# Lowlands Farming Systems Research Team

LFSRT

Occasional Paper 2

## ON-FARM RESEARCH: AN APPROACH TO TECHNOLOGY DEVELOPMENT FOR THE RESOURCE-POOR FARMERS

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October 1991

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**Abstract**

## On-Farm Research: An Approach to Technology Development for the Resource-Poor Farmers

R.D. Ghodake

In PNG, like in many developing countries, a lot of component/commodity focused and discipline oriented agricultural research has been carried out on research stations, with only a small proportion of the results being adopted by the farmers, especially by the resource-poor farmers. It is generally accepted that this is generally because of the inappropriateness of many of the technologies generated from such research. Research efforts are often based on inadequate understanding of the farmers and their conditions and production goals, their physical, economic and sociocultural environments and their preferences and resource constraints. The farmer as the decision maker is usually not involved in the process of the technology development and transfer.

Typical smallholder farming systems in PNG are very complex with mixed gardens, complicated interactions between various on-farm and off-farm activities, influences of socioeconomic factors and market imperfections. Their agroecological, sociocultural and economic environments are so diverse and unique that those cannot be simulated and/or perceived on research stations. On-farm research is therefore considered essential to develop relevant technologies especially for the resource-poor farmers in PNG. This approach allows the consideration of the human aspect - the farmer involvement. On-farm experimentation corresponding to testing and design stages is regarded as the central activity of on-farm research.

Besides the concepts and the need of the approach, this paper briefly outlines the on-farm studies carried out by the Lowlands Farming Systems Research Team based at Bubia and emphasizes the on-farm research as an effective vehicle for the researchers to recognize and consider the farmer circumstances and the farmers to appreciate the process of technology development. The procedure outlined and views taken in this paper, however, are only a guide and demonstrative and their real utility depends on the interest and imaginations of the researcher.

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## I. INTRODUCTION

In PNG, like in many developing countries, a lot of component/commodity focused agricultural research has been carried out on research stations, with only a small proportion of the results being adopted by the farmers, especially by the resource-poor farmers. It is generally accepted that this is not because of the farmers' ignorance but invariably due to the inappropriateness of many of the technologies generated from such research. Many research studies remain incomplete. Only some get written with minority published in the form of research papers and a meager proportion of these get transformed into extension material.

More importantly, research efforts are often based on inadequate understanding of the farmer and his conditions, production goals, his physical, economic and sociocultural environments and his preferences and resource constraints. The farmer as the decision maker is not involved in the whole gamut of technology development and transfer.

To address the problems of the farmer recognition, his involvement and systems perspective, an approach of farming systems research was proposed (Dillon et al. 1978 and Shaner et al. 1982). But because of the complexity of this approach and confusion over the concepts and implementation, an approach of 'on-farm research with systems perspective' was suggested by Byerlee et al. (1982).

Rhoades and Booth (1982) called this as an approach of farmer-back-to-farmer which assumes that the effective applied agricultural research and transfer begins and ends with the farmers i.e. that research must come full circle from the identification of the problem to acceptance or rejection of the solution. Some researchers have referred to this as the farmer first and last approach (Chambers and Ghildyal 1985). Hilderbrand and Poey (1987) have described this as a farmer participatory approach to the generation, evaluation, and dissemination of technology.

The idea is to recognize the farmer and his decision making environment and involve him in the entire process of the problem identification, technology generation, adaptation and transfer so that the technologies are relevant and fit the conditions of the farmer, especially those of the resource-poor farmers.

## II. ON-FARM RESEARCH

On-farm research (OFR) is a problem-oriented approach to agricultural research that begins by diagnosing the conditions, practices, and problems of a particular group of farmers. An interdisciplinary team describes the on-farm environment from the farmer's point of view. The system is then analysed and the constraints identified and ranked. On-farm experiments/studies are then conducted to evaluate the alternate solutions that have high probability of acceptance by the resource-poor farmers and that will overcome the constraints. The solutions should be feasible given the farmer's available resources and support services and government policy. The experiments/studies are evaluated not only in terms of their biological feasibility, but also in terms of their economic viability and social acceptability, as well as their efficiency of resource use. In essence, in OFR, farmers participate in identifying problems, managing experimentation, and evaluating results.

Byerlee et al. (1982) have characterized on-farm research as: 1)seeking to generate technology for specific groups of farmers over the short term, 2) focusing on a limited number of enterprises, but maintaining a farming systems perspective by taking into account the interactions between the selected enterprises and the rest of the system, and 3)following a set of stages. Such stages may overlap and include the selection of target area and recommendation domain, description of farming systems, diagnostic work to identify and prioritize problems, designing and planning experiments, conducting location specific adaptive experiments in farmers' fields, assessing technologies using farmers' criteria and derivation and diffusion of recommendations (Tripp and Woolly 1989). This process thus allows integration of institutionally organized knowledge with indigenously acquired knowledge (Farrington and Martin 1988).

