'Middle of Tangaroa'	Fruit is ripe
26	Akaoti Tangaroa	'End of Tangaroa'	Finish planting
27	Tane	'God of Forest	Good planting time
28	Rongonui	'Period of greatness'	A great planter gets good fruits
29	Rongomauri	'Ghost time: disappearing moon'	Bad days
30	Motu	'Expiring of the moon'	Bad days

Source: Atiu Tumu Korero.

Generally accepted rules on planting crops seem to be:

taro, arrowroot, introduced vegetables	any time
Kumara, yam, *tarua*	full moon, low tide
Bananas and other fruit and leaf crops	(selected days (depending on (calendar, low (tide

There are many variations on this. For example, one man plants his root crops at a full moon, and his other vegetables at a new moon, claiming this is the time when it usually rains. These variations are supported by experiences growers have had or heard about. One of the most progressive growers had once planted a very large area of *kumara* forgetting about the state of the tide. Most of it grew poorly, but the few rows planted by chance during the low tide prospered. Another reported growing *kumara* at the wrong phase of the moon: he grew a healthy leafy crop, but when he pulled it up there was hardly any root.

Almost everyone including the most scientific growers appears to follow this calendar in some way. Only one grower questioned it - a young man recently returned from agricultural college in Samoa. He had planted out a trial plot in yams in four sections specifically to test the effect of the moon and the tide. Unfortunately, pigs destroyed that crop, but at the time of my fieldwork he was repeating the experiment with *taro tarua*, undaunted by this ominous crop failure.

One agricultural officer told me he believed in the calendar but did not always follow it as his job left him little time to arrange plantings this way. The agriculture teacher at school said he did not plant his crops by the moon and he taught his pupils not to. This was not because that system did not work, but because it was inefficient to wait for the propitious time when one could have a similar effect by applying fertilizer and sprays. This interpretation of the planting calendar as 'nature's fertilizer' is common.

Overall, the arrangement appears flexible and pragmatic, and parts are linked with sound horticultural practice. Rules are convenient and changeable. For example, the best tides for planting are in the early morning and evening, which is the only time wage earners have free; it is also the coolest part of the day, best for workers and plants. *Taro* may be planted any time which allows the convenient practice of replanting shoots immediately as they are harvested.

The fishing calendar also remains in strong use, based on the same 30-day month. It probably rests on stronger scientific foundations, storing the local knowledge essential in locating certain fish at certain times. This calendar is constantly revised with information from recent expeditions. In general the favoured fishing time is during the new moon; this is a slack agricultural period, and furthermore the darkness hides fishermen from their quarry.

Introduction of new crops backed by new scientific techniques and advice has challenged much Atiuan indigeneous knowledge, especially since 1950. How have Atiuans responded? When likely new outcomes are completely unknown and where costs of learning are low, the current stock of knowledge is felt to be sub-optimal. Then growers may agree to plant a crop they know little of partly in order to learn about it. This occurred with many of the new project cash crops. But where the costs of learning are high because they involve a risky investment of resources, and growers think their experience is adequate, change is resisted. Readily available fertilizers and sprays are rarely used in the subsistence sector because a crop failure induced by misinformed use of these could bring disaster.

New techniques often contradict engrained beliefs. Then follows a period of adjustment when a grower has to decide whether to accept or reject the new information. On Atiu this was a long and painful process: most growers publicly disclaimed old magics yet privately followed them, sometimes combined with new sciences, sometimes as a substitute.[8] For example, questioned whether they believed in the efficacy of citricultural practices such as pruning, weeding and fertilizing, most growers assured me that they did, and yet they did not use them on their own plots. Belief was strongest

[8] Faced with a sick child an Atiuan mother frequently tried to combine an old herbal remedy with a doctor's prescription - a similar dilemma of belief.

in cases like slash weeding: growers had witnessed smothered orange trees being cleared and responding dramatically. This was the old principle of belief by oserved correlation. A new process such as preventative spraying against insects brought no such startling results and it was difficult to explain.[9] Ignorance of an explanation sometimes led to confusion. One grower was observed trying to cure a *taro* blight by adding manure to the soil. But growers rarely repeat such mistakes, which is some evidence of a learning process.

The speed of learning and the degree of belief depend crucially on the role of the change agent, in this case the agricultural officer who advises about new project crops. Several men have filled this role on Atiu and have been reasonably credible in translating scientific change into Atiuan terms.

Itu is a 40-year old Atiuan agricultural officer who lives with his wife and ten natural and adopted children; he also has a grown son in New Zealand. He was educated in Rarotonga and has worked on neighbouring islands. He has also travelled in Australia on a course.

He has been fully involved as a grower in the projects he helps administer. He has planted several orange plots and a coffee plantation that all yielded well. Since 1950 he has participated in all but one of the new crops introduced. In 1974 he was experimenting with fertilizers and spray on his own new vegetable crops.

Itu has proved to be a good agricultural officer, working hard for himself and for the community. He shows high empathy with his clients: being an Atiuan commoner himself, earning an average income and leading an ordinary life, he can pitch information at the right level for other growers. And others find him credible. At the same time he is shy and quiet, and is clearly not looked up to as a leader. Itu himself faces a dilemma in belief. On one hand he has scientific knowledge of plant growth: on the other, he has the background of an Atiuan grower. He reconciles the two views with typical Atiuan pragmatism and sees no contradiction in using modern fertilizers on crops planted according to the traditional planting calendar.

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[9] The process could only be translated as *vai rakau* (medicine).

Attitudes to the community

In pre-contact days Atiuan society was highly stratified, based on the economic control of land and the extraction of tribute. For the commoner classes, conformity to this pattern was encouraged by grants of land, and deviance punished by its confiscation. From this conformist though decidedly inequitable past have arisen present-day pressures to conform in work habits (despite inherited differences in factor availability) and consumption patterns (despite more recent differences in money earning ability).

Households on Atiu vary in size from one to seventeen, but flexible rules of adoption mean a large family may adopt out children to less well-endowed relatives. Households are expected to help with community work schemes. Land rights are most inequitable, being based on tribal rank; but low population density and an informal system of land lending means everyone has a share in each type of land.

The distribution of money incomes among households is skewed also (see Fig.7). But despite this, households on Atiu live conspicuously similar lifestyles. House designs and interiors are identical. Expenditure and nutrition surveys show people eat the same foods. Generosity is admired. A man who is too covetous in accumulating money acquires a reputation for meanness; ultimately he may find he can acquire no more land nor labourers to work it.

One important means of exerting social pressure to conform is the household inspection (*tutaka*) held quarterly. With one such *tutaka*, the women's health committee announced the date and several weeks of intense activity followed. Men stayed home to cut lawns, weed gardens, and tidy around the houses: women cleaned houses and laid out handicrafts. Pigs illegally rooting round the houses mysteriously disappeared into the bush. Houses were painted. The few men owning lawn mowers were kept very busy.

On the day of the inspection, the women's committee met in the village hall, together with the health inspector, nurse, resident agent, minister and other notables. After prayers and speeches they began a slow and thorough inspection of every house on the island, village by village. Each house was spotless, and the women looked through every room, complementing owners on particularly fine pieces of needlework, scolding them for untidiness, and making scornful remarks about any home that boasted too many possession. People criticized a man trying to grow a high hedge around his house for privacy. Over a feast afterwards, fines were announced for substandard houses, and a trophy awarded to the best village.

The aim of this *tutaka* is to ensure that a minimum standard of living is met, and also to discourage privacy and check that no household is too acquisitive. Finally it is an enjoyable and competitive social occasion. A similar inspection used to be held of household gardens; a minimum planting quota was set on all households and was enforceable by fine. Consequently subsistence production was quite uniform.

Recent economic changes associated with project aid have probably increased economic inequality in several ways. To some extent entrepreneurial talents appear concentrated within certain families, even over generations. Faced with successive projects the same growers have responded keenly and made most money. For example, almost all of the men who are participating in the latest vegetable project are proven growers and they have above average incomes (a mean of $2,210 compared with $1,304 for all of Atiu).

Recent migration has probably worsened this trend. Some households boast a lot of wealth left as gifts by migrant relatives on holiday. And those who leave generally hand over project plots to relatives who have rights in the land and often already own their own plots. Some growers have been left caring for up to five orange plots. The Gini coefficient measuring the distribution of orange plots among households dropped from 0.48 in 1955 to 0.39 in 1975.

There are differences in grower responses to projects, sufficient to allow categorization by economic roles. The standard method (Rogers and Shoemaker 1971) is to divide the population into innovator, early adopter, majority, and laggard groupings by their timing of participation, using arbitrary cut-off points. It was shown in Chapter 4 that participation rates for Atiuan projects fit this basically normal shape, although separate adopter categories merge together.

The first people to participate in a project are the innovators, who introduce an idea and adapt it to their own purpose. Frequently they are set apart from the community, being risk-takers, willing to experiment with incomplete information, and having a high regard for the future; they also display initiative, acting independently of the rest of the population, and not relying on the government. There have been very few true innovators in Atiu, and in the case of the Citrus Replanting Scheme, none at all (see Fig.12). In almost no cases did Atiuans introduce new crops themselves: the government did the innovator's usual work of obtaining new crop varieties, trial planting, and selecting best strains. On Atiu the social penalties for deviance and the ease of migration means that many frustrated potential innovators have left. Consequently, there are many

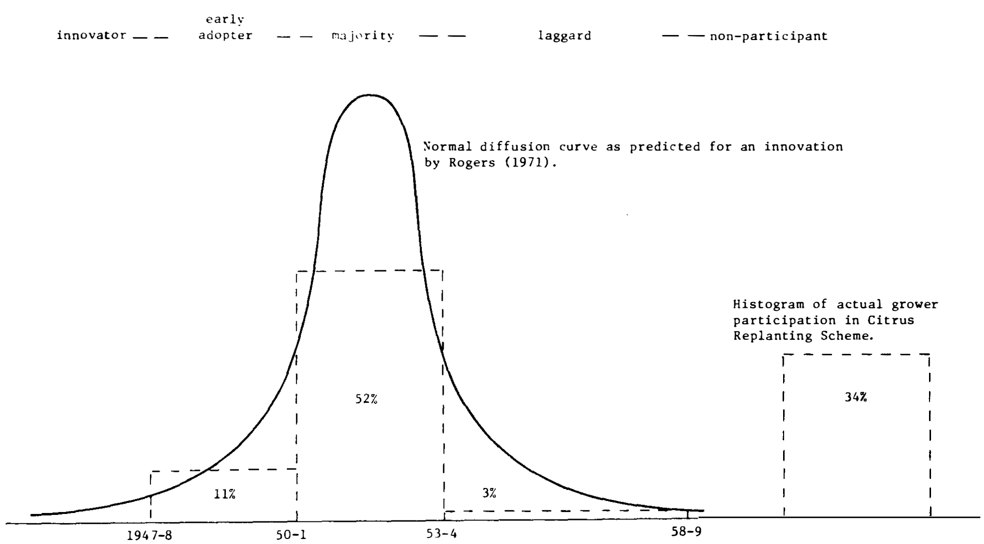

Fig. 12. Distribution of adopter categories

Source: Rogers (1971 :Table 19.)

potentially profitable entrepreneurial opportunities neglected.[10]

The next growers to participate are the early adopters, men who still display some initiative and foresight, and who will act under uncertainty and incomplete information, but who are a little more conformist and reliant on others. It is difficult meaningfully to separate them out from other conforming categories; I arbitrarily class all those who participated in the Citrus Scheme in its first year as early adopters (11 per cent of households). Those adopting in the next three years are classified as the early and late majority (52 per cent), growers for whom a major concern is conformity, patterning their actions on those of others.[11] Finally come the laggards who waited till the last years of the Scheme (3 per cent); they will not introduce a new technique until they are assured of its certainty, full information and early returns, as evidenced by the participation of most others. Laggards are cultural conservatives.

Reactionaries are people who will never accept the project. Rogers and Shoemaker (1971) takes no account of such a possibility. A third of Atiuans refused to join the Citrus Scheme, though the number decreased for later projects. Very few households did not participate in any projects at all between 1950 and 1975.

Table 36 summarizes this progression of adopter categories from preference for risk to aversion to it; from long time horizons to near-sightedness; from willing experimentation and learning using incomplete information to dislike of ignorance; from low dependence on other members of the community to high dependence, and back to low again, in keeping with their degree of social deviance.

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[10] Compare this with other Polynesian economies where there has been little opportunity for migration. For example in Tonga people introduce new crops and techniques, set up stores, bake bread, and drive taxis even on the isolated island (see Bollard 1976).

[11] Typical of these was the man who told me he grew his crops 'for as long as the others did'.

Table 36

Generalized attributes of adopter categories

	Attitudes to:				Participation in CRS		Case Studies
	Risk	Time	Ignorance	Inter-depen-dence	Actual	Pre-dic-ted	
Innovator	Risk-taker ↓	High regard for future ↓	Ignorance-accepter ↓	Low Inter-depen-dence ↓	-	5 (2½%)	Tai
Early Adopter	↓	↓	↓	↓	21hh (11%)	25 (13½%)	Rua
Majority	↓	↓	↓	High	96hh (52%)	126 (68%)	Toru
Laggard	↓	↓	↓	↑	6hh (3%)	30 (16%)	Rima
Reactionary	Risk-Averter	Low regard for future	Ignorance-averter	Low	63hh (34%)	-	Ono

Records of Atiu projects show that when an innovation is introduced by government, the whole island is quickly aware of it; there is no time lag in the dissemination of information. A few innovators may try a crop, and, depending on their success, some of the opinion-leaders may be induced to adopt it. This is the signal for the majority to join in. The time span required for all growers to make their decisions is very short, compared with some similar documented innovations elsewhere (Table 37).

Table 37

Time taken for community to adopt innovations

	Average years	Source
Atiuan projects	4	Fieldwork
Grain varieties in India	5	Lockwood and Moulik (1971)
Pesticides in India	8	Bose (1964)
Spray in Iowa	10	Rogers and Shoemaker (1971)
New crops in Kenya	16	Garst (1974)
Hybrid corn in U.S.A.	16	Griliches (1957)

Case studies of adopter categories

In the five case studies that follow, not only does the speed of adoption of projects decrease from innovator to laggard, but so too does the number of projects entered and the rate of success in them (see Table 38). Furthermore, the income earned from agriculture and other self-employment decreases from innovator to laggard, as does the time spent on cropping.

Tai, the innovator. Tai is a nervous, energetic and intense man of 40 who lives with his non-Atiuan wife - a teacher - their six young sons, and an elderly woman relative. He was raised by his grandmother and received only elementary schooling on Atiu. He planted his first project crop, forest trees, at an early age, though he later dug them up to grow other crops.

Table 38

Project record of different growers

		Innovator (Tai)	Early adopter (Rua)	Majority (Toru)	Laggard (Rima)	Reactionary (Ono)
Citrus	(1950)	-	-	1951	-	-
Forestry	(1951)	1956	-	-	-	-
Tomatoes	(1955)	-	-	-	-	1955
Peanuts	(1964)	1964	1964	1964	-	-
Coffee	(1963)	1964	1965	1966	-	1964
Citrus Extension	(1965)	1966	1967	-	1972	-
Taro	(1966)	1971	-	1972	-	-
Pineapples	(1970)	1970	1970	-	-	-
Vegetables	(1974)	1974	1974	-	-	-
Number attempted		7	5	4	1	2
Number continuing		3	2	1	0	0

Sources: Files of Atiu Administration, field notes.

In 1961, at his grandmother's suggestion, Tai went to Auckland, New Zealand, for a year. He worked long hours at two jobs and earned enough money to buy materials to start building his large house on Atiu.

On his return he worked on the family coffee plot. Instead of selling the berries to the government like most other growers, he went to the trouble of drying them, roasting them, and selling them locally; this was at a time when sale of produce on Atiu was not a socially approved habit. Then Tai tried growing peanuts; he hired school children to harvest them and paid them in nuts. He roasted the nuts and sold them at local dances and picture shows; but he could not make a profit and gave up after a year.

In 1971 Tai went away again, worked hard, and in a year saved $2,000. With this he bought a light truck in Auckland and freighted it back to Atiu. He says he realized this would not be a particularly profitable investment, but the community needed another truck. In 1974 he was having difficulty running it, with legally fixed hireage rates and high petrol costs, and he could not afford to pay himself a wage. He confided that he gets very annoyed with relatives who expect to borrow it for nothing (he told them they must pay), and by people wasting his time while they collect firewood or have a picnic. He is now trying to form a union with the two other private truck drivers to negotiate a fare increase.

Also on his return from New Zealand Tai entered a contract with two Rarotongans to open a small shop equipped with a refrigerator in the front of his house. He and his wife own half the shares and serve in it. The other two send the goods from Rarotonga. Tai is getting dissatisfied with them too as he does not think he is getting a fair return; he intends to buy all the shares himself. Turnover is $300 to $400 per week and profits are fixed by government at 15 per cent on landed cost. Tai allows customers to buy on credit but they must settle up their accounts each weekend. His relatives know they must pay there.

In 1966, before leaving Atiu, Tai planted half a hectare in orange trees. They were poor stock and only about half survived the transplanting. On his return he extended the plantings with some new experimental lime, lemon and mandarin trees. He maintains his oranges very well, weeding the whole plot by hand; though young, the trees are now bearing heavily, the healthiest on the island.

Tai was the first Atiuan to grow pineapples commercially; his brother-in-law sent him some stock from Mangaia. A number of other private growers have followed his example since then. Before he went to New Zealand he obtained a legal order on his pineapple plot giving him secure tenure and sole right to the proceeds. He lent the plot to his brother, but the latter neglected it in his absence. On his return Tai replanted the pineapples, and enlarged his plot and employed his cousin to weed it. He resisted the attempts of the newly formed Pineapple Incorporation to include his land. Today his small plot stands, completely surrounded by 100 hectares of Incorporation lands, a symbol of his independence and mistrust of authority.

He is an inveterate experimenter. He persuaded a European friend in Rarotonga to send him seeds of new varieties of vegetables to try. He grew the first onions on Atiu as an experiment and sold them all at the local market. He is now planting the first beetroot and eggplant and using new tomato rootstocks. When the New Zealand Army contingent provided a temporary outlet in 1974, he took full advantage of it and grew pumpkin, cabbage, cucumber, peas and melon. Tai points out vegetables require a lot of work but they are a profitable crop that grow all year round. He has invested in a wheelbarrow and a knapsack sprayer; currently he is spraying vegetables with several different sprays to test them. He uses small quantitites of blood and bone which he prefers as a 'natural' fertilizer. When the government set up a growers' association to introduce vegetable growing in 1974 Tai was already an experienced grower.

Tai keeps forty to fifty pigs, and considers them a good investment, because they clear the land for planting, even though they take a long time to feed every day. Sometimes he sells a pig through his shop. He grows *taro*, building the patches himself and selling the surplus; when a blight infected plants in 1973 he obtained some disease-resistant strains to plant. He also plants *taro tarua*, hiring labourers and machinery to clear the land, and bananas. He encourages his young sons to help him, proud of their ability. His latest venture has been to order a billiard table from New Zealand, and hire this out on Atiu.

Tai makes some effort to conform to Atiuan society, working on communal labour gangs, deacon in the church, chairman of his village committee, and participant in a community drive to record local traditions. For this he receives a certain amount of respect from the community, but he stands somewhat aloof and is not regarded as a leader. Basically Tai is an individualist scornful and mistrustful of other people. He refuses to drink in bush beer schools, employs workers, enjoys earning money, and sells crops to relatives; this is all considered anti-social behaviour.

Rua, the early adopter. Rua is a very intelligent man of 40. He lives with his non-Atiuan wife and seven young children. He comes from a family of high rank with large land holdings, and his father was well known as a good grower. Rua received secondary education on Rarotonga, trained as a teacher, and travelled widely through the outer Cook Islands.

Returned to Atiu to teach, he took up his father's peanut plot for a while. In 1965 he planted a coffee plot, but he found it too troublesome to pick the berries, and let the plot run to weed. His father distrusted government motives and had refused to join in the Citrus Replanting Scheme. But in 1967 Rua planted his own orange trees on a half-hectare plot. Today they are beginning to bear.

In 1970 Rua followed Tai's example and planted a very small trial plot of pineapples. But he encountered trouble with disease and did not repeat the experiment; he handed over his lands to the Incorporation. In 1974, as chairman of the Growers' Association, he helped organize the vegetable project. He himself planted tomatoes, melon, cabbage, beans and lettuce on a piece of land jointly with his brother. The brother was a full-time grower and sold some of the crop, but Rua mainly wanted healthy green vegetables for his family.

Today Rua and his oldest son also grow large quantitites of *taro* and *taro tarua*, and arrowroot, *kumara*, yam and bananas. They keep a few pigs, goats and fowls. Rua is also a keen fisherman and is toying with techniques that might increase his catch. One problem is finding the time for all these activities, for he has a great love of alcohol and spends much of his time drinking.

Rua is something of an enigma. He is very proud of old traditions and is careful to share his harvests and catches with the *ariki* and the minister; he boasts about his hereditary land rights. And yet he has a very searching scientific mind, with a good working knowledge of principles like crop selection. If Tai seeks money, Rua seeks knowledge for its own sake, trying to understand, and taking pleasure in teaching his son.

Toru, the majority adopter. Toru is a 45-year-old man who lives with his wife, six children, and an older relative. Another son is married and lives in another village, occasionally helping his father. Three more children live in Rarotonga and New Zealand, and they send a lot of money back to their parents ($725 in 1974). Toru inherited his tribe's senior *mataiapo* title from his father.

Toru planted a citrus plot in 1951 and later induced his father to join the scheme too. Today he maintains both with another plot left by a migrating friend, and the effort is too much; even though the whole family helps, the trees are deteriorating and yields dropping. Toru considered growing tomatoes in the 1950s but was put off by the losses others suffered. But he did try growing peanuts for one year.

After the coffee project had been introduced and most growers had expressed interest, Toru decided to plant a plot. However, he underestimated the work required to maintain it and he never marketed any berries. A few trees are still there and these yield just enough coffee for the family. Toru had always grown a lot of *taro* and in 1972 was induced by the success of others to send the surplus to the market in Rarotonga. Today he hires the bush beer gangs to help when necessary. He hires a tractor to clear land for arrowroot, but otherwise plants his *taro tarua*, yams, *taro* and bananas in completely traditional fashion according to the planting calendar, and without fertilizer or spray. He will not buy or sell produce locally. He also keeps a few pigs, goats and chickens.

In many ways Toru reflects typical Atiuan attitudes and habits. He was initially keen to join in most community projects though he often preferred to use the produce for home consumption rather than sell it. For the last few years he has worked as a labourer on the Pineapple Incorporaation. Today he prefers this work with its lower but steady income, and he works there regularly, tending his plantation in the late afternoon.

His economic knowledge is typical of many growers: he shows some understanding of citriculture and claims to appreciate the difference pruning and weeding make to orange trees, yet like most others he does not apply these to his own plots. He cannot say what price he receives for his oranges, and he does not know what the outstanding debt on his plot is. He prefers to talk of the good old days when money was easier to earn and the old native orange trees yielded more fruit.

