IDRC-189e

Coming Full Circle

Farmers' participation in the development of technology

Coming full circle: farmers' participation in the development of technology

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Abstract

Involving farmers in identifying the constraints to rural agriculture and in designing measures to alleviate them is the subject of this publication, which resulted from a meeting, held in Ouagadougou, Upper Volta, 20–25 September 1983. Agronomists, economists, anthropologists, and others seeking to get the most from research efforts discussed the pitfalls of assembling packages that are sound technically but have some essential flaw because the developers have overlooked some crucial constraint at the farm level. The subject is one that is receiving much attention currently as agriculture in developing countries has failed to net major increases in production despite thousands of dollars invested in research and optimistic claims that improved varieties, techniques, equipment, etc. have been developed. The gaps between results on research stations and those on farms in the Third World have prompted some researchers to view the farmers' conditions as the real laboratories. Why, how, where, and when to get farmers involved in research are the focus of this document, and the degree to which researchers and the agencies they represent have been able to listen and work with their new partners varies, as is clear from the 11 papers and the commentary that follows them.

Résumé

La participation des paysans à l'identification des problèmes agronomiques et à la recherche de leurs solutions est le sujet de cette brochure qui rapporte les états d'un séminaire tenu à Ouagadougou (Haute-Volta) du 20 au 25 septembre 1983. Afin de mieux exploiter les résultats des recherches, des agronomes, des économistes, des anthropologues et d'autres personnes intéressées ont discuté du danger de préparer des blocs agronomiques, solides sur le plan technique, mais possédant des vices fondamentaux, les développeurs n'ayant pas pris en compte certains obstacles critiques au niveau des fermes. Ce thème est largement débattu aujourd'hui alors que la production agricole stagne dans les pays moins avancés malgré l'injection de milliers de dollars dans la recherche et les espoirs mis dans la création de variétés, techniques et équipement améliorés. La différence entre les résultats obtenus dans les stations de recherche et ceux recueillis sur les fermes ont conduit des chercheurs à reconnaître que la ferme même constituait le vrai laboratoire. Le thème principal de cet ouvrage qui se dégage des onze communications présentées et des commentaires qui suivent, est donc de déterminer quand, où, comment et pourquoi les fermiers doivent participer à la recherche et aussi, jusqu'à quel point les chercheurs (et les organismes qu'ils représentent) ont su être à l'écoute des paysans et travailler avec eux.

Resumen

La participación de los agricultores en la identificación de las limitaciones a la agricultura rural y en el diseño de medidas para superarlas es el tema de esta publicación que resultó de una reunión celebrada en Ouagadougou, Alto Volta, del 20 al 25 de septiembre de 1983. Agrónomos, economistas, antropólogos y otros interesados en obtener lo mejor de los esfuerzos investigativos, discutieron los problemas de producir paquetes técnicamente válidos que no obstante presentan fallas básicas porque sus diseñadores han perdido de vista alguna limitación crucial a nivel de la finca. El tema recibe actualmente mucha atención debido a que la agricultura de los países en desarrollo no ha podido aumentar la producción pese a los miles de dólares invertidos en la investigación y a las optimistas voces que proclaman haber desarrollado variedades, técnicas, equipo y otros elementos mejorados. La brecha entre los resultados de las estaciones de investigación y aquellos de las fincas del Tercer Mundo han hecho que algunos investigadores consideren las condiciones de los agricultores como los verdaderos laboratorios. Por qué, cómo, dónde y cuándo involucrar a los agricultores en la investigación es el tema central de este documento, y el grado en que los investigadores (y los organismos que representan) han podido escuchar y trabajar con sus nuevos socios varía como lo demuestran los 11 trabajos del libro y el comentario final que los sigue.

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Farmers' participation in the development of technology

COMING FULL CIRCLE

Editors: Peter Matlon, Ronald Cantrell, David King, and Michel Benoit-Cattin

Contents

Using ethnoscientific tools to understand farmers' plans, goals, decisions

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Farming-systems research and extension programs are now generally viewed as having some hope of increasing food production on small rainfed farms in the Third World (Gilbert et al. 1980; Shaner et al. 1981). Approaches to farming-systems programs are varied, with debates raging about "downstream" vs "upstream" approaches, and FSIP vs FSR/E (the farming systems' approach to infrastructural support and policy vs its approach to technology generation, evaluation, and delivery) (Norman and Gilbert 1981; Norman 1982).