In summary, on-farm research is a holistic with systems perspective, involving the farmer and his on-farm and off-farm activities and is iterative and dynamic in nature and is conducted by multidisciplinary research team with task orientation.

## III. THE NEED FOR ON-FARM RESEARCH IN PNG

1. Like in many developing countries, the environment at research stations in PNG is not representative of the farmer environment, especially that of the resource-poor farmers. Research stations are very different in terms of soil fertility, topography, diseases and pests and water

management. Our work on taro to assess losses due to beetle and leaf blight and to design control options at Bubia has clearly demonstrated this. The levels of disease and pest infestation are insignificant at Bubia as compared to those on-farm situations in many taro growing areas.

2. Economic and sociocultural factors such as size of farm and management, access to inputs and credit, prices of inputs and outputs, food production preferences, risk attitude, risk bearing ability, farmer goals and group actions are crucial determinants of technology adoption and are unique under on-farm situations and cannot be simulated on the stations.

3. There is a tendency to wrongly assume that resource-poor farmers are interested solely in making a profit. However, PNG farmers may have a much complex set of goals and objectives than the simple pursuit of profit. These m!y be to have enough food for family, to avoid or minimize risk, to have enough time free of farm work for social and community activities etc. Reasonable considerations can be given to such goals and objectives only under on-farm situations.

4. Technology giving high performance under the high management - usually the case on research station- does not essentially show similar performance under the low management (the farmer management).

5. Practices recommended on the basis of pure on-station research are not usually accepted in totality by the farmers, especially by the resource-poor farmers, may be due to their perceptions, opportunity values, risks, and a variety of other factors.

6. Typical smallholder farming system in PNG is very complex with mixed gardens, complicated interactions between various on-farm and off-farm activities, influences of socioeconomic factors and market imperfections. These, therefore, require a systems perspective to be effectively captured in the process of technology generation. Such situation can only best be seen on farmers' fields.

7. Recognition and considerations of both backward and forward (micro and macro level) linkages are necessary for the successful acceptance of the technology. Very often farmer objectives conflict with the national polices and vice-a-versa. Technology introductions may require infrastructual and institutional changes such as input supplies, output

marketing, access to information, price support, etc. Therefore, part of the process of assessing new technology may require a judgment to be made about how well that technology meets national goals and simultaneously satisfy the farmer objectives. These assessments can only be effectively done through the process of on-farm research.

8. Generally, the criterion of technical feasibility alone is not sufficient but economic viability and social acceptability of the technology are equally important in disseminating and adopting technologies. On-farm research would allow these considerations to be incorporated as an integral part of the technology design and evaluation.

9. A very important aspect of human -the farmer- involvement lacks in the process of on-station research. Similarly, considerations to crops, animals, soils, pests and diseases are necessary if farmers are to accept the technologies. Therefore, farmer participation in the entire process of research is essential.

10. Although some preliminary assessments of technologies can be made on the research stations using economic tenets, the acid test is whether the technology is taken up by the farmers. On-farm testing of possible technologies and therefore on-farm research is very vital process whereby one can conduct this acid test.

## IV. ON-FARM EXPERIMENTATION

On-farm experimentation (OFE) corresponds to testing and design stages of the OFR process. It can be regarded as the central activity of on-farm research. It is a set of experiments carried out on farmers' fields with an active participation of farmers. The experiments are often designed to test hypotheses and evaluate innovations, as well as farmers' reactions to those innovations.

### 4.1 Types of on-farm experiments

On-farm experiments may be of three types depending on the objective of the experiment, the development stage of the technology and the degree of involvement of researchers and farmers (Table 1).

1. Exploratory Trials (Researcher Managed and Researcher Executed): These are carried out to evaluate the performance of new technologies in the farmer's fields. Here farmers'

biological environment is more important than his level of participation. These are also referred to as technology generation trials. Examples of this type of trials carried out by the Bubia Team are taro fertilizer investigation, control of taro beetle at Brahman, Wapi, and Tikeling, cassava variety testing at Wosera, taro variety performance, onion variety assessment, yam variety trial at Brahman, etc.

