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Linking On-Station Research with On-Farm Testing: The Case of Agro-Forestry and Organic Matter-Based Cropping Systems for the Rwanda Farming Systems Research Program

Charles Yamoah, Ron Grosz

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LINKING ON-STATION RESEARCH WITH ON-FARM TESTING: THE CASE OF AGRO-FORESTRY AND ORGANIC MATTER-BASED CROPPING SYSTEMS FOR THE RWANDA FARMING SYSTEMS RESEARCH PROGRAM

Charles F. Yamoah, FSRP Soil Scientist/Agronomist
Ron Grosz, FSRP Extension/Training Specialist

ABSTRACT

Hillside farming with its attendant erosion and decline in soil fertility is commonplace in the area served by the Farming Systems Research Program. The project is designing land use systems that would check erosion, increase soil organic matter and restore soil fertility. These systems will allow small farmers to increase or sustain production on a long-term basis without resorting to the use of high doses of inorganic fertilizers that are not readily available in the country. Use of leguminous shrubs and cover crops as nutrient sources--concepts embodied in agroforestry and organic farming systems--is an option that land use experts think might solve the problem. However, there is a dearth of knowledge about the biological feasibility of these interventions in the project area.

This paper reports how FSRP combined problem diagnosis and analysis, researcher-managed adaptive trials and a field day to attack this lack of information. The rationale for using this approach is to address farmers' real needs, save time and minimize risk to poor farmers.

INTRODUCTION

The Central African country of Rwanda is administratively divided into ten different provinces. Each such province is further sub-divided into communes. In 1983, the Government of Rwanda requested USAID assistance in developing the FSR/E approach to strengthen the applied research capability of the Rwanda agricultural research institute (ISAR) and to integrate all research and extension activities (cf. Project Document, p.3). The Rwanda Farming Systems Research Program (FSRP) was subsequently situated in the Ruhengeri Province in the northwestern highlands of the country. This province is composed of 16communes, among which the FSRP was asked to work specifically in four: Butaro, Cyeru, Nyamugali and Nyarutovu.

The project region is noted for its high potential in agricultural production. It is also one of the most densely inhabited areas of the country, with about 372 people/km^2 (FSRP, 1986a; USAID, 1984). Because of the rugged topography, hillside farming is the norm in the four-commune project area. Slopes are generally steep, ranging from 10% to over 60%. Thus, the number one enemy to soil fertility maintenance is soil erosion. This also appears as a symptom of another major problem, land scarcity.

Because of population pressure and the resulting severe demands placed on existing cultivable land resources, the use of long fallow periods to rejuvenate soil fertility does not seem to be a feasible option for most farmers. Land-locked Rwanda is located about 1000 km from the nearest sea port. This geographical reality means the high cost of importation and use of high doses of commercial inorganic fertilizers by small farmers will not be economically attractive and would, at best, prove logistically difficult to implement.

Agro-forestry and organic matter-based cropping systems, using leguminous plants, are therefore seen as two of the most promising interventions available to deal with accelerated soil degradation problems on sloping lands (ISNAR, 1983; Lundoren and Nair, 1985; USAID, 1984; Young, 1984, 1985).

This paper reports the approach used by the Rwanda FSRP to involve farmers in the entire research process.

DIAGNOSIS AND ANALYSIS OF PROBLEMS

In concurrence with the philosophy of Farming Systems Research and Extension (FSR/E), researchable problems for FSRP were identified through review of secondary data, exploratory surveys with farm families, consultations with scientists who have experience in Rwanda and direct communication with local administrators and key informants. Analysis of information gathered revealed the following technologies as potentially most appropriate for the four FSRP communes covering parts of the Buberuka Highlands and the Central Plateau agro-ecological zones. The interventions suggested were

tillage (zero and minimum),
mulch systems (live and in-situ),
manures and composts,
agro-forestry systems and
inorganic fertilizers

Tillage

In general, untilled soils show few erosion problems compared to tilled soils. No-tillage, on the other hand, has its associated weed problems for which farmers in the FSRP area do not have the right weapons or the time to fight. The clay-textured soils dominant in the area also do not allow widespread adoption of no-tillage systems. However, minimum tillage, as currently practiced by farmers for cultivation of peas, combined with the use of selected green manure crops as sources of organic matter, was considered worth investigating.