Above all, Toru is a conformist who accepts community patterns and fits in well with them. He spends a lot of time working in community groups and work parties. He is the chairman of one of the bush beer schools and organizes their work; much of the time he is to be found down at the school, drinking and talking. Like so many others he has many relations overseas, but he seems satisfied with his life on Atiu.

Rima, the laggard. Rima is a 30-year-old who lives with his wife, seven children (another is adopted by relatives), and a middle-aged male relative. Rima is the youngest son of one of the outstanding families on the island, and something of a black sheep. He was educated on Rarotonga, but was expelled from college. Apart from a trip to Tahiti, he has spent the rest of his life on Atiu. Although highly talented he has achieved little. After he was dismissed from a job with the co-operative, his father managed to get him a part-time job as a shopkeeper; occasionally he works there, but much of his time is spent asleep on the front verandah of his house, ostensibly babysitting.

He keeps a few pigs and fowls, and plants a little *taro* and arrowroot with the relative who stays with him, on the latter's land. This relative does most of the work, providing the family with foods and fish; without his help Rima would certainly have to work harder himself.

Money is earned by Rima's wife, the New Zealand-educated daughter of a rich half-Chinese trader. She has a highly paid clerical job and is a hard worker. She is also well endowed with land; they live in her old family house. She even bought Rima the motor-cycle he rides. Recently, Rima, helped by relatives, built a second, smaller, house.

Rima used to work on his father's coffee plot and his uncle's oranges, but he was soon disillusioned when he received none of the harvest. He has only joined in one project: in 1972 his wife's sister planted a new orange plot on some jointly-owned land. Rima and his wife decided they should re-assert their own rights in the land block, so they hired some friends to plant sixty young trees nearby. The plot was not looked after and an accidental fire killed the trees. Refusing to do it himself, Rima hired more people to replant the trees. Today half are dead and the rest sickly through neglect.

Rima is inherently lazy; his wife considered sending him to New Zealand to earn some money but she feared he could never save any. He has an inferiority complex and gives up easily. Other more hard-working Atiuans look down on him. Yet Rima embodies many traditional traits. He particularly likes working with others, spending some time on voluntary communal projects and bush beer gangs. He is not avaricious, and is generous and hospitable. He loves drinking and spends a lot of time at the bush beer schools. He does not have to work hard for a living and sees no reason why he should.

<u>Ono, the reactionary</u>. Ono is a 40-year old who lives with his wife and six children on Atiu. He also has several children in Rarotonga and New Zealand. He was brought up by foster parents, received a good education on Rarotonga, and returned to Atiu.

For a while he tried to make a living as a planter. He grew tomatoes for four years until returns became too uncertain. He grew peanuts but rats dug them up. He planted a large grove of coconuts but they died. His last effort was to plant coffee in 1964; he did not look after the bushes properly and they were soon smothered by weeds. Since then he has given up all interest in planting. New project crops do not enthuse him. He can afford this attitude because he has a highly paid job as an administrative clerk.

Today he keeps a few pigs, fowls and a flock of goats. He does a minimum of planting: a few bananas, four *taro* patches (all made by bush beer gangs), and some arrowroot on a plot cleared by tractor. He actually has to buy *taro* and other vegetables, most unusual for an Atiuan household. He possesses little agricultural equipment, an old bike and a dilapidated home. He is also dissatisfied with his job: he can rise no further, and claims he is the victim of political

Table 39

Money income of different growers, 1974

	Tai	Rua	Toru	Rima	Ono
Agricultural income	765	81	32	-	-
Wage income	2,346[a]	1,804	1,034	1,242	1,295
Remittances and transfers	30	80	725	40	200
Total income	$3,141	$1,965	$1,791	$1,282	$1,495

[a]Includes Tai's shop activities.

Sources: Files of Atiu Administration; field notes.

Table 40

Labour hours worked by different growers in sample week, 1974

	Tai	Rua	Toru	Rima	Ono
Self-employed labour	28	14½	11½	4½	3½
Wage labour	15[a]	6½[b]	37½	12	30
Communal work	12½	-	2½	12½	1
Drinking time	2	20½	14	14	28

[a]Includes Tai's shop activities.

[b]A teacher during school holidays.

Sources: Files of Atiu Administration; field notes.

manoeuvring. Consequently he is planning to leave for New Zealand soon. He pores over the newspapers his children send him, looking at advertisements for jobs, houses and cars.

There are two types of reactionaries: one is so tied by cultural conservatism that he will tolerate no change; the other sees nothing to gain from participating in his society and has opted out of it - this is Ono. He does not expect to remain long on Atiu, so there is no point in planting long-term crops. Anyway he knows he is a poor planter. He dislikes agricultural work and makes the children do most of it. He even dislikes working for the community or the bush beer gangs. In his own way he is as much a deviant as Tai the innovator. Ono finds his solace in alcohol, and in the week I questioned him about his daily work had spent 28 hours drinking.

Attitude to authority

Atiuan growers have for a long time responded with subservience to paternal administrations. In pre-contact times the *akaere* planned and directed plantings, and there was little room for individual initiative. They could force growers to plant a minimum quantity; they could forbid them to harvest crops in times of scarcity. Successive authorities have continued this paternalism through the church, the resident agent, the village committees and the island council. They can command a volunteer work force, lay down planting requirements, and declare health standards.

The crucial links in this chain of authority have been a small group of opinion leaders, men who, by virtue of their personality and actions, fill a number of Atiuan social ideals, and are consequently looked to for community leadership. Today the resident agent, island councillors and *ariki* do not mould Atiuan public opinion as much as a few individuals - one a member of the Legislative Assembly, one an agricultural officer, and several teachers and deacons.

Profile of an opinion leader: Varu. Varu is a 65-year-old Atiuan who lives with his wife and grandchild in Rarotonga, because he is the Atiuan member of the Legislative Assembly which sits there. He also has a house on Atiu maintained by an elderly relative.

Varu received little early education, but went to sea on a trading schooner and travelled widely around the Pacific for many years. In 1952 he returned to Atiu and became the local teacher and later, headmaster. He was a competent grower while there, planting forest trees, tomatoes, peanuts and coffee bushes. He also planted a special coconut plot for government fertilizer trials.

While teaching he found time to organize the youth of his village to rebuild the local meeting house, against the opposition of elders. He eventually redesigned and supervised redecoration of all the other villages' meeting houses too. Next, at a time when most people still lived in thatch huts, Varu decided to build himself a house of wood and blocks. He designed one by trial and error, and built it helped by his three brothers. It was a great success and they ended up building eight more. Then Varu decided he wanted running water, so he designed and built the first water tank. It was square, made of lime, and leaked badly, but he perfected it with later designs.

About 1960 the government offered Housing Authority loans of $400 to rebuild houses. Varu was appointed housing officer. He experimented with the mixture for making blocks, and cut costs by ordering bulk cement wholesale, and by getting Boys' Brigade and Boy Scout groups to haul sand and mix the blocks in his own mould. He redesigned the government plans to enable the loan to finance a larger house. He organized men into groups of six to eight each working on several houses. In this way almost all Atiuans built new houses in ten years.

Meanwhile Varu had helped organize the co-operative movement acting as a go-between for government and growers. He became the head of the Marketing Co-operative and the Takutea Island Committee. He also organized Atiuans into preserving historical traditions, and introduced the teaching of indigeneous craft-making into schools.

In 1965 the first Cook Islands Legislative Assembly convened. Varu was elected one of Atiu's two representatives, and he had to spend most of his time on Rarotonga. In 1968 he found himself not re-elected, much to his surprise. He interpreted this as a sign from God that there was work to be done, and set about redesigning and rebuilding the Cook Islands Christian Church building; this is the largest church in the Cook Islands, and it was a massive job. Varu drew up the plans, then supervised the rebuilding. He employed twelve full-time tradesmen and organized each village to provide forty men to work on it in rotation one day each week. It was finished in 14 weeks. The result is impressive. Varu was re-elected to the Assembly in 1968; he has been there ever since, a senior statesman in the opposition party. However, these absences have weakened his ties with Atiuans.

How could Varu achieve all this? Partly through his high community office and status: he is spokesman for the three *ariki*, the chief *akaere* on the island, and he derives prestige from his ability as an orator and holder of cultural knowledge. He is a senior church deacon and the choir leader. He is currently head of the Boys' Brigade for the whole of the Cook Islands, a very powerful position. He has an easy rapport with Europeans. Despite little formal education he has considerable writing, drawing and engineering skills. Varu has developed a wider outlook on the world than most Atiuans possess, from travelling widely through the Pacific and New Zealand, to Tahiti with a choir, to Korea on a church mission, and to Britain with the Boys' Brigade.

Varu is an energetic innovator. He possesses considerable charisma and is an expert organizer. His main role is as the man who interprets change in terms Atiuans can understand, and puts the stamp of respectability on them. He is successful as an opinion leader only because Atiuans respect and trust him.

The response of Atiuans to control has been subservient. They plant as directed, and when instructions are not given, appear at a loss.[12] As a result they have been unable to display initiative when required. Market signals have been frequently ignored as indicator of economic intelligence. For example, in 1974 copra prices reached record levels: Atiuans had the facilities and experience to make copra, but did not respond.

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[12] One informant, questioned why he planted an orange plot, replied 'because the government wanted it'. Another told me the reason why planters stopped pruning their orange plots in the 1960s was that they realized the government would not prosecute them for not doing it!

Part 2
Theoretical model of grower response

Chapter 6

The pre-project economy

Typically in the Pacific a pre-contact indigenous economic system consisted of people using very simple techniques to get food from the land, for individual or communal consumption, in keeping with a long-standing set of social rules on how to behave. This chapter describes how such a system produced goods, how it organized itself, and what limited decisions were left to the individual. Early European contact brought monetization which in turn led to changes in production and consumption opportunities and increased scope for individuals to make economic decisions. Attempts by outsiders to change techniques in the economy through aid projects have been more recent. This chapter builds the foundations on which later chapters will analyse the effects of these projects. The theoretical discussion is illustrated with a case study of Atiu using material drawn from Part I.

The pre-contact economy

Characteristics of production. A major characteristic of pre-contact agriculture was the short time span between the planning of a catch or a crop and its fruition. For the hunter and gatherer, the production process consisted of combining the labour under his control in a skilled manner with a straightforward (and usually easily obtainable) technology such as bows and arrows, nets, digging sticks. The decision that some food or housing or clothing material was wanted meant that the person must go and search for it, whether fruit, nuts, wild vegetables, animals, birds or fish. This search could be dangerous, uncomfortable or unsuccessful; it frequently took a lot of time, especially in less affluent areas.

In its more developed forms the planning period spanned a seasonal cycle. Crops not found growing wild had to be planted and sometimes roughly cultivated. Planning could mean simply that shoots were roughly replanted when root crops were harvested. On the other hand grain crops demanded more precise management. Yet cultivation generally implied no more than planting at the start of the season and harvesting at the end, with a little maintenance in between.

Even long-term tree crops management was reduced to single period decisions. Frequently self-sown and hardy, trees were rarely cultivated for the future. A harvester simply decided how much fruit to collect off them. In a hunting and gathering economy, cultivation practices reduced to searching and catching or collecting. This did not preclude a long-term view of economic resources - it was necessary for survival that land fertility be managed, flora and fauna conserved, and sometimes population regulated. Almost all communities had some way of imposing social taboos on particular resource use in times of need. Such problems were socially regulated, and the ordinary person was not involved in day to day multi-period decision making.

The character of this simple one-period one-input production process may be specified further. The function was continuous and non-increasing for a range of divisible inputs and outputs. In hunting and gathering activities, returns to scale could be nearly constant, especially in conditions of primitive affluence. If berries were relatively abundant and it took an hour to collect one kit, the second kit should take only another hour.[1] Empirical confirmation of this comes from Sahlins (1972).

Production of native oranges in Atiu in the late nineteenth century provides an example of such a production function. Native oranges, though a tree fruit, were regarded as a single period crop which required no maintenance to help raise future yields. Young trees were allowed to sprout from seeds wherever oranges had fallen and the bush had not smothered them.

When oranges were needed a family would go into the bush to one of their groves, roughly clear the undergrowth, shake down some oranges, and carry them home. Unwanted oranges were left to rot. There were many trees relative to the needs of the population, so oranges were not highly valued. In season plenty could always be found.

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[1] We assume that land was relatively abundant, and hence labour was the only scarce input.

A second characteristic of pre-contact agriculture was the low realized variance in crop yields, and hence the relative unimportance of risk avoidance as a criterion of decision making. On an isolated island, indigeneous crops became biologically adapted to the physical environment, gradually developing resistance to the extremes of climate and immunity to native pests and diseases. This natural breeding was at the expense of high yields. The outcome was a hardy plant that could be relied upon to give consistent but low quality returns. In a similar way, hunted animals developed high survival abilities but not the meat or skin quality of domesticated ones.

Some production variation did inevitably occur in extreme years. In affluent communities many wild growing crops were not fully exploited in ordinary years, so in a poor year needs might still be met. Furthermore, in a non-specialist economy with little exchange, uncertainty from prices and markets was not a problem.

Where exogenous fluctuations were unavoidable and potentially harmful a community attempted to counteract the disturbances with appropriate magic and ritual. This explanation was first given by Malinowski (1922:421):

> In garden magic, soil, rain, proper work are given their full due. None the less, no one would dream of making a garden without the full magical performance being done over it. Garden magic is thought to make just this difference, which a man hopes for from 'chance' or 'good luck', when he sees everybody around him working as hard as he can, and in all other respects under similar conditions to himself. So we see that in all these cases, magical influence runs parallel to and independently of the effects of human work and natural conditions. It produces these differences and those unexpected results, which cannot be explained by any of the other factors.[2]

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[2] The algebraic consequence of this explanation is that in a production function any yield variance is caused not by a disturbance term, but by inputs that vary in (magical) quality.

To illustrate for Atiu, it appears that the native orange trees there offered far more consistent crop yields than do modern citrus plants. The trees that survived to maturity did so because they had survived the smothering of surrounding bush and had adapted themselves to the Atiu environment. For example there was little evidence of biennial bearing - the alternate good and poor yields common with modern citrus. Atiu was essentially a closed ecological system; there are no stories of bad pest or disease infestations occurring in the past as they do today. The trees grew very large, 10 metres or more high, and heavily trunked. They yielded more (low quality) fruit per tree than do modern citrus (though considerably less per hectare) and conservative estimates put this at 6 cases per mature tree. This implies a potential production of 45,000 cases in the 1930s. Since exports never exceeded 20,000 cases and household consumption was a fraction of this, it is clear that even in poor years there must have been considerable wastage of oranges: supply variability was minor. At a rough estimate native orange exports for 1930-49 had a supply variance of 0.09 whereas modern orange exports over the last 20 years had a variance of 0.35 (see next chapter for derivation).

A third characteristic of indigeneous production was informational: established techniques were well known. After a crop had been grown repeatedly in the same area for a long time, a body of knowledge was built up, containing the most efficient techniques of production given the community tastes and technical ability. This evolved from generations of experimenting, both conscious and subconscious. It was the substance of folklore. It might not have represented the full information set in the light of outside experience and modern knowledge. Sometimes it contained a strange mixture of scientific logic and *ad hoc* (e.g. magical) explanation. Nevertheless, given the indigenous experience and outlook, it represented the best information available. Anthropological studies are full of accounts of indigeneous technical knowledge in closed communities.

For their survival all communities developed formal or informal arrangements for the passing on of this accumulated body of knowledge between generations. Whether the knowledge was available to all or only to closed specialist groups depended on the nature of the work and the stratification of the society. General agricultural technique was common knowledge; specialist magical ritual was usually the preserve of the initiated.

Again to illustrate with Atiuan native oranges, by the 1930s (when ownership records are first available) it is clear that every household had picking rights over a few groves totalling about thirty trees. Everyone knew where to find these trees and to whom they belonged. They knew the easiest ways to pick them. They knew that the only major influence on production was adverse weather - long droughts and hurricanes especially. The trees had been planted since the mid-nineteenth century, so the oldest growers had a lifetime experience of them, and the youngest had generations of knowledge to fall back on. All that needed to be known about customary management of native orange trees was common knowledge.

A more detailed study of a pre-European contact production process is given by Firth's (1965) description of *taro* growing on a remote Polynesian island.[3]

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[3] In their agricultural system the Tikopia have formulated the simple thesis that rain is necessary for taro to grow, and they plainly see that at times the crop suffers from drought. I did not hear them discuss plant growth in terms of water or moisture in general, though doubtless they could have formulated their generalization in such wider terms. But in any case, though taro is a plant that needs considerable moisture, they have made no attempts to improve their cultivation of it by irrigation, nor did I ever hear the possibility of such a process mentioned.... But the position is complicated by the religious factor. Invention and technical control can only take maximum effect where they do not run counter to other established formulations. In Tikopia, rain is believed to be controlled by the spirit beings, who are appealed to in verbal formulae and by offerings. On the whole the tendency is for the Tikopia when faced by a drought to intensify their efforts to placate and cajole their gods rather than to seek methods of water conservation or diversion ....

A theory of magic sponsored by Malinowski, and generally accepted, is that appeals to supernatural agencies such as those mentioned above act as a supplement to technical knowledge, filling the gaps in it, so to speak, and do not displace this knowledge.

Social organization. Decisions about economic production and consumption depended on the systems of social organization and control. In a closed economy these were usually established and stable, though by no means static. Very often they limited individual economic choice to tight bounds of convention. The case discussed here is typical of island Polynesia.

Communities developed stratified hierarchical structures where different levels of authority controlled different

3 (Continued)
The practicality of the Tikopia observation of natural processes and the type of limited abstraction which they formulate is well illustrated by their generalizations concerning the growth of taro. It is held that the quality of the crop stands in direct relation to the height of the brushwood on the plot before it is cleared ... I was told: 'If when the brushwood is *tarutaru maru* [immature] it is cleared away, and taro is planted, it is bad. If the brushwood goes up above then the taro goes up above.' Here then, the Tikopia have formulated a correlation empirically observed. How far have they integrated it into a scientific agricultural explanation? That they use this principle as a basis for action is shown by the fact that they adopt different styles of planting for ground which has stood in immature and and in mature brushwood ... This shows that the Tikopia are not considering soil nourishment but an overt growth-parallelism. I questioned people to find if the judgment of future crop quality by height of brushwood embodied any idea of any magical contagion between them. But I could not get the formulation beyond the equation of the states of brushwood and taro. The Tikopia have clear ideas on the importance of rain to the taro crop, and the value of using the cut brushwood and other vegetable material as a shelter round the root of the taro to conserve moisture. But the equation is not in terms of the material as a mulch but of the standing brushwood. They realize also that the taro derives its growth from the soil. When they mould up the earth ... at a later stage they speak of heaping it together to 'feed' ... the plants, using the same term as is used for the feeding of a child by its mother. But they have not linked up these separate propositions; they have not attempted to translate the value of a mature brushwood into terms of soil recovery, nor have they any theory of how rain and soil properties combine to make taro grow (Firth 1965:90-4).

aspects of economic activity. For the commoner, survival meant acceptance of this system and deference to the authorities. The chiefs filled many economic roles as regulators, co-ordinators, experts, holders of property and capital. They extracted tribute in goods and labour. They laid down norms and punished defiance. Commoners learnt to rely on chiefly paternalism and they lacked initiative when they were absent. In some societies chiefs went so far as to lay down planting standards and times to plant. Growers were not allowed to plant less than an imposed minimum amount.

The other social influence on individual economic performance was the degree of interdependence with fellow workers. Closed hierarchical societies tended to stress conformity, and frequently commoners modelled their actions by copying their peers. This led to a society stressing reliance on others. Capital and consumption goods were distributed reasonably equitably and were very mobile. Many societies practised customs of exchange on request. If a relative or friend grew a successful crop it was reasonable to request some, and difficult for him to refuse. The outcome was that there was little point in planning to produce more than family requirements. This in effect imposed a maximum limit on production.

The monetized economy

The effects of European contact. European contact with indigeneous economies followed different forms. But commonly in the Pacific and elsewhere, colonial political influence as well as private traders and missionaries induced monetization without altering basic production patterns. Only much later were attempts made to introduce more efficient production techniques through aid projects.

The first changes induced by monetization were the opportunities for trade in goods. Traders brought new consumption goods to offer indigenes as an inducement to sell their own produce, and set up trading posts. This instituted an explicit price system. Neale (1971) shows that monetization did not imply a total dependence on markets and was compatible with a non-commercial sector. But it did make it possible to compare otherwise unlike events, opening up new opportunities and temptations.[4]

The other changes were to the social system. Sources of non-indigenous authority destroyed the principle of rank and privilege that underlay many societies. Institutions such as land courts freed factor control from traditional chiefs and priests. Old customs of tribute payment were replaced by monetary taxes and church titles. These changes were justified by the concepts of Christianity and democracy. Naturally such social change was a gradual and painful process, lagging behind trading opportunities. For a case study of monetization in Tonga and a suggested time sequence, see Bollard (1977a).

Individual decision-making. Previously most economic decisions had been made by collective agreement or authoritarian directive. Now, social emancipation freed commoners from the social constraints on their production. Individual optimization of individually-controlled resources for individually-consumed rewards became a possibility.[5] Production techniques were little changed, but growers were now offered a price for their produce. This money was useful for it could be exchanged for new consumption goods. How much of these newly monetized crops should a grower produce? This was the new allocation decision that had to be faced at an individual level.[6] Following the standard neoclassical model

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[4] Because of tighter social prohibitions factor markets were not established so quickly. The model we develop assumes no markets for labour or land, and only an infant market for capital.

[5] The individual unit envisaged here depends on the social organization of the particular community, usually some form of extended or nuclear household. Sen (1966) touches on the allocation of production and consumption within such a household.

[6] In the following model we represent the no-risk, single-period, full-information production process described in the first section of the chapter as:

$q = f(\ell)$, where q is crop output, ℓ is labour input

defined so that $f_\ell > o$, $f_{\ell\ell} \leqslant o$.
We also assume that preferences about consumption and work may be represented by a continuous utility function

of allocation, to maximize his utility a grower should keep working until the (non-increasing) marginal revenue product of another unit equals the (increasing) marginal real cost of labour in terms of utility. This result (equation (1)) is well established in various forms. So are the likely equilibrium positions. Above certain conventional levels extra income was little use and the extra labour (or absence of leisure) required to earn it became very undesirable; this was particularly so in the case of primitive affluences where a backward bending labour supply curve could be observed (see Rottenberg, 1952; Berg 1961). In this case price increases made it easier to earn income, but growers were not always interested in working harder to earn more (or they did so only in irregular bursts - see Fisk 1964).