**Table 1. Types of On-farm experiments (trials)**

| Mode | Exploratory trial | Adaptation trial | Verification trial |
|---|---|---|---|
| Researcher farmer involvement | Researcher managed and executed | Researcher managed and farmer executed | Farmer managed and executed |
| No. of treatments | 6-8 | 4-5 | 2-3 |
| No. of reps (fields) | 5-10 | 20 | 50-100 |
| No. of reps./ field | 3 | 1-2 | 1 |
| Total no. of reps. | 15-30 | 20-40 | 50-100 |
| No. of plots/ field | 18-24 | 4-10 | 2-3 |
| No. of villages | 2-3 | 4-5 | 10-20 |
| Plot size | 20-50m² | 30-100m² | 200-500m² |
| Design | Randomised complete block with three blocks per field | Randomised complete block with one to two blocks per field | One block per field |

Source: Steiner 1987

2. Adaptation Trials (Researcher Managed and Farmer Executed): In this type, the farmer makes no management decisions himself but executes all operations. These contribute to adaptation,

development and evaluation of the new practices. Here, technical options are modified to fit the farming systems and to overcome the constraints. This allows the researchers to understand how the farmers respond to suggested improvements. Trials on guinea pigs and australorps in the Upper Ramu area fall under this type.

3. Verification Trials (Farmer Managed and Farmer Executed): In this type, the farmers make decisions themselves. They obtain recommendations and are free to modify. Here, the farmer's management itself becomes a test factor and is monitored by the researchers. All on-farm trials on assessment of food crop varieties in the Lae, Upper Ramu, and Wosera areas are examples of this type.

## V. ON-FARM RESEARCH BY THE BUBIA TEAM

The Agriculture Research Division of the Department of Agriculture and Livestock (DAL) has adopted a programme of on-farm research with systems perspective to generate relevant technology options for improved productivity and sustainability (Ghodake et al. 1989). At present three agricultural research stations - Bubia, Laloki and Aiyura - two livestock centres - Labu and Manifo - are participating in adaptive on-farm research in four areas - Wosera in East Sepik Province, Upper Ramu in Madang, Jimi in Western Highlands and Okapa/Marawaka in Eastern Highlands (Ghodake 1990). The aim is initially to generate appropriate technologies and later on to verify such technologies under farmers' field conditions and management.

The main components looked at are crop variety assessments and introductions, food legumes in cropping systems, pest control, crop diversification, cash cropping, tree species, fallow management diagnostic/descriptive surveys, livestock integration. Technologies tried are generally simple options with reasonable chance of acceptance. For example, in the Wosera area, these include variety assessments of food crops such as yams, aibika, beans, banana, cassava and sweet potato. Some of the trials are researcher managed while the others are farmer managed.

### 5.1 Design and Implementation of On-Farm Research

The following broad procedures are followed by the Bubia team in designing and implementing the on-farm research.

#### 5.1.1 Problem Identification

Normally research proposals are prepared after rapid rural

appraisals and/or problem identification surveys involving provincial extension staff, voluntary agencies and subject matter specialists. DAL researchers collaborate for such surveys with integrated development projects such as SMAFSP, with a view to identify researchable problems in such target areas (DAL 1989). Such proposals list priority problems, constraints and options to solve/alleviate such problems. Problems that require solutions from research are shortlisted.

This is followed by a separate reconnaissance by the researchers themselves and provincial extension officers. These quick surveys cover representative farming systems zones within the project areas and emphasize heavily on farmer interactions and involvements to obtain further insights into their problems and views. Farming systems zones are further delineated on the basis of soil type, population density, road and market access, and cropping systems. Such zoning helps deciding on priority problems for each zone, choosing potential technologies for trial, delineating recommendation domains and considering variability for adaptive on-farm research.

### 5.1.2 Adaptive Research Teams

A team of resource scientists for each target area is formed. These researchers are from DAL and other organizations who have worked for developing potential technologies. The members are chosen on the basis of the identified and short listed problems and the potential technology options available. They then become responsible for selection of technologies and for planning and conducting on-farm experiments in the target areas. Researchers from provincial set-up are also involved. For example, an agronomist from Saramandi Research Station under East Sepik Province is participating in the Wosera area. A proposal is for concerned provincial governments to appoint a scientist on full time basis to look after adaptive on-farm research in the target area.

Such a group of scientists and extension officers is called a multidisciplinary Adaptive Research Team (ART). For example in the case of Upper Ramu, the ART includes one agronomist from Laloki, one agronomist, one entomologist and two economists from Bubia, two livestock scientists from Labu and three extension officers from Madang Province.

### 5.1.3 Extension Involvement

The linkage between research and extension is very vital for problem identification and dissemination of information. For example, in the Wosera case, an agronomist from Provincial

Division of Primary Industry (PDPI) is responsible for the day to day activities of the on-farm research in the area. Implementation of trials and studies is carried out by two extension officers who are based in the target area. They are responsible for data collection, monitoring, close contact with farmers, multiplication and supply of seed material etc. Senior extension officers from the province are involved in making decisions related to delineation of farming systems zones, identification and prioritization of problems, selection of villages and farmers for on-farm studies, selection of sites for researcher managed trials, choice of potential technologies for trials and assessment of technologies.