Mulch Systems

Both in-situ and live-mulch systems require the use of leguminous cover crops. The difference between the two is that pre-plant herbicides are used to kill the cover crops in the case of in-situ mulch, whereas growth retardants are employed to suppress growth of cover crops in live-mulch systems. Arable crops, especially maize and cowpeas, have prospered under the two systems in trials carried out at the International Institute of Tropical Agriculture (ITTA) in Nigeria (Akobundu, 1980; FSRP, 1986b; IITA, 1984, 1985).

Difficult acquisition and high costs of herbicides and growth retardants are the main deterrents to adopting these innovations in the project area.

Manures and Composts

Applying animal manures, although in insufficient quantities, and composting of household refuse, are practices often followed by farmers. Green manuring is seldom practiced due to the unavailability of suitable species and increasing pressure on arable land. Thus, research was directed towards identifying low-growing cover crops for use as living mulches. Leguminous cover crops that could serve as quick soil improvers were screened as part of the research.

Agro-Forestry Systems

Agro-forestry, multipurpose and scale-neutral, was considered the most promising technology for farmers in the area who are faced with declining soil fertility, shortage of fuelwood and lack of animal feed. Information on the socio-economic aspects of agro-forestry in the project area exists (Robins, 1985), but data germane to biological performance of potential shrubs are scanty. Preliminary trials on agro-forestry were therefore conducted to look at performance of shrubs in various agro-ecological zones with respect to growth rates, dry matter and nutrient yields.

Inorganic Fertilizers

If one were to consider only the relatively short five-year project life, with one year already completed, one might think that the most rapid way to reduce farmers' soil fertility problems would be to pass on to them, via on-farm demonstrations, the value of inorganic fertilizers and animal manures. However, a realistic appraisal made during the project's initial diagnosis of the farming systems of the region clearly showed this option to be no solution at all. Even if available, most Rwandan farmers, with minimal economic resources, could not purchase such inputs without heavy subsidy. And the eventual cost of

such inputs would be high given Rwanda's landlocked location and difficult logistics and marketing support infrastructure.

Within this context, fertilizers and manures, where and when they can be found, should be employed to supplement low-nutrient-input agro-forestry and related cropping systems. Thus, research in agro-forestry and related cropping systems is critically important to soil fertility improvement studies in the project area. Such systems, however, by their very nature, are long term in scope, making proper long-term evaluation and monitoring of anticipated benefits difficult during the life of the FSRP project. For this reason, training of Rwandan technicians to understand the objectives and importance of continuing such applied research is a primary objective of the technical assistance field team.

NATURE OF AGRO-FORESTRY RESEARCH

Unlike inorganic fertilizers and manures, the benefits of agro-forestry and cover crop trials are not immediately evident. We would expect a period of at least two years to even begin to realize some of the potential of such systems. And, unlike inorganic fertilizer use, agro-forestry systems have a built-in element of permanence as opposed to fertilizer or manure applications where effects rarely last more than a season or two.

Agro-forestry also has some negative aspects. Nursing, transporting, planting and tending the seedlings of agro-forestry shrubs can require high labor costs. The shrubs do take space meant for food crops. Some tree/bush species of agro-forestry systems can become a menace by attracting crop pests or posing as a weed when they start producing seeds that begin to germinate down the slopes among the food crops. Furthermore, like food crops, agro-forestry shrubs have special soil and climatic requirements for good growth. These are but a few of the potential problems inherent in the practice of agro-forestry.

In theory, at least, agro-forestry research generally should follow the following pattern: In order to minimize exposure to risk by poor farmers, evaluation of shrubs on-station prior to on-farm testing is usually considered important. Later, during on-farm testing, the researcher elicits farmers' opinions on the design, implementation and maintenance of a particular agro-forestry system. Feedback from farmers is relayed to the research station for further research. The exercise continues until the technology is considered suitable for full-scale on-farm testing. Properly done, the whole process may take three to five years, or even more, before a shrub is recommended for widespread testing in on-farm field situations. And even then it is not certain that recommendations will be adopted.