This situation may be illustrated from Atiuan history. Decisions of growers there can be formalized in terms of the production function - utility analysis using the observations at the beginning of Chapter 5. From 1900 to 1950 traders offered to buy native oranges. In response Atiuans gathered some for sale, but they thought it unpleasant and unsociable to spend too much time working to earn money. This implied a very high and increasing marginal disutility of labour. A few store-bought items were becoming necessary for a family: however, beyond these there was no great need for more earnings. Consequently money incomes remained low in this period ($51 per capita in 1930).

Produce prices fluctuated during this period, causing growers to review their work allocation. But such movements were all along known production functions. Provided price changes were not too abrupt, the information set was not disturbed and the grower could easily adjust his work pattern. But the introduction of new project crops after 1950

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6 (Continued)

$u = u(y, \ell)$, where $y = pq$ is grower income; p is unit market price

defined so that $u_q > o$, u_{qq} , u_ℓ , $u_{\ell\ell} < o$.

Then contrained optimization occurs where

$$-\frac{u_\ell}{u_y} = p\ f_\ell \qquad (1)$$

Note that this formulation assumes that decisions about the subsistence and cash sectors are made independently.

caused structural changes of a more fundamental type in the Atiuan economy, as was the case throughout the Third World.

Introduction of projects

More deliberate attempts to induce improvements in productive techniques have now been made in developing countries, frequently in agriculture.

Economic treatment of technical change. Blaug (1963) defines technical improvement or process innovation as an addition to technical knowledge that may or may not involve new equipment, but that can reduce the average cost per unit of output despite constant input prices. Technical improvement does not imply anything about its adoption by a firm or the firm's resulting changed profitability.

Most of the discussion on technical change concentrates on its neutrality or bias, and its effect on factor substitution and reward (for example Heady 1960). Though usually applied to commercialized economies, technical change may also affect the subsistence sector (Fisk and Shand 1969). For example, Salesbury (1962) relates the effects of the introduction of steel axes on a subsistence community of New Guinea highlanders.

Early theoretical discussion concentrated on the effects of disembodied technical change: technical improvement was assumed to originate from outside and affect production by increasing the output from current inputs. Early proposals assumed that it would fall on existing factor input combinations equally, that is, 'Hicks-neutrality'. Later variations suggested that technical change more often affected capital productivity in which case it was capital augmenting or 'Solow-neutral'. This assumes that the available labour is capable of using improved capital, whereas it might require extra training or education; this in itself could be a form of labour-augmenting technical change. Many improved methods of husbandry - drainage, irrigation, fertilizers, sprays, when used to improve existing crop yields - are examples of such disembodied technical change.

But frequently change is embodied in new inputs. An improved tree variety cannot be added to the existing production process, but requires that old trees be uprooted and new ones planted. Similarly a new strain of livestock requires extensive breeding. This technical progress is embodied in a vintage of capital, and means that the new production function applies to that vintage only. This is Ruttan's (1959) definition of an innovation as the setting up of a new production function rather than a shift in the old one. A path of technical progress is described by a series of dated production functions (Salter 1960). The vintages model also provides an explanation why current techniques may lag behind best practice ones: depending on capital costs, it may be more profitable to use outdated equipment for a while rather than uproot it for new.

The transfer of new technology from the circumstances for which it was designed, and in particular its misapplication in under-developed countries, remains a problem. Atkinson and Stiglitz (1969) point out that the effect of technological change is usually to improve one particular production technique, but not other techniques or input combinations. The production function shifts at one point only. Although this may have been optimal previously, it is no longer necessarily the best combination. In particular, this explains why research on a particular range of the function carried out in developed countries is not necessarily relevant to developing ones where a different cost structure implies a different neighbourhood of best performance. If technology is imported from a country characterized by relative capital abundance then it will be labour saving (Eckaus 1966). The current debate on 'appropriate technolgoy' sparked off by Schumacher (1974) rests on this.

Even when only one input is involved, there is no reason why a production function should increase monotonically. In fact evidence on the Green Revolution from Mellor (1969) and elsewhere suggests that so called 'improved' crops frequently offer much higher capacity yields (at least under controlled conditions) in return for a much higher initial labour requirement; productivity may or may not be higher.[7] Figure 13 illustrates such simple differences in a new crop. Whether growers themselves will regard the crop as improved or not is

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[7]We may illustrate this algebraically by a suitably shaped production function (the Mitscherlich function), which is used later:

$$q = \bar{q}\ [1 - e^{-k(\ell-\ell_m)}]$$

Here 'improvement' would imply that $\bar{q}$ increases, ℓ_m increases and k remains constant.

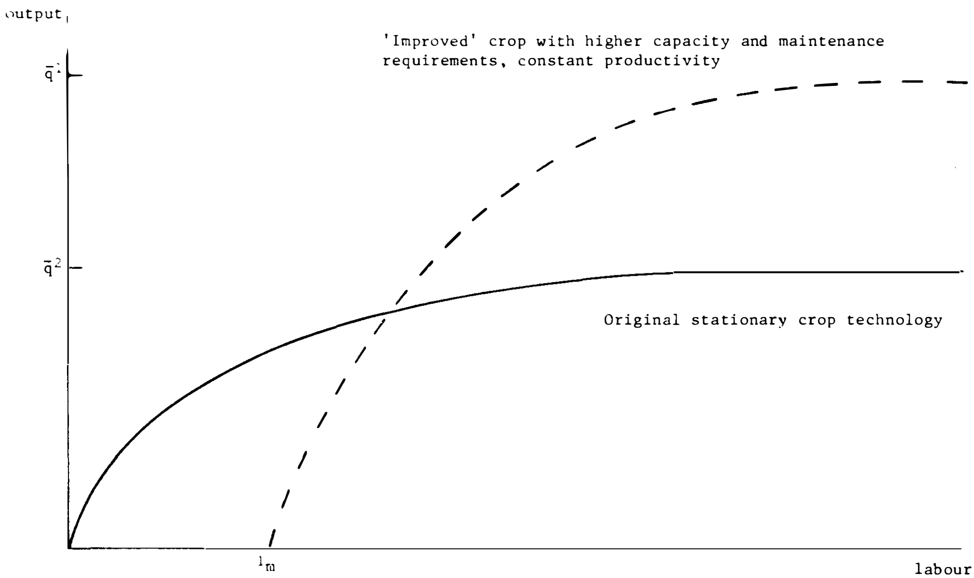

Fig. 13. Example of improved crop

less obvious. This was the pattern of many new projects on Atiu. An Atiuan grower sums up the changes

> The [old] Maori orange you just pick. No weeding, manure, spray and taking away the dry 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 (quoted in Menzies 1970:102).

In practice technical change is usually embodied in new vintages of human capital too; here existing economic theory underestimates the extent of change required. What is intended as a simple innovation requiring a change in factor combinations in fact requires and induces far more basic changes in farming systems, family life and communal activities. Technical change cannot occur independently of these other changes to the social structure, cultural and psychological outlook of a community, especially in many underdeveloped countries which are characterized by the very interdependence of this structure.

Economic anthropologists have been more sensitive to this interdependence. Wharton (1969) and Smelser (1963) both show the linkages between economic change and structural change in society. Mead (1955) provides an example: she sees the change from subsistence agriculture to cash cropping in the corn growing communities of the North American Indian and the potato growing communities in Peru as entailing a radical change from making a living from a value crop, to earning a living from a merely utilitarian crop.

More generalized theories of change. There are very strong aspects of a community's culture, society and psychology that may not be sympathetic to some aspect of economic change. This means economic change must either be embodied in these characteristics, or else it must expect some resistance from them. Foster (1962) outlines cultural barriers to change that reflect the basic values and attitudes of a community - things like their feeling for tradition, their fatalism, cultural ethnocentrism, pride; social barriers reflect group connections in the community - the nature of mutual obligations, public opinion, factionalism, vested interests, attitude to authority, castes and class; and psychological barriers reflect individual and group motivation, ways of perceiving, communicating, learning. Induced change that is designed in accord with these indigenous traits is more likely to find easy acceptance than if it requires them all to change first.

Parsons (1950:70) tries to generalize the phenomenon of structural change beyond the boundaries of economy or culture:

> There are two types of integrative mechanism in the social system - those allocative mechanisms, operating through media like money and power, that affect the balance of advantages and disadvantages in the situation of an acting unit;[8] and those which, like integrative communication, operate through affecting the motivational state of the unit, concerning the definition of what he wants not how he can get it[9]. ... Only when strain impinges on and involves this level of the system of behavioural control can structural change in the present sense become

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[8] e.g. through the production possibilities relationship.

[9] e.g. through the utility function.

> possible. Once it has occurred, the question is whether the impetus to change goes 'over the watershed', or under the countervailing impact of the mechanisms of social control, falls back again.

The impact of the disturbance, which may be exogenous (induced change) or endogenous ('strain' in relationships) depends on its magnitude, direction, frequency, the strategic nature of the units affected, and the degree of resistance by the system to change.

Treatment of project effects. Established theories of technical change and their inadequacy where more basic changes to noneconomic activities are involved have been outlined. How can this be treated? The procedure followed in this theoretical part is to isolate economically important cultural, psychological and social characteristics of a community, and show the effects they have on the decisions made by an 'average individual' facing an agricultural aid project, such as a new crop, with certain technical characteristics.

The following five chapters investigate the effects of such structural change, as each of the five pre-contact production conditions outlined in Chapter 6 is in turn upset.[10] Chapter 7 considers how the increasing riskiness of new crops affects their popularity; next the dynamic nature of their technologies which requires multi-period planning is studied; these new techniques also place growers in a state of ignorance (Chapters 8 and 9). The following chapter outlines the interdependence of different individuals' decisions. The last theoretical chapter considers lessons for project administration by modelling the effects of various government services - its role as banker, as insurer, as teacher, as co-ordinator.

The overall aim is to fact the issues raised above and summed up by Nelson (1973:221):

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[10] Each of these chapters builds a model based on a variant of the neoclassical result (1) in Footnote 6. We continue to assume that subsistence income is roughly constant from year to year and that a grower regards each aid project as an independent decision.

What is involved in technology transfer? ... The development process involves to a considerable extent introducing and learning to use efficiently techniques that have been employed for some time in a developed country. Once we have freed ourselves from the concept of a simple-minded cross-country production function, it is apparent that what is taking place transcends less developed countries simply moving up the production function as their physical and human capital resources are augmented. The technology transfer process involves transfer of information in an explicit sense. It seems important to understand and develop a model to handle the kinds of information and processes at work.

Chapter 7

Decisions with objective risk

This chapter investigates how objective risk in a project affects decisions to participate. The analysis is limited here to the simple case where a grower cannot predict the outcome of his work due to outside disturbances, but where he knows perfectly well the probability distribution of outcomes. This is objective risk (in the terminology of Knight) as opposed to uncertainty, where an individual lacks perfect knowledge about the likelihood of outcomes but forms some subjective distribution on the basis of partial knowledge. This subjective risk is frequently considered along with pure risk. Indeed the two are often confused in case studies of technical change which imply imperfect knowledge by definition (e.g. Cancian 1972).[1]

Can a producer make rational decisions under known risk? Marschak (1974) defines rationality under uncertainty as requiring a complete ordering of preferences by a utility function, which in turn requires an ordering of prospects based on a complete and known probability distribution of the environment.

Types of risk

Wharton (1971) documents three main sources of profit risk that face all farmers: variability in crop yield affecting production, variability in product price affecting revenue, and variability in factor costs. The last of these is less important in communities where social customs have inhibited

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[1]Subjective uncertainty is treated in a separate chapter, because ignorance involves two additional issues: a grower may wish to modify his behaviour in case his guesses prove wrong; and repeated trials mean he improves with subsequent guesses and adjusts his labour accordingly. The distinction between objective risk and subjective uncertainty is not well defined, for it is the distinction between nearly perfect and partial knowledge.

the growth of factor markets.[2] But the introduction of a project crop usually requires new factor inputs (fertilizers, sprays, etc.) that are subject to fluctuations in supply. Chapter 11 touches on this.

Another type of risk associated with new projects is institutional: for example, better crops can lead to uncertainty about the land rights of producers. Lockwood and Moulik (1972) document the introduction of a high-yielding wheat variety in an Indian village. After its profitable acceptance 70 per cent of tenants and sharecroppers were turned off their land by landlords attracted by high rates of return, and rents rose 55 per cent for the remainder.

The model of pp. 142-5 includes the first two risks: in yield and prices. New crops of the type introduced into less developed countries as aid projects in general give high yields compared with pre-project crops, but suffer from much greater variance in yield. Strains of livestock and plants bred specifically for their high bearing characteristics tend genetically to be very sensitive to the conditions under which they grow. Any deviation from the optimum climate, maintenance or inputs can produce fluctuations in output. This is exacerbated because plants bred under experimental conditions suffer greater variance in the field because of the uncontrolled environment and absence of immunity to the pests and diseases found there. This relationship between experimental and farm crop performances is observed by Davidson (1968).

In addition, plants bred for developed countries characterized by temperate climates, few pests, skilled scientific management, controlled water supply, heavy use of fertilizers, machinery and sprays, are frequently those recommended for aid projects in less developed countries where they will encounter a tropical climate, extremes of moisture, pests and diseases to which they have no resistance, and machinery and raw material shortages.

This was the pattern of the Green Revolution in Asia. Myrdal (1968) cites examples of such increased riskiness and the consequent reluctance of growers to participate.

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[2] For example, in much of Polynesia land may not be formally traded, labour is rarely hired, and capital is difficult to obtain.

These crop risks may be illustrated by records of orange growing on Atiu. The yield variance of project citrus trees on Atiu from 1955 to 1974 was 0.35.[3] Similar tree varieties grown under controlled conditions in experimental trials in Australia (West and Howard 1938) yielded a variance of only 0.21. No data are available for trees grown under controlled conditions within the Cook Islands but we would expect a variance somewhere between these two. (From available records of 1930-49 the effective yield variance for native oranges grown on Atiu was only 0.09, suggesting that trees had adapted themselves to their Atiuan environment.) When market fluctuations are included, the project orange trees suffer less revenue variability than the native ones, for they earned constant prices, whereas 1930-49 was a period of violent price changes. Table 41 records estimates of the riskiness of different crops.

The type and extent of risk met by growers may be illustrated by the typical orange plot owned by Toru, the 'majority grower' of Chapter 5. Figure 14 shows the fluctuations in the weight of oranges he produced and the net revenue he received for them over eighteen years. (This includes the variation in Toru's work effort that obviously took place from year to year.) A major source of variation was the climate: two hurricanes ravaged the trees, and a drought stunted production. Citrus fruit is characterized by biennial bearing: having been stripped of oranges by a hurricane a tree will flower well and consequently fruits heavily the next year. Then having exhausted itself it may fruit poorly the year after. Other uncontrollable variability came from shipping shortages and a white moth infestation at a time when no spray was available. In comparison, prices have been relatively stable.

The significance of this risk to Toru is clear when we see from the few records available that the returns on the native oranges marketed by his father in the late 1930s varied annually by no more than a few pounds.

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[3] The measure of risk used is the variance of returns from a crop over a period, normalized about an estimated labour trend in order to compensate for planned variations in inputs. Clearly this measure is only an approximate one.

Table 41

Estimates of crop variance

Project	Variance in yield	Variance in revenue	Data source
Native citrus	.09	.36	Atiu records 1930-49
Experimental citrus	.21	-	West and Howard (1938)
Projects:			
I Citrus Scheme	.35	.26	Atiu records 1955-74
II Forestry	-	.20	Estimate only
III Tomatoes	.11	.48	Atiu records 1955-62
IV Peanuts	.54	.59	1957-64
V Taro	.50	.45	1959-73 (exaggerated as it concerns surplus over local consumption only)
VI Coffee	.47	.55	1965-74
VII Citrus Extension	.35	.26	1955-74 Citrus Scheme data
VIII Private pineapples	.22	.25	1971-74
IX Vegetables	-	.30	Estimate only
X Pineapple incorporation	-	.00	Certain returns for wage labour

Note: Native citrus variance measured from marketed production not total yield.

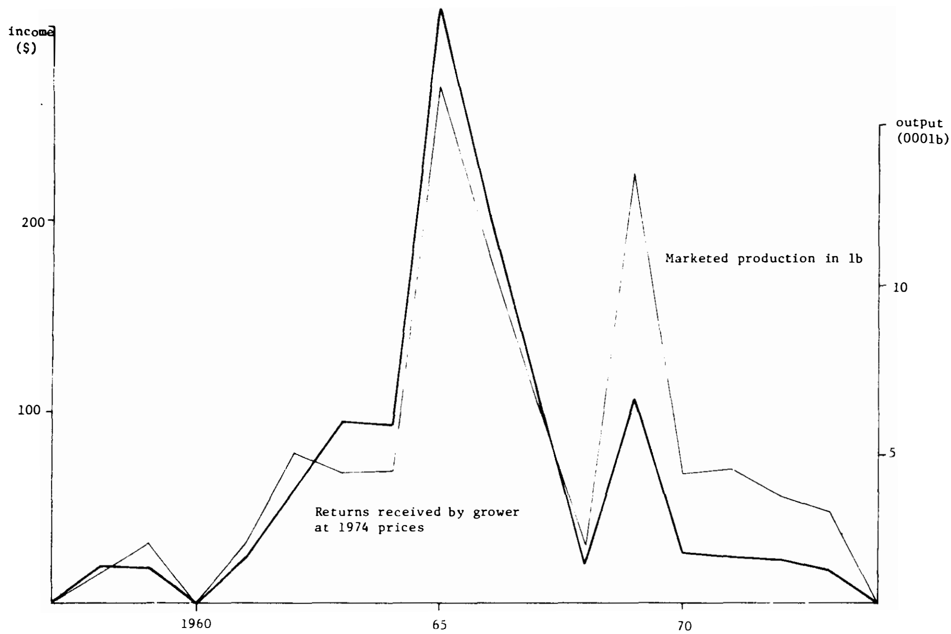

Fig. 14. Fluctuations in orange returns

Note:	hurricanes	1960, 1968
	infestations	1961, 1962
	shipping delays	1964
	floods	1967
	biennial bearing	1969, 1970
	drought	1974

Source: Files of Atiu Administration.

Attitudes to risk

It is generally accepted that farmers in less developed countries dislike risk. The usual explanation is that they have low incomes and cannot afford bad luck. Wharton (1971) builds a plausible model where there is a preoccupation with risk avoidance rather than with maximum income. Faced with a new crop a grower considers its variance rather than its average yield. Johnson (1971) documents such a case: he describes a community of poor Brazilian peasants who spread their risks and maximize security by planting a diverse range of crops on several types of land, using low variance crops, maintaining kin traditions involving land and food reciprocity, keeping on goods terms with shopkeepers and patrons, and avoiding entrepreneurial opportunities.

But to claim that the main aim of all peasants is risk aversion (as does Brookfield 1971) is to overstate the case. Awad (1971) argues plausibly that each community does have its potential risk-takers but because of problems of information about investments and institutional discrimination against low-income borrowers they do not always get the chance to take risks. It has also been suggested that these risk-takers are more likely to be the innovators and early acceptors of new practices in a community.[4]

An individual's preference for or aversion to risk in income depends on the level of this income and on economic-cultural attitudes to it reflected in the shape of his utility function. Friedman and Savage (1948) suggest that a common attitude to risk is to insure against a possibility of losing heavily but at the same time enjoy a gamble with a small cost. The person who behaves like this has a marginal utility of income that decreases for a certain income range, then increases after a point.

Two intuitive measures of aversion to risk have been developed by Arrow (1971). Assuming labour levels have no effect on risk preferences, then the curvature of the utility function provides a measure of absolute risk aversion, and the elasticity of the marginal utility of income is a measure of relative risk aversion. Both measures are positive for a convex (risk averter's) utility function. Arrow suggests that absolute risk aversion is likely to decrease with income (a richer man is more likely to engage in bets of a fixed size), and relative risk aversion is likely to increase (if the size of the bet increases at the same rate as income, a man is less willing to accept it).

Just how strongly does a risk averter dislike risk? Pratt (1964) defines a premium for risk as that amount of money required such that the expected utility of income should equal the utility of the expected income discounted by the premium. This risk premium then turns out to be roughly proportional to the income variance multiplied by Arrow's measure of absolute risk aversion.

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[4] This is not as obvious as it sounds. Innovators clearly have to work with little information with the chance that their conception of a project may prove wrong. Accepting crops known to be risky is a different proposition: it is the distinction between objective risk and subjective uncertainty.

To illustrate: the observations of pp. 93-6 suggest that typical Atiuan growers might have a similar attitude to risk to western farmers, given a similar income. But because of their lower incomes and the likely magnitude of crop variations, they may be expected to exhibit a positive and moderately large risk premium.

Model of choice under risk

Using the Pratt-Arrow formulations of risk aversion, standard models of risky choice can now be adapted to an individual faced with a risky crop to grow. Assume initially that there is a static decision involving a single period production process, where risk affects the process independently of the level of inputs, as a variation in the 'state of nature' (cf. Diamond 1967; Stiglitz 1974).[5] Further, assume that the probability function describing the risk is additively separable.[6]

Then it is possible by optimization and simplification to derive an established risk result: if a grower maximizes his expected utility, he will work until the marginal real cost of his labour (in terms of utility) equals the expected marginal revenue product discounted by the variance in likely revenue times his risk aversion at that income level. Thus he modifies his old work rule by his risk premium.[7]

An hypothesis is set up to test from this result.[8] As the riskiness of the crop increases so will the (risk-

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[5]So for example rainfall affects a crop in the same way regardless of how much is produced and by what technique.

[6]That is, $y = (1 + \varepsilon)\, pf(\ell)$, where risk ε is distributed $N(o,\sigma^2)$.

[7]Equilibrium result is $- \frac{u_\ell}{u_y} = y_\ell^e \left[1 + y^e . \sigma^2 . \frac{u_{yy}}{u_y} \right]$,

where y^e is expected income.

[8]This is the pattern of hypothesis testing that is followed through the models of the next four chapters: testing both statistically by linear regressions, and descriptively by observations, that the relative responses of growers to a series of project characteristics, are as predicted by the model. We should be cautious about accepting the statistical evidence alone because of the theoretical assumptions of the models and the poor quality of the data.

averse) growers' premium, and he will work less and produce less.

The hypothesis is tested for the Atiuan case. The aim is to estimate the differing response of one community to a range of different projects.[9] Then, from the equilibrium result of Footnote 7, the decision of a grower to participate in a project at any time depends only on the riskiness and the profitability of that project (independent of the level of involvement). Assuming it is possible to approximate this relationship by a linear function, least squares regression may be used to test whether the risk variable is significant in explaining participation, and whether its coefficient is negative as predicted.