### 5.1.4 Location of Trial

Trials are of two main types - on-station and on-farm. Some are researcher managed while others are farmer managed. Researcher managed trials are carried out generally on DPI extension centres, base camps, mission farms, school gardens, and often on-farmers' fields. The Upper Ramu area, for example, has four such trials on the Catholic Mission farm at Brahman - yam variety, crop rotation, onion variety and taro beetle control.

Farmer managed trials by necessity are on farmers' fields under their management. Technologies tried here are generally simple options with reasonable chance of acceptance. In the Wosera area, these include variety assessments of food crops such as yams, aibika, beans, banana, and sweet potato. While in the Upper Ramu area, these include taro, cassava, aibika, beans, guinea pigs and poultry.

### 5.1.5 Farmer Participation

All these trials, especially farmer managed trials, have ensured maximum farmer participation. Such participation is right from the stage of problem identification and extends through to the stage of technology evaluation/acceptance. Fourteen farmers in the Wosera area and 23 farmers in the Upper Ramu area (called co-operative farmers) located in different villages and zones are involved in on-farm crop variety assessments. They use their fields and cultivation practices while trying test factors (varieties). Their preferences (consumer preferences) are elicited for tried technologies. Besides, additional 2 to 3 farmers (called respondent farmers) from each village are covered for agroeconomic survey. Care is taken to include representative farmers who represent resource-poor farmers in the area. In general, our experience so far suggests good participation and co-operation from farmers.

### 5.1.6 Technology Choice

Technologies tried in the area (both for researcher managed and farmer managed trials) are chosen by considering the priority problems, available potential options, and probability of their success. These options should help directly or indirectly in solving the identified problems. The aim here is to generate technologies and/or refine these from half baked ones. A technology that is likely to create adverse effect in the existing system is carefully considered. For example, many potential sweet potato varieties from Laloki are not tried in the Wosera area because of the fear of transmitting viral disease (little leaf). Therefore, only a few pathogen tested varieties have been included. A range of options are included so that there is a greater chance of a few being accepted. Some newer options like cassava, sweet potato varieties, and tree species are also tried in the Wosera area. Often, number and choice of technologies are limited by the options available to the team.

### 5.1.7 Design of On-farm Trial

Our experience of planting an on-farm trial in the Wosera area is shared here. This is rewarding experience and can be useful for others. The approach is flexible and practical.

A counted number of plants of each species are given to farmer and he is allowed to plant these species in a random and mixed fashion (farmer practice) along with his own material. This, to a large extent, avoids the problem of plot selection and helps treating individual plant as a sample unit for recording. This is quite consistent with the farmer practice of gardening wherein individual plants are cultivated and looked after rather than a crop.

The farmer is allowed to follow his way of planting (spacings, number of plants per hill, mound size etc.). He is given planting material one unit (set, tuber, plant) of a treatment at a time and asked to plant. His material is given first followed by researcher material in the sequence of various treatments and these turns are continued until all planting material (all units) for that crop is over. It is then followed by another crop. This ensures random distribution of various varieties (of researchers and farmers) in the garden. Many farmers planted yams, aibika, banana, and beans as mixed crops. While some farmers planted banana in rows around mixed gardens.

## 5.2 On-Farm Trials/Studies by the Bubia Team

Table 2. On-farm research conducted by the Bubia Team

| Stages of on-farm research | On-farm trials/studies |
|---|---|
| - Farming systems zoning recommendation domain | - Rapid rural appraisal<br>- Exploratory survey |
| - Farming systems description | - Agroeconomic survey<br>- Upper Ramu, Wosera and Lae<br>- Market studies |
| - Diagnostic studies identification and prioritization of constraints | - Taro loss assessment, leaf blight<br>- Taro loss assessment, beetle<br>- Sweet potato loss assessment, vine borer<br>- Smallholder loss assessment by corn stem borer<br>- Agroeconomic and biological survey<br>- Taro fertilizer trial |
| - Technology design, testing and verification | - Control of taro beetle (cultural and chemical)<br>- Taro fertilizer trial<br>- Adaptive food crops trials in Wosera<br>- Adaptive trials in Upper Ramu, food crops and livestock<br>- Onion variety*time of planting<br>- Tomato varietal performance<br>- Taro variety*site experiments<br>- Banana skipper butterfly |
| - Recommendation/training extension | - All on-farm experiments<br>- Adaptive location specific studies, yam, cassava, crop rotation, and alley,<br>- Socioeconomic surveys |
| - Monitoring and evaluation | - Farmer perception studies<br>- Consumer preference<br>- Impact assessment<br>- Market survey |

A list of on-farm studies carried out by the Bubia team, and their places in various stages of on-farm research are presented in Table 2. A single study may contribute to more than one stage. For example, the agroeconomic surveys are useful and necessary during most of the stages.

