GROUP INNOVATION IN UTILISING LAND AND WATER RESOURCES IN RWANDAN VALLEYS[1]

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1. INTRODUCTION

A variety of methods have emerged in recent years that seek to draw upon farmers' knowledge, insights and innovative capacity in the identification and selection of agricultural technologies. However, the focus of research has generally been on innovations that are feasible for individuals acting alone. Few accounts describe the development of alternatives where potential benefits depend critically on the area over which they are practised or on the number of farmers adopting them. Exceptions can be found in the domains of irrigation management (Korten, 1982) and wide-area pest management (Loevinsohn et al, in press), but in these cases farmer groups have most often been involved in the planning and implementation of pilot projects at a production scale, rather than in selecting among and testing technical options.

This paper describes the process and results of research, with groups of small-scale farmers, on sustainable irrigated agricultural alternatives for highland valleys in Rwanda.

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2. THE CONTEXT OF VALLEY FARMING

The Central Plateau of Rwanda is a region of rolling hills and generally well-watered valleys between 1500 and 1800 metres in altitude. The population density is among the highest in Africa, with typical holdings in the order of 0.5 - 1.0 hectares (ha) (Ministère de l'Agriculture, 1984). Phaseolus beans, sorghum, sweet potato and banana form the basis of small farmer agriculture, which until relatively recently was restricted to the tops and flanks of hills. Over the last few decades, however, demographic pressure and the resolution of a centuries-old conflict between herders and farmers have opened the valley bottoms to cultivation. Though representing less than a tenth of the cultivable area, highland valleys are responsible for some 18% of food energy and 22% of protein production (Jones and Egli, 1984). With more assured access to water and less degraded soils, the valleys are widely thought capable of greater intensification than the hillsides (Ministere de l'Agriculture, 1987). Rainfall is approximately 1200 mm, distributed between two wet seasons.

Farmers exploiting the valleys almost invariably farm a substantially greater area on the hills. The valleys are most intensively used during the long dry season (June-August) under irrigation: a second or third crop may be possible where the risk of flooding is low. Crops are grown on raised beds separated by ditches whose spacing and dimensions represent a finely-calculated balance between the need to drain or irrigate (Steenhuis, 1987), a practice that has evolved over the 20-60 years the valleys have been cultivated. Maize, sorghum beans and vegetables are widely grown in the valleys, but sweet potato dominates. Though its yields are lower than on the hills, dry season cultivation in the valleys ensures a continuous supply of planting material which has permitted a marked expansion of sweet potato on the hills (Jones and Egli, 1984).

Land in the valleys is public property and individuals enjoy only usufruct rights there. 'Coopératives', formalised groupings expected to cultivate collectively, are favoured by government policy, and may be granted land that is unoccupied, or, more often, already cultivated by independent farmers. Land may also be accorded to state or parastatal enterprises which then organise small farmers around cash crop production, specifying techniques and ensuring inputs and marketing.

The Projet Rizicole de Butare (PRB) manages some 750 ha of paddies at around 1400 m on the eastern edge of the Plateau, where rice has been

grown since the late 1960s. High production costs in these 'perimètres' due to low marketed volumes (yields in the two annual harvests average 2.5-3.5 t/ha), inefficient use of chemical inputs, expensive hydraulic infrastructure and high staffing levels have threatened the project's objective of reducing national dependence on imported rice. It was with a view to exploring the agronomic, social and economic feasibility of farmer-managed, low input rice production in higher altitude valleys, that the project supported the research described here. The scarcity of resources (3 person days/week of both researcher and technician time) and the diversity of conditions in highland valleys helped convince senior PRB officers of the utility of participatory techniques.

3. METHODS

We began by conducting rapid appraisals of valley agriculture in several communes of Butare Prefecture in the heart of the Central Plateau. We spoke to researchers, extension officers and, particularly, farmers whom we approached in their valley fields. Using an open format, we asked about current agricultural practices and how they had evolved, the extent of cooperation within and among households and the links between hill and valley cultivation. Where farmers' interest in collaboration appeared real, we asked if it was possible to organise a meeting of those cultivating contiguously in a part of the valley.

These larger meetings, attracting 30 or more farmers and local authorities, focused on the problems people were encountering in the valleys and the options they saw for dealing with them. Most frequently cited among the constraints were the extreme shortage of land and insecurity of tenure, declining soil fertility and difficulties in drainage or irrigation. The solutions envisaged for the most part involved intensifying what was already being done, for example, renting more land (though cash was scarce) and using more compost or manure (though supply was limited and employed preferentially on hillside fields). We were asked how we could help and offered some ideas. For example, more land could be found in the uncultivated drains between their raised beds. Rice might be grown there, as we had observed a farmer trying with a handful of seed in one valley, and as Javanese farmers do in a system known as *'sorjan'* (Suryatna et al, 1979). Would they like to try? We emphasised the range of options, for example, in time of planting and the possibility of creating paddies, as well as the risks we foresaw (primarily cold sterility and disease). The choice of option, and

its risks would be theirs; we undertook to provide seeds and advice, but could only work with groups. We made no stipulations, however, about their size or form.