A project, like our own, however, has a limited time frame in which significant work must be accomplished. And, because of the rapidly increasing problem of erosion and loss of productivity, the country itself cannot afford the luxury of long-term, possibly unfocused research. Rwandan researchers cannot afford years of experimental research on experimental stations until all possible researcher options have been exhausted to finally begin testing "results" on farmer fields. Such "good results" may, in the end, prove unacceptable to farmers because of as yet unencountered (on the station) socio-economic factors or agro-climatic variability. The problem is further exacerbated because biological data on agro-forestry in the target area contain great variability from one location to another. The same holds true for cover crops.

LINKING ON-STATION ADAPTIVE RESEARCH TO ON-FARM TESTING

Figure 1 explains the route being followed by FSRP in an attempt to circumvent the time-demanding path discussed in the preceding section. Research began with adaptive trials sited on the research station and on communal plots found outside the station. The areas were strategically selected to represent different agro-ecological zones with respect to altitude, soil type, rainfall and temperature (Raintree, 1986). The trials installed were

1. Evaluation of an alley cropping system with Sesbania sesban. Sesbania was the leguminous shrub discovered to exhibit good growth performance during the project's diagnostic survey of the area.
2. Evaluation of 12 leguminous cover crops, with and without inoculum, for dry matter and nutrient yields. The legumes used were Mucuna, Canavalia, Alfalfa, Stylosanthes, White Clover, Centrosema, Lupin, Vetch, Desmodium, Glycine wightii, Cajanus cajan and Dolichos.
3. Assessment of four leguminous shrubs, leucaena, markhamia, calliandra and sesbania for use in alley cropping systems.

Details of the protocols for the above trials are reported elsewhere. The research sites were used as demonstration and training points for farmers and field technician/collaborators in this effort. Demonstrations were organized in the form of a field day.

ROLE PLAYING

Role playing was an important activity which preceded the field day. Role playing was used here to assure accurate and effective communication in the cross-cultural and multilingual situation under which this field day was to be held. The key players were:

- the farmers, who, by and large, spoke only Kinyarwanda;
- a research station (ISAR) research assistant, the major presenter for the field day, who spoke Kinyarwanda as his mother tongue and French as his second language;
- a Rwandan researcher on the project staff;
- an expatriate scientist, the one conducting the agro-forestry research, from an anglophone African country, with limited French; and
- a French-speaking expatriate extension specialist from the United States who was asked to design a system to facilitate the field day.

Given this mix of people, cultures and languages, the potential for communication problems was high. The communications flow for the role-playing exercise is shown in Fig. 2.

During the role-playing exercise, two local FSRP extension agents acted the role of "farmers." As would be the case on the real field day, the research station assistant practiced his leading role with the acting "farmers" in Kinyarwanda. The expatriate African scientist passed on his messages in French to the research station assistant. Difficult expressions and concepts were passed through the extension specialist to the research station assistant. More difficult terms in both French and Kinyarwanda were passed through the Rwandan scientist. Communication was multi-directional, and collaboration depended on who could best express which concepts in which language. The ultimate objective was to establish effective two-way communications with the farmers.

After the role-playing exercise, the two "farmers" were asked to explain to the group in French what they had understood to have been said by the research station assistant in Kinyarwanda. This feedback enabled the group to catch terms and concepts that might prove difficult during the actual field day. The experience also provided the research station assistant with the technical knowledge and self-confidence that were essential preconditions for the success of this field day.

THE FIELD DAY

The field day was designed to:

1. identify with farmers key soil fertility management problems in the project area and their possible solutions. This was done to confirm the accuracy of the information gathered during the diagnostic phase and to ensure that farmers' felt needs were properly addressed (Raintree, 1986);
2. expose farmers to new management options such as alley cropping, live and dead mulch systems, green manuring and related organic farming systems that might offer solutions to some of the identified constraints;
3. give farmers the opportunity to evaluate the above management options and use their feedback as a basis for improvement of these potential technologies;
4. select cooperating farmers for on-farm testing.

