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KEEPING RESEARCH RELEVANT: EXPERIENCES WITH ON-FARM TRIALS IN TONGA*

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1. Introduction

In Tonga a large proportion of the population depend on farming for their livelihoods. The traditional farming system is complex. It is based on family-operated smallholdings, typically of about 3.5 ha. Crop rotations are based on bush fallowing to maintain soil fertility and typically incorporate a wide range of crops. These crops include long-term crops, such as coconuts and other tree crops, medium-term crops, such as bananas and pineapples, and short-term crops, such as root crops and vegetables. Intercropping, sequential cropping and multi-storey cropping are all practised. This system has developed to suit the subsistence and (traditionally limited) cash needs of Tongan rural families.

The objectives of this society are changing in many ways. With the increase in recent years of both population and western influence, there is an increasing need for food and cash. The growth of non-agricultural sectors of the economy (largely fuelled by aid and remittance flows) means that the domestic market for food is growing, creating new opportunities for commercial farm production, while agricultural exports continue to account for the majority of the export income of the country (Sefanaia

* Paper contributed to the 33rd Annual Conference of the Australian Agricultural Economics Society, Lincoln College, New Zealand, February, 1989.

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1988), chiefly in the forms of copra, vanilla, bananas, squash and root crops.

Recent development efforts have been directed at expanding some of these exports, and there have been some successes. However, attempts to intensify agricultural production have not always met with the degree of success hoped for. Nor has the expansion of agricultural production for the domestic market been up to expectations of planners and policy makers. Moreover, there is growing concern about the possible longer term implications of some of the changes that are under way. With the increase in cash cropping has come greater use of chemicals, such as pesticides and mineral fertilisers, more machine cultivation, often including land clearing with damage to, and eventual loss of, trees on farms, while the length of the fallow period and the practice of intercropping are both decreasing. There is an urgent need to obtain more information about these changes and to assess the impacts they are likely to have on the fertility and long-term productivity of the land and hence on the welfare of village people.

During a recent study by the South Pacific Smallholder Project (SP2), the major constraints to the development of smallholder farming systems in Tonga were investigated (Hardaker, Delforce, Fleming and Sefanaia 1988). The study showed that there is substantial variation in technical efficiency between farms and villages, suggesting scope for transfer of technologies from better farmers to other farmers. The study also emphasised the need for more productive farming technologies, especially those that will increase the productivity of labour while still being capital economising.

The complex nature of the farming system in Tonga, the changes occurring that are mentioned above, and the requirement for improved technologies for smallholders, underlie the need for effective and relevant agricultural research. This may be possible through farming systems research and extension (FSR&E), where an understanding of the technical, ecological, social and economic aspects of the farm-households is used to help pinpoint problems and possible solutions (Hardaker 1988). The FSR&E approach (variously named) embodies as an essential component

the conduct of on-farm trials as a means of improving the links between farmers, advisory officers and researchers. The purpose of this paper is to outline the experiences of a recently established program of on-farm trials implemented as part of an attempt to promote the FSR&E approach in Tonga and partially funded and assisted by the South Pacific Smallholder Project.¹

The FSR&E approach has had both its vehement advocates and its critics (Chambers and Ghildyal 1984, Heinemann and Biggs 1985). However, much of the debate has been conducted at a theoretical level, too often by those with little or no first-hand experience of trying to apply the methods. The ideas had their origins in the well-funded International Agricultural Research Centres and there have been rather few reports of the successes and failures of FSR&E in general, and on-farm trials in particular, in resource-constrained national agricultural research systems (Gibbon, 1985, 12; Farrington and Martin 1987, 66-7). This paper is an attempt to remedy this lack of feedback, drawing on the experience of the early attempts to put a program of on-farm trials into operation with a very limited budget in a very small national program.

