SOCIAL SCIENCE AND THE MANAGEMENT AND SELECTION OF AGRICULTURAL TECHNOLOGY IN RWANDA

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INTRODUCTION

Some of the familiar actors in international development work are the economist concerned with trade and exchange rate policies, or with "getting the prices right"; the anthropologist who affirms the need to pay attention to farmers' practices and constraints; the agronomist who conducts trials about seed density, plant spacing, and correct fertilizer doses; the plant breeder concerned with gene frequencies, chromosome segregation, and phenotypic stability; and (too often last) the farmer worried about how a particular rainy season will affect his or her crops and how the children's school fees will be paid.

In their daily concerns, these individuals appear to have little in common. But they are joint participants in the profusion of consultancies and contracts known as international development. Practitioners of positivist, empiricist science are the new missionaries who would convert developing countries to western bureaucratic and scientific norms and values. Most of the scientists and the institutions for which they work would agree, however, that African agricultural research and development are at an impasse.

The 1984-1985 Ethiopian famine brought the dimensions of crisis to world attention and stimulated new donor projects and relief efforts. But many of the underlying difficulties of food production, distribution, and marketing in Africa remain beyond the reach of much foreign assistance. The litany of problems is familiar — a deteriorating natural resource base, soaring birth rates, overvalued currencies, inadequate infrastructure, and declining per capita food production. In addition, and less amenable at present to donor intervention, are problems concerning the accountability, representativeness, and responsiveness of African political and administrative institutions.

The reasons for the impasse in African development are complex. They range from the structure of African states, to the material and social conditions of the continent's small farmers, and global economic forces (Berry 1983, Hart 1982, and Hyden 1980, 1983). This paper considers lessons that emerge from two years of research in an IARC and in a national agricultural research program supported technically by the IARC in eastern Africa.

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INSTITUTIONAL CONTEXT

Social scientists who are expected to address technology management issues in agricultural research institutions do not always find any promising new technologies available for their attention. That was not the case in the project discussed here, which already had had notable local success with its improved cultivars. Social science research in collaboration with biological scientists, however, did contribute recommendations for more effective technology selection and management.

From 1984-1986, the author, an anthropologist, was affiliated with the CIP, whose headquarters are in Lima, Peru, near the Andean Center of origin of the potato *(Solanum tuberosum).* Over the last decade, CIP has had several anthropologists and economists on its staff or as research affiliates (Brush 1986, Horton 1983, Monares 1984, Poats 1981, Rhoades 1984, Scott 1985, and Werge 1981). Until the research discussed here, however, CIP's social scientists had been based at the center's Lima headquarters rather than at its regional program offices in Latin America, Asia, and Africa. CIP, like other IARCs, provides technical support to national agricultural research programs in developing countries. One of these programs is in Rwanda in eastern Africa, where the author was based for two years while conducting research in Rwanda, Burundi, and Kenya. This paper focuses on Rwanda.

PNAP is part of that country's national institute of agronomic research. PNAP was established in 1979 by the Government of Rwanda, with technical and financial assistance from CIP (see Bicamumpaka and Haverkort 1983, and Nganga 1983). The program had attracted national and international attention before the research discussed here began. It was, for example, nominated for the 1985 UNESCO prize for scientific achievement; the ISNAR at the Hague uses it as a case study training document; the President of Rwanda awarded it a national prize for its role in helping to alleviate famine during the 1984 drought; it is widely praised by national officials and foreign aid donors as one of Rwanda's most successful agricultural projects; and it is used as a model for new projects in Rwanda and neighboring countries.

PNAP previously had neither local nor expatriate social scientists on its staff, though short-term CIP consultants had conducted some social science research and Poats (1981) had done an eight-month study on potato consumption in Rwanda. In spite of CIP requests to do so, Rwanda did not assign any of its own social scientists to PNAP.

How much flexibility and autonomy do anthropologists in the IARCs have in defining their research, and to what degree is basic as well as applied research acceptable? Answers to these questions vary from one institute to the next, as do definitions of basic and applied research. While one center may find land tenure research, for example, to be "academic" and unncecessary, another may view it as essential. Although it is now generally recognized that basic and applied research are

mutually beneficial (Brush 1986), this recognition in the IARCs is perhaps more admissible in the biological rather than the social sciences. There is a perception on the part of the biological scientists who dominate the international centers that anthropologists "if not controlled, are commonly tempted into complex and complete studies of particular communities or situations" (Rhoades, Horton, and Booth 1984).