Other ideas were introduced in a similar manner. These included growing two indigenous species of *Sesbania* for green manure, constructing peripheral canals to improve irrigation, and integrating fish culture into their systems.

Four groups agreed to work with us on these terms. Though situated within a radius of only 6 km, they differed markedly in their organisation, economic orientation and cropping pattern. The valleys they farmed also varied in soil type, topography and hydrology. The 'cooperatives' manage their land collectively, whereas farmers in the informal associations cooperate as and when their members see fit.

We encouraged innovation by several means:

(a) During weekly visits to the valleys, we met groups or individuals who wished to consult us, examined the progress of their experiments and discussed further trials;

(b) A 'travelling seminar' was held each season, in which groups visited each other and discussed the experiments they were conducting;

(c) In 1989, representatives of the groups were brought to the 'perimètres' to observe farmers' fields and researcher-managed experiments which focused on themes the farmers were themselves pursuing.

4. RESULTS

Integration of Rice

Adoption of rice by each of the groups has been rapid, though no more than a handful of farmers had previously had direct experience of the crop. Marked improvements in irrigation, land preparation, transplanting and crop protection have been evident and are, in large, responsible for the increase in mean yields from 2 t/ha in the first season to 3-4 t/ha subsequently. This production has been obtained without external inputs and thus far with little reliance on biological fertilisation. As in the lower altitude 'perimètres',

yields are constrained during the long rainy season (March-May) by diseases, primarily blast *(Pyricularia oryzae)* and sheath rot (mostly *Sarocladium* spp).

Farmers are impressed by the productivity of rice, comparing it favourably to previous crops they have grown in the valleys, despite the greater labour requirements. A survey of neighbouring farms in February 1991 indicated that gross economic returns to rice were greater than for any other crop harvested at that time.

While there has been experimentation with the *sorjan* idea in each of the groups, paddies have been, from the first, the preferred approach to growing rice. The reasons farmers give are consistent: the space available between their raised beds does not justify digging a canal, building a dam and sowing a seedbed, all of which could equally serve a larger area. However, in the last two seasons, two of the groups have employed the *sorjan* alongside or after paddies, thus benefitting from the infrastructure already created. While widespread use of the *sorjan* would permit even greater landuse intensity, the introduction of paddies has reduced the uncultivated area to 11% of bottom land from 32% when raised beds are employed.

Though both appear committed to rice, the associations and 'coopératives' diverge in the land-use strategies they are developing. The former have almost doubled the per capita area devoted to rice cultivation to effectively 100% of the land available on a seasonal basis. In contrast, the two 'coopératives' have maintained the area planted to rice roughly constant, at between 25% and 40% of their holdings. Their cropping patterns conserve greater diversity: rice is present in all seasons, but is generally rotated between fields. This involves building and then dismantling raised beds, a highly labour-intensive procedure.

The cropping patterns emerging in the four groups (Figure 1) represent modifications of patterns that existed before the advent of rice. Some of the variation is explained by difference in hydrological conditions, other key factors are farmers' orientation to market or subsistence production, and the scale of management. In Gatovu, for example, a single-season monoculture of sweet potato has given way to uniform double-cropping of rice. In part, the variation in cropping pattern appears to be a response to physical and hydrological constraints. Gatovu farmers explain that nothing survives the flooding they experience during the long rains, except rice, and previously their land lay fallow. Two kilometres downstream in Cyamuginga, the valley broadens and the risk of flooding is less, hence sweet potato and eggplant

can be planted on rebuilt, raised beds, reserving rice for the next season when it generally yields best. Conditions in Rujangari are more moderate, permitting greater crop diversity, but the collective use of the land also creates possibilities, such as fish ponds, not available to individuals farming only a few ares (.01 hectare). The option for an independent farmer of maintaining a raised bed, with one or more crops, beside a paddy encounters the same 'economies of scale' argument as the *sorjan:* a large investment of labour is required for a small area of rice. Other considerations encouraging wide and uniform rice cultivation are the difficulties intervening raised beds create for irrigation and the refuge they provide for grain-eating birds.