2. Agricultural Research and Extension in Tonga

The Ministry of Agriculture, Fisheries and Forests (MAFF) in Tonga is comprised of a number of divisions and sections. These include the Research, Advisory and Livestock, Fisheries and Forestry Divisions, as well as a Planning Unit and a Women's Section, among others. There are two Research Stations and a number of advisory districts (which have recently been reduced in number as part of a restructuring program implemented at the beginning of 1989).

Although there has been a program of agricultural research in Tonga for many years, with substantial expenditure on the program (Sisifa 1986), the actual benefits to smallholders have not been great. The reasons for

1 The work of the SP2 was funded and supported by the Australian Centre for International Agricultural Research (ACIAR), Canberra.

this poor level of effectiveness are similar to those prevailing in the agricultural research systems of many developing (and some developed) countries. They include the fact that the linkages between farmers and the Advisory and Research Divisions are weak (Sisifa 1986). Also, most research has been commodity orientated and work has been concentrated on export crops such as bananas, vanilla and coconuts, to the relative neglect of local foodstuffs. Moreover, the work has been directed towards the technical aspects and very little consideration has been given to the socio-economic circumstances of farmers (Fa'anunu 1988). Some of the techniques suggested to farmers required substantial changes in attitudes of the small-scale subsistence farmers with adaptation to new, relatively complex production techniques in order to achieve high yields. Consequently, there has been limited success due to very slow rates of farmer acceptance and adoption (Fa'anunu 1988).

In an effort to strengthen the linkage between the MAFF Research and Advisory Divisions and farmers, a Research-Advisory Liaison Officer position was created in 1980. An expatriate Advisory Officer from the Tongan-German Plant Protection Project (GTZ) occupies the position, with a Tongan officer selected from the Research Division as counterpart. These officers maintain a high level of contact with the Research Division and the Advisory Division by attending work programming meetings, making regular field visits, running technical training sessions, helping with farmer meetings and by producing radio and video documentations as well as technical bulletins. The Liaison Officer position has been valuable in strengthening the links between researchers, advisory officers and farmers; however, there is scope for further communication between these groups (Sisifa 1986).

Recently there has been increasing interest in the FSR&E approach to agricultural development. Under this approach, farmers, advisory officers and researchers work together as a team to gain a better understanding of the situation of the farm family, the constraints to production faced and the production opportunities available. These teams are then able to pinpoint important problems that farm families face and can direct agricultural research to help overcome these restraints. An important part of FSR&E is to try out agronomic practices in farmers' fields before

formulating extension recommendations (Muriithi 1980). On-farm trials are used to test techniques judged to offer solutions to farmers' problems. These selected techniques may have undergone extensive development and testing on a research farm, or they may simply be best-bet options chosen on the basis of existing knowledge as being likely to be successful. The idea is to speed up the processes of technology development and uptake by establishing early in the development stage whether it is likely to be successful under the conditions farmers face and so whether they will be likely to adopt it. These trials provide a key link between members of the FSR&E team, allowing feedback both ways - farmers learn of better methods from the research and extension personnel by trying out new ideas in their own fields or by seeing them introduced in the fields of their neighbours, extension officers learn more about farmers (including more about successful indigenous technologies) and about the work of their colleagues in research, and researchers learn more about the reality 'down on the farm' so that, not only is the development of the specific technology kept on track, but also they can learn through farmer contacts what the real problems are and so what research priorities ought to be (Fa'anunu 1988).

In May 1988 the SP2 assisted in the conduct of a workshop on 'Farming Systems Research and Extension' in Tonga. Extension officers, researchers and planners from the MAFF attended, as well as staff from other agricultural organisations. The aim of the workshop was to introduce the ideas of FSR&E and to establish how this concept could be incorporated into the work of the MAFF. An expansion of the existing rather limited program of on-farm trials was seen as a first step to achieving this.