### 5.2.1 Fertilizer use for taro

Low and declining soil fertility is identified as one of the priority constraints to productivity of taro in the Bukawa area of the Lae district and in similar other taro growing areas in the lowlands. Two experiments were conducted in farmer's fields to explore the potential of fertilizer use on taro. The results have been quite encouraging but need to be further verified by using higher and more doses of nutrients, especially nitrogen (Table 3). A formal researcher managed trial is planned to be carried out during 1991-92 in a farmer's field in the Lae area. The objective is to quantify the response of taro to various combinations and levels of fertilizers under farmers' field conditions and to assess the economic feasibility of the fertilizer use.

**Table 3. Economic analysis of the undominated fertilizer alternatives: on-farm investigation of taro fertilization in the Lae area**

| Alternative | | | Corm yield (tonnes/ha) | Net benefit (K/ha) | Variable cost (K/ha) | Change from the next highest benefit | | |
|---|---|---|---|---|---|---|---|---|
| N | P | K | | | | Marginal increase in net benefit (K/ha) | Marginal increase in variable cost (K/ha) | Marginal rate of return (%) |
| (kg/ha) | | | | | | | | |
| 100 | 100 | 0 | 12.64 | 6270 | 1550 | 240 | 484 | 50 |
| 100 | 0 | 0 | 12.69 | 6030 | 1066 | 1654 | 193 | 856 |
| 0 | 0 | 100 | 8.84 | 4376 | 873 | 255 | 82 | 311 |
| 0 | 50 | 50 | 9.70 | 4121 | 791 | 521 | 160 | 326 |
| 0 | 0 | 0 | 7.71 | 3600 | 631 | - | - | - |

Source: Akus et al. 1990

### 5.2.2 Assessment of taro yield loss due to leaf blight and use of ridomil

The aim of this trial is to verify the need for and practical appropriateness of the use of ridomil to control leaf blight

*Phytopthora colocasie* on taro under farmer field conditions. Ridomil (*metalaxyl*), although found to be effective against taro leaf blight, has not been recommended to farmers for a variety of reasons. There is no enough information on the magnitude of loss in quality and quantity due to leaf blight under farmer field conditions, farmer perceptions on the losses and use of fungicide, economics of fungicide use for the smallholders, technical know-how of the farmers, possible health hazard, availability of chemicals and spraying equipment, practical appropriateness of spraying in a complex gardening system etc. To get overall perspective on above aspects, this trial is planned. The trial will help assess yield loss under farmer fields and determine considerations for formulating recommendations on ridomil use by smallholder subsistence farmers.

The trial has been conducted by agronomists, pathologists, and economists. The biometrician has been involved in planning, implementing and analysing the trial. The first phase is the researcher managed and will address questions on quantification of yield losses, farmer perceptions, economics of fungicide use and relationship between the disease incidence and the level of yield and quality losses. The second phase will be under the farmer management conditions and will consider practical aspects and variations in agroclimatic and disease environment. The trial is to be conducted on 20 farmer fields in the high disease incidence areas around Lae.

5.2.3 Control of taro beetle

Our earlier surveys in the lowlands of PNG have conclusively established the severity of losses due to taro beetle Papuana woodlarkina (Table 4). Two trials have been carried out to evaluate taro beetle control methods. The first trial involves assessing different rates of Suscon Blue at Wapi village near Lae. This trial will allow us to make economic assessment of the insecticide use for taro beetle control in a farmer's field. The second trial is initiated on farmers' fields in the Lae and Upper Ramu areas to test several cultural control methods including mulch, coconut husk, polythene, flywire etc.

5.2.4 Corn stem borer

There were reports of stem borer Ostrinia furnacalis damaging corn on large size commercial fields. However, information on smallholder subsistence gardens was not available and it was not known whether there was economically significant damage. A survey has been conducted to assess corn damage, if any, by stem borers on the smallholder gardens. That should allow to appreciate the extent of damage and design appropriate control

strategy. Our preliminary assessment shows no significant damage on small holder gardens.

**Table 4. Average physical and monetary losses due to taro beetle in five areas of the lowlands**

| Area | Physical loss (kg/ha) | Physical loss (%) | Monetary loss (K/ha) | Monetary loss (%) |
|---|---|---|---|---|
| Lae | 170 (0-660)* | 2.2 (0-8.6) | 700 (0-2250) | 15.0 (0-50) |
| Finschafen | 60 (0-260) | 1.1 (0-5.8) | 110 (0-1130) | 7.7 (0-21.5) |
| Wau | 150 (30-520) | 1.4 (0.2-4.5) | 660 (0-1790) | 11.0 (0-43) |
| Upper Ramu | 370 (0-1950) | 4.2 (0-24) | 560 (0-5210) | 21.6 (0-55) |
| Huon Gulf | 100 (7.7-270) | 1.5 ( 0.1-4.3) | 190 (0-780) | 6.9 (0-29) |
| Average over all areas | 160 (0-1950) | 2.1 (0-24) | 450 (0-5210) | 13.4 (0-55) |
| Coefficient of variation (%) | 172 | 153 | 185 | 131 |