A too narrowly defined range of permissible research questions, however, can reduce the quality of any study. Social scientists are in the IARCs because it is increasingly recognized that they can help to define biological and technological research priorities relevant to fanners' circumstances, and can provide useful information on adoption and distribution constraints and on the impact of improved agricultural technologies. It is up to the social scientists themselves to define the relevant range of inquiry for their own research, taking into account the needs and objectives of the institutions with which they work. Part of their task can be to widen the scope of admissible social science inquiry, if they believe this would benefit the IARCs or the users of improved technologies.

The material accouterments of a professional in an IARC (housing, vehicles, and funds for research and travel) immediately remove one further from the conditions of fanners than is customary in traditional anthropological fieldwork. In addition, such a position can involve formal and overt identification with a government research program or project. Although such associations are often intentionally avoided by anthropologists in the field, they are not necessarily a disadvantage. In the case discussed here, association with a popular and successful national research program was a decided advantage in fieldwork with local farmers.

FIELD RESEARCH

One of the most effective ways to increase agricultural production in a country such as Rwanda is to breed, select, and release improved crop varieties that require no complementary purchased inputs. The cornerstone of the Rwandan national potato research program is the selection and release of new disease-resistant, higher-yielding potato cultivars that require no purchased inputs other than the seed itself (which in the eastern African highlands have a low rate of degeneration so that farmers need not repurchase seed for 5-10 years). During its first five years, the Rwanda program released six improved cultivars whose yields under local farm conditions (without fertilizers or chemicals) were two to five times the previous national average.

Given the program emphasis on selecting and releasing improved cultivars, the author's research first addressed how farmers assess and use potato varieties already cultivated in rural Rwanda. CIP has supported similar studies in Peru and Nepal (Brush, Carney, and Huaman 1980, and Rhoades 1985).

In Rwanda, formal and informal surveys were used to collect information on farmers' agricultural practices, and on what cultivar traits farmers in various environmental zones and wealth categories prefer and why. These data were used in the national breeding, germplasm screening, and seed production programs to help define research priorities, and criteria for trial management and varietal selection that reflect accurately farmers' circumstances.

With one crop (potatoes) as the starting point, surveys addressed farming systems issues concerning production, consumption, storage and marketing, and questions of household dynamics (e.g., differences within the household -- in responsibility for particular crops, in access to income and land, and in selection of seed; and exchanges between households of planting material, land, and labor). The intention was to collect an internally consistent and coherent body of data that would serve complementary theoretical and practical purposes. Field research also involved participation in the design, monitoring, and evaluation of on-farm trials to test and improve specific new techniques and practices.

This paper discusses three major research results and their programs' consequences: I) the utility of shortduration cultivars, **2)** the importance and feasibility of intercropping and cultivar mixtures, and 3) problems of disseminating information and distributing program benefits equitably in all parts of the target area.

Short-Duration Cultivsn

Farm survey results contributed to a new program emphasis on selecting improved cultivars that have shorter growth cycles and shorter dormancies (time elapsed between physiological maturity of the tuber and adequate sprouting for planting the next season). Since land is a major constraint and rainfall is well distributed in the eastern African highlands, shortduration cultivars that permit multiple cropping are a particular advantage, even if the shorter cycles entail some sacrifice in yields. While one of the improved potato cultivars that **PNAP** first introduced in Rwanda does have a short growth cycle (about three months), most of the program's improved cultivars have later maturity (four to five months). It was not suggested that the later-maturing (and usually higher-yielding) cultivars be abandoned for an exclusive emphasis on short-duration cultivars, but rather that the latter be given greater emphasis in the germplasm screening and seed production programs.

Farm surveys of 186 farmers in all of Rwanda's major potato production zones suggested the need for such a shift in emphasis in the following ways. First, for example, among the four most frequently grown potato cultivars in Rwanda is a cultivar (*Gashara*) introduced a number of decades ago, which has degenerated and would have been abandoned long ago if yield and disease resistance were farmers' principal cultivar selection criteria. However, the surveys showed Gashara to be still among the most frequently grown cultivars, because farmers value its short growth

cycle, short cooking time, short dormancy, good taste, and high starch content. None of the available new cultivars combines all of these preferred characteristics.