There have been number of on-farm trials run in Tonga in recent years and, as is commonly encountered in other countries, large differences have been observed between yields in trials in farmers' fields and yields of similar treatments replicated on the research farms (Savello 1987, Speijer 1988). This is because of the large variation in environmental factors and management practices, as well as labour and capital restrictions on Tongan farms, compared to the relatively controlled environment on the research farms. The existence of such large

differences highlights the need for on-farm trials to identify the causes of the yield gaps and to find out to what extent the gaps can be closed through appropriate recommendations to farmers.

An expanded program of on-farm trials was initiated as a result of this workshop and an on-farm trials officer was appointed to the Advisory Division of MAFF in June 1988 to supervise and co-ordinate the program. This officer works closely with the Liaison Section of the Research Division, the Planning Section and resource personnel from the SP2. Meetings of these directly involved people are held at least once a week to discuss progress of the trials, plans for future on-farm trials, field trips and workshops. Regular visits are made to the trials and videos and slides are taken for documentation. By November 1988 a total of 12 trials in the program were under way or completed. Details of the trials are given in the Appendix. Funding for the trials so far has come from various sources, including MAFF, ACIAR (via SP2) and the Tongan-German Plant Protection Project (GTZ).

Extension and research officers are encouraged to talk to farmers to get their ideas for on-farm trials, and are then required to submit proposals to the on-farm trials officer who organises funding. Extension, research staff and farmers work as a team to design and monitor the trials. Farmers, who are selected by extension officers to run a trial on their land, are usually already planning to plant the crop or have the animals that are being tested and must show enthusiasm for running the trial. The understanding is usually that seed, fertiliser, pesticides and other inputs are supplied for the farmer, while he or she provides labour; the output is retained by the farmer. Easily recognisable signs are placed outside trial sites to inform people of their purpose. Farmer visits are organised by the local advisory officer or the on-farm trials officer. The MAFF personnel involved are encouraged to record the opinions about the technologies being tested of both the farmer upon whose land the trial is being run and of visiting farmers. It has been suggested that asking the participating farmers' friends and neighbours may be a better way of getting the actual opinions of the farmers who may relate only positive aspects of the trial to research and extension personnel, but who may be more forthright with others.

3. Successes and Failures of the On-Farm Trials Program

A workshop was held in November 1988 to evaluate the progress of the on-farm trials program to date. During the workshop a description of each trial was presented by the advisory officer involved, using video film and slides of the trials to enhance each presentation. The trials were discussed and evaluated by the group of advisory and research officers attending the workshop. (Perhaps it would have been better if some farmers had also been present, but the workshop was intended primarily as a learning experience for MAFF personnel and this objective might have been compromised by the presence of farmers.) A brief discussion of each trial is presented below.

(a) Irish potato variety trial. This trial was in an area where potatoes had not been grown before. It was successful not only in testing these varieties under farmer conditions, but was a good demonstration plot for potatoes, which are not widely grown despite an expanding local market. The trial showed that very high yields are achievable in farmers' fields, particularly with regular advice from research and advisory officers. However, further trials are needed to obtain results from which recommendations for farmers can be derived.

(b) Sweet potato cultivar trial. This trial is a result of an intensive selection program on the research farm. One trial was successful in demonstrating these new cultivars to farmers, although the trial has not yet been harvested. The other trial was abandoned, a result of poor farmer selection. Further on-farm trials have been planted on other farmers' fields to test further these cultivars under a variety of conditions.

(c) Broiler trial. The experience and results of this trial were not extended to other farmers. There was no involvement of research staff and, as a result, the design and sampling methods were inadequate. The cost of the trial was high while the benefit to other producers was low. In addition, the immediate value of the results was reduced because the

recent importation of low-priced chicken meat has caused local broiler production in Tonga to cease.

(d) Banana cover crop trial. There is little commercial banana production in Vava'u where the trial was conducted, so this trial was not examining a problem commonly faced by farmers in the area. However, the technique could be applied to other areas of Tonga. The results showed the technique to be technically and economically successful, although further examination in other farmers' fields is required to confirm this finding. The trial was done in an area where the legume used as a cover crop is naturally occurring, which is not a common situation in other locations of banana production.