In general, however, all farming-systems programs share (Hildebrand and Waugh 1983:4):

- A concern with small-scale family farmers who generally reap a disproportionately small share of the benefits of organized research, extension, and other developmental activities;
- A recognition that a thorough understanding of the farmers' situation is critical to increasing their productivity and to forming a basis for improving their welfare; and
- The use of scientists and technicians from more than one discipline as a means of understanding the farm as an entire system rather than the isolation of components within the system.

The focus of a farming-systems program is the farmer, rather than the crop, the technology, or the environment (CIMMYT Economics Program 1980). The farming-systems approach thus starts with the farmers' constraints and develops, through experiments on their fields, recommendations to improve their family's standard of living. Most farming-systems programs accomplish this aim via a multidisciplinary team that, first, diagnoses farmers' problems, goals, and constraints; second, identifies new technologies or strategies to deal with or alleviate those constraints; third, tests the promising technologies or strategies via experimentation and on-farm tests; and, fourth, diffuses or extends the new technologies or strategies to the local farmers (Gilbert et al. 1980).

As farm trials and farmers' tests are on farmers' fields and the farmer is consulted during both the diagnostic and the evaluation stages, the farmer is clearly at the centre of the program and farming-systems projects all espouse the goal of involving farmers more explicitly at each stage (of diagnosis, technology development, and technology assessment). However, as noted by the sponsors of this conference, " . . . the goal of direct and creative farmer participation has been elusive. . . ."

How to increase and improve direct farmer participation — and at which stage(s) — has been widely debated. At one extreme are those who call for continual but informal contact with participating farmers, disavowing all formal social-science surveys as "superfluous," not directly useful to the technical team designing trials and offensive to farmers who have been researched to death (P. Hildebrand, personal communication). At the other end of the spectrum are those who subject farmers to nine different kinds of questionnaires on a weekly, monthly, and yearly basis for 4–5 years (Ryan 1977).

Based on the Economics Program at CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo), we propose a compromise solution — a mixture of an initial, informal phase and a formal follow-up (Winkelman and Moscardi 1981). Our solution differs from CIMMYT's, however, in aim and purpose. Rather than focusing on factual data collected to test scientific theories about farmers, the "ethnoscientific" approach to increasing farmer involvement concentrates on cultural symbols used by farmers. The aim is "to grasp the native's point of view, . . . relation to life, . . . vision of [the] world" (Malinowski 1922:25). To see the insider's world through the insider's eyes is the goal of ethnography, which differs from other social sciences in its emphasis on indigenous or folk knowledge rather than on scientific knowledge. Because "the subject matter in ethnoscience is not environmental phenomena as such, but people's knowledge and interpretation of these phenomena" (Glick 1964:273), an ethnoscientific approach to involving farmers in farming-systems research is quite different from previous approaches. It differs most notably in use of trained personnel and choice of research tools. To acquire an understanding of folk or indigenous knowledge systems in a natural way (Brokensha et al. 1980), ethnoscientists participate and live in the culture they are observing, often for extended periods (Spradley 1979). To test their understanding, they model farmers' knowledge of the meaning of important cultural symbols in their farming systems. This indigenous or folk knowledge can be summarized and represented in taxonomies, plans or scripts, goals, and decision models. To describe and illustrate the usefulness of these tools, we present models of farmers' classification systems, decision processes, goals, and plans, and show how we use them to understand and evaluate traditional farming systems of family farmers in north Florida. Our models of farmers' folk knowledge are " 'micro' in scope and deal mostly with conditions inside the farm gate" (Hildebrand and Waugh 1983:4). As such, ethnoscientific research falls within an FSR/E rather than FSIP program.

Taxonomies

The pillar of ethnoscientific tools is taxonomy, based on the relationship "x is a kind of y" (e.g., trees and flowers are kinds of plants; oaks and elms are kinds of trees; white and red are kinds of oaks; etc.). More formal definitions are found in Frake (1971), Kay (1971:868–869), and Werner and Schoepfle (1979:49–50). Taxonomic analysis searches for the internal structure of domains, which are sets of cultural symbols that carry meaning for and to the members of the culture.