Second, the survey results indicated that only two percent of the 186 farmers interviewed prefer to use only long-cycle cultivars (which had been emphasized by PNAP). Over half of the farmers (52 percent) stated a preference for only short-cycle cultivars, 2 percent preferred medium-duration cultivars, and 44 percent preferred a combination of long-, medium-, and short-duration cultivars. Many farmers grow both long- and short-cycle cultivars in order to increase the number of months when fresh potatoes are available for sale and consumption, to reduce the risks of rainfall uncertainty, and to exploit different ecological zones. If a farmer grows a short-cycle cultivar which he knows he can harvest early, he is then more likely to be able to afford (if he has adequate land) to wait for the later harvest with a higher yield of a longer-cycle cultivar.

For Rwandan farmers, the acceptable range of days to maturity in potato cultivars is strikingly skewed toward the short end of the international breeder's theoretical range (which extends to over 150 days). Rwandan farmers' preference for a mixture of long- and shortduration cultivars translates into short and medium maturity (no more than 120 days) on a plant breeder's scale.

With regard to length of dormancy, most farmers surveyed again prefer either to maintain diversity in this trait by planting some cultivars with short and some with long dormancy (54 percent of those surveyed), or to plant only shortdormancy cultivars (43 percent). Short dormancy (to minimize the time between harvest and adequate sprouting of seed for replanting) is an advantage where rainfall distribution allows double and sometimes multiple cropping. Keeping cultivars with both long and short dormancy allows farmers greater flexibility in managing seed stocks and harvest and planting dates.

The type of cultivar PNAP had emphasized in its germplasm screening and seed production programs has large tubers, high yields (20-30 tons/hectare), relatively late maturity (110-I20 days), long dormancies (3-4 months), and good late blight resistance. Farmers who can benefit most from this type of potato cultivar have above-average land and capital assets. They *can* afford to keep plots of land occupied with longer-maturing cultivars, and they have adequate cash to purchase food while awaiting the potato harvest. A central recommendation of the farm surveys, however, was that PNAP's germplasm screening and seed production program begin to give less emphasis to (but not eliminate) the type of cultivar just described and more emphasis to those with early maturity or short dormancy or both. Given Rwanda's very small farms and high population density, many farmers can benefit from the latter type of cultivar. They cannot necessarily afford to keep scarce land occupied under longer maturing cultivars, and they do not have adequate cash to purchase food while waiting for the potato harvest.

Intercropping and Cultivar Mixtures

While agriculture in developed countries is made vulnerable by increasing genetic uniformity in the form of cultivar specialization, the cultivar mixtures and intercropping already practiced by so many African farmers are an excellent first line of defense against crop biological and climatic hazards. Maintenance of such diversity is an important means of managing risk, environmental hazards, and resource limitations; and a means of meeting varied production goals (home consumption, sale in different types of markets). Many agricultural research institutions, however, give little attention to the possible benefits of cultivar field mixtures and intercropping.

In Rwanda, recorded observations of 360 potato fields in all of the country's major potato production zones demonstrated the prevalence of intercropping and field mixtures of potato cultivars. Surveys showed that most Rwandan farmers grow three to five different potato varieties at once and that most of their fields contain cultivar mixtures. They find advantageous the mixtures' variability in such traits as length of growth cycle and dormancy resistances, tolerances of rainfall excesses and deficits, dry matter content (which affects taste and storability), and marketability. Nearly half (47 percent) of the observed potato fields were intercropped. The most common crops associated with potatoes were maize, beans, sorghum, colocasia, and sweet potatoes. Government agricultural survey data show that over half of Rwanda's total cultivated area is intercropped, and that 48 percent of the area under potatoes is planted in crop mixtures (Government of Rwanda 1985:71). There is evidence that far from being a dying "traditional" practice, intercropping in Rwanda is increasing over time as population density increases (Janssens et al. 1985).

On the basis of these results, it was recommended that PNAP begin on-station research with cultivar mixtures to test their comparative performance under late blight and other environmental pressures. It was also suggested that given the scarcity of land, increasing population pressure, and likely increase in intercropping, it would be useful to conduct agronomic trials testing common crop associations to determine land equivalent ratios, possible positive effects of intercropping on disease and pest vulnerability, and the performance of different potato cultivars in crop associations. It was also recommended that germplasm selection criteria for some material should include short stolons and vertically extensive, rather than horizontally extensive leaf coverage (i.e., emphasizing height rather than breadth of foliage) in order to reduce competition of potatoes with associated field crops. PNAP then began new on-station trials to test the comparative performance of the program's improved cultivars when grown in crop and cultivar mixtures rather than in pure stands, On-station intercropping and cultivar mixture trials in Rwanda will measure the effects of genotype mixtures on disease and pest transmission and yields. Such trials help to correct publicly the idea that agricultural progress should necessarily involve the monocropping and cultivar specialization common in Western industrial economies.