(e) Banana nematocide trial. This was mainly a researcher designed and implemented trial. There was little farmer or advisory officer involvement, although the Banana Services Section did take part in the trials. The results of the on-farm trials successfully completed confirmed results of those run previously on the research farm. The large number of trials abandoned because of the problem of the Bunchy Top Virus suggests a need for increased research on control of Bunchy Top virus, obviously a far more important problem than nematodes.

(f) Vegetable intercropping trial for insect control. The selection of this trial is questionable considering that a similar trial planted on the research farm at the same time of year proved unsuccessful. As shown in the on-station trial, there was no significant effect of intercropping onions with cabbages on the infestation with diamond backed moth - a major pest. The accuracy of data collection was low; if such a trial is to be repeated it should be done on a smaller scale to avoid big losses in terms of inputs and time and effort of those involved.

(g) Intercropping of beans and watermelon. No research officers were involved in this trial, and there were deficiencies in trial design and layout. The crop was affected by pests and disease, possibly due to the farmer using too low concentration of the chemicals he was provided with. It is suspected that the farmer used some of the fertiliser and

sprays provided on his own crop of watermelons, with a marked effect on yields of the trial plots. Further on-farm trials, with improved monitoring, are required before any reliable recommendations for growing these crops as intercrops can be made to farmers.

(h) Watermelon fertiliser trial. The original aim of the trial was to test human manure as fertiliser, which is a practice of some farmers. However, the original plan was abandoned due to an outbreak of typhoid and suspected risk of infection, and poultry manure was used instead. There was little research involvement in the trial because the soil scientist was on leave. Although the trial was not harvested at the time of reporting, it appears that one treatment was affected by shading. Further trials are needed before reliable recommendations can be made to farmers.

(i) Vanilla intercropping. These plots are more akin to demonstration plots than on-farm trials. Monitoring of the plots needs to be improved so that exact yields, incomes and other important factors are recorded.

4. Lessons Learnt and Plans for the Future

There is scope for making future on-farm trials more relevant to farmer needs. No proposals for trials came directly from farmers, although the proposals from advisory officers in some cases reflected the ideas of farmers. Nor, in most cases, was there any attempt to specify formally a target group of farmers (or 'recommendation domain') to whom the results were expected to be applicable. Increased attention needs to be given to the selection of topics for on-farm trials, including more thought to allocating priorities to the issues brought forward. Greater participation of farmers in the identification of problems will help direct research towards the most important issues faced by farm families.

The selection of farmers proved important, showing that priority should be given to farmers who are planning to grow the crop or the type of livestock being examined. They need to be genuinely interested in

testing the technology and following the trial through. At the same time, they need to be reasonably 'representative' of other farmers in their area to provide a valid test-bed for the proposed technology. In a number of trials, close friends and relatives of the MAFF staff were selected as the participating farmers, and at least one trial was carried out on the land of the Advisory Officer involved. Such people are unlikely to be representative of the population of farmers and such bias in farmer selection should be avoided.

The most successful trials generally involved good collaboration between extension and research personnel. There is a definite need to improve the involvement of research staff, to utilise previous on-station trial experiences, as well other sources of knowledge such as overseas work of a similar nature. Researcher inputs are also important to ensure that trial design is adequate for the intended purpose. In farmer-managed trials, which most of those reported above were, complex experimental designs are clearly inappropriate. On the other hand, some attention to layout of the trial may help to minimise possible bias, as observed in the watermelon fertiliser trial.