The dependent variable that best reflects participation is the labour time spent on a project (ℓ). This is available for 1974 only (from a grower survey). Consequently the revenue received from a crop (y) (available from projects records) is also used as a proxy for participation. The measure of project risk (σ^2) is the variance of normalized returns as calculated in Table 41. The measure of profitability (P), the second explanatory variable, is explained in the next chapter. Each regression uses data grouped from one or several years from 1955 to 1974, long enough to provide sufficient observations but not so long as to allow intertemporal distortions.[10]

The results of the simple regression are presented in Table 42. This simplistic equation provides only a moderate fit. However, in every period the coefficient of the risk variable is highly negative, suggesting that growers dislike risk just as we predicted. In all but one period the coefficient is significantly greater than zero, at a 95 per cent confidence level. It is also worth noting that the coefficients of the profitability variable are strongly positive and highly significant: this suggests that growers are attracted to commercially profitable crops. On this statistical evidence the hypothesis that Atiuan growers dislike risky projects is not rejected.

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[9] We assume here that growers have identical utility functions.

[10] The years 1960 and 1968 are omitted from the data base because two hurricanes caused major disturbances in crop production then.

Table 42

Effect of variance on participation

$(y^*, \ell^* = \beta_o + \beta_1\sigma^2 + \beta_2 P)$

	β_o	β_1	β_2	R^2
y_{55-59} (n = 19)	557.1	-1306.0 (0.54)	7.8*** (2.71)	.36
y_{60-64} (n = 20)	1771.9	-5876.7** (2.02)	9.1*** (4.26)	.60
y_{65-69} (n = 24)	3689.9	-10972.7** (2.32)	18.1*** (5.00)	.64
y_{70-71} (n = 16)	2959.0	-6746.2*** (3.94)	5.7** (2.32)	.58
y_{72-73} (n = 18)	4997.1	-11699.9*** (3.28)	13.4** (2.09)	.51
y_{74} (n = 10)	6863.4	-16637.7** (1.98)	12.2 (0.51)	.46
ℓ_{74} (n = 10)	192.0	- 461.5** (2.06)	0.2 (0.28)	.67

Note: t statistic is given in brackets.
y*, ℓ* are optional allocations of income and labour.

* significantly > 0 at 90% level of confidence.
** significantly > 0 at 95% level of confidence.
*** significantly > 0 at 99% level of confidence.

Observation leads to a similar conclusion. For example, tomatoes were considered an attractive crop in the 1950s. Then several harvests were lost because there was no available ship to the New Zealand market. As these huge risks were realized, growers quickly withdrew.

In a similar way, coffee producers began to realize the variability of yields a few years after planting. Most then gave up their crop. A few decided it was worth maintaining their investment: this small group of growers marketed their crop. They were keen growers who had been quick to join this and other projects - the innovators and early adopters with relatively low risk premiums.

Chapter 8

Production decisions over time

In indigeneous economic systems, producers frequently faced choices between a variety of techniques and products. Typically, these processes combined labour with intimate local knowledge. Where capital equipment was needed it was simple and generally built by the producer himself (for example digging sticks, fishing equipment). Production was usually a single period process, whether point-input point-output (fishing) or requiring a seasonal gestation period (root-crop growing). People also picked fruit, nuts and berries off slow-growing trees. But these were generally self-sown and growing wild - an endowed resource like land rather than an accumulated stock of capital.

This did not mean there was no planning for the future. For their survival, all communities had to be prepared for unexpected crop failure or other disaster. Communal chiefs often held power to place a taboo on the use of certain crops during bad times. The reverence in which many growers held their family lands ensured they were managed in a far-sighted way.

The introduction of project crops changed this established system. Not only were these new crops risky as noted in the last chapter, but they also required planning over time. New tree crops posed particular problems in the management of investment capital fot future returns. This chapter investigates this new dynamic decision-making. It formulates a suitable dynamic production function and shows how it usefully describes the different characteristics of projects. It can be recast in a form suitable for estimation giving some idea of parameter values. Then a theoretically optimal level of participation is derived, and it is shown how a grower will adjust his work pattern to attain it. Next a prediction is made as to how a grower will respond to differing types of projects; and finally these predictions are tested on Atiuan evidence.

Formulation of a non-stationary production process

When a new 'improved' crop is introduced, especially if it is a tree crop, a grower must evaluate its complex new technology. In general it will be more productive, but will also require more cultivation. This could include land preparation, planting, weeding, fertilizing, watering and harvesting, most of which is done by hand in the Pacific. Consequently the major input is labour in its various roles.[1] The growth of a tree crop differs from short-term production in several ways.

1. Labour input affects not just immediate yields, but more basically the potential yield of the tree when it is mature.

2. These yields take some time to respond to changes in the labour input.

3. As the tree grows older its yields will grow too.

1. Steady static capacity yields. The bearing capacity that a tree grows up to have depends on how much work is put into looking after it. If the same labour is applied for some time, the tree will reach some steady state capacity when it matures. More labour increases this capacity but at a decreasing rate. This is postulated as an exponential relationship (because of its easy estimation).[2] Some level of maintenance labour is necessary before the tree will produce at all. The effective labour input is the extra work above this minimum maintenance that a grower does. So, for example, weeding orange trees more than is necessary for their bare survival in early life will increase their yields later, but at an exponentially declining rate.

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[1] In writing of a certain labour input, we mean that combination of tasks that yields the greatest ouput for that effort. In Chapter 11 this assumption of a single input is relaxed.

[2] Labour relation is:

$$q^{s^*} = \bar{q}\,[1 - e^{-k(\ell-\ell_m)}] \qquad (1)$$

with $\bar{q}$, k, $\ell_m > o$

where q^{s^*} is the capacity of the crop at maturity, given indefinite applications of labour input.

The maintenance labour parameter (ℓ_m) is botanically determined: hardy trees that grow in the wild do not need any care at all. Introduced high-yielding sensitive trees typically do need a lot of care just to survive. If a grower continues to give a tree less than its maintenance requirements, then the steady state capacity of the tree will decline and the tree deteriorates.

If effective labour inputs are very high, then the mature tree's yield will asymptotically approach some best-practice fixed capacity level ($\bar{q}$). This capacity parameter is never exactly observed, but it is a statistic commonly quoted by crop experts and useful for project description.

The third parameter (k) can also be interpreted; the exponential constant is the productivity of net effective labour in raising the steady state mature tree capacity. This is also an important crop characteristic.

2. Rate of adjustment. If a grower decides to change his labour input, the potential bearing capacity of the tree will take some time to respond. So the new input must continue for some time for the adjustment process to be completed. A logarithmic-linear adjustment process is assumed.[3] Interpret the coefficient of adjustment (λ) as a measure of how quickly asymptotic capacity responds to an input, and hence how long labour change must continue.

Knowledge of this fourth parameter is particularly important for growers learning about a new crop: the effect of experimental inputs may not be visible for several periods. It is also one indication of what Hirschman (1967) calls the latitude of a project.[4] A crop with slow adjustment is difficult to change actively by working harder; conversely, neglect is slow to cause deterioration.

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[3] Adjustment relation is:

$$\log q^*_t = \lambda \log q^*_{t-1} + (1-\lambda) \log q^{s^*}(\ell_t) \qquad (2)$$

$$o \leqslant \lambda < 1$$

where q^* is capacity at maturity given current labour input.

[4] 'this characteristic of a project (or task) that permits the project planner and operator to mold it, or to let it slip, in one direction or another, regardless of outside disturbances' (Hirschman 1967:86).

3. Natural growth. As a tree grows older its production will increase quite independently of these managed inputs. So the production relationship (1) and (2) as formulated so far has a non-stationary aspect. Growth is postulated to be logistic or S-shaped: actual yields grow at an increasing rate in the early stages, and then at a declining rate until they asymptotically approach a particular (not necessarily maximum and not observable) mature level.[5] This logistic form implies that the percentage growth rate in a period is proportional to percentage deviation from mature capacity in the previous period.[6]

The logarithmic rate of growth of output to capacity (α) provides the fifth parameter. If it is large, then maturity yields are reached relatively soon and the crop is a 'short' one; if it is small, there is a long wait for maturity. This provides a measure of the length of a project, and gives some indication of its gestation period. Even short-term ephemerals (several crops per year), annuals and biennials may be distinguished from one another in this way.

These relationships (1), (2), (3) constitute a suitable non-stationary dynamic production function in which successive labour inputs determine successive (unobservable) asymptotic capacity yields, to which real output gradually grows. The system is usefully characterized by its five parameters: the steady state labour productivity, the best practice capacity yield, the growth rate, the rate of adjustment to change, and the maintenance labour level.

Consider a brief illustration taken from Atiuan life. A grower planted a plot of orange trees. He was an old man and spent only a little time looking after them; consequently the oranges he picked (growing along q^1 in Fig. 15) fell short of what he could have grown. After a time he died.

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[5] There is plenty of biological evidence for a logistic growth function: for example see Bliss (1970). Mathematically it is attractive because of its easy transformation into estimating form.

[6] $$q_t - q_{t-1} = \alpha \frac{q_{t-1}}{q^*_{t-1}} (q^*_{t-1} - q_{t-1}), \quad \alpha > 0 \qquad (3)$$

where q_t is actual production at t.

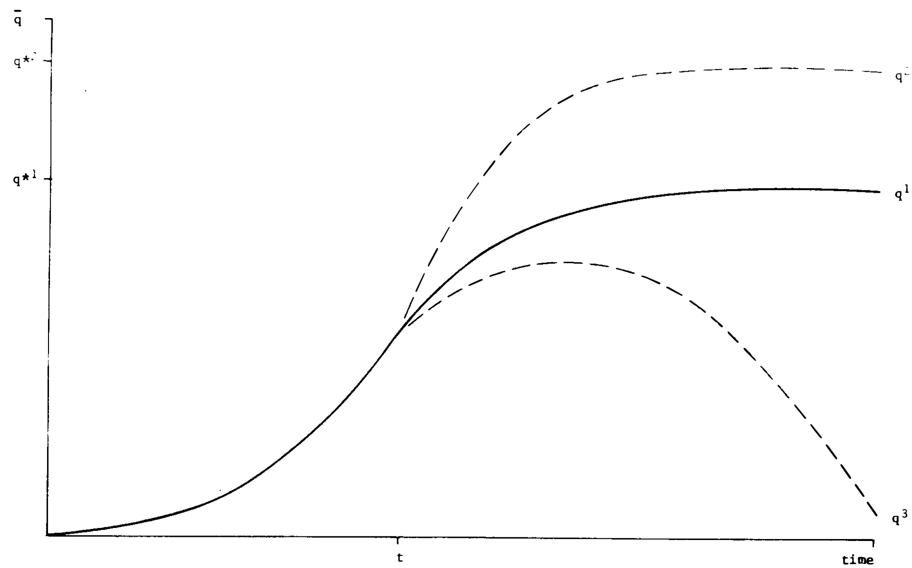

Fig. 15. Effect of changing maintenance

Note: Increased labour input ℓ^2 and zero labour input ℓ^3 cause new growth paths q^2 and q^3.

The plot was divided, and inherited by his two sons. The older one was an industrious grower and he looked after his trees well. They responded to the improved treatment, and jumped on to growth path q^2, reaching q^{*2} at maturity. The younger son was not interested in cash crops. He did not even carry out basic maintenance. His trees continued to grow naturally along q^3 for a short while; gradually weed competition strangled them and production dropped away.

It can be shown that in a steady state where inputs are constant and there are no disturbances to the system (1), (2), (3), it reduces to exactly that single period production function used in footnote 7, Chapter 6. Thus that static function turns out to be a special case of the more general dynamic function, with stationary productivity and establishment labour equivalent to the steady state parameters.

This non-stationary production function is similar to the usual treatment of production using a stock of capital equipment which must be accumulated and which can depreciate. However, there is a logical difference: the function describes a relationship between two underlying processes -

productive labour and natural growth. It may be adapted to describe any managed performance of a growing organism.[7]

Several limitations of the formulation should be noted: the productivity of inputs is assumed to depend on their level of application and the maintenance labour is assumed constant irrespective of the age of the tree.[8] Furthermore, it is assumed that nothing is permanent - that early mis-management can always be compensated for by later inputs. Finally, the decline of crops from old age at the end of a project is not covered.

Empirical estimation of the process

Lave (1966) points out that little work has been done on the specification of agricultural microeconomic production function, particularly because of data problems: frequently data cover a small range, they are autocorrelated and collinear; they are observed rather than controlled, and hence *ceteris paribus* restrictions on other inputs do not hold; estimation in less developed areas is even more hazardous because of high disturbances and unreliable records.

These data problems apart, one of the attractions of this production specification is the way it may be transformed into estimating form. The unobservable asymptotic capacity yields are substituted for, and the system simplified by expanding suitable logarithmic expressions into an approximate truncated series. The outcome is estimating form (4).[9] This is attractive because it bears a sensible theor-

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[7] Some examples are: explaining eight gains of maturing livestock on different diets; predicting efficiency of workers in a 'learning by doing' process where information can decay; predicting athletic performance where fitness must be built up.

[8] This is an advantage of the vintage capital model which assumes labour inputs are most efficient only on the latest vintages of capital, i.e. the young trees.

[9] Estimating form is:

$$\left(\frac{q_t}{q_{t-1}} - 1\right) = \lambda\left(\frac{q_{t-1}}{q_{t-2}} - 1\right) + \alpha\left(1 - \frac{q_{t-1}}{\bar{q}}\right) - \lambda\alpha\left(1 - \frac{q_{t-2}}{\bar{q}}\right) - \alpha(1-\lambda)e^{-k(\ell_{t-1} - \ell_m)} \quad (4)$$

etical explanation, it reduces to the familiar form of the original system under steady state conditions, and it performs in a suitable way given likely parameter values. The equation says that the rate of deviation of current ouput from the natural logistic growth rate partly depends on what it was in the last period, and partly adjusts to the last period's labour input.

It is intended to estimate the five parameters of equation (4). This may be done in several ways:

(i) Equation (4) is a non-linear function in five variables with five parameters. By writing it in maximum likelihood form, the values that minimize the estimating error may be found. This can be done by one of the computerbased iterative gradient or quasi-Newton methods (see Goldfield and Quandt 1972). These estimates are the asymptotic approximations to the true parameter values.

(ii) As a second best method of estimation, equation (4) may be roughly linearized then estimated by multiple linear regression. One parameter will be over-identified and *a priori* knowledge of another is required to complete estimation.

(iii) A third approach is to use extra knowledge from other sources, to allow partial estimation of particular parameters by simple techniques. If a crop is perfectly maintained then estimating form (4) reduces to the original growth function (3): the crop grows along the fastest logistic curve. It is then usually possible to guess the capacity production parameter ($\bar{q}$), and the growth parameter (α) can be estimated by ordinary least squares regression on the logarithmic-linear transform. The response rate (λ) may be seen as roughly linked to the growth rate and therefore not independently estimable (see footnote 15). Then equation (4) rewritten in logarithmic-linear form allows easy estimation of the remaining parameters, productivity (k) and maintenance labour (ℓ_m), by ordinary least squares. This is particularly useful as these are probably the two crop characteristics most liable to change during the introduction of the crop to the field, whereas the others may be reasonably estimated from known experimental results.

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9 (Continued)
Because the aim here is simply a logical overview, mathematical details of this and subsequent derivations are not given. They may be found in Bollard (1977b).

In order to explain the effects of different crop characteristics on project participation in Atiu, rought estimates of these parameters are now needed for each project. Obtaining suitable field and experimental data presents a problem. Table 43 lists the best estimates. The productivity and capacity parameters are reconstructed from technical records of crops, and together they constitute the marginal productivity of the first unit of labour, an indicator of crop profitability. The growth parameter is based on the statistical estimation above. The labour maintenance figures are estimates given by agricultural officials.

Intertemporal decision making

A grower seeking the best work pattern for him to apply to this dynamic production process has some implicit conception of the relative value of income and leisure in different periods. This weighting is represented here by the rate of time preference. It is generally assumed that consumption and labour in future periods are respectively less desirable and less distasteful than in the present. A discount factor weights the corresponding future utility with respect to current utility.

This characterization of attitudes to time in terms of a single parameter is simplistic, but it does allow some crude generalizations about the temporal responses of different growers to projects. For example, Rogers (1969) claims that 'lack of deferred gratification' (that is a low rate of time preference) is a general characteristic of peasantry.

The evidence of pp. 93-6 allows comment on the likely form of Atiuan time preferences. Clearly growers' views of the future depend on the activity they are considering. Most people have a very long-term concern for their family lands. But in the management of recently introduced cash crops they show a marked preference for consumption and leisure in the present rather than the future.

A grower's response to a project over time can be analysed in a similar way to the analysis of variance, given grower risk premiums, of the previous chapter. In fact Malinvaud (1972) draws parallels between the two concepts: one a systematic preference for certainty, the other a systematic

Table 43

Estimates of technological parameters

	Capacity $\bar{q}$	Productivity k	Growth α	Maintenance ℓ_m
Citrus	12,320	.0234	1.0	15
Forestry	0	0	0.4	0
Tomatoes	800	.027	44.0	0
Peanuts	230	.0073	37.0	0
Taro	1,000	.056	31.0	0
Coffee	1,125	.0084	1.1	14
Citrus Extension	12,320	.0234	1.0	15
Private pines	35,500	.0006	2.0	34
Vegetables	1,200	.0084	55.0	0
Pineapple Incorpn	1,700	.0016	244.0	0

Sources: (i) $\bar{q}$ in lb, from project records.
(ii) k in units per day. Derived from formula $k = \frac{mp_\ell}{\bar{q}-q}$ where mp_ℓ, the marginal productivity of labour in an average year, comes from tables in Chapter 4. Then $P = pk\bar{q}$ in \$ per day is marginal revenue product of the first unit of labour, the rough measure of project profitability used in each chapter. Prices are derived from Table 13.
(iii) α, a constant, comes from logistic estimation of best growth rates, from experimental and administration records.
(iv) ℓ_m, in days, comes from material in Chapter 4.

preference for the present.[10] Blitzer (1973) considers this time weighting should include such things as a risk premium for future savings.[11]

Stein (1971) challenges the concept of a fixed culturally determined intertemporal discount rate. He quotes work of psychologists who explained the different preferences of different racial groups for rewards over time by whether they thought they would ever actually receive these rewards or not - in effect their time preference reflected their concept of risk.

In this chapter it is explicitly assumed choice is made over time under riskless conditions and with perfect information. It is also assumed that utility from the total planning period is additionally separable into a series of stationary single period utility functions.[12] The planning period is less than the lifespan of the crop. The rate of time preference is specified by the common discount factor that Heal (1973) shows is the only consistent one (in the sense that the marginal rate of substitution between any successive periods is constant).

Then the problem faced by the grower trying to maximize his utility over the entire planning period subject to the multi-period production function may be represented (by optimization of the Lagrangean function) as a 3-equation difference system in three variables: labour input, production, and a multiplier.

Dynamic adjustment and steady state solution

How does a grower adjust his labour to reach an equilibrium over time? How does output respond? And how will he correct his labour in response? The system of difference equations implies that at the end of any period, output for the following period and the multiplier for two periods

[10] But he warns that whereas time preferences are related to interest rates in competitive equilibrium, risk premiums are independent of the price system.

[11] For a case where premiums for time and risk have been confused see Moulik (1973:10).

[12] We assume no learning and hence no new items in the functions.

hence are already predetermined. The grower will decide on his next period's labour, and the production function will then determine the following year's output.

The outcome of this 2-period lagged system is that adjustment to the true equilibrium becomes a complex procedure. One reason is the yield lag in response to labour decisions. Here is another example from Atiu: a grower decided how much time to spend weeding his orange trees in 1973; unfortunately he overestimated, and spent too long. He was rewarded by an unusually large crop of oranges the next year and suspected something was amiss. But it was not until the end of 1975 that he knew how much extra utility that movement on the production function was worth. Only then was he quite sure of his mistake. In the meantime he probably overworked in 1974 and 1975 too, and this would bias output for several years.

Conversely, production outcomes depend on the inputs over several years. So the high production of 1974 could have been caused by excessive input not only in 1973, but in previous years too. The grower needs another year to find out. As a result labour adjustment to a disturbance is lagged. This explains the slow (and wrong) reactions often observed to changes in the market for tree products, and the difficulty the grower faces in learning about them.

If the planning period is assumed long lenough to permit close approximation to the asymptotic capacity level, and there are no more disturbances to the system, then inputs and outputs will eventually settle down to a timeless equilibrium: the 'steady state'.

Under these conditions the adjustment system reduces to a single equilibrium condition (5).[13] This has a familiar form. It says that in steady state a grower will keep on

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$$-\frac{u_\ell}{u_y} = K.MRP^\circ \qquad (5)$$

where $MRP^\circ = p\bar{q}ke^{-k(\ell^\circ - \ell_m)}$, marginal revenue product in steady state

and $K = \dfrac{\delta(1-\lambda)\alpha}{(1-\delta\lambda)[1-\delta(1-\alpha)]}$, discount factor $(o < K < 1)$

Again, the reader must refer to Bollard (1977) for explanation.

working until the marginal cost of extra labour in terms of utility equals the discounted marginal revenue product of steady state labour on the project. The discount factor depends on the grower's rate of time preference, and on the project rate of growth and speed of adjustment. It is positive but less than unity, implying that the grower will work less than in the equivalent single period equilibrium.

Sensitivity analysis and project design

Now the sort of response to be expected from small changes in project design may be investigated. In particular the following questions are asked: will growers work harder and produce more of a crop with greater or less labour productivity, higher or lower capacity, slower or faster maturity and response, and more or less maintenance labour? Secondly, what sort of grower would one expect to be most enthusiastic over such changes?

This involves sensitivity analysis on each project and grower parameter, to find out the effect of a change in each on the level of grower participation, assuming all others are held constant. Implicit partial differentiation of the steady state equilibrium condition (5) with respect to each parameter in turn, yields the results presented in Table 44.

A grower works on a tree crop. This is then replaced by a new variety that boasts a higher steady state labour productivity, and is similar in all other respects. The effect of this can be cast in terms of the likely utility gain from extra income, the disutility from extra labour, and the windfall gain in utility from the increase in productivity. Overall, the grower will work harder and he will produce more of the crop.[14] This increase will be especially marked among growers with high rates of time preference involved in fast maturing crops with high capacity levels, speedy adjustment, and low current productivity levels.

What is the reaction if the new crop offers increased capacity yields instead? Again the grower will work harder and produce more. He will be especially interested if he is far-sighted and the crop is a short-term relatively

[14] We assume here and for the rest of the chapter that the marginal utility of income is never negative.