* *Figures in parentheses are ranges.*

Source: Bubia Annual Report 1990

### 5.2.5 Sweet potato variety assessment for vine borer

Sweet potato vine borer Omphisa anastomosalis has recently been observed to be a serious pest in some dry areas of PNG, such as Central Province and the Markham Valley. Observation plots were set up at Bubia last year but this work was discontinued because of lack of enough pest incidence. The work has currently been done to assess stem borer damage on sweet potato collection at Laloki. The objective is to evaluate sweet potato varieties for possible tolerance/resistance to the vine borer. Potential varieties will then be tried under farmer managed field situations.

### 5.2.6 Rhyparid beetle studies on banana

The banana rhyparid beetle Rhyparidella sobrina (Bryant) was first recorded causing severe damage in the Mutzing area of the Markham Valley in August 1988. Since then, an observation trial showed that beetle damage could be reduced significantly (about 90%) if the plants were covered as soon as the fingers opened up. However reports from farmers state that banana bunches are wrapped about 3 months after the fingers open. Since the rhyparid beetle attacks on the onset of the opening of fingers, the spraying of insecticide is planned to suppress the beetle until the banana is covered.

### 5.2.7 Biological control of bananas skipper

A biological control using a larval parasite Apenteles erionotae is considered to be a promising option to control the banana skipper butterfly. After the initial work at Laloki between DAL and CSIRO/ACIAR, the parasite has been released in the Lae and Markham Valley areas. The parasite has been established in one of the release sites. Monitoring of skipper damage and the effect of the parasite is being continued. Wosera, Upper Ramu and other on-farm sites could be the other release sites in the country.

### 5.2.8 Verification of food crop varieties in Wosera

These are farmer managed and implemented on-farm verification trials in the Wosera area to test the performance of different varieties in the area and to adapt promising varieties to farmer conditions.

One cropping cycle during 1989-90 season was completed and the second one has been undertaken during this year. The crop species tested are *Babi* and *Kurisa* varieties of banana, *Yard long* and *Bush Sitao* species of beans, *LA16, LA20, LA45, LA9 and LA19* varieties of aibika, *S5, L22, L9, Gonime*, and *Muduwana* varieties of sweet potato, and variety *NG454* of peanuts. These trials cover 14 farmers spread in East Nanu and West Nanu zones of Wosera. One researcher managed experiment (exploratory trial) on taro -varieties *BCE30, BCE121(1), BCE3* and *BCE25* and two local cultivars is being carried out in one farmer field. These assessments are planned to consider yield parameters, consumer preference, taste, cooking quality, nutrition, market demand etc.

5.2.9 Study of farming systems in Wosera and Upper ramu

An agro-economic survey covering 35 farmers was carried out in the Wosera area to identify and verify problems and constraints in the area and to gain further insight in the farming systems. A typical result on constraints to production and income is presented in Table 5.

Similar survey was carried out in the Upper Ramu area to collect data on socioeconomic and agrobiological aspects covering details like labour, family size, land resource, land allocation, cropping patterns, consumption patterns, farmer preferences, constraints and problems, and options for improvement. These data are used for assessment of technology options tried. In all 35 farmers in 23 villages of 4 census divisions have been covered.

**Table 5. Constraints to production and income in Wosera (frequencies of responses): results from diagnostic agroeconomic survey**

| Constraint | West Nanu | East Nanu | Aggregate |
|---|---|---|---|
| -Pest and diseases | 3 (9.7)* | 4 (10.8) | 7 (10.3) |
| -Low prices for cash crops | 7 (22.6) | 13 (35.1) | 20 (29.4) |
| -Inadequate DPI advice | 2 (6.5) | 3 (8.1) | 5 (7.4) |
| -Community group work | 9 (29.0) | 7 (18.9) | 16 (23.5) |
| -Drinking water problem | 3 (9.7) | 3 (8.1) | 6 (8.8) |
| -Poor soil fertility | 2 (6.5) | 1 (2.7) | 3 (4.4) |
| -Flood damage | 0 (0) | 1 (2.7) | 1 (1.5) |
| -Old age | 3 (9.7) | 0 (0) | 3 (4.4) |
| -Difficult transport | 2 (6.5) | 0 (0) | 2 (2.9) |
| -Lack of tools | 0 (0) | 2 (5.4) | 2 (2.9) |
| -Inadequate land | 0 (0) | 1 (2.7) | 1 (1.5) |
| -Stealing | 0 (0) | 2 (5.4) | 2 (2.9) |
| Total responses | 31 | 37 | 68 |

* *Figures in parentheses are percentages.*

Source: Sowei et el. 1991

5.2.10 Verification of food crop varieties in Upper Ramu

This trial programme has studies on crop variety assessment of staple food crops, legumes and vegetables.