The maintenance of diversity has been a recurring theme of discussion within and among the groups. Some farmers in Gatovu and Cyamuginga have suggested that the associations divide into contiguous rice and raised bed areas, rotating seasonally as in Rujangari, in order to spread risks, ensure a source of sweet potato cuttings for the hills and pursue speculative ventures (such as highly profitable out-of-season maize), while facilitating irrigation management and crop protection. The idea has not received general support as most farmers see rice as the 'best bet' and are unwilling to accept the second best 'for the good of the group'. Our arguments that double-cropping risks aggravating disease and fertility problems have not proved persuasive, at least in Gatovu. Farmers are not convinced of the imminence of these threats and point to the double-cropping long practised in PRBs 'perimetres'.

Organisational Innovation

By the end of the first season, all four groups had constructed peripheral canals, up to a kilometre in length, that feed their fields directly. For the most part, these have been efficiently managed. However, the maintenance of irrigation infrastructure has at times been compromised by 'free-riders', people who do not participate in cooperative work knowing others will complete it. The phenomenon was most apparent in Cyamuginga, where large stream volumes during the long rains in 1990 necessitated frequent repairs to the simple sandbag-reinforced dam. The group has since largely avoided the problem by cultivating rice during the short rains, a strategy that was also favoured for agronomic and economic reasons. By the third year, both associations had elected coordinators, two or three per group, responsible for mobilising members for common tasks and enforcing cash or labour penalties. Such sanctions already existed in the 'coopératives' when we arrived.

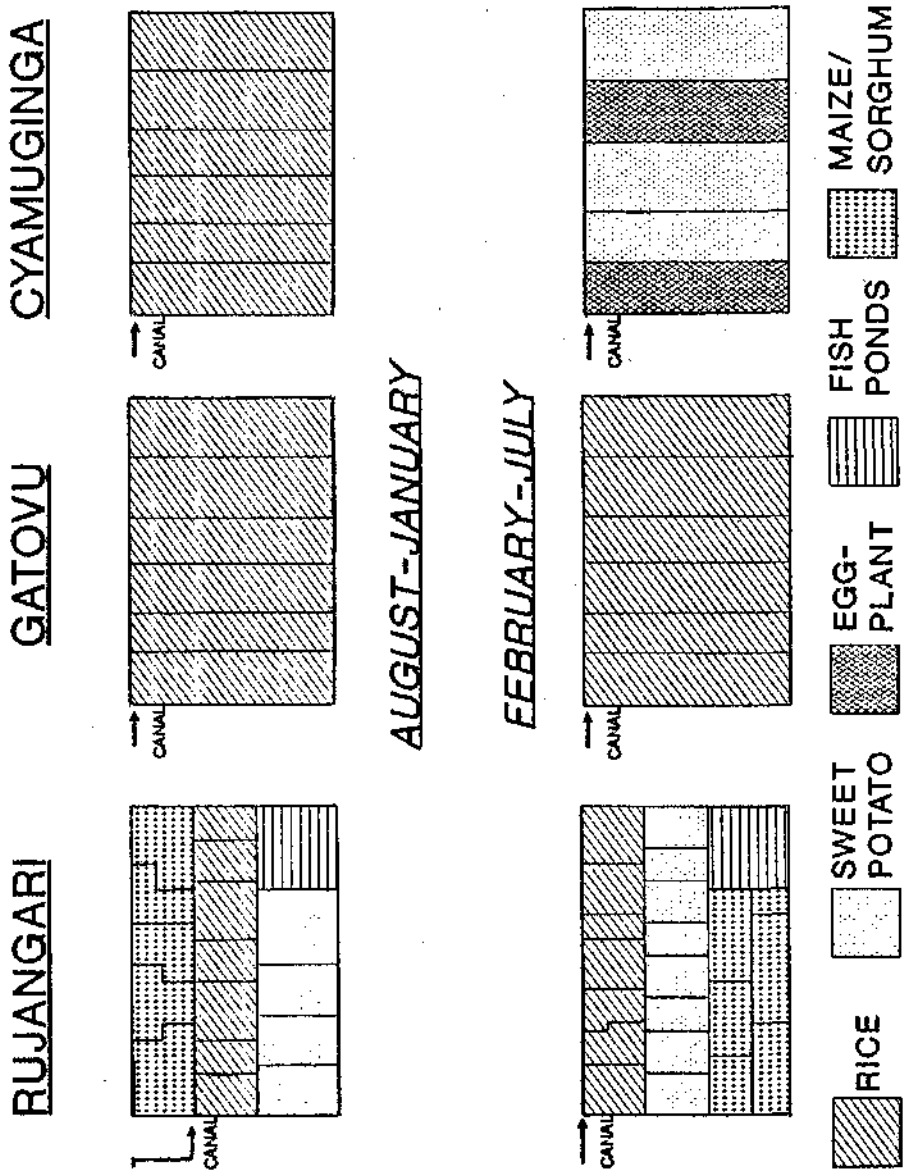

Figure 1: New Seasonal Land-Use Strategies Evolving in the Different Farming Groups

Whereas irrigation maintenance usually involves all members of the associations, other tasks are accomplished by smaller groups, reflecting their specific scale economies. In both Gatovu and Cyamuginga, rice nurseries are now maintained by groups of ten to fifteen, which appear able to avoid the inequitable sharing of seedlings that occurred with a single nursery.