Table 44

Sensitivity analysis on system parameters

Effect of parametric change	Conditions for strong effect
(i) $\frac{\partial q}{\partial k} = \{\frac{1}{k}\} \cdot \frac{K.MRP^{\circ}.MP^{\circ}.u_y}{D+K.MRP^{\circ}.k.u_y} > 0;$	$\delta,\alpha,\bar{q}$ high λ,k low
(ii) $\frac{\partial q}{\partial \bar{q}} = \{\frac{1}{\bar{q}-q}\} \frac{K.MRP^{\circ}.MP^{\circ}.u_y}{D+K.MRP^{\circ}.k.u_y} > 0;$	δ,α,k high $\lambda,\bar{q}$ low
(iii) $\frac{\partial q}{\partial \alpha} = \{\frac{(1-\delta)}{\alpha[1-\delta.(1-\alpha)]}\} \frac{K.MRP^{\circ}.MP^{\circ}.u_y}{D+K.MRP^{\circ}.k.u_y} > 0;$	$\bar{q}$ high λ,α, low
(iv) $\frac{\partial q}{\partial \lambda} = \{\frac{(1-\delta)}{(1-\lambda)\ (1-\delta\lambda)}\} \frac{K.MRP^{\circ}.MP^{\circ}.u_y}{D+K.MRP^{\circ}.k.u_y} < 0;$	$\bar{q},\lambda,\alpha$ high
(v) $\frac{\partial q}{\partial \ell} = \frac{1}{D} \{u_{\ell\ell} - \frac{u_\ell}{u_y} u_{y\ell}\} \cdot MP^{\circ} < 0;$	k,$\bar{q}$ high
(vi) $\frac{\partial q}{\partial \delta} = \{\frac{[1-\delta\lambda(1-\alpha)]}{\delta(1-\lambda\delta)[1-\delta(1-\alpha)]}\} \frac{K.MRP^{\circ}.MP^{\circ}.u}{D+k.MRP^{\circ}.k.u_y} > 0;$	k,$\bar{q}$ high

Note: Assuming positive MP°, $\frac{\partial \ell}{\partial p}$ has some sign as $\frac{\partial q}{\partial p}$

$$D = \{-[MRP^{\circ}.u_{\ell y} + u_{\ell\ell}] + \frac{u_\ell}{u_y}[MRP^{\circ}u_{yy} + u_{y\ell}]\}$$

$$K = \frac{\delta(1-\lambda)\alpha}{[1-\delta\lambda][1-\delta(1-\alpha)]}\text{, discount factor.}$$

productive one with speedy adjustment and low current capacity yields.

Similarly , the effects of partial changes in the other project parameters may be analysed. A faster maturing crop will induce more effort and yield more output. A faster responding crop will be more popular.[15] A crop requiring greater minimum maintenance labour will mean withdrawal of interest.

What happens if the same non-stationary crop is offered to a grower with a higher rate of time preference? It can be shown that he will work harder on it than would a grower less concerned with the future, especially if the crop is highly productive and high capacity.

Each of these changes is assumed to take place in isolation from the others. If this is relaxed and other simultaneous changes are considered, each perturbation might still be expected to have the same general effect on participation. Furthermore, a disturbance term may now be recalled to the production process, incorporating variance of output as another parameter of project design, without expecting these results to change.

Hypothesis testing

On the basis of these results the hypothesis is tested that the different characteristics of project design (productivity, capacity, growth and adjustment rate, maintenance labour, and riskiness) affect participation as prediced by Table 44.

Observation of the Atiuan economy suggests that in the early years growers were partly attracted to a project for non-economic reasons such as the prestige or social change it offered. However, in later years growers took more notice of the different technical characteristics of different projects (or what they perceived them to be). For

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[15] The response rate (λ) seems to be related to the growth rate (α): the more slowly a tree grows the more slowly it is likely to respond to inputs. Confirming this, the two parameters have a completely symmetrical effect on participation in Table 44.

Table 45

Effect of techological parameters on participation

(y^*, $l^* = \beta_o + \beta_1 P + \beta_2 \alpha + \beta_3 \ell_m + \beta_4 \sigma^2$)

	β_o	β_1	β_2	β_3	β_4	R^2
y_{55-59}	1425.9	4.5	77.0	87.0*	-7755.9	.45
(n = 19)		(1.06)	(1.14)	(1.45)	(1.13)	
y_{60-64}	-660.4	4.2**	-28.8	291.0***	2153.3	.84
(n = 20)		(2.19)	(0.62)	(3.74)	(0.40)	
y_{65-69}	4941.2	7.2**	182.2***	646.0***	-25116.7***	.80
(n = 24)		(1.81)	(2.81)	(3.86)	(4.07)	
y_{70-71}	725.8	4.7**	15.5***	46.4*	-2824.2*	.80
(n = 16)		(2.50)	(3.50)	(1.63)	(1.66)	
y_{72-73}	211.9	10.7***	39.4***	49.2*	-2843.0	.89
(n = 18)		(3.25)	(6.21)	(1.38)	(1.19)	
y_{74}	130.2	4.5	61.5***	53.3	-4040.7	.96
(n = 10)		(0.58)	(7.20)	(1.14)	(1.21)	
ℓ_{74}	25.2	0.0	1.6***	0.8	- 136.6	.97
(n = 10)		(0.13)	(6.03)	(0.52)	(1.26)	

Sources: P, α, ℓ_m from Table 43; σ^2 from Table 41.

example, in 1974 most growers specialized either in growing oranges or labouring on the Pineapple Incorporation. These were similarly profitable pursuits, but the latter offered fast payment, certain returns, and required no maintenance labour: it became increasingly popular as predicted. More evidence comes from the coffee project. This crop was structurally very similar to orange growing, but less profitable; by 1974 there were only about fifteen commercial growers left.[16]

A more systematic test of the hypothesis is attempted by treating the relation between grower participation and the project parameters as roughly linear, and then estimating the correlation. Table 45 presents the results. In the 1950s these parameters provided a poor explanation of grower activity. Since then it appears that growers have been attracted by profitable crops, that they do like fast maturing (and fast responding) projects, and that they have been put off by risky ones as predicted. Most of these parameter coefficients are significant, and do not contradict the hypothesis.

However, it is surprising to note that the coefficient of the maintenance labour parameter is positive. Against all expectations, growers seem to have planted crops that require hard work just to maintain them. This cannot be explained satisfactorily. It may be that growers' perceptions of a crop's maintenance needs are very far from reality: this should become clear in the next chapter.

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[16] Epstein (1970) observed New Guinea highlanders using similar crop characteristics as a basis for choosing new cash crops.

Chapter 9

Learning about new technology

One reason why producers in developing countries resist apparently profitable new technology is because they are scared they cannot be sure just how this technolgoy will perform. A production process depends on the accumulated stock of knowledge just as it depends on the existing stock of capital.

There is no established theoretical approach to the treatment of knowledge in technological change. (For this reason the approach and conclusions of this chapter are tentative.) The most basic work investigates the role of knowledge in production. Shell (1966) shows how Kaldor's technical progress function formulates production as depending on the changing stock of technical knowledge, as well as the levels of human and physical inputs. Nelson and Phelps (1966) argue new knowledge is basically labour-augmenting (Harrod-neutral technological change). Sheshinski (1967) sees new knowledge as both allowing people to learn about their work and letting machines be more efficiently designed (Hicks-neutral); he considers cumulative gross investment or gross output to be a suitable measure of the stock of information.

The extensive literature based on this deals with measurement of the rate of learning and the conditions for optimal invention and accumulation of private knowledge in a competitive economy. The problems here are different: the things growers have to learn about in new projects and how they do it; their attitudes to ignorance, learning and knowledge; the way these attitudes affect their decisions whether to grow a new crop or not; and the implications this has for the transfer of projects. This has received little attention from economists beyond the glib conclusions of

Solo (1966, 1972) that it is a very difficult thing to transfer a body of knowledge between countries.[1]

Knowledge about a crop is treated here as a public good: it is non-tradeable and observed by all in the community. The broad approach of Arrow (1969, 1971) to learning is applied: a grower's knowledge of a crop enables him to make an estimate of the likely outcome of some planting policy with some degree of confidence. Learning from trials or observation allows him to revise his earlier estimate if new evidence suggests it is wrong, and also to increase his confidence about it. In the terminology of Chapter 7, learning progressively changes decisions under subjective uncertainty to decisions under objective risk.

Types of knowledge and ways of learning

What does a grower need to know for efficient management of a new crop? He must know how much maintenance it needs, what it is capable of bearing, how quickly it grows, how it responds to different inputs, how risky it is, and other production characteristics. He needs to know how easy and how costly it is to get the necessary inputs; also the value of the crop and what the likely demand for it is.

When they introduce a new crop, the administrators of a project possess some information about it. But if the crop has been developed in a nursery in a temperate developed country, then transferred without change to the field in a tropical developing country, much of this information will be irrelevant, being based on different physical environment, factor costs, and management. Growers soon come to distrust an administration that passes on such knowledge.

How can a grower facing a new activity learn about it for himself? If it has a fixed (though unknown) outcome, learning is easy. One trial with the new technique establishes the exact effect under these circumstances. For example, Sansom (1970) writes about Vietnamese peasants' reactions to

[1] The many studies by anthropologists and others of technological change in a community rarely recognize the basic theoretical distinction between making decisions where an outcome is risky but of known probability (objective risk) and making decisions where even these probabilities are not known for sure (subjective risk).

a new simple motorized water pump. A farmer needed only to try the pump once to establish exactly how superior it was over foot power in raising water a particular height. Consequently, dissemination was rapid.

But most agricultural processes involve highly variable returns because of changing inputs and outside disturbances such as the weather. Now learning is more difficult and more costly. The grower must gather all the official publicity and local hearsay that he feels is relevant into an initial information set; then he can update this by actively experimenting with different planting combinations himself, or by passively watching the trials of others. This is costly, for it may take many seasons of observation. It is difficult too, because the grower must somehow isolate the effect of the new technique from the effect of exogenous disturbances.[2] A simplified problem is analysed first.

Learning about a parameter. If the grower can isolate one particular constant characteristic of production that he wishes to learn about, then it is conceptually easy to represent the way he learns.

If the parameter may be directly derived from easily observed variables, then the grower can build up successive estimates from these variables. For example, it is easy to learn about the expected product price or the variance of returns by recording successive crop proceeds for a time.

But how can a grower learn about a parameter that he never observes? In the specific case of the non-stationary production function of the previous chapter, how can he ever guess at the value of the labour productivity parameter, or the capacity output, or the maintenance requirements, or the crop's growth rate, or its speed of response to cultivation?

The production relation is simplified to analyse the learning process. A grower hears of an improved variety of a well-established crop. He knows the form of the one-period production relationship, and only wants to learn the value

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[2]For example, he tries pre-fertilizing a crop, then it rains heavily all season. The crop bears well: somehow he has to separate the effects of fertilizer and rainfall.

of a single constant parameter in the process. He plants this same crop each year and maintains it in the same way.[3]

After he has harvested the crop at the end of the year, he finds that the yield is not quite what he expected. Because of this he changes his perception of the unobservable parameter. In fact this means that he approximately modifies his idea of the mystery parameter by some proportion of how wrong the previous year's expectation of output has turned out to be.[4] This is the familiar adaptive expectations rule, first derived by Nerlove (1958) to explain farmers learning about an equilibrium price by a cobweb mechanism. It is also shown by Turnovsky (1969) to result where people make rational predictions of observable variables using Bayesian sampling under certain conditions.

In learning this way, the grower's estimate of the parameter is never confirmed directly, only indirectly through being able to make more accurate production forecasts. Depending on his initial information, he will probably make poor predictions at first and have to revise his ideas radically. Then as predictions get better he can adjust his estimate more and more finely.[5]

The coefficient of adjustment depends partly on the sort of random disturbances inherent in the production process. If the grower knows that outcomes are risky, he will be less inclined to revise his estimate. The coefficient is also culturally determined. A farmer with engrained beliefs will require a lot more evidence to change his views than one less rooted in tradition.

Is it possible to derive an approximation to the grower's adaptive expectations rule that will allow an empirical

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[3] This assumption of one trial per period is not essential to the argument: it merely simplifies the indexing.

[4] $\hat{P}_t = \hat{P}_{t-1} + D_t\ [q_t - \hat{q}_{t-1}]$, where $\hat{P}_t$ and $\hat{q}_t$ are estimates made of parameter P and output q immediately after period t.

[5] In practice he may never put an absolute value on the parameter, but simply decide each period whether he is currently over- or under-estimating by a large or small margin.

illustration of his pattern of learning? By linearizing the production function it is possible roughly to rewrite this rule as an estimable relation: that the annual adjustment to the parameter estimate is proportional to the real error in the old estimate.

As a first approximation, assume that the coefficient of adjustment is constant. Then this learning pattern is exponential:[6] a grower starts from his initial estimate and approaches the true value asymptotically. This corresponds to the exponential learning curves fitted by psychologists to subjects guessing the probability of an event (Hilgard 1956), and by economists to the rising productivity of workers in a new process (David 1975).

However, the assumption is quite unreal. The adjustment coefficient is related to the variance of the parameter estimate and this is decreasing. It is likely that the coefficient will decrease too.[7] This means that an exponential curve under-estimates the rate of learning in the middle stages. In addition, the coefficient contains the exogenous disturbances of the production function. So real learning oscillates about this adjusted exponential curve as an abnormally good harvest biases a parameter estimate one way and an abnormally bad one biases it the other way. These oscillations will decrease over time as the number of trials increases.

Parametric learning is a simplification, but a useful one. It allows the distinction between different types of ignorance. For example, growers involved in the Atiu coffee production did not realize how variable returns would be, nor how hard they would have to work to increase them. Compare this with the pineapple project: here growers did not realize the work they would have to do just to maintain their crops, and they had inflated views of their maturity yields.

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[6] $\hat{p}_t = \emptyset^t p_o + (1-\emptyset^t)p$, where p_o is initial estimate of p.

[7] Turnovsky (1969) shows in his similar model that the adjustment coefficient will be constant only if the learner organizes his trials so that the knowledge contained in the sample is proportional to that in the prior estimate.

Learning about a production relationship. Faced with a new crop rather than just an improved variety, it is more likely a grower will need to learn the nature of the whole production relationship. Now the grower controls the input and observes the result, but the mechanism involved is unknown.

The process is simplified by assuming the same stationary single input production function with one trial per period, and a normally distributed known disturbance term.[8] The learning problem reduces to the likely distribution of output from some input. Because this is normal, it is characterized by its mean (the expected output level) and its variance (the precision of the estimate).[9]

The grower learns about these by gathering information on the outcome of past trials where the inputs were in any way comparable. The way he sorts and weights these past results depends on his skill in weeding out abnormalities and compensating for input variation. Just as in simple parametric learning, his initial estimates will be poor ones, but they will improve until the mean of expected output approaches true ouput and its variance approaches zero (indicating a precise estimate).

Consider a special case: the grower wants to find the expected output from working a particular fixed amount. He has some idea of the distribution of this expected output. He puts in another period's labour and records another outcome. Now he can revise his estimate of the distribution in accord with Bayes' rule; his learning rule may be specified. Following the approach of Turnovsky (1969) it is also possible to show precisely how this new estimate depends on the old estimate and the latest outcome. In fact the grower learns about both the sample mean and sample variance by revised expectations, learning rules as for the parametric

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[8] i.e. q_t is distributed $N(\tilde{q}_t , \sigma^2)$; σ^2 is known , $\tilde{q}$ is unknown.
Most of these assumptions may be relaxed and the results will still follow in principle. If the disturbance term is unknown too (as is likely) then results are more complex.

[9] i.e. $\tilde{q}_t$ is distributed $N(\hat{q}_t , \hat{\omega}_t)$; the grower is learning about $\hat{q}_t$ and $\hat{\omega}_t$.

case, the first in a roughly exponential way and the second in a roughly logistic way.[10]

But the grower cannot make a rational decision on how hard to work, knowing only one point on the production function. He must establish reasonable estimates of outcomes for a whole range of inputs. Then he has a problem of guessing a continuous relationship from a set of discrete points. He may start to observe some input-output relationship that holds generally true over an interval. In this *ad hoc* way he can formulate what he suspects to be the best approximation of this relationship. If it has a simple monotonic form like some other crop he is used to, this will be easy. But if the process is completely new, then the grower may misinterpret its purpose altogether.[11]

In learning, a grower builds up a confidence region for the function. Because sampling will be concentrated in certain labour ranges, this confidence region will be uneven. The most popular work habits yield the most observations, hence the lowest variances for the estimated outcomes and the smallest confidence interval. Growers will be more vague about the outcome of uncommon work habits. This point is made by Fellner (1966). Figure 16 suggests what the growers' impression of the true relation might be.

In this simple case the vector of variances of expected ouputs from different inputs provides an indication of the

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[10] i.e. $\hat{q}_t - \hat{q}_{t-1} = \frac{\hat{\omega}_t}{\sigma^2} (q_t - q_{t-1})$, exponential learning;

$\hat{\omega}_t - {}_{t-1} = \frac{\hat{\omega}_t}{\sigma^2} (\omega_t - \hat{\omega}_{t-1})$, logistic learning.

This means that the estimate of the expected value will quickly approach its true value, but the confidence the grower has in this estimate increases only slowly at first, then faster, then slowly again.

[11] A loose illustration of a bad misinterpretation is provided by Moerman (1968). He describes the introduction of tractor technology in a remote Thai village. Instead of using the tractor to replace the plough, farmers used it to replace the axe clearing land. It was not efficient at doing this, and they gave up using it after a few years.

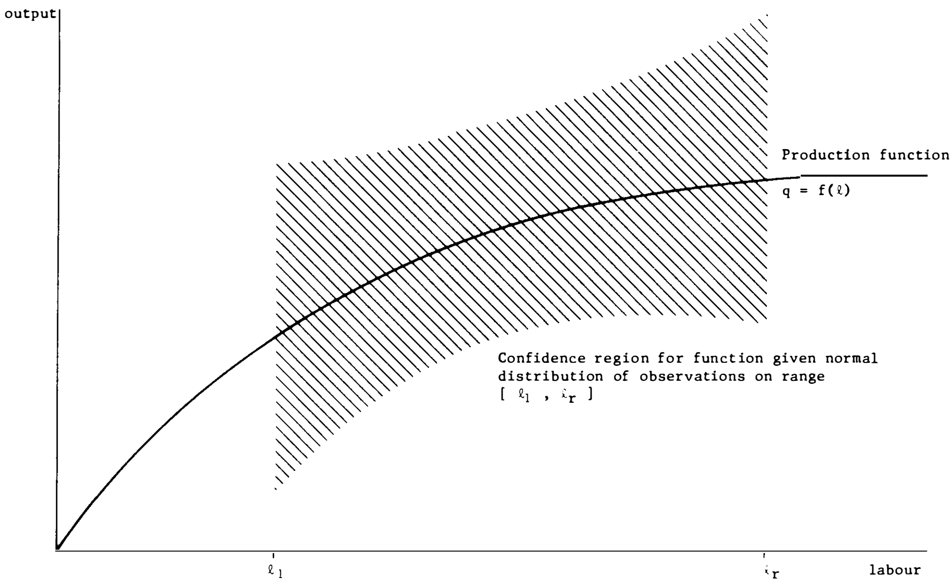

Fig. 16. Growers' conception of production function

extent of a grower's knowledge about the production function. Low variances imply a high stock of information.

Luckily, in practice, learning is made easier in several ways: firstly information gained from a trial with a certain labour input also yields (less relevant) information about surrounding input-output combinations.

Secondly, a grower in a tight community will undoubtedly learn from others as well as from himself. He must judge how relevant someone else's experiences are - whether they used the same factor inputs as he would in the same way, and whether he trusts their conclusions.

If he regularly observes the experiments of a group of growers he will form a mean of their outcomes, subjectively weighted by the reliability and relevance he assigns them. He will have more confidence in this grouped outcome and will be able to revise his expectations more closely each time. With the extra information, his estimates of the distribution will converge to the true outcome faster.

Thirdly, in introducing a new crop an administration generally helps a grower to learn by providing good initial information or suggesting relevant areas to research. The section covered by pp. 194-8 investigates this. But as Hirschman (1967) points out, no government can provide complete information to each grower, nor does any grower plant a crop without learning something about it in the process.

Myrdal (1968) claims that most high-yielding crops of the Green Revolution are characterized by their complementary inputs. It is necessary to relax the assumption of single input production. How does a grower learn about a crop that needs both labour and fertilizer? Each experiment can only yield information about one variable input at a time. The number of trials necessary to gather a certain knowledge about the effects of a range of inputs increases by the power of the number of inputs. It is more costly to learn and more difficult to pick out the underlying relationship. Communal co-operation in joint learning becomes crucial here.

Many new projects are tree crops. Now the assumption of stationary production is relaxed: learning becomes harder. If current output depends on inputs over several previous periods, then the effect of each period's input must be learned about separately. This will be difficult for the crop will probably respond to new inputs only gradually. Furthermore this has to be distinguished from the effect of natural growth on yields. The problem is more complicated than multi-input learning and more expensive too, because each trial takes several periods to complete. This poses the danger of getting 'locked in' to a suboptimal crop. A farmer plants some trees to see how well they grow on his soil. It is several years before he finds that, alas, they fruit poorly; but after that investment of time he feels he must persevere with them rather than plant another variety.

The Atiu experience illustrates patterns of learning. For example, growers had not known peanuts before they were introduced in the 1950s. The resident agent grew them in the government nursery for several years before releasing seed. If was not difficult to learn how to grow this simple crop, and many households experimented for a few seasons. By then they had learned that productivity was lower than initially expected, and returns more variable. Within five years most had realized the crop was unprofitable. By this time they had a good idea of peanut response to small inputs of family labour. They had no knowledge of the possibilities of large organized labour inputs, nor of the response to fertilizer and machinery.

It was more difficult to learn about new tree crops. When the Citrus Replanting Scheme was introduced, growers knew only about their old native orange trees. The administration assured them that capacity yields would be higher (though they exaggerated how much), but they failed to stress how hard the growers would have to work to maintain the trees and how highly variable yields would be. So growers had to learn about each of these characteristics by experiencing them. The administration advised on the requirements for fertilizer, spray and pruning, but often mistrustful growers had to observe the effects of these for themselves before they would follow recommendations. The growth of the crop complicated learning too. For example, the effects of pruning might not be visible for several seasons and even then only gradually so. By this time yields could be changing for other reasons too.

With all these unknowns, and with strongly ingrained traditional beliefs, growers required considerable evidence before they were willing to accept that their preconceptions of orange production were wrong. For some, this took a decade of experience and observation. By this time they were 'locked in' to a crop that was not ideal. Evidence that growers did eventually learn came when a citrus extension scheme was introduced in 1965. Few growers were interested this time. Most of those who did join the new scheme had proved themselves efficient specialist orange growers and wanted to increase their holdings.

Attitudes to ignorance and learning

Growers regard decision-making where there is a chance of the unexpected happening differently from decisions with assured outcomes. A limiting case was the objective risk analysed in Chapter 7. However, when the grower knows there is risk but is not sure just how severe it is then his actions will differ from when he knows the odds he faces. In other words, ignorance adds a new dimension to the old risk problem - how to cope with subjective uncertainty.

This subjective uncertainty will lessen with experience. This introduces an implicit investment problem - whether to trade time for experience. Wharton (1971) points out that a subsistence farmer distinguishes future events of which he has had past experience from those which are new to him. This corresponds to the distinction between 'exploration risks' and 'commercial risks' discussed by Awad (1971).[12]

In Chapter 7 growers' attitudes were represented by a specialized risk premium in a case of complete knowledge. Now this may be generalized to a risk-ignorance premium: it depends on the true distribution of outcomes of an event and on the knowledge the grower has of the distribution. Assuming any disturbance to production is normal as before, the premium may be written as a function of the expected outcome, its variance and the information set. Following the definition of the risk premium this generalized risk-ignorance premium is defined to satisfy the certainty-equivalence condition that the expected utility from income in a period should equal the certain utility to be had from the likely income minus that period's premium: in other words, what a grower would give up to be assured of a known return.