The effectiveness of the on-farm trials will also be improved considerably if they are incorporated into other work of the various sections of the MAFF to complement other programs, especially of the Research Division. This is not to say that the selection of trials should be determined by the existing priorities of the Research Division, since an objective of the use of on-farm trials within an FSR&E approach is to influence and, where necessary, redirect this work to problems of most importance. On the other hand, unless on-farm trial topics are selected with close attention to the needs of the majority of farmers, the program actually adopted may tend to bias the work of the Research Division away from what is really important.

The risk of 'failure' in on-farm trials is seen as high by some, usually researchers, and, as noted above, many of the trials begun did not produce the sorts of results looked for. However, there are always lessons to be learnt from experiences in the field, which could be valuable in redirecting future research, both on farm and on station.

Researchers may take some time to become accustomed to the need for simple trials, which fit in with farmers' practices, and yet which allow useful results to be obtained. Working out just what is possible is clearly a matter of experience since it will depend on the skills and interest of the co-operating farmer, the inherent complexity of the technology itself (e.g. it is more difficult to do trial work with tuber crops that are typically progressively harvested than with grain crops that are normally harvested on a single day), and on the support services offered to the farmer by MAFF.

The experience of these trials confirms the expectation that a proportion of on-farm trials will be abandoned due to lack of farmer cooperation, unsuitable climatic conditions, pest infestation, or other factors. In planning an on-farm trials program, therefore, it is necessary to account for the fact that about 50 percent of trials will not be completed as planned.

The experience from this pilot program of work points to the need for much more emphasis on replication of trials. Mainly because of financial constraints, too much of the work so far done comprises single, isolated trials which provide insufficient data to make reliable recommendations to other farmers. It is advisable that trials be replicated through time and space to provide a firmer data set for drawing conclusions and to allow comparison of results between different situations to gain a better understanding of the important factors contributing to the success or failure of the technology. For this to occur, there must be some co-ordination of activities between advisory districts as well as with researchers to ensure that the trials are appropriately designed. The liaison section is the suitable body for this task.

Improvement in the monitoring of trials is necessary to allow appropriate analyses of the results to be made. Close supervision of the farmer by the extension and research officers is important to see that the relevant information is recorded and to provide advice and other help to the farmer to maintain his or her enthusiasm. It was also found to be important to ensure that farmers use the funds or inputs provided in the

stated manner. Documentation of the trials through videos, slides and extension through farmer visits proved valuable but is not a substitute of accurate recording of quantitative data on inputs used and outputs obtained.

The experience of these trials showed the scope for improvement of the extension of trial experiences to the farming community through casual or formally organised farmer visits, through discussion at village meetings, radio interviews, and by other methods.

While the ultimate test of any technology is its uptake by farmers, assessment and use of trial results is a very important component of FSR&E to facilitate the feedback of information to guide further research. Reports on each trial must be written up and distributed to relevant people. While rather little time has elapsed since the start of the program in Tonga, there are already grounds for concern that in a proportion of cases this will not happen. Means to encourage and assist the personnel involved to write up their work need to be found.

The financial cost and provision of useful results varied widely among the trials. It is important to keep the costs of each trial low so that a larger program of on-farm trials, with a greater number of replications, can be run. The experience in Tonga shows how much can be done within a very modest budget, and there is no doubt scope to improve on this early experience.

The trials so far have been on two of the main islands, with little attention given to more remote locations. Farrington and Martin (1987) have argued that communities remote from the principal commercial centres provide much potential for researching possible improvements in the traditional farming system and that farmer-orientated research should be conducted in these areas. Clearly, the costs of work in more remote locations will be higher, and/or the types of trials that can be attempted will be more limited, due to the extra difficulties in getting personnel and materials into place for the conduct of the work. Yet these are just the difficulties faced by the farmers themselves in their everyday lives.

Some trials in such situations may provide not only results about improved methods, but also insights valuable to policy makers about how some of the most binding constraints facing these communities may be eased or lifted.