Given the small size, limited resources, and youth of the Rwandan national potato research program, it has achieved a remarkable impact. Two of the improved cultivars that the program released in 1980, for example, were found in all of the country's major potato producing regions by 1985. In 40 percent of the potato fields observed in four production zones, the PNAP cultivar (*Sangema*) was the variety that occupied the largest field area. In nearly another quarter of the observed fields, a second PNAP (*Montsama*) occupied the largest field area. Such success becomes equivocal, however. As expansion of the area under the one or two most popular cultivars increases genetic uniformity and therefore vulnerability of the crop to pathogens (especially late blight). It is now important that cultivar diversity be encouraged and supported by the selection and effective distribution of a number of additional improved varieties that suit local circumstances.

Distribution and Impact

Farm surveys drew attention to two distribution and impact issues: 1) regional biases in germplasm screening and cultivar selection, and 2) limitations of farmers' access to improved seed. Although PNAP conducts multilocal cultivar trials throughout Rwanda, by the time would-be new varieties reach the multilocal trial stage, hundreds of genotypes (usually introduced from CIP's Lima or Nairobi programs) have been tested and eliminated during several seasons of screening in the northern volcanic soil zone where the national potato research program is based. Varieties selected according to this scheme often perform better on the highly fertile volcanic soils than they do elsewhere. A proposal is now under consideration to screen germplasm before the multilocal trials stage in the other two principal potato zones (lateritic and forest soils).

Although farm surveys showed that Montsama and Sangema (the first two improved cultivars released by PNAP) achieved a wide distribution, cultivars released later have yet to achieve a comparable impact. In part, this is because the time elapsed since their introduction simply had been shorter when the surveys were conducted in 1985 (no more than three years had passed since the later introductions, and it had been five years since the successful early releases). In addition, however, the present system of seed distribution makes access difficult to many farmers.

The national potato research program breeds and selects improved varieties, and produces a small stock of clean seed of the new cultivars which it distributes to a parastatal seed multiplication service and to a number of rural development projects, but not directly to farmers. These projects are responsible for multiplying the basic seed and distributing it to farmers. Because many farmers (89 percent of those surveyed) have not acquired improved seed through this system, proposals are being considered to widen farmers' access by involving private traders in seed sales, and by allowing the national potato research program to sell some of its seed in 5 or 10 kilogram units directly to fanners, rather than distributing all of its seed in multi-ton units to designated projects.

In short, producing suitable cultivars is only one step. Getting the technology right is sometimes more easily accomplished than is its effective distribution. The latter requires direct (and not necessarily welcome) involvement in political and administrative institutions.

DEVELOPMENT POLITICS AND ADMINISTRATION

While the effects of political and administrative structures on agrarian change and development receive considerable scholarly attention, they are often taboo subjects in project design and evaluation documents. **Some** development project personnel quietly attempt to overcome regional and ethnic biases in national agricultural research programs (by requiring, for example, that they be permitted to conduct agronomic trials in "representative"zones). But many others operate in a self-willed political vacuum. Ignoring politics does not necessarily preclude the achievement of technological improvements and production increases. But neither can it be assumed that improved technologies will find their own way to needy clients.

These considerations raise the issues of when, how, and by whom advocacy for clients underrepresented in national-level institutions is appropriate for international centers. Pleas for participatory research are not new, but the need remains to find ways of increasing the voice of less-privileged groups in defining agricultural research priorities and procedures.

For the most part, the IARCs respond to research priorities identified **for** them by state bureaucratic elites. One African country, for example, disfavors expansion of potato production into more marginal lower-altitude zones **as** counter to its policy of regional economic specialization and trade. Breeding potatoes adapted to marginal zones, however, is an important global priority of CIP. Potatoes can add an imporant new protein source *(see* Woolfe 1986) to some of Africa's more marginal zones that now depend heavily on low-protein staples such **as** sweet potato and manioc. In the country in question, CIP negotiated an arrangement to continue its development of new potato varieties adapted to zones outside of the cooler, well-watered highlands where the crop is traditionally grown.