This premium will decrease as information increases over time. This is the principle of Marschak (1974), that a decision maker begins most tasks with subjective probabilities that become more objective with experience. Then the premium reduces to the special risk premium.

Will a grower enjoy making decisions where there is an element of the unknown or will he prefer well-established activities? It seems likely that if he was averse to objective risk he will be averse to decisions under ignorance too, and for the same reasons: he cannot afford the chance of a miscalculation just as he could not afford the chance of a misfortune. If his income is small, his premium will be large. If he has little information, the premium will be large too.

Growers in isolated communities with strong traditional beliefs are particularly unwilling to experiment with new crops, or to invest in a crop without full information about it. Within a community we might expect that the keenest

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[12] 'Exploration risks face innovators and arise from the inability of the pioneers to predict precisely the outcome of their own actions. Commercial risks are present in all economic operations whether they are familiar or not, and stem from the well-known unpredictability of economic activity in general' (Fellner quoted in Awad 1971).

innovators will be the ones most prepared to act on little information and learn for themselves; these may also be the growers with highest incomes best able to bear the costs of failure. Laggards may be least willing to get involved in experimental crops.

Decision making with ignorance and learning

Most producers do not like working without full information, but it may be the only way for them to learn more. This section derives an original formulation, built on the ideas of two established fields: the learning by doing approach of Arrow (1962a), Nelson and Phelps (1966), Fellner (1969) and Rosen (1972), where efficiency in a task depends on the operator's experience; and the pure learning principle of Stigler (1961) where optimal learning implies a search for information until the extra savings earned equal the marginal cost of another trial.

A grower has the opportunity of a new crop. He knows a little about it, but lacks full information. How does this ignorance affect his decision on how much to plant? Assume a simplified model where a grower maximizes his expected (additive) utility over two periods subject to a simple single-period product function.

Under these conditions it can be shown to be best for him to keep on working in the first period until the marginal real certainty-equivalent cost of his labour equals the discounted expected marginal revenue product. This discount factor reflects not just a relative change in the dislike of objective risk, but a change in the whole risk-ignorance premium taking into account the relative present value of extra income in the next period resulting from an extra trial. This change in the premium comes from an adjustment to the estimate of next period's income, and an improvement in the confidence given to this prediction owing to the extra information.

Thus at any time a grower will want to work relatively less on a new project than on an established one. This is the disincentive of risk. However, he knows he may reduce the subjective part of this disincentive by investing in trials to improve his scarce information. He is most likely to do this if he cares about the future, and he is now in the early stages of a project where information is scarce and there are high returns to learning. As his knowledge grows, this incentive to invest weakens: but by then his premium will be smaller.[13]

The same principle holds for multi-period planning. If production responds to inputs over a period then the grower has another issue to consider: working now is an investment in capital for the future as well as an investment in knowledge.

The hypothesis is formulated, that ignorance-averse growers will be relatively keener to participate in projects with more information. However, to test this requires a measure of the information about a crop. Instead the hypothesis is modified to a more general statement: growers act on the basis of learned rather than perfect information about the characteristics of a production function, and their learning may be roughly viewed as revising expectations.

Production is represented by the non-stationary function of the previous chapter. Can grower participation be explained better by reformulating the full information technical parameters used there as partial information ones? The parameters used to explain grower participation were crop variance, productivity, capacity yields, growth rate, and maintenance requirements of a crop.

Table 46 sets out a conception of the grower's state of knowledge about these crop parameters. It appears that growers probably realized the likely growth rates of different crops and the product prices, but were sadly astray with the other characteristics. It is assumed they initially expected projects to have the same variance as pre-project crops, then successively updated them. It is also assumed that footnote 6 approximates their learning about unobservable parameters. They formed estimates of capacity production from what aid administrators told them. They guessed at the productivity parameter (correctly it is crudely assumed, except for peanut and coffee projects). As for maintenance labour levels, they

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[13] If the premium is too high, a grower may never be able to afford to experiment to improve his information, even though it would be in his long-term interest. Baldwin (1963) sees this investment problem, rather than the pure risk, as the major reason subsistence producers are reluctant to adopt new crops.

Table 46

Estimates of learned parameters

	Variance (σ^2 in $)		Productivity (k /day)		Capacity (q in lb)		Maintenance (ℓ in day)	
	True	Initial	True	Initial	True	Initial	True	Initial
Citrus	.26	.36	.023	same	12,320	15,400	15	0
Forestry	.20	.20	.010	same	.0	1,056	0	0
Tomatoes	.48	.10	.027	same	800	800	0	0
Peanuts	.59	.10	.007	twice	230	230	0	0
Taro	.45	.10	.056	same	1,000	1,000	0	0
Coffee	.55	.10	.008	twice	400	600	14	10
Citrus Ext.	.26	.29	.023	same	12,320	15,400	15	12
Private pines.	.25	.10	.001	same	35,500	35,500	34	12
Vegetables	.30	.10	.008	same	1,200	1,200	0	0
Pine. Incorp'n.	.00	.00	.002	same	1,700	1,700	0	0
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

Note: Parameter estimate at any time grows from initial to true value, using learning rule in footnote 6. Arbitrarily set ϕ = 0.9 constant, so that grower takes 20 years to revise his estimate by 90 per cent (on assumption that production is highly variable and growers are very set in their beliefs).

Sources:

(a) From Chapter 7.

(b) Method of Chapter 7, assuming Citrus Replanting Scheme estimate based on native citrus; citrus extension estimate based on Citrus Replanting Scheme; forestry and Pineapple Incorporation estimates assumed true; all other projects set arbitrarily low.

(c) From Chapter 8.

(d) All arbitrarily assumed the same as true values for want of better estimates, except for peanuts and coffee which were clearly overestimated.

(e) From Chapter 8.

(f) Citrus, forestry, coffee, citrus extension, private pineapple estimates based on claims of administration during introduction, from Atiu files.

(g) From Chapter 8.

(h) For annual crops, known to be zero. For capital crops assumed zero (like native citrus). Later capital crops assume ℓ_m = current estimate of ℓ_m for Citrus Replanting Scheme.
Assume grower knows crop growth rates, i.e. $\alpha = \hat{\alpha}$.

thought that new capital crops were like native citrus and native coffee and could look after themselves.

Then the regression of Chapter 8 is repeated, replacing true project characteristics by these estimates of learned project characteristics. The results are shown in Table 47. These learned variables do provide a reasonable fit in a number of cases. However, in general they are not much improvement on the full information variables. This is not surprising in view of the empirical assumptions we had to make.

Yet there is plenty of evidence from Atiu on the importance of information in decision making. Hence rather than reject the hypothesis altogether, this may be seen rather as a failure to represent the extent of information meaningfully. Therefore these data are not used in future analysis.

Learning about oneself

Analysis so far has been limited to growers learning about the production process. They must also learn about their own reactions when they are placed in totally new situations. How much enjoyment will come from a lot more money than they have ever had before? How unpleasant will more regular work prove? These are the problems typically posed to growers by new project crops.

Most economic work on self-learning is in the context of the role of new goods in utility (Lancaster 1966; Ironmonger 1972). Tarascio and Murphy (1972) suggest how this theoretical problem of learning about utility functions may be dealt with in a similar way to learning about production functions. People will make tentative decisions, experiment, evaluate the outcome, and revise their decisions.

There is evidence of this happening on Atiu. The Citrus Replanting Scheme and again the coffee scheme promised to be high yielding projects. The thought of the extra money, and the prestige and material goods it might buy, lured many growers into joining. They soon found out the regular commitment to work that was needed, and how it cut into subsistence and social activities. After a few seasons many decided the extra money was not worth the extra work, and gave up the projects.

Table 47

Effect of learned parameters on participation

$(y^*_t,\ \ell^*_t = \beta_o + \beta_1\hat{P}_t + \beta_2\hat{\alpha}_t + \beta_3\hat{\ell}_{mt} + \beta_4\hat{\sigma}_t^{\,2})$

	β_o	β_1	β_2	β_3	β_4	R^2
y_{55-59}	-342.2	6.9*	5.4	289.9	592.6	.41
(n = 19)		(1.39)	(0.18)	(1.00)	(0.11)	
y_{60-64}	-1,550.8	6.7***	-32.2*	266.8	6,435.7*	.91
(n = 20)		(2.61)	(1.50)	(1.16)	(1.73)	
y_{65-69}	331.7	6.7	-9.7	364.8	-1,961.9	.40
(n = 24)		(1.29)	(0.11)	(1.13)	(0.15)	
y_{70-71}	493.7	3.2*	17.5***	101.5*	-2,985.8	.83
(n = 16)		(1.95)	(3.66)	(2.03)	(1.26)	
y_{72-73}	-627.1	11.0***	43.0***	116.8**	-2,311.5	.93
(n = 18)		(3.92)	(7.42)	(2.15)	(0.94)	
y_{74}	-1,637.9	4.3	68.8***	138.8*	-937.8	.96
(n = 10)		(0.56)	(8.20)	(1.91)	(0.31)	
ℓ_{74}	-44.93	0.0	1.9***	4.2**	-24.1	.98
(n = 10)		(0.17)	(8.24)	(2.14)	(0.29)	

Chapter 10

Communal interdependence and bandwagon effects

Grower interdependence

A marked characteristic of decision making in many small isolated communities is the communal interdependence of reactions: people copy one another, especially when faced with a new and confusing choice. When a new cash crop is introduced into an area, initial suspicion is frequently followed by a bandwagon participation effect. Growers may follow their neighbours for a variety of reasons: it may be a way to insure against the risky decisions outlined in Chapter 7; it may prevent a grower having to make an individual assessment of the long-term investment choices of Chapter 8; it may be an easy way to learn (Chapter 9); or it may be purely gregarious: people like to work with others, and it can be easier for them if they do so. This section will show that, whatever their rationale, people faced with an innovation do exhibit strong communal interdependence.

Rogers (1969) counts this communal reliance as a defining characteristic of peasant communities. In a closed society, many growers are related to one another; others are linked by ties of rank and patronage. Any experiment made or decisions taken by a grower are closely and critically observed by others. The outcome can then affect the observer's decisions. The more ethnocentric the culture, the tighter this interdependence.

Evidence on the importance of interdependence comes from the wide literature on innovation diffusion.[1] The rate at which different members of a community accept a potentially attractive innovation can vary for several reasons: some

[1] See bibliographies in Brown (1968), Rogers and Shoemaker (1971) and Gibbs (1973).

people may not hear about the innovation until later than others; some will take longer to make up their minds; some will wait to be convinced by others and will not participate in a project until a number of their friends do. If a community hears about an innovation simultaneously and accepts it quickly, then it is likely that growers' decisions were highly interconnected: they influenced one another.[2]

The derivation of the common form of the innovation diffusion curve shows this. Assuming that the percentage rate of adoption of a project at any time is proportional to that part of the community who have already adopted it, diffusion follows a logistic or S-shaped curve. At first the number of new adopters is small, but it grows at a rising rate as the information base grows; eventually the growth slows as the later more reactionary groups are induced to participate. This implies that the rate of acceptance is normal, a distribution observable in many human behavioural traits. The relationship may be interpreted as the diffusion of information between pairs of similar households (Brown 1968), or as a communal learning curve (Norris and Vaizey 1973). A measure of the degree of interdependence is the parameter of participation estimated from the acceptance curve.

Of course, all households are not equally influential in swaying others into participation. The rank and personality of some growers makes them natural leaders in the adoption of new practices. Coleman (1964) shows how this may bias the acceptance curve. Aid administrators usually aim to introduce new techniques through such people.

There is a mass of empirical evidence that these acceptance curves do fit the observed pattern of project participation. Logistic relationships have been observed for the diffusion of agricultural innovations in a wide range of communities.

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[2]An alternative explanation is offered by the theory of Liebenstein (1969) that firms produce inside production frontiers and there are a number of market and production reasons why they may delay innovation acceptance. The vintages model is a special case: if the age of existing capital equipment is normally distributed then the rate of capital innovations may be normally distributed too.

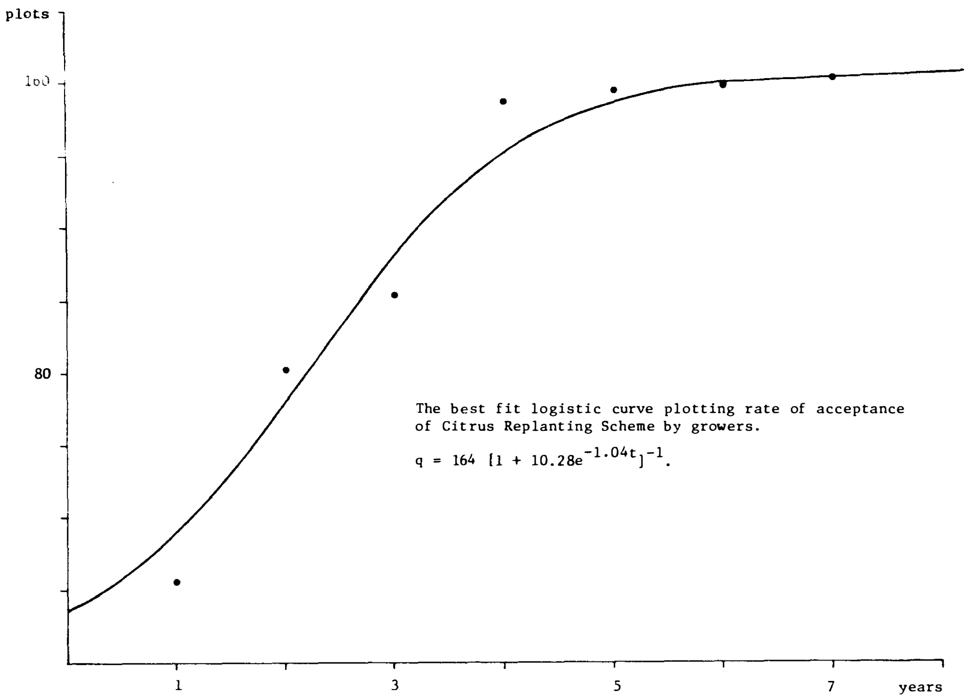

Fig. 17. Logistic acceptance curve

Source: Table 19.

Atiuan project records provide an example (see Fig. 17). When a logistic curve is fitted to participation in the Citrus Replanting Scheme, the rate of acceptance parameter is estimated at 1.04. In contrast the average parameter estimated by Griliches (1957) in his study of diffusion of hybrid corn through the USA was only 0.54. This shows diffusion was much faster through the Atiuan community.

On an island as small as Atiu, information about the Citrus Replanting Scheme was common knowledge. By 1950 everybody knew about the new improved orange trees growing on nearby Rarotonga. But no one volunteered to introduce them on Atiu. Eventually in 1951 the government planted out eight demonstration plots on the private lands of some of the more influential farmers. This encouraged another sixteen bolder growers to plant citrus trees later that year. This was the impetus that the rest needed: most growers joined the scheme over the next three years. From 1954 to 1958 a few more laggards joined in.

Over the next twenty years Atiuans displayed the same tightly interdependent approach to new projects. On average it took only four years for those interested in a new crop to decide to adopt it. Contrast this with the record of the

Gusii in Kenya (Garst 1974). Faced from 1941 with six similar profitable new crops, this widely spread and loosely knit community took over sixteen years on average to adopt each crop.

It is clear from this that Atiuans place a relatively high value on company in new economic ventures. Work done with friends and neighbours is much less onerous. Income earned and consumed with the extended household or occasionally with the tribe is more pleasurable. In addition the involvement of community leaders and respected growers gives people more confidence.

Communal interdependence and individual decisions

Consider a community where there is strong social interdependence; how does this affect the decisions of a grower faced with a new crop? This section builds a model of individual participation where an explanatory variable is some measure of the proportion of other participating growers in the community, weighted by how involved they are and how important and reliable the grower believes them to be.

The case is investigated where the company of others in a new project is valued for its own sake, as well as for the cross effects it has on other elements of utility. People enjoy company, but at a diminishing marginal rate. Further, income earned communally is more enjoyable, and communal work is less distasteful than usual. There is also the case, especially in technologically-simple economies, where group work is physically easier; again company helps production, but at a decreasing rate.[3]

If a new crop is introduced, offering riskless known returns in one period, it has been established that a grower will apply labour up to the point where its marginal cost in terms of his utility equals the marginal revenue product of the crop. The project looks attractive but not many people are growing it: so the grower cautiously plants a little by

[3] A communal work party rebuilding a village meeting house provides an example. The job appears to go faster when everyone is working; the reward is the approval of all the villagers; and the occasion provides an enjoyable outing in its own right. Finally, when it comes to raising heavy materials without mechanical aids, many men are necessary.

himself. Later other growers decide to join in. Decision making is socially interdependent. How will these new participants affect the grower's initial decision?

If it is assumed there is no substitution between projects, then the grower will work harder and produce more of the crop because the new participants have made extra income more desirable and extra labour less distasteful, as well as making production easier (although it is possible that with a highly inelastic labour supply curve he might get saturated with extra income). If there are no physical economies of communality he will always work harder and produce more, in proportion to the size of the marginal revenue product.

It can also be seen that in a project with many people involved, a majority planter (that is, by definition, one who likes to conform to the most common planting patterns) will work relatively harder than the others. These two results are not surprising. Nevertheless, they are crucial in project administration, and are rarely fully exploited.

Atiuan growers are gregarious, so added company should increase their participation. This is commonly observed in Atiuan cropping. Consider the export of *taro*. In the mid-1960s a few of the younger innovative growers saw the opportunities for earning money by sending their surplus *taro* to be sold on the Rarotonga market. They earned reasonable returns for a few years and some early adopter growers followed their example. But most Atiuans would not join in: there was something in the new practice of selling a subsistence crop to fellow Cook Islanders that disturbed them. Then in 1969-70 several respected influential community leaders took up the idea: a senior *akaere*, a *mataiapo*, the chairman of the Island Council, the chief agricultural officer, a deacon, a grower returned from overseas, and later the chief administrative officer and the family of one of the *ariki*. Quite suddenly the practice became respectable. In the next two years nearly half Atiuan farmers began to export their *taro* too. It had only needed the acceptance of key people to induce the majority to join a profitable venture.

The hypothesis that company is important in encouraging gregarious growers to join a project may be statistically tested. A suggested measure of an individual grower's perception of the value of company in a project (C) is the relative effort put into that project by every other participant

Table 48

Effect of communal and other parameters

$(y^*, \ell^* = \beta_0 + \beta_1 C + \beta_2 P + \beta_3 + \beta_4 \ell_m + \beta_5 \sigma^2)$

	β_0	β_1	β_2	β_3	β_4	β_5	
y_{55-59}	-425.6	40,479.2***	6.7**	85.7**	5.4	-8755.4**	.77
(n = 19)		(4.31)	(2.35)	(1.90)	(0.12)	(1.92)	
y_{60-64}	-420.6	5,021.9	4.3**	-21.7	231.0*	941.2	.84
(n = 20)		(0.44)	(2.18)	(0.42)	(1.46)	(0.15)	
y_{65-68}	-3,740.1	51,488.6	10.6***	82.3*	6.8	-15873.0	.78
(n = 24)		(1.18)	(2.61)	(1.40)	(0.20)	(2.70)	
y_{70-71}	-184.1	12,070.4***	1.3	19.6***	22.9*	-1027.9	.96
(n = 16)		(5.94)	(1.18)	(8.58)	(1.57)	(1.15)	
y_{72-73}	-768.8	14,627.2**	3.3	42.2***	38.8	-702.2	.93
(n = 18)		(2.46)	(0.79)	(7.68)	(1.26)	(0.32)	
y_{74}	-115.1	8,969.6*	-10.9	60.5***	35.3	-2740.8	.98
(n = 10)		(2.03)	(1.12)	(8.98)	(0.93)	(1.02)	
ℓ_{74}	15.9	296.4**	-0.54**	1.6***	0.28	-95.8	.99
(n = 10)		(2.65)	(2.18)	(8.81)	(0.28)	(1.28)	

weighted by the subjective value the grower places on each. To measure this the simplifying assumption that each grower regards all other growers similarly is made; the relative labour efforts of the community on a project are approximated by the number involved in that project at a time as a proportion of the number involved in all projects.[4]

Now individual participation in a project is regressed on the level of community participation (C), as well as on the other previously discussed technical features: the project's profitability (P), timing (α), labour requirements (ℓ_m), and riskiness (σ^2).[5] The same data base is used. Results are shown in Table 48. The variables seem to provide a good explanation of project involvement. As expected, the coefficient of community participation is always strongly positive and highly significant. On this evidence the hypothesis is not rejected. Indeed the interest of other growers seems to be the major influence on an indecisive grower.

It is also likely that a 'majority' planter will work relatively harder than others on a popular project. On Atiu this is the man who is happiest doing as the others do: joining in the communal work group, planting the common subsistence crops, joining in the popular projects, and drinking in the bush beer schools with his friends. This is the role exemplified by Toru, the typecast majority adopter of Chapter 5. He participated keenly in the most popular project, the Citrus Replanting Scheme, looking after three plots. He also planted coffee, but like most growers did not bother looking after his crop. Today he has joined the Pineapple Incorporation along with many of his friends, and he enjoys the communal work organization; he spends longer hours there than he ever did on his project crops.

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[4] Thus C is easily calculated by the data in Part I. An underlying idea is that someone joining a new project will probably be less interested in his old ones.

[5] The simultaneity problem inherent in this test function should be noted. Put simply, the model says each person's labour effort depends partly on their conception of the value of company in the project. But this company depends by definition on the relative labour effort of the other growers involved. We assume this chicken and egg problem is not too disturbing.

Chapter 11

Project administration

The role of government

The last four chapters have analysed the effects of project design on a community and have found that risky long-term decisions which require learning are common, and communal pressure on an individual is important. So far it has been assumed these projects have been available on the open market for a grower to assess on his own initiative. In practice it is usual for an administration to introduce an aid project and play an active role influencing grower participation decisions.

For a variety of rational private reasons a grower may refuse to grow a new project crop. Then the government can step in to make it more attractive.[1] The government should do this if the public interests of the community diverge from the private ones. For example, growers may be more cautious, more short-sighted, more ignorant and less individualistic than is good for the community as a whole. Thus the government can identify a particular project characteristic and artificially manipulate it. Many objectives and policies are possible. In this chapter four roles of government, each corresponding to a previous chapter, are investigated: it can act as insurer cushioning the impact of risk, it can act as banker providing credit to help investment, it can act as teacher providing information to cope with new technologies, it can act as co-ordinator inducing people to participate together for their mutual benefit.