Commitment to the running of on-farm trials is necessary if the FSR&E concept to become part of agricultural development in Tonga. The full co-operation and enthusiasm of the advisory officer is crucial as they play a key role in communication between the participating farmers and researcher as well as having responsibility for extending useful trial findings to other farmers in the district. Advisory officers have a large number of responsibilities, and for this reason, the number of trials in each district should be limited so that the necessary time is devoted to each trial. Research officers also have numerous responsibilities; however, on-farm trials should be seen as an essential element in their duties - to be reflected in their duty statements, promotion criteria, etc. Finally, the commitment of funding and support from the planning and senior levels of MAFF is necessary to enable a program of relevant and potentially successful on-farm trials to be run.

5. Conclusions

As in most developing countries, funds for agricultural research in Tonga are short. Therefore, research methods that will be most cost-effective in generating economic benefits to the nation and in raising the incomes of the poorer farmers are required. A FSR&E approach may be one way of improving cost-effectiveness, and relevant, well designed on-farm trials are an essential part of this approach. The pilot program of trials described was therefore an important experiment.

The program was successful in increasing the flow of information between farmers, advisory and research officers. The long-term benefits to the farming community of the trials are difficult to measure at this early stage. Ultimately, adoption by farmers of the tested technologies will be a test of the success of the research. Meantime, lessons have been learned about improvements needed in the design and running of on-farm trials in the future. Improvement in the identification of problems faced by farm families is necessary, so that areas of greatest potential

benefit can be pin-pointed. This may be achieved by greater participation of farmers in the research process and by increased collaboration between the research and advisory staff. To have the maximum benefit, on-farm trials should be carefully designed and closely monitored. The maximum use should be made of experiences gained in formulating recommendations to farmers, in designing agricultural development projects and in planning further research.

All the trials so far conducted have dealt with production questions, chiefly of crops. In a country such as Tonga, which is an island archipelago, remote from overseas markets, and with severe domestic transport problems, marketing looms large on the list of farmers' problems. In future, therefore, it would be useful to look for opportunities for practical testing of some novel marketing technologies or methods - as part of a program of agricultural marketing systems research.

The on-farm trials program in Tonga is by no means a full-scale farming systems research and extension project. These trials should be seen as the first step in the process of getting farmers, extension personnel and research staff more involved in the development of appropriate technologies. Further changes in organisation and operation of the Ministry will be needed if it is decided to implement a full-scale FSR&E approach. As noted, some major changes in MAFF have been made recently but it is too early to comment on their likely consequences.

Despite the many limitations and deficiencies of the trials so far conducted, as discussed in this paper, the pilot program may be subjectively assessed as successful provided that it is seen and used by MAFF primarily as a learning experience. What is needed next is for the Ministry to develop a continuing program of work that builds on this experience and that ultimately depends upon the growing expertise within Tonga in the conduct of such studies, rather than on outside assistance. It is encouraging that this need is recognised in the MAFF so that it is possible to be optimistic that the eventual outcome will be accelerated development of techniques that will help improve agricultural production and incomes of Tongan smallholder families.

APPENDIX

Details of On-Farm Trials Conducted

1. Sweet potato cultivar trial. On-farm trials of new lines of sweet potato developed from a breeding program on the research farm (Taufatofua et al. 1986) are being tested under farmer management. These varieties have been bred for resistance to scab (*Elsinoe batatas*), high yields, agronomic characteristics and culinary quality. There have been ten on-farm trials since October 1986 for comparison of the performance of four new varieties with the Hawaii variety, which is currently the main sweet potato variety in Tonga. Results show there is a variation in the performance of each species with different levels of management and under different environmental conditions. Two on-farm trials of the latest varieties in were planted in mid 1988, and further trials were be planted in late 1988.