Where national and international interests differ, foreign donors may become unwitting participants in regional or ethnic rivalries and conflicts. International insistence on an approach not locally favored also risks acquiring neocolonial overtones. The edifice that development "experts"have helped to establish in Africa is fragile. Projects have a tendency to revert to distribution of products and services through patronage once the expatriate buffer is absent. It is not surprising that some development project staff opt for the gains possible through the patronage networks that define their own institutions, rather than relying on the alien values and "civic public morality" (Hyden 1983, Ekeh 1975) of Western bureaucracies.

Formal economies in Africa are often the subordinate partner of the informal economy or "economy of affection" (Hyden 1981, **1983).** Similarly, the state and its civic public morality are counterpoised to the morality of patronage politics that is rooted in rural social and economic structures, and that sanctions the diversion of state resources into private hands. Reality of course involves more complex shadings than such dichotomies allow. But it is evident that formal economic and political structures in Africa are increasingly threatened by their opposite faces.

Individuals too are torn, as wealth accumulation and success in the formal economy and polity bring increased demands from kin and clients in the informal economy and polity. Individuals are not secure enough in their positions to risk cutting themselves off from the informal system, but the pressures of the latter inevitably undermine the formal system. For the moment, these counterpoised systems fuel both individual wealth accumulation, and redistribution of that wealth through the ties of kinship and clientage upon which its accumulation **is** based. Aid donors must find means to deal constructively with these sociopolitical and economic realities.

It is of course politically easier to focus on plants, genes, and soils, which **is** one reason why social scientists are not always welcome additions to agricultural research institutes, and why, when they do join them, they sometimes find it more politic to focus on getting the technology right than on the institutional issues involved in managing the technology.

Developing suitable technology is itself a long and difficult process. But it is the institutional questions (e.g., how sociopolitical relationships and particular local institutions structure individual access to resources such **as** improved seed, fertilizers, or chemicals) that largely determine a technology's impact. Social scientists can address such institutional issues; they can filter information about the conflicting interests of different economic, sociopolitical, ethnic, and regional groups; they can help to define research priorities relevant to local conditions; and they can help to develop and to test improved technologies. In **so** doing, they improve the appropriateness, distribution, and impact of new agricultural technologies.

BUILDING NATIONAL SOCIAL SCIENCE CAPACITY IN AGRICULTURAL RESEARCH

Both foreign and national anthropologists in African agricultural research institutes often encounter the view that social science research is inherently impractical, and that it should he a low priority for developing countries because they cannot afford the luxury **of** research for its own sake. Given a choice, many African agricultural programs prefer an agronomist, plant breeder, soil scientist, or plant pathologist to a social scientist. While social science research cannot be expected to assume a leading **role** in agricultural development, international donors

and institutes nonetheless increasingly recognize the need to take explicit account of the circumstances and needs of the users of proposed new agricultural techniques, and of the local institutions responsible for their development, adaptation, and diffusion.

African agricultural institutions are sometimes unwilling to recognize the actual and potential contributions of social science, or to allow staff positions for their own national social scientists — whether locally or externally financed. At least one eastern African country turned down in 1984 a multilateral donor offer to fund a national social science position that would have been filled by locally selected candidates who would have worked with biological scientists in a national agricultural research institution. This unwillingness is linked not only to the view that biological scientists are more useful, hut also to the common perception that social science research is politically sensitive and risky.

In spite of these difficulties, one of the most important tasks of expatriate social scientists in national agricultural programs is to support the training and apprenticeship of local social scientists in agricultural research. At least as important as the results of particular research projects is the institutionalization of replicable approaches and methods for acquiring an understanding of farmers' circumstances and practices. This is especially Important given the enormous microdiversity of African farming systems and environments, and the location-specificity of particular research results.

SUMMARY AND CONCLUSIONS

This paper has considered the role of anthropological research in the IARCs and in national agricultural research institutions. It discussed some specific implications of such research for technology selection and management in Rwanda. Farm surveys in that country helped in identifying potato cultivar selection criteria suited to local needs and constraints, proposing specific new on-station experiments that reflect local farmers' practices and constraints, and assessing the impact of previously introduced, improved cultivars, and of the associated seed distribution program.

Although social scientists in agricultural research can help to develop suitable agricultural technologies and research priorities, their Contributions are too often sought after substantial investment in technology development has occurred. In addition, it is often difficult for them, and for the IARCs to address adequately the more sensitive, hut crucial, issues concerning sociopolitical and administrative structures that affect the management, distribution, and impact of the new technologies.

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