The farmers who participated in the field day were selected by commune-level extension agents. Group interviews were held. Questions were framed to generate discussion among farmers. The questions asked, and a brief summary of the responses given, are presented below.

Questions regarding soil problems and possible solutions

Why is your soil not as productive now as five or ten years ago?

- soil is too old
- lack of manure
- there is too much rain

What do you think will maintain the productivity of the soil you are now cultivating in the next five to ten years?

The soil will be productive if:
- we control erosion
- we leave the land to fallow
- good cultural practices are followed
- improved seeds are used

Will you be able to support your family on the same land you use now in 5 to 10 years?

- No

What do you think can be done by this project to sustain the soils you are now cultivating?

- We need your advice to enable us to use the appropriate cultural practices.
- We need chemical fertilizers and improved seeds.

What do you think you can do in the absence of this project to sustain the productivity of your soil?

- We would use organic manures.

Do you use chemical fertilizer?

- Fourteen farmers out of thirty responded yes. They also said they had been pleased with results.

You have told us you do not use chemical fertilizers every season. Why is this?

- We would buy it if the price were reasonable.

Questions regarding evaluation of management options

The merits and demerits of alley cropping and the other organic farming systems were explained to farmers as they observed them in the field. They were given time to debate among themselves. Then the following questions were posed:

For alley cropping:

Do you think this technology has anything good to offer toward resolution of the soil problems in your commune?

- Yes

What other benefits, if any, could you derive from this system?

- We could obtain materials for construction.
- The shrubs would serve as wind breaks.

What spacing would you prefer between rows of shrubs?

- The largest spacing (8 m) to give more land for food crops.

What problems do you see with the use of this technology?

- The shrubs can harbour birds, which destroy the food crops.
- The shrubs reduce cultivable land area.

At one of the sites, farmers could not fully assess the growth performance of the leucaena, calliandra, markhamia, and sesbania used for the alley cropping trials they saw because these had only been planted 2 months before the field day. However, they were quite pleased with the integration of the shrubs with food crops (potatoes, wheat and peas) as demonstrated in the trial designs. Questions on cover crops were suspended until farmers had the chance to observe their performance at the two ecological zone test sites representing the Buberuka Highlands and the Central Plateau. The performance of the cover crops differed drastically at the two sites. This obviously influenced the farmers' choices of which cover crops they preferred.

The farmers who lived in the Central Plateau Region, a relatively low- altitude area, were more interested in trying Mucuna and Canavalia. Those from the high-altitude Buberuka Highland region opted for Vetch. Most farmers felt the two locations used for the trials did not adequately represent the various micro-agro-ecological zones in the project area. They asked for additional multilocational testing of the cover crops.

Farmers indicated provision of fodder and green manure as the major benefit from planting cover crops. They mentioned lack of seed as the problem that could hinder the adoption of these new methods.

When asked how many of them would be willing to collaborate with FSRP to further test the proposed technologies, all participating farmers enthusiastically said that they would.

PROPOSED PROTOCOL FOR ON-FARM TESTING

To begin this collaborative effort, farmers were encouraged to discuss exactly how they thought the on-farm testing should be organized. To facilitate testing the proposed interventions over a wide area, farmers agreed among themselves to form groups of three. This resulted in ten groups to cover the entire project area. For each group representing a specific agro-ecological area, the details of the trials are as follows:

Alley Cropping

For each site there are alley cropping shrubs that are planted along the contours at 0.5 m within rows. Spacing between rows is determined by the steepness of the slope using the relationship $D = 100/S$ where D = distance between rows of shrubs and S = the percent slope represented by a whole number. Each row of shrubs is between 15 m and 20 m long and is reinforced by grasses such as Pennisetum or Setaria.