2. Irish potato variety trial. After four years of research on Irish potato, the Research Division has recommended four varieties for Tonga. Two of these are old varieties (Red Pontiac and Sequoia); the other two are CIP clones (Serranna and Dalisay) that are believed to yield well in Tonga but have never been grown by farmers. Highest yields were achieved by the Serranna variety (42 tonnes per acre), followed by Red Pontiac (35 tonnes per acre), Sequoia (31 tonnes per acre) and Dalisay (26 tonnes per acre). Further trials are needed to test different times of planting, environmental conditions and methods of storage and seed production (presently seed potatoes are imported each year).

3. Vanilla intercropping with kava, yams and bananas. After following earlier recommendations to monocrop vanilla, farmers are now intercropping vanilla with a variety of crops in the first four years of production. Recording of several plots of vanilla intercropped with kava, yams and bananas is taking place in Vava'u. The effect of intercropping on the growth of both vanilla and the intercroops will be measured and an economic analysis will be done after harvest.

4. Watermelon intercropped with dwarf beans. The aim of this trial is to

compare the yield of watermelons intercropped with beans with watermelons grown as a monocrop. The benefits of the crop combination is expected to be improvement in soil fertility as a result of the fixing of nitrogen in the soil by the beans, with possible improvement in watermelon yield, together with additional income from selling the beans.

5. Banana and cover crop. The yield from bananas in a clean weeded block is being compared to that of bananas with a legume cover crop, centrosema (*Centrosema pubescens*). This cover crop is expected to increase the fertility of the soils, reduce the labour required for weeding and protect the soil from erosion. Banana yields and returns were found to be significantly higher for the plot with centrosema cover crop compared to the clean weeded plot.

6. Broiler production. A group of 100 chickens were raised on chicken starter, and then the growth of those fed finisher ration compared to those scavenging were compared. The results showed that, under the particular farm conditions, scavenging chickens were lighter than those fed finisher ration, although it was more economical not to feed the finisher ration. Further trials are needed to confirm the finding.

7. Nematocide treatment of bananas. Results of a nematocide comparison trial run at the research farm in Tongatapu indicate that the nematocide Oxamyl gives better control of the banana nematode (*Radopholus similis*) than the currently recommended nematocide Carbofuran. In the trial run in the farmer's field, significant differences in mean bunch weight were observed in Oxamyl treated plots and the control plot with Carbofuran. Also, the number of bunches produced per mat was higher in the Oxamyl treated plots. These results confirmed the results of the on-station trial. A number of the on-farm trials were abandoned due to severe Bunchy Top problems.

8. Cabbage and carrots intercropped with onions. Methods of reducing the need for pesticides when growing vegetables are required in Tonga. Onions have been known to reduce infestation in other crops by releasing repellant odours. In this trial the effect of intercropping cabbages and carrots with onions on disease and pest incidence was measured. The trial was heavily infested with Diamond Backed Moth as a result of late planting

and lack of available sprays. There was no significant difference in the pest damage of crops whether they were intercropped with onions or not.

9. Watermelon fertiliser trial. The aim of this trial is to compare the response of watermelons cultivated using chicken manure, manufactured fertiliser (N-P-K) and a mixture of the two. At the time of writing, the crop had not been harvested.

10. Agroforestry trial. The aim of this trial is to help supplement rapidly diminishing forest vegetation, to reduce the effect of wind evaporating and to help maintain the supply of firewood. This is a long-term trial, as any benefits will not be evident for a number of years.

11. Legume fallow. With the reduction in the fallow periods, soil fertility is said to be decreasing in some areas of Tonga. This problem might be partially overcome if legumes were sown during the fallow period to restore nitrogen to the soil. There are some native legumes that have been grown traditionally during the fallow period, such as the Tongan bean in Ha'apai. The aim in this trial is to encourage farmers to plant legumes such as the Tongan bean on their fallow land. Any results from these trials are not expected to be apparent for several years after their initiation.

12. Paper mulberry. Two varieties of paper mulberry, which is used to make tapa (bark) cloth, are being compared for their growth. Methods of propagation (suckers versus cuttings) and optimum spacing are also being tested.

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