The associations have resisted calls from local officials to form 'coopératives', in large measure because they wish to avoid the closed structure, formal statues and full panoply of officers, though they do seek recognition of their rights to the valley land. The 'coopératives' themselves, however, do not always work collectively, as officially expected. While the most labour-intensive aspects of rice cultivation are carried out together, sweet potato beds and the *sorjan* rice plots beside them may be the responsibility of individual women. One of the 'coopératives' has experimented with assigning smaller rice fields to members for their own subsistence, while larger fields are collectively cultivated for the market.

5. DISCUSSION

The diverse ways in which farmers have integrated rice into their production systems reflect the diversity of their physical and socio-economic conditions, underlining once again the importance of ensuring that a wide range of technological options are available for on-farm research. Our methodology also reduced the danger of conflict between rice and upland systems, for example in competition for labour, as farmers themselves decided the intensity and timing of rice cultivation. None of the farmers we worked with mentioned that rice had aggravated labour bottlenecks.

In collaborating with farmer groups from the earliest stages, the project avoided costly investments in seemingly appropriate techniques that would later have proven unacceptable. The *sorjan* is a case in point: it appeared to offer a low-risk means of increasing the intensity of land and water use while maintaining crop diversity. Farmers, however, were prepared for a much larger step; many, including some of the poorest, turned all their valley land into paddies to accommodate a crop they had never before grown. We doubt whether, even with substantially greater research resources, it would have been possible to predict this response, which belies the common image of the risk-averse small farmer. On the other hand, had we attempted to design technology in isolation before taking it on-farm, it is unlikely we would have considered the method employed in each of the groups to rotate

rice and other crops. Building and then destroying raised beds is prodigiously demanding of labour when considered on a hectare basis, but appears to be acceptable to farmers who manage only a few ares.

The integration of rice into these highland valleys has required innovation in organisation, particularly on the part of those farmers who previously farmed entirely independently. Together farmers have been able to realise what an individual could not do alone. In irrigation terms, this has involved building and maintaining simple sandbag-reinforced dams and peripheral canals. Success in cooperation is largely attributable to the significant benefits farmers derive from cultivating rice and the relative evenness with which these benefits are distributed within the groups, two factors that Wade (1987) identifies as crucial in determining the likelihood of sustained cooperative action. The associations were able to effectively realise economies of scale in water management and rice production, lack of attention to which may explain the failure of earlier, scattered attempts to introduce the crop in the Central Plateau.

Though based on a small sample of groups, the findings suggest that the quality as well as the scale of cooperation may be important in the innovations that can be developed. Collective ownership appears to make possible a degree of crop diversity that escapes farmers in the associations. The minute size of holdings in the valleys severely limits the choices open to individuals but their situation is not unusual. Larger Asian rice farmers find themselves similarly constrained, particularly by irrigation-related factors, in diverging from the prevailing cropping pattern (Schuh and Barghouti, 1987). If our analysis is correct, that the intensity of the relationship among members is key, one will find that existing groups with demonstrated cohesion and regular contact, possibly for reasons other than joint cultivation, make more dynamic research and management partners than those whose members are selected by scientists (Norman et al, 1988).

Discussions are currently underway among local institutions over how to build on these results in a larger extension programme in the Central Plateau. A major challenge will be to maintain the flexibility in presenting technological options, where extension workers have generally been expected to transmit simple messages in a large number of domains. The utilisation of these findings will also be affected by the outcome of current debate concerning agrarian reform in Rwanda.

The Commission Nationale d'Agriculture (1990) contends that the minuscule size of valley holdings precludes significant technological advance and efficient use of land and irrigation resources. It proposes that most valleys be cultivated by large, commercially-oriented groups of farmers who will have surrendered their hillside fields. Our work suggests that even the smallest of farmers have a capacity for innovation that includes a willingness to associate so as to realise economies of scale. Except in bringing the valleys under cultivation, agriculture as commonly practised has not placed much demand on that capacity. An alternative to the Commission's proposal would involve first presenting farmers with new options for land and water management that make cooperation worthwhile, then giving them the time to adapt the technology to local conditions and their organisation to the new possibilities.

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