Cover Crops

The most favored cover crops, Mucuna, Canavalia, Vetch, Alfalfa and Lupin, are planted in plots of 10 to 20 m square.

Each cover crop is replicated twice per site.

All the trials are to be managed by farmers but under close guidance by researchers because the technologies are still in the testing stage (Collinson, 1983). The trial locations will serve as demonstration centers for neighboring farmers. It is proposed that the participating farmers assume the role of para-professional extension agents for subsequent seasons. Training is currently being planned to effect this proposal.

CONCLUSIONS

This is the first time a field day has been used in the project area to involve farmers in agricultural research. The occasion gave the scientists an opportunity to know and appreciate farmers' real problems related to soil fertility management and to work toward identifying appropriate solutions in the project area. Farmers were also exposed for the first time to technologies such as alley cropping, green manure and mulch systems using various cover crops. They said they were pleased to have had the occasion to see these interventions and to express their opinions about them.

This event was also an opportunity to show communal extension agents how to use a field day as an effective communications tool to integrate farmers into their activities. It was thus a learning experience and a linking event for all three partners in the FSR/E approach: researchers, farmers and extension agents.

Farmers now are sharing with researchers a common effort in solving their own agricultural constraints; they recognize their important role in the overall research process. This has become evident by their willingness to offer their land and labor to help further test and fine tune the proposed technologies. Extension agents, too, share in the common search for solutions to these problems. In keeping with FSR/E methodology, this kind of research is on-going. The process is iterative. Researchers, extension agents and farmers are working together as a team to attain mutual objectives.

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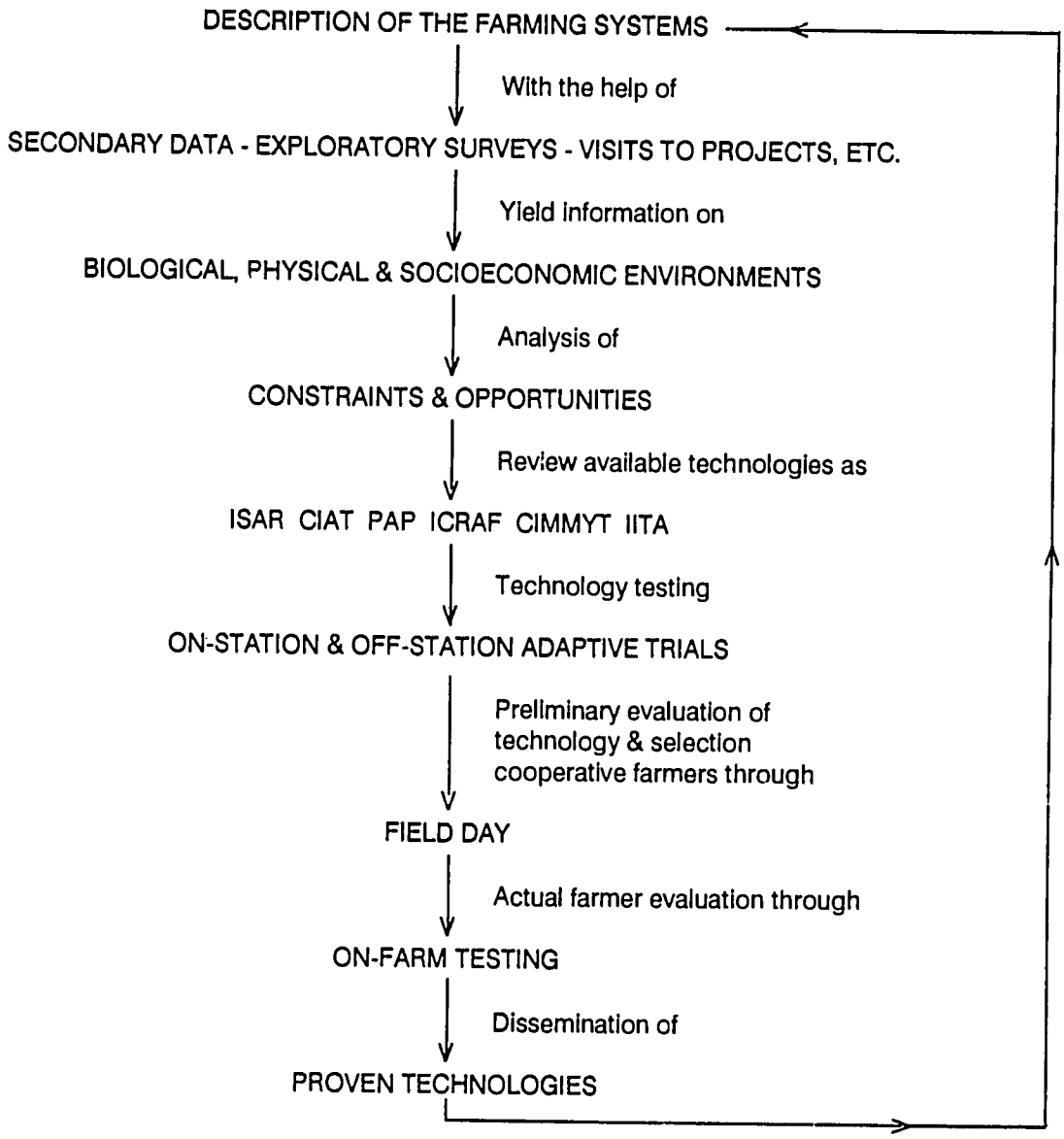