The potential need for such action is seen from the vigorous growth of public and private insurance, banking and education institutions and unions in western countries. Whether these roles are best assumed by central or local

[1] A government is here defined as a body administering a project in a community's public interest.

government or private enterprise depends on the economic and political culture of the particular community. In a less developed country a public body is more likely to show the economic tolerance required in a learning situation. The danger is that a government institution can also become excessively paternal, stifling local initiative, and ultimately alienating growers from their own crops.

It is nothing new for a central authority to assume these roles: chiefly classes dealt with similar problems in pre-European times, especially in areas where there was a potential conflict between public and private interests (for example small island communities). Firth (1965) reported that in Tikopia chiefs filled all these roles: by collecting produce as tribute and redistributing it to those who needed it because of misfortune they insured against localized risk. By using their right to prohibit immediate consumption of certain crops they encouraged investment for the future; furthermore, they controlled most of the capital equipment. Chiefs and their priests were holders and disseminators of the stock of agricultural knowledge accumulated over generations. Above all, chiefs co-ordinated economic activity, calling out members for agricultural work, war, or feasts, for the communal good.

The following four sections investigate in detail the effect of government participation in project introduction. Each section builds a government sector on to the non-government models developed in the preceding chapters.

<u>Government as insurer sharing risk</u>

A government has the resources to make risky projects more palatable to small producers. And there are reasons why it may wish to do so at some cost to itself. Low-income growers are very vulnerable to risk, but it may be in the community interest that they should nevertheless attempt some risky projects: the society's risk premium is usually less than the private grower's. In most less developed countries there are few western-type institutions to protect against risk: insurance companies, and stock and station agencies are rare; banks will not lend to small producers and there is no way they can diversify their portfolios on other capital markets. Instead farmers rely closely on ties of kin and on informal institutions like money-lenders and sharecropping. Stiglitz (1974) argues this is a major role of sharecropping: the richer and less risk-prone landlord shares the variations in yields by contracting for a fixed share of those yields instead of a fixed land rent.

Government-sponsored insurance occurs in different forms in many project packages; one scheme will be analysed in detail. Consider a new crop requiring labour for cultivation, and also some other traded input, say fertilizer (or land in a sharecropping arrangement). The grower must decide how hard to work and how much fertilizer to apply. But in common with many project crops, yields are highly sensitive to climatic disturbances and price fluctuations. Then, as in the risk model of Chapter 7, the grower will be most satisfied by working and applying fertilizer to the crop until their respective factor prices equal the resulting marginal revenue product again discounted by a measure of relative risk aversion; this implies less fertilizer and less labour is used than for a non-risk crop.

In an effort to overcome this distaste for risk the government decides to handle all fertilizer sales. Instead of requiring exact payment for fertilizer bought each year, they require the grower to pay back some share of his crop proceeds, calculated so that he will just pay for the input in an average year. This is an actuarially neutral fixed rate payback scheme. The advantage of this scheme is that it evens out the grower's net return to labour. In a good year when he can afford to, he pays more for his fertilizer than he would on the open market; in a bad year he pays less. Unless the government collects a premium to cover operating expenses, or allows itself to absorb input price increases, the grower's fertilizer bill should average out at the market level over a series of years. This effectively reduces the felt disturbances from the variability of total returns to the small variability of net returns. Figure 18 demonstrates this for the simple case of constant factor costs. The net revenue is the same for both cases but less variable in the second. The grower's risk premium is less with the government scheme.

This question may also be approached algebraically. We assume that the grower buys fertilizer (at a constant price) from the government, paying in return that fixed share of crop proceeds which would be expected to cover input costs in an average year.[2] The grower's problem then reduces to

[2] In practice this repayment ratio will vary between growers because it differs for each input combination. This is

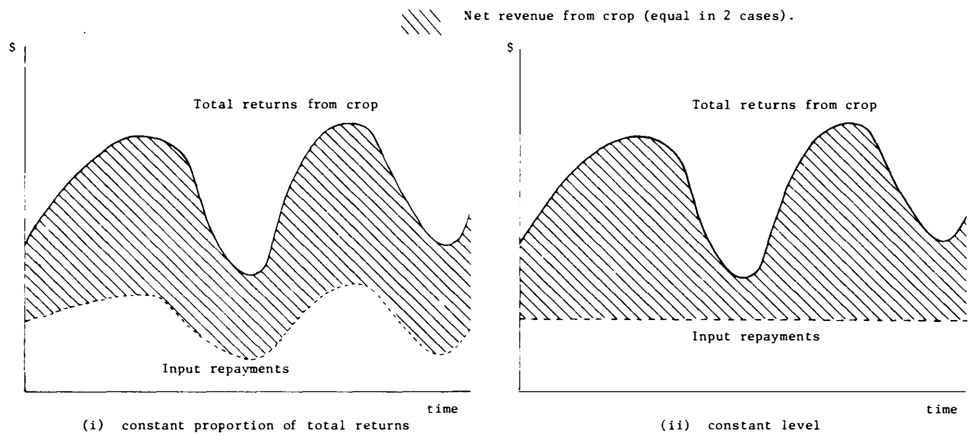

Fig. 18. Effect of insurance scheme

Note: Consider risky production with constant input requirements.
Net revenue in (i) is less variable than in (ii).

maximizing his expected satisfaction from managing a crop which is subject to variability in *net* proceeds rather than *gross* proceeds. He should work and also apply fertilizer until the marginal real cost of each factor equals its marginal revenue product, discounted by his aversion to the risk in net (not total) proceeds. Consequently he will work harder and use more fertilizer to produce more ouput than without the insurance scheme. The magnitude of the increase in output will depend on how large a part fertilizer costs

2 (Continued)
equivalent to the crop share that has to be stipulated as part of the decision problem faced by landowner and sharecropper in signing a contract (Stiglitz 1974). We assume that growers do not vary much in their input allocations and so the ratio set by the government for the average response is an appropriate one.

are of total proceeds. If the fertilizer prices fluctuate too, then the cushioning effects of the scheme are even more pronounced.

Such an arrangement is in practice in Atiu: the Citrus Replanting Scheme offers growers a private account with the government to which fertilizer, spray and tractor input costs are debited. These are paid for by deduction of a fixed proportion of crop yields until the accumulated debt is paid off. Initially three-quarters of crop revenue was deducted for this, later decreased to two-thirds, and then one-half by 1963. Given the very poor crop yields achieved this has been insufficient to pay off most debts. In retrospect the average repayment rate should have been higher for the scheme to be self-supporting.

Some idea of the reduction in risk obtained may be had by considering a typical orange plot, for example that belonging to Toru, the majority adopter (and typical planter) of Chapter 5. Though exaggerated by unrecorded variation in labour and other inputs, the coefficient of variation in net revenue from 1952 to 1974 was 1.1, considerably less than a coefficient of 5.2 had he produced the same amount outside the scheme.

It is impossible to quantify the effect on grower participation caused by this risk reduction. Growers questioned did not consider growing oranges under the Citrus Replanting Scheme to be a risky venture. Most of them worked as it harder than they did on the truly high risk crops like coffee and peanuts. A similar but minor scheme used to operate for tomatoes: growers were levied 4 pence per case exported to cover fertilizer costs. This was inadequate to cushion the severe uncertainty caused by having to transport a perishable crop with irregular shipping.

There are more direct ways of dealing with price fluctuations. Price stabilization schemes may set minimum or maximum levels for produce prices which they may not exceed. This reduces the known variance. Hence risk averters can be expected to produce more. Such schemes require strong financial backing and frequently face administrative problems.

The government might be tempted to side-step risk completely by offering a grower the option of working for a fixed wage instead of on his own crops. A similar situation with a similar result occurs when the government (or large entrepreneur) hires the lands of a grower at a fixed rental, and the grower may work on them at a fixed wage rate. A risk averse grower may be induced to hire out more land and work more for wages than he would otherwise. But as Sen (1975) points out, labour working for wages is qualitatively different and in many cultures less desirable than working for oneself.

Atiuans appear to consider this type of work prestigious rather than inferior, however. The Pineapple Incorporation rents all its lands from landowners who then have the right to work on the crop for a wage. This type of work has proved popular: most households have a member who works on the pineapples for perhaps 20 hours per week and spends the rest of the time growing his own crops.

Government as banker sharing credit

A second characteristic of project crops is that they often require considerable effort and expense before they bear fruits (Chapter 8). This involves the grower in an investment problem: whether or not to work now and forego present for future consumption. A government has the resources to provide credit to such growers allowing them to reallocate their consumption over time.

Why should a government wish to do this? Malinvaud (1972:244) writes:

> In actual societies it seems to be common that social choices deviate from consumer [and producer] preferences in the assessment of the relevant importance of future needs with respect to present needs. It is frequently held that individual choices contain too marked a preference for present consumption and that it is necessary to bring about a larger volume of savings than appears spontaneously. Public saving and legal arrangements such as compulsory pension schemes allow this objective to be realised.[3]

[3] With this in mind, Allais defined an optimum where individual preferences would be retained for all choices except intertemporal ones.

Many small producers in under-developed countries do not have the resources to postpone immediate consumption for a high yielding but slow maturing crop; hence their low private rates of time preference are quite rational.

Consider a new project tree crop that promises good returns, but will take several years before it bears any fruit, and even longer before it is at full yield. Again it requires labour and some traded input like fertilizer for best growth, especially during the crucial infant stage. How is the grower to provide these? Indigenous arrangements such as kinship borrowing or private dealers lending at extraordinary rates have evolved to deal with the limited seasonal bridging finance problem of traditional crops. But these have proved inadequate for long gestation project crops.

If there is no capital market available at all, then the grower will only apply fertilizer to the crop until the sum of future flows of discounted utility from the extra yields induced by the extra fertilizer equals the input price. This is likely to imply very low or zero fertilizer inputs, for it will make no difference to income in the immediate (non-mature) future and the grower's low rate of time preference means he is not interested in looking further to the future. Similarly, his labour input will be small initially because returns from the crop are low, owing to its natural immaturity and its lack of fertilizer.

This is one reason why the crops industry never succeeded on Atiu. Serious copra-making required new trees. Coconut palms do not yield nuts for ten years. The administration suggested planting trees in the 1960s, and set up several fertilizer demonstration plots on private lands. But they offered no lending scheme. Growers often planted a few nuts and left them to be suffocated by weeds or to grow into low-yielding palms, but they were not prepared to invest time and money in proper tree management.

If commercial capital markets exist, their poorly developed structure and the risks of lending without security probably limit loans to short-term with penalty rates of interest. Some governments have set up rural banks specifically to offer low income growers low interest long-term loans for project participation. By financing input bills a bank can allow the grower to reallocate his crop returns into a more desirable pattern over time. This makes a slow maturing tree crop where initial net returns are negative more attractive to a grower with a low rate of time preference. As a result he will care for his trees better in the critical early stages, and they will bear more fruit later.

One particular type of government loan scheme is investigated here. The administration agrees to market a new project tree crop and handle fertilizer sales. When growers buy fertilizer they do not pay immediately but run a debit account. After some years the fruit begins to mature and is sold; then the administration automatically deducts a fixed share of the proceeds. This share is predetermined to pay off the costs of fertilizer with interest over some time period, for example over the lifetime of the project.[4]

Then the grower will work until the current marginal disutility of extra labour equals the sum of discounted flows of future marginal utility derived from the share of extra income that he receives from working harder plus the part of his total fertilizer bill that he can pay off by doing so. This net income is always positive. He will keep on applying fertilizer until the sum of discounted flows of future marginal utility derived from the share of extra income that he receives from a better fertilizer crop plus the part of his total bill that he can pay off from this better crop equals the extra costs involved. These costs are the discounted future marginal utility forgone through having to pay back part of the extra fertilizer cost each period. As this repayment is related to income, it will not stop the grower applying fertilizer in early years when the tree is not yielding.

Figure 19 illustrates the potential advantage of such a scheme. Assuming a logistic growth curve and constant inputs, then, if he cannot borrow, a grower must accept negative early net income growing slowly to highly positive returns. If he can pay back debts as a proportion of returns his initial net income will be small but positive, growing to a lower peak than before. This second stream of returns is probably preferable to him.

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[4] Like the insurance scheme, this payback rate is uniquely determined by each grower's long-term factor allocation decisions. We assume these are similar among growers, hence the single rate set by the government for all.

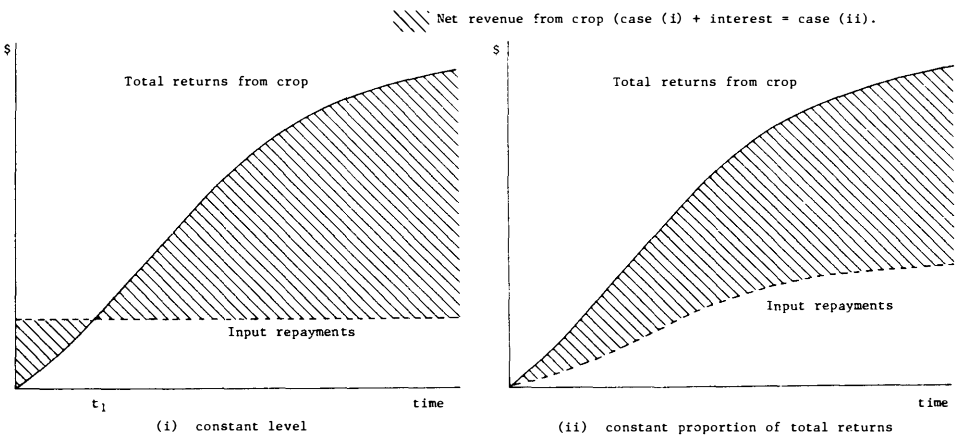

Fig. 19. Effect of repayment scheme

Note: Consider increasing output from constant output requirements.
Net revenue in (i) is negative until t_p then highly positive, while in (ii) it is more gradually increasing.

How attractive such a scheme is to a grower over other types of credit depends on the rate of interest, the likely pattern of crop yields, and the grower's time preference scheme. If it is well designed, it should offer a stream of returns attractive to growers planting a particular crop.

There are, however, some problems with this dual purpose support scheme. It does not offer the grower the optimal degree of intervention. The most appropriate community pay-back rate for insurance is not necessarily the same as for credit. In general the payback mechanism allows a grower less flexibility than does a commercial capital market.[5]

[5] Another practical problem is that in determining a payback rate the administration in effect is reaching a long-term

The main advantage of the scheme is its simplicity of operation; it uses normal government records, it helps extension work, it is easily explained to farmers, it is self-financing and relatively riskless, and it is easily administered. On Atiu a fixed share dual purpose payback arrangement has operated for the Citrus Replanting Scheme since its inception. It required only two clerks to administer it.

The administration had problems determining the appropriate rate of payback: initially set at three-quarters, it was progressively reduced, an admission that grower time preferences were lower than anticipated. At this rate repayments barely covered increasing input costs. By 1974 only 20 per cent of growers had paid off their plots partly because growers realized that they could easily break their contracts: abandoned plots are taken over by the administration and worked at the latter's expense to pay off the debt.

However, despite its shortcomings and miscalculations, the scheme has produced a long-term grower commitment not seen in the other project crops. For most growers the scheme yielded a more preferable stream of net returns from citrus than would otherwise have been received.

The other long-term crop was coffee: to finance early work and materials the government offered general loans at 5 per cent interest for three years for approved growers. Only 40 per cent of coffee producers used these loans which were too short to cover the gestation period of the investment and required considerably more grower initiative than the Citrus Scheme did: as a result fewer than 20 per cent of producers ever marketed their crop.

Government as teacher, sharing knowledge

Chapter 9 established how important knowledge about a new technical process is for optimal decision-making. Peasant cultivators do not like making decisions under ignorance; they cannot afford to - the costs of errors are too high.

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5 (Continued)
agreement with each grower that he will produce a predetermined quantity of this crop for a period. Since the latter may only be learning about a new technique, he is in no position to sign such a contract. Evidence comes from the number of schemes where growers never pay off their debts.

Yet they also do not have the resources to experiment and learn for themselves; furthermore, typically in less developed countries, barriers of caste, education, language and location divide peasants from agricultural experts. While they may be receptive to properly presented new techniques, they may also find it difficult to obtain information about them.

The government, as project administrator, possesses this information or can gather it from experts. If its agricultural extension force is effective, it can transmit it to planters.

Why should the government wish to share knowledge? Shell (1966) points out that information is both a public and a common good, for it can be used by any number of units, and it is durable with low costs of transmission. Arrow (1962b) constructs a model which shows that a community operating under perfect competition will achieve suboptimal accumulation, because it is an indivisible uncertain public good. This difference between the private and social optimum levels of investment in learning provides the classic case for government intervention.

How can a government help ease learning pains when introducing a new project? As in Chapter 9, learning about some aspect of production is interpreted as implying some initial viewpoint and progressively revising it in the light of a series of new observations over time (or space), so that expected probabilities of outcomes become progressively less subjective. The government can help this process in several ways.

Faced by a brand new crop, growers derive their initial expectations from government advice on its performance. A technology imported from overseas may perform differently in a new environment, making this advice unreliable. In experimentation the greatest rate of accumulation of knowledge is expected from the first few trials. The government can help the production of knowledge by bearing the costs of these few most risky experiments itself and then transmitting the results. For example it may be worth its while for a government introducing a new tree crop to set up nursery trials and withhold crop seedlings for a few years until the most serious faults (or advantages) of the crop are known. This may reduce the number of growers who try out new crops and after a period find themselves 'locked in' to a second best variety.

In learning by trials growers must continually revise their earlier estimates by some amount after each new observation. A reactionary grower is loath to change his ideas; a very impulsive grower throws previous experiences away in favour of the latest. Somewhere between these two extremes is a socially optimum rate of revision. The government can encourage growers towards this. One way is to point out the varying reliability of different trials: confirmed results of an experimental station or a good farmer can be trusted more than mere rumour. Trials carried out in a climatically unusual year should be treated with caution.

Furthermore, learners need a good memory for information they have already accumulated and access to other relevant experiences happening elsewhere concurrently. Arrow (1969) claims that a major problem in innovation diffusion is the capacity of communication channels: how good growers are at hearing about and remembering relevant information. The government can help this by keeping records of past trials and publicizing results of experiments occurring in other communities.

Other government schemes aim to transmit knowledge automatically. An input subsidy scheme that would normally lead to inefficient resource allocation may be justified, because growers ignorant or suspicious of its effects use less than is socially desirable. For example, planters may refuse to use enough fertilizer on young trees because they do not understand the potential productivity gains later on.

Hirschman (1967) believes that most projects meet teething problems but these may be solved by experimenting if only participants have the self-confidence to do so. He suggests that a deliberate technique of project administrators should be to pretend that the project is straightforward and exaggerate its benefits. If Hirschman is wrong and grower reluctance really means their dislike of risk and ignorance, then he is only confusing their rational decisions. Furthermore, growers may assume that other projects have been similarly exaggerated.

The dangers of this practice are clear on Atiu. There the administration exaggerated the benefits to be had from several of the projects, and minimized the costs. As a result they lost grower confidence. For example, a 1950 report on the Citrus Replanting Scheme (which presumably contains the same information given to growers in public meetings on Atiu in 1949-50) advertises the likely yield of a 15-year-old plot of 45 trees as 16,000 lb netting a return of $310. In fact the best plot on Atiu only reached about 11,000 lb and because costs were so much higher than expected, has netted only about $115 annually (in 1950 prices). The average plot on Atiu yielded only 8,000 lb and $75. Such high predictions should never have been given: evidence of well managed orange orange plots in other countries at that time suggested Atiuan yields would be much lower.[6] Furthermore, no suggestion was given of the likely fluctuations in returns. This sad story of unfulfilled expectations is seen in Fig. 8. A few experiences like this soon create a community of growers who mistrust administrative claims and steer clear of subsequent projects.

In some of these subsequent projects the Atiu administration has been more successful in passing on information. They operate an agricultural nursery. In preparation for the forestry project, 1,000 trees of many different varieties were planted out here for several years before the albizzia type was selected. This shortened the grower's learning process.

Minor changes in recommended project cultivation are passed on to agricultural officers at instruction courses in Rarotonga, and subsequently reach growers at infrequent field days. Radio Cook Islands carries an agricultural program and the government newspaper runs an agricultural column aimed at improving crop technique. Atiuan growers are well aware of experiments in progress on Atiu, but do not take much notice of developments on other islands.

More basic developments in crop cultivation are passed on by the government, but information transmission is slow. For example, among improved techniques for growing oranges in New Zealand in the 1960s were the use of trifoliata rootstock, denser plantings and mechanical pruning, to obtain small trees and high per hectare yields. These were recommended to the Cook Islands Agriculture Department (see Fletcher (1972). By 1975 the Rarotonga nursery had begun to grow

[6] For example West and Howard (1938) reported yields of around 13,000 lb for similar sized plots of similar varieties of orange trees in Australia.

seedlings on new rootstock. It will be several more years before such practices are in use on Atiu.

Government as co-ordinator

As observed in Chapter 10 many growers in closed communities will not join in a project unless other local growers are involved too. They enjoy doing things together; and it may be safer and easier to work this way. If enough people feel like this a new potentially profitable crop may not be accepted: each grower is unwilling to grow it by himself.

The government can manipulate this private reluctance for social benefit. By artificially encouraging a few growers into planting a crop they may be able to induce many others to follow in a communal bandwagon effect. Typically, they may offer free plots to a selected group of respected community leaders (rather than to the technically best growers). The participation of these influential people is a drawcard for other more dependent growers to follow. The justification for doing this is again the divergence of private from social ends.

Co-ordination of group activity is nothing new. Organizing many men to work together in a communal task for their mutual benefit was always a major role of chiefs in most societies. More formalized institutions fill this role in the western world: unions and farmers' federations group people together in a common interest, whether it be lobbying or marketing their produce. In an under-developed country this may be the role of government.

The highly inter-dependent community of Atiu illustrates this. The Citrus Replanting Scheme initially met with strong grower resistance. The administration concentrated on convincing community leaders of its benefits. It planted out eight demonstration plots on the lands of respected older growers in one village. By the end of the next year all the *ariki* families and many other senior title-holders had planted orange plots and most of the rest of the community followed suit within two years.

To introduce the vegetable scheme in 1974, a Rarotongan agricultural officer offered a dozen of the best growers free seed and advice, hoping there would be demonstration effects on others. But these dozen growers, through technically knowledgeable, lacked the prestige and standing to convince others. Today only a few teachers and full-time casual growers plant vegetables. It seems this technique of induced communal action was understood better by more traditional organizations like the tribe and the church.