Twenty-three farmers from 10 villages spread across four zones have participated in the on-farm variety assessment trials. The crop species include 3 bean species - *Yard long, dwarf*

*contender*, and *bush sitao* - 6 aibika varieties - *LA9, LA16, LA19, LA39, LA45*, and a farmer variety - 6 cassava varieties - *L11, L34, L45, L49, L50*, and a farmer variety - and 5 taro varieties -*Numkoi, BC003, BC030, BC021*, and a farmer test. Initial results on assessment of yams, taro, cassava and aibika are very promising both in terms of relative yields and farmer preferences (Table 6 - 8).

**Table 6. Performance of taro varieties on farmers' fields**

| Variety | Yield (Tonnes/hectare) |
|---|---|
| BC 121 [1] (Numkoi) | 21.1 |
| BC 003 (Unabuae) | 9.7 |
| BC 030 (Waharau 15) | 14.2 |
| BC 031 (Waharau 16) | 6.3 |
| Local variety | 11.1 |

**Table 7. Performance of cassava varieties on farmers' fields**

| Variety | Yield (Tonnes/hectare) |
|---|---|
| L11 | 79.9 |
| L34 | 45.9 |
| L45 | 38.5 |
| L49 | 61.3 |
| L50 | 39.2 |
| Local variety | 41.4 |

Table 8. Performance of aibika varieties on farmers' fields

| Variety | Yield (Kg/hectare |
|---|---|
| LA 9 | 1647 |
| LA16 | 2557 |
| LA19 | 997 |
| LA39 | 1604 |
| LA45 | 1655 |
| Local variety | 1568 |

5.2.11 Livestock adaptive research

Small livestock - australorps and guinea pigs - are assessed on farmers' fields under their management. A total of five farmers from five villages in the Upper Ramu area were selected for guinea pig trial. Each farmer was given 6 fourteen-week old animals (1 male and 5 females) to rear. Preliminary results are quite encouraging. Despite the initial time taken for acclimatization, most of the animals were pregnant by the fifth week, showing good breeding performance. Australorps were given to farmers to see if the bird can perform well in the area. Five farmers from five different villages were given 10 pullets. An advice was given on how to look after these birds but no material assistance provided. The results to date suggest that the birds can perform satisfactorily under village conditions. Feeding with commercial feeds appeared to be resulting in bigger birds than those fed with local feeds.

5.2.12 Alley cropping

The potential tree species are tried at the Wosera station under researcher management to assess their performance under the local agroclimatic conditions. One is a replicated alley cropping trial involving, Gliricidia sepium, L. mexican, Acacia angustissima, and L. diversifolia. Another is an observation block with legume tree species such as L. lanceolata, L. mexican hybrid, L. macrophalla, L. Shannonii, and L. leucocephala K636.

## VI. SOME ISSUES

So far our involvement in on-farm research has raised quite a few issues which need to be considered for strengthening the research activities.

### 6.1 Resident Scientist

Many difficulties are encountered because a full time researcher is not available in target area. Physical distance and present communication do no allow resource scientists to supervise and take day to day decisions. At least one scientific officer is required to be stationed in each project area. In the Wosera case, the Saramandi agronomist is physically far away from the trial site. Communication by phone or fax is usually unreliable for him to reach the field staff. Certain decisions are required to be taken on the spot and any delay may affect the trial results adversely. The Upper Ramu does not have scientist for adaptive research.

### 6.2 Data Variability

Large variability in technology performance is obvious because of high diversity in farm conditions and almost no control on farm-level variables. Even variability within a field/farm is very high. Variability in farmer management is another important source. Therefore, evaluation of technologies needs to be fairly robust to account for such variabilities. Such variabilities may, however, be specific to recommendation domains. The superior options should be quite distinct, obvious and show quantum jump results. Replications of proper size and type are often not possible given the topography of farmer plots. Adjustments are required to be made with farmer practices and their methods of planting.

### 6.3 Externalities

In contrast to station-based research, the on-farm research is influenced by many external factors on which the researchers have no control or have very little control. These externalities arise due to problems with communication, transport, funding uncertainties, law and order, staff transfers, accommodation, damages by domesticated and wild animals, stealing, political interference and often lack of extension support.