ISAR	Institut des Sciences Agronomique du Rwanda
CIAT	International Center for Tropical Agriculture, Columbia
PAP	Projet Agronpastoral de Nyabisindu, Rwanda
ICRAF	International Council for Research in Agroforestry, Kenya
CIMMYT	International Maize and Wheat Center, Mexico
IITA	International Institute of Tropical Agriculture, Nigeria

Fig. 1. The FSRP approach to agro-forestry research and allied cropping systems.

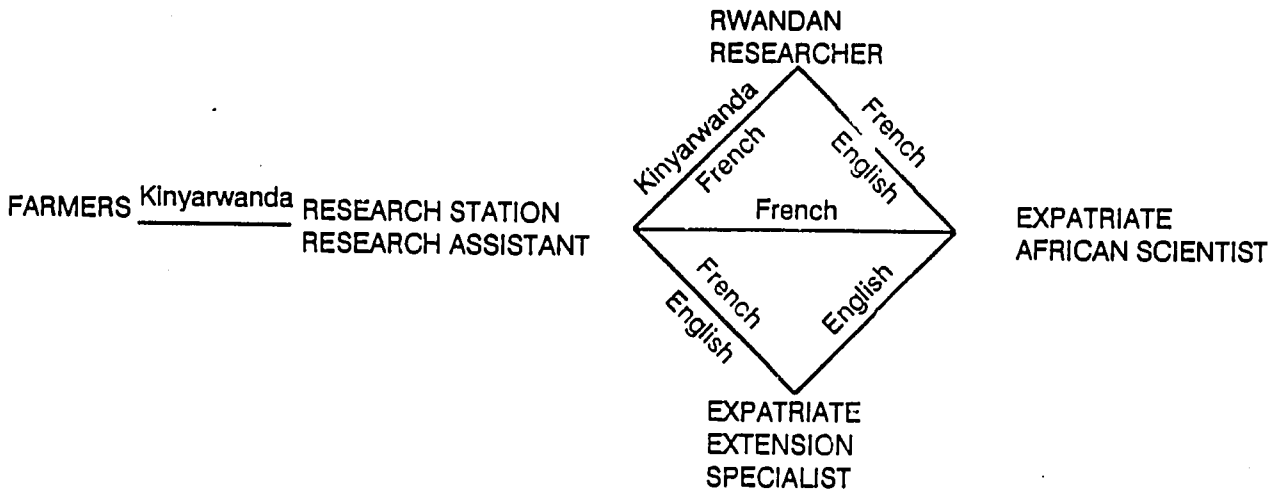

Fig. 2. Communications flow for the role-playing exercise.