Table 49

Government participation in Atiuan Projects

Project		Government role		Dummy variable
I	Citrus Replanting Scheme	I,B,T,C		1
II	Forestry	-		0
III	Tomatoes	(I, B	1955-60	1
		(-	1961-74	0
IV	Peanuts	(I, B	1964 only	1
		(-	1957-74	0
V	Taro	-		0
VI	Coffee	(-	1965-66	0
		(I,B,T	1967-74	1
VII	Citrus Extension	I, B, T		1
VIII	Private pineapples	-		0
IX	Vegetables	T, C		1
X	Pineapple Incorporation	Employer		2

Key: I = Government insurance

B = Banking

T = Teaching

C = Co-ordination

In general, the administration on Atiu has helped interpret the relatively newly monetized cash cropping system for the subsistence grower. They have done this by laying down rules for the distribution of money proceeds from the produce. This is a complex problem owing to the nature of Atiuan communal work habits and joint land ownership. They have also acted as a quality controller, regulating growers

Table 50

Effect of government and other parameters

$(y^*, \ell^* = \beta 0 + \beta_1 G + \beta_2 C + \beta_3 P + \beta_4 \alpha + \beta_5 \ell m + \beta_6 \sigma^2)$

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	R^2
y_{55-59}	-23,516.7	18,906.1	16,758.5***	27.4***	-1276.5***	-1716.9***	115,795.8***	.95
(n = 19)		(6.5)	(2.86)	(7.83)	(6.07)	(6.48)	(6.02)	
y_{60-64}	- 386.5	- 524.1	8,973.5	4.3**	- 20.7	219.9	769.6	.84
(n = 20)		(0.07)	(0.16)	(2.16)	(0.37)	(0.96)	(0.11)	
y_{65-69}	3,559.0	1,851.7	57,104.5	9.2**	78.8	- 115.2	-14,928.7**	.78
(n = 24)		(0.60)	(1.25)	(1.90)	(1.31)	(0.26)	(2.41)	
y_{70-71}	- 157.4	218.7	11,015.7***	1.4	17.8***	18.9	- 1,023.5	.96
(n = 16)		(0.59)	(3.98)	(1.23)	(4.69)	(1.14)	(1.11)	
y_{72-73}	- 646.8	1,349.0**	5,495.1	6.5*	32.8***	24.9	- 1,034.2	.94
(n = 18)		(1.81)	(0.74)	(1.56)	(4.52)	(0.86)	(0.51)	
y_{74}	31.4	1,366.4*	3,237.6	-4.7	52.9***	18.8	- 3,280.4	.99
(n = 10)		(1.61)	(0.63)	(0.52)	(7.18)	(0.56)	(1.42)	
ℓ_{74}	6.0	33.1*	235.6**	-0.6**	1.44***	0.4	- 83.5	.99
(n = 10)		(1.68)	(2.37)	(2.91)	(8.89)	(0.51)	(1.34)	

who have tried to take advantage of the impersonal marketing system where consumer and producers are isolated from each other.

The overall aim of this intervention is to increase grower participation by reconciling private and social ends. The generalized hypothesis is now tested for Atiu: that government intervention in a project induces more growers to join than would otherwise do so. Because the government applies several schemes in different projects, its intervention is denoted by a dummy explanatory variable. This takes on a zero value for projects without active government support; a value of one for projects with a public insurance, credit, information or co-ordination scheme; and a value of two for projects where the government assumes total managerial responsibility for production and employs Atiuan growers on wages only. Table 49 documents the level of government intervention in each project.

The government intervenes in crops that are unsuitable because of their risk, their gestation period, and their lack of communal participation. It is logical to assume all these are explanatory variables of grower interest too. Table 50 records the result of an extended multiple linear regression. The presence of a government variable improves the goodness of fit; in every case but one it has a positive influence, but it is significant only in recent years. There may be some multicollinearity between government involvement and the other explanatory variables. Indeed if the government is consistent then there should be, for administrative action is specifically aimed at these other project characteristics. Overall, statistical evidence and observation are both convincing that an active government has the power to involve more growers in a project on Atiu.

Part 3
Conclusions and policy implications

Chapter 12

Analysis, control and evaluation of aid projects with variable labour response

The theoretical chapters of this monograph point out some of the more important issues that a producer weighing up a new project has to consider. This producer has been represented as aiming to maximize his level of utility in the face of a given production opportunity introduced from outside.

In the simplest one-input, static, riskless, full information case this can be represented by Fig. 20. For a long time a grower has worked at point e^1. Now an alternataive attractive new process p^2 is offered to him. How hard should he work on it? Chapter 6 shows that he will do best for himself at e^2, where the increasing marginal cost of labour on new higher utility curve u^2 equals the decreasing marginal revenue product of labour on new function p^2; it also gives some idea of the relative position of this equilibrium for different cultures and technologies.

Subsequent chapters relax some of the assumptions about the production process and the community's attitude to it. To simplify the results: Chapter 7 shows how risk averters will work less on risky projects. Chapter 8 shows how increased single-period productivity and capacity yields, and decreased maintenance labour requirements in a project will generally increase participation; also relatively far-sighted people will work relatively more on slow maturing, slow responding projects. Chapter 9 shows how growers disliking ignorance will work more on projects they are familiar with. Chapter 10 shows how conformist growers will seek out the most popular projects. Finally Chapter 11 shows how an active government can manipulate a project to cushion a producer from undesirable risk, waiting, ignorance or solitude. These results are summarized in Table 51.

The value of this analysis as an explanation of decision making depends critically on the assumptions made. As noted in the introduction, a number of assumptions simplify the

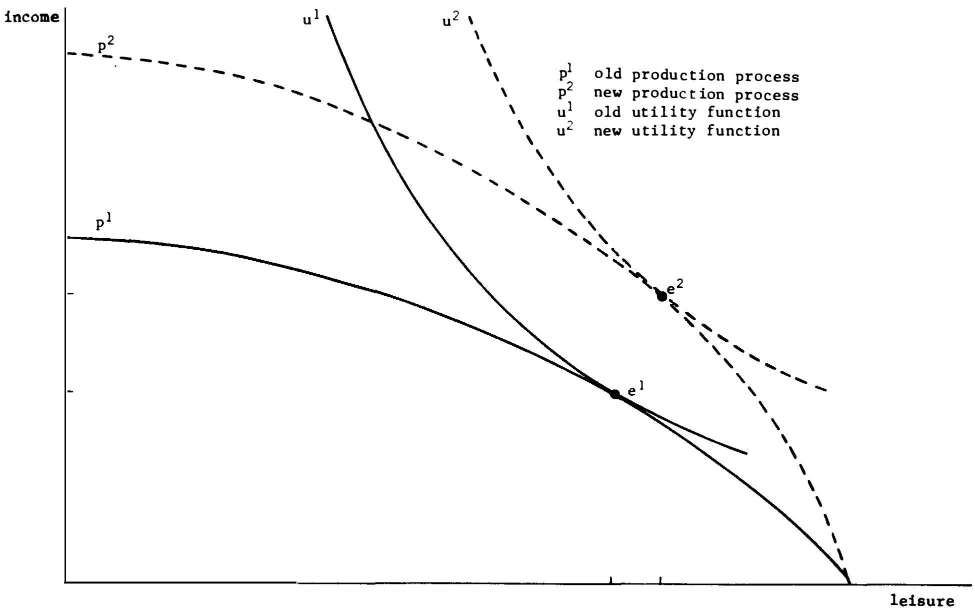

Fig. 20. Optimal participation in crops

problem into an established pattern in order to use established results. The problem lies in reinterpreting these results in a more realistic setting.

The theoretical assumptions are basic: that attitudes may be represented by a neoclassical utility function, technologies by a production function, and rational behaviour by their interaction. It has also been specifically assumed that growers regard participation in each project independently of the other projects. This may be the worst assumption for it is certainly not realistic in general. In the case of Atiu it probably caused little bias in results, because growers seemed to concentrate on one project at a time.

Most of the chapters initially assume a technology simplified in all but the single characteristic under investigation. Results from this partial analysis are then extended to the generalized case of a technology simultaneously complex in a number of ways. It is assumed that no unexpected cross effects arise from, say, risky technology and fast maturing technology.

Table 51

Summary of project effects on participation

Decision	Project characteristics		Attitude of recipients	participation
Ch 7 Risk	Variance in returns	[σ_y^2]	Risk premium	-
Ch 8 Dynamic technologies				
	Productivity	[k]	Utility of income and labour	+
	Capacity yield	[$\bar{q}$]		+
	Maintenance labour	[ℓ_m]		-
	Growth rate	[α]	Rate of time preference	+
	Response	[λ]		+
Ch 9 Knowledge	Information	[A]	Ignorance premium	+
Ch 10 Communal inter-dependence	Company	[C]	Attitude to company	+
Ch 11 Govt participation	Govt role	[G]	All the above	+

The illustrations drawn from Atiu generally appear to support the model hypotheses; but there is a danger (which the reader cannot check) that they may be selective ones.

Partly as a control, partly to learn the statistical extent of explanation, this evidence is supplemented by regression equations. This involves empirical estimates of grower participation and project parameters. Most primary data come from good administration crop records. These are supplemented by my own (empirically less reliable) grower surveys. As a result most primary data are relatively reliable. The parameters of crop variance, project communality, single-period productivity, and maintenance labour are all conceptually difficult or unobservable; therefore their estimates are questionable, though they generally reflect the desired aspects of the projects.

In estimating the equations two assumptions are made: firstly that the relationship between variables is approximately linear; secondly that all growers in the sample possess the characteristics of a typical grower (this is reasonable for Atiu, and is easily relaxed).

The estimates of project parameters appear to provide a good explanation of grower participation. Only a very loose (signed) hypothesis test is applied. However, in view of all the assumptions, a good fit and coefficients of the expected sign are not conclusive evidence of a complete understanding of grower behaviour.

It is found that maintenance labour requirements do not appear to have affected growers as might be expected, and the effect of learning has not been captured very well. But none of the other hypotheses are rejected. It seems reasonable to accept that grower response to this situation does depend on these characteristics in the *direction* hypothesized (for example Atiuans dislike risky projects), but it may not be possible to say anything very useful about the *magnitude* of response.[1]

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[1] This is a familiar problem in microeconomics. For example, forecasts of the effects of a price change on consumer behaviour may be based on theory predicting the direction of movement; but estimates of size of the change are little more than guesses based on past experience.

Thus this analysis offers few direct quantitative implications for the design and evaluation of aid projects with variable labour response. Nevertheless, it does offer a framework for the analysis of the interaction of project and community. With this foundation to build on, the designer is much better equipped to start formulating rules of thumb about project impact. This area of project control is now considered.

Control of projects with variable labour response

Ex ante project design. Envisage the situation where there is a chance to design a project from the beginning. What will be the best type of production process to introduce to a community? In the simple situation of Fig. 17 this problem is how to design p^2 (given any constraints on the resources to be used) in view of a given utility formulation to derive the optimal participation level e^2.[2]

In practice, new aid projects usually arise out of some perceived need and some potential production capability of a community. However, they are rarely designed explicitly to use the latter to meet the former in the best way. The intermediate technology movement was intended to do this (see Schumacher 1974). It works on the generalization that small-scale simple technology based on indigenous materials and design is likely to be more technically viable and more culturally acceptable in a rural developing community than imported western techniques.

It should be possible to refine this principle, and design a project more sensitive to community needs and capabilities.[3] A way to do this is suggested.

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[2]Hirschman (1967) sees an important aim of project aid as changing the recipients' attitudes to work and its rewards through learning by project involvement. He calls this trait-making. This involves shaping p^2 so as to induce u^2 to change its shape too. We are not initially concerned with these long-term demonstration effects (nor with the moral question of the designer's right to impose them). We merely aim to design the best project that fits current tastes. Hirschman calls this trait-making.

[3]We are talking here of crop design, but design of technologies for associated machinery, small industry, etc. follows the same principle.

Step (i): Identify the relevant characteristics of a community that are likely to make a difference to the way people there view a project. (In terms of the simple figure this means identifying the components and shape of u^2). These may be cultural attitudes, historical experiences, social organizations or psychological outlook; they may be as spiritual as religious feeling or as physical as customary body positions.

This is really a job for the community itself, though it may require someone like a social anthropologist to articulate feelings in western terms. This has been done, for example, in Chimbu Province in Papua New Guinea, using 'rural planning workshops' to express local needs (see Howlett *et al.* 1976).

Step (ii): Identify the range of possible new production activities and how they are likely to operate in the particular physical environment. (In terms of the figure this means identifying a range of possible p^2 curves differing in shape.) This is the job of a technologist and requires knowledge of the community setting. It can be done concurrently with step (i).

For example, in the case of a fertilizer project it means gathering information on all the possible different fertilizer packages and the way they might affect output, not in controlled trials in developed countries, but in field production in developing countries. Market information such as costs and supply of the fertilizer is also necessary, and whether it is mined, processed locally or totally imported.

Step (iii): Select and if necessary modify a suitable project to maximize communal welfare subject to any exogenous constraints. This is the job of the economist armed with the information of steps (i) and (ii). (On the figure this means selecting a suitable p^2 to optimize e^2.)

The economist must pick out what he considers the crucial economic characteristics from each of the technical options. For a process such as growing labour-intensive crops these characteristics will be the parameters used in the earlier model. He can then use the knowledge of community attitudes to predict (from an explicit or implicit model) whether growers will find this particular characteristic attractive, unattractive, or irrelevant.

A project may appear most attractive on all counts. More likely the project that performs best on the risk criterion will not perform best on, say, the growth rate criterion. Here a formal model is little use for selecting the best overall characteristic, and the designer may have to rely on experience and rules of thumb.

Frequently a person introducing new types of economic activity has neither the resources, nor time, nor ability, to design it from the beginning specifically for a particular community. He must then select from processes that are already available, picking out small components that may be independently adapted to local conditions. This is a cheap pragmatic approach that is often used. For example, with Atiuan citrus this might mean fertilizing trees with a mixture of locally available lime and seaweed rather than expensive imported fertilizers.

The designer must work within constraints imposed by the government of the recipient country. For example, it may be laid down that a project should be fast-acting to alleviate immediate need: this will prevent a 'learning project'. In a similar way the government may rationally specify a project design fitting in with any number of public policy objectives: communal equality, employment expansion, overseas exchange earning, etc. These requirements constrain the designer's choice, and may eliminate otherwise attractive projects.

How then should a project be designed on Atiu? In step (i) the strong taste Atiuans have for leisure compared with their limited needs for income, their dislike of risk and ignorance, their short time horizons, and the psychological attraction of company, should be identified.

Step (ii) should accumulate information on how a range of tropical cash crops might perform (physically and commercially) in the Atiuan environment. This must take account of the leached soils, the erratic climate, tropical diseases, limited management skills, and isolation from a market. It must include what sort of returns are likely from different inputs, what the likely variance of yields and revenue is, how the crop changes as it grows older, how much Atiuans know about it, and whether there are economies of scale.

Given all this information, step (iii) requires the designer to pick a project that is relatively highly profitable, has low risk, fast growth to maturity, and requires interaction among the community. These were shown to be the most important project characteristics by the tests of Part II. (Careful observation should show the same.) Less vital but still favourable characteristics are a high capacity yield, fast rate of adjustment to inputs, a lot of experience, and probably low maintenance requirements.

The designers of the first project, the Citrus Replanting Scheme in the late 1940s, failed to carry out step (ii) properly: they assumed that oranges would grow in Atiu as they had in temperate countries. The nine subsequent projects gave them plenty of opportunities to learn better. Progress was very slow, but project design did improve.

The Pineapple Incorporation project embodies these improvements: wages of 40 cents per hour (1974) make it relatively profitable by Atiuan standards. Potential returns can be very high for a man prepared to work long hours. A worker is paid fortnightly - a quick and riskless return on labour. If he works particularly hard one fortnight, then his reward is an immediate increase in pay. Little prior knowledge is needed because the men work together in gangs directed by foremen; they enjoy one another's company and they approve of working for a community project. From these characteristics the Pineapple Incorporation might be considered a good project choice. It is certainly the most popular one at present.[4]

Ex poste project administration. Often a project is formulated without reference to the community: it will then need revision. Even if all the designing steps have been carried faithfully through, the project is still unlikely to turn out to be perfect. How can a project that has already been designing be administered in order to induce a better response? In the simple figure, p^2 and u^2 are given; how can knowledge of them be used to manipulate p^2 to raise equilibrium point e^2 on to a higher utility level? This problem differs from that of the previous section by being based on *ex poste* experience of the project in action.

Step (iv): The rules are the same whether project administration is aimed at correcting an imposed project package or finely tuning a specially designed one. The administrator

[4]But the scheme is suffering from severe management problems; this underlines the importance of the next section.

must observe why the project is failing, and this may prove difficult. Then he must use the resources of government to adapt or disguise the undesirable project characteristic so as to suit the community better. He may introduce schemes to insure against risk, provide credit, spread information, co-ordinate action, or compensate for other project shortcomings (see Chapter 11). This way he can change the grower's perception of the project, and make it more attractive.

Again the administrator must act within constraints. Usually the money that may be spent on administration schemes is limited, encouraging self-financing ones. A government may require project administration policy to correct the biases of introduced project design to its own objectives.

For example, the Citrus Replanting Scheme, planned by the New Zealand Government, proved to be poorly designed for Atiuan needs. The efforts of administrators to improve it illustrate their ability to manipulate project design. Based on the experiences of Rarotonga, a repayment scheme was formulated to share risk with the growers and allow them credit. Citricultural techniques were taught through agricultural officers. The project was made more community-based by encouraging communal work groups and competition. Whatever success the Citrus Replanting Scheme eventually enjoyed was due to this administration.

Ex ante project evaluations with variable labour response

The introduction criticized cost-benefit analyses for their unreal assumptions of total grower participation. Is it possible to do any better? In order to carry out an *ex ante* cost-benefit analysis of a project already designed but not yet in use, labour response to it must be predicted. The knowledge of grower participation in earlier similar activities and the results of the model, may be used as a basis for predicting changes in behaviour towards the new project.

In terms of the simple figure, the project evaluator must use his knowledge of the previously observed equilibrium e' (and guess the shape of p' and u') to predict ℓ^2. He can then derive an estimate of y^2 from his knowledge of the new p^2, and carry out traditional cost-benefit analysis based on these.

How can likely labour response be predicted in practice? It is necessary to observe the effects that a similar production process has had in that or a similar community. The distribution of response must be analysed - how many growers were enthusiastic and successful, how many uninterested? Also the timing examined: whether growers worked hard in the early stages or not.

If the new process is very different from the old, the conclusions of Chapters 7-11 might be used to guess at the effect this could have on response. If the studied community is not the one where the project is to take place, cultural differences between them must be allowed for. In this way an estimate of labour response is obtained. If there are many unknowns the estimate may be best represented as a confidence region. In practice, a project evaluator may use his general knowledge and follow these steps implicitly.

Step (ii) above provides some knowledge of the new production process. The range of production levels the labour response will yield may be predicted. Given the necessary price data and administrative costs, a traditional cost-benefit analysis may now be carried out.

This is shown, by a very simple *ex ante* cost-benefit analysis of the Citrus Replanting Scheme. The aim is not to thoroughly analyse the project; rather to show how the administrators of the scheme might have used the information then available to them to predict grower interest and anticipate the project success or failure. No formal evaluation was initially carried out, but information from the original project proposals is used to calculate the rate of return they implicitly expected.[5] The experience of grower involvement in native orange production in the 1930s allows the reaction to a new project to be predicted.

The administration apparently assumed most growers would join the new scheme and work on it as required. In this analysis, the production figures they anticipated in 1946 are used and a flow of costs and returns are calculated over a project life-time of twenty five years. It is assumed there are no administrative costs (the project was meant to be self-financing). Externalities and shadow pricing are not considered. This yields an internal rate of return of 22 per cent, a very reasonable reward for a risky project of this type.

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[5]Derived from 1946 files of the Atiu Administration on the Citrus Replanting Scheme.

But administrators did not allow for a variable labour response, and they did not use realistic production figures. The obvious yardstick to predict likely participation rates was the native orange cultivation. Incomplete records from the 1930s suggest nearly a quarter of households did not export oranges, and the other three-quarters of the population spent varying lengths of time earning money this way. Atiuan labour involvement is approximated by four labour levels. Would one then expect the same response to the Citrus Scheme?

The new activity differed in several important ways from the old one. Chapters 7-11 suggest that the most important technical differences were the increased risk (implying less participation), the increased labour productivity (more participation), the decreased knowledge available (less participation), and the increased government role (more participation). The conclusion is that these differences are so wide, that the best that can be done is to assume a new response similar to the old, then investigate what happens if it varies.

The evaluation may be improved in a second way. The early estimates of production capabilities were clearly exaggerated. Drawing on the (pre-project) results of West & Howard (1938), the technological estimates may be improved. Using these and the labour predictions in the non-stationary production function (equation (4) of Chapter 8), returns and costs may be estimated more realistically.

The results are shown in Table 52. Now the rate of return is negative. Moving the labour estimates over a range of ± 20 per cent makes no difference. This is a much less rosy result than had been expected. If such an evaluation had in fact been carried out, it should have at least meant a re-designing of the scheme. This could have saved some of the $2 million loaned and granted to the scheme in the whole of the Cook Islands, as well as hours of wasted effort and lost confidence among growers. In fact many other things have changed over this 25-year period. However, these pseudo-predictions of labour response and production capabilities have both been roughly borne out. Today this type of evaluation of variable labour response is rarely performed explicitly though sometimes implicit adjustments are made.

The second section of this monograph provides an analysis of grower response, not just to small changes in prices or

Table 52

Ex ante estimates of costs and returns in Citrus Replanting Scheme ($)

	Administrative estimates		Revised estimates	
	(a)	(b)	(c)	(d)
Year	Total returns	Total costs	Total returns	Total costs
1	-	14,120	-	11,623
2	-	5,480	-	4,003
3	-	5,833	-	4,230
4	-	6,123	-	4,313
5	5,400	8,028	2,083	5,452
6	10,800	8,393	2,487	5,897
7	13,500	8,411	2,922	6,222
8	16,200	8,317	3,372	6,441
9	18,900	8,299	3,801	6,709
10	21,600	8,421	4,173	6,762
11	27,000	8,673	4,254	6,812
12	27,000	8,673	4,326	6,858

Note: Administration estimates yield 22 per cent internal rate of return over 25 years; revised estimates yield negative rate.

Sources: (a) and (b) Files of Atiu Administration, 1946.
(c) Generated from production function (4), Chapter 8, using parameter estimates $\bar{q}$ = 12,320, k = .0234, α = 1.0, ℓ_m = 15, γ = 0.25, for 4 labour inputs (0, 20.4, 26.6, and 33.4 days, each for ¼ of Atiu households).
(d) Labour costs and interest charges from (c), other costs as in (a) and (b).
All figures are in 1946 values.

costs as is usually considered by agricultural economists, but to the more fundamental changes in the structure and organization of crop production that are frequently encountered in planning development. This last chapter has shown that there are important implications for the design, administration and evaluation of such projects. But to put these theoretical results into practice does not prove easy: the policy-maker must still rely mainly on experience, rules of thumb, and common sense.

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Alan Bollard is a graduate of the University of Auckland. As an economist with interests in agricultural development and anthropological microeconomics he has studied projects widely through the Pacific. This monograph arises from his PhD thesis. In 1977 he was appointed Assistant Economist with the South Pacific Commission in New Caledonia.