### 6.4 Statistical Design and Analysis

Statistical design and analysis is a highly debatable topic but no much literature on this topic is available especially in the context of PNG farming systems. One has to be satisfied with

single test factor at a time and farmers' method of cultivation. Formal replicated trials are not possible. However, one can have replications of individual plants. Method of analysis of variance for many farms, locations, and years, particularly for on-farm trials, is given by Gomez and Gomez (1984) and can be carried out using MSTAT/MINITAB programmes available on micro-computers. Level of significance needs to be set at much higher levels (around 20%). The results will still be quite relevant. Complex analytical procedures may be required for technology verification experiments. Biometrician's involvement in adaptive research, especially on-farm experiments, is essential, both for planning the experiments and designing the data analysis. This, besides interactive training, would help improving trial designs and generating relevant data.

### 6.5 Farmer Assessment

Although the real achievement has to be in terms of the farmer acceptance of the technologies, some assessment of farmer reactions are required to be done by researchers for exploratory and adaptation trials. Invariably such assessments are highly subjective, reflecting a variety of farmer considerations of various nature such as physical, economic, socio-cultural, preferential and personal. Therefore, objective assessment of technology performance may not be possible for the researchers.

### 6.6 Discipline Orientation

Many of the biological scientists are trained in discipline oriented research and may not feel comfortable to face the real world situation of the farmer field. There is also a fear that they lose their identity as a specialist scientist while engaged in on-farm research with systems perspective.

### 6.7 Peer Recognition

Due to large variability and externalities involved, the results obtained from on-farm research may not often help produce scientific publications for academic journals. Researchers involved thus may not receive recognition from their scientific peers which is often considered important for promotions and growth in the job career.

### 6.8 Transport and Communication

This is an usual problem in location specific research in isolated areas where access is a serious constraint. Wosera experience suggests that lack of road transport for the field staff is a major constraint to successful implementation of research activities. Fourteen villages, spread over a distance

of 50 km need to be reached as often as possible for close monitoring. Communication by phone is very unreliable. Field staff in Upper Ramu do not have phone even at the district headquarters. Major share of research fund is required to be spent on traveling to reach the target areas.

### 6.9 Planting Material

Generation of planting material for staple root crops such as taro, yams, and to an extent for banana is another serious problem. New planting material needs to be transported from Laloki, requiring high expenses. Even road transport may not be available on time. Multiplication of seed and planting material in the target area is a priority need. The integrated project in the area has a component on distribution of planting material but its effective functioning is a matter of concern. Slow bulking of taro planting material has hampered the taro variety assessment trial both in Wosera and Upper Ramu.

### 6.10 Funding

On-farm research obviously appears to be expensive by at least looking at the intensive and time bound funding requirements. It's efficiency can only be judged on the basis of effectiveness of the technology transfer and the benefits to the farmers. Often unexpected funding needs arise during the process of on-farm research, rendering the recurrent system of funding inappropriate. Besides, there is a high degree of uncertainty in allocation and release of funds.

### 6.11 Farmer Cooperation

In general, farmers are co-operative and have been participating enthusistically in on-farm research. Some, however, get discouraged and go ahead with their plantings, realizing that researchers are not on time. This has implications for our planning and rigidity in following schedule of activities. Farmers need to be informed about the intentions of these trials so that their expectations are reasonable and realistic. Our experiences with yard-long bean variety trial in Wosera and with taro, cassava, and aibika in Upper Ramu are quite encouraging.

### 6.12 Planning

Our experience shows that meticulous and advance planning is essential. And such planning should well consider the practical uncertainties and lack of information. One has to be considerate of many externalities. Our failure to plan and implement will result in inordinate delays and in losing farmer co-operation.

### 6.13 Staff Training

Field researchers are extension staff who have basic primary level training and good understanding of agriculture. Adaptive research involves dealing not only with biological processes but also with socio-cultural aspects and is a complex of activities, interactions, physical environments, uncertainties and personalities. Besides formal training, on the job training in planning, organizing, farmer training, and implementing adaptive research is essential.

## VII. CONCLUSION

Conventional approaches of developing technologies and generating research results under station-based conditions, with focus on individual components and commodities, have generally had only limited success in transferring results to farmers, especially to resource-poor farmers. A top-down approach, with prescriptive recommendations flowing from researchers to extension workers and to farmers does not serve the farmers to any significant extent.

On-farm research conducted with systems perspective and that involves a close partnership between research-extension-farmer, and that integrates research, extension, and development can potentially generate, adapt, and transfer technologies to farmers within the framework of their present circumstances. The generation of technology through on-farm research consequently provides the necessary human linkage, and acts as a catalyst in the creation of a dynamic system for technology transfer to farmers. The on-farm research thus serves as an effective vehicle for the researchers to appreciate the farmer circumstances and the farmers to appreciate the difficulties in technology development. The procedure outlined and views taken in this paper, however, are only a guide and demonstrative and their real utility depends on the interest and imagination of the researcher.

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