For an example of a taxonomy, let us look at the case of Gadsden County, north Florida. For the better part of its agricultural history, Gadsden County's farming has been based on "shade," or cigar wrapper, tobacco. At its height, shade tobacco was planted on more than 2.4×10^3 ha, produced more than 3.6×10^3 t annually, and accounted for 65% of the value of all agricultural products in 1969, and 45% of the value of all agricultural products in 1974, just 3 years before it dropped out of production completely (US Agricultural Census 1974, 1978). Shade, as a type of tobacco, was first developed during the latter part of the 19th century. During the 1890s, the area's tobacco industry was being revived through the production of "sun," or cigar filler, tobacco (Womack 1976:99–101). Growers soon discovered, however, that the light-coloured, silky leaves found near the shaded base of the plant and on plants shaded naturally by trees brought the highest prices at market because these leaves made the best cigar wrappers. Until the mid-1970s, shade was a labour-using, land-saving, ideal crop for Gadsden's relatively small fields with rich soils. Because production inputs for shade were supplied partially by tobacco companies who established a formal "forward contract" with the farmer, shade was not a risky crop to produce, even though input costs increased from \$3125/ha in 1955 through \$7500/ha in 1968 to more than \$17 500/ha in 1977. At the same time, the farmer's profit margin remained in the range of \$2500–5000/ha, with increasing costs of production (mostly labour) keeping the profit margin down.

Shade tobacco was also part of a more general farming strategy. Although shade tobacco received the most attention, other commodities (e.g., cattle and corn) were managed around the production of shade tobacco. The cattle were maintained for their manure that was added to the soil to maintain soil structure and supplement the chemical fertilizers. Corn was produced mainly for cattle feed. Interestingly enough, farmers frequently stated that the value of cattle and corn was associated only with their benefit to shade tobacco; in and of themselves, they were only breakeven ventures.

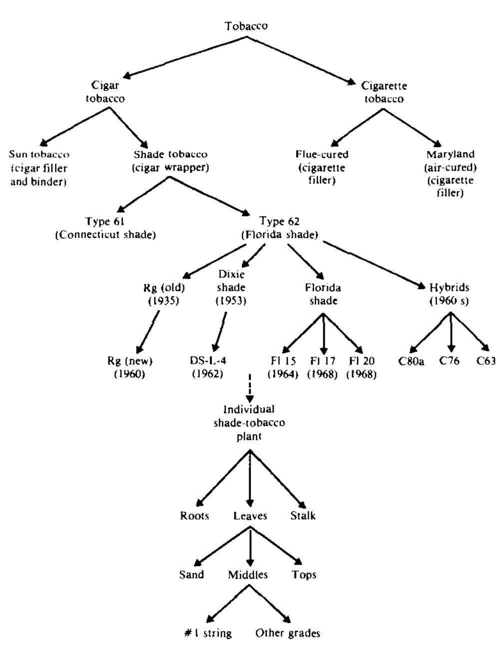

Fig. 1. Ethnoscientific taxonomy of Gadsden farmers' understanding of tobacco.

During the decade 1967–77, however, shade tobacco as a farming system and the basis of a unique farming culture disappeared because of increasing costs of production aggravated by increasing labour costs; competition from Central America where a shade tobacco industry based on cheaper labour was developed with the help of the US government and some Gadsden farmers; the development of synthetic or manufactured "homogenized" wrappers for cigars and the use of a plastic tip that eliminated the need for a full leaf to hold the cigar together; and the decline in the demand for cigars (Plath 1970). The traditional farming script thus interrupted, shade producers had to decide whether to continue the traditional farming system and find a crop similar to shade tobacco, to change their farming system drastically and increase their row-crop and livestock operations, or to cut back substantially and even drop out of farming completely. To understand how they made this difficult decision, one must understand how they thought about shade tobacco and what meaning shade had in the culture of Gadsden County, which had, after all, developed for 80 years around the crop.

To find a substitute money crop for ex-producers of shade, a member of a farming-systems team could consult the USDA (United States Department of Agriculture) classification of the different kinds of foreign and domestic tobacco (Gardner 1951:18). But, because farmers' decisions and survival plans depend on and are influenced by *their own knowledge* or perception of tobacco, rather than USDA's knowledge of tobacco, a more useful approach is to understand shade tobacco as the farmers do. Thus, an ethnoscientist would elicit the classification structure of tobacco internal to the Gadsden farmer. Briefly, this taxonomy (Fig. 1) says that, first, Gadsden farmers classify tobacco by use, into cigar tobacco (sun and shade tobacco) and cigarette tobacco (flue-cured and air-cured, Maryland) (Zabawa and Gladwin 1983). At the next level, shade tobacco, used for cigar wrappers, is distinguished from sun tobacco, used for cigar fillers. Produced in Gadsden in the 1930s, sun tobacco production declined as shade tobacco became more prominent.

Since the 1930s, the national government has controlled production by granting farmers the right to grow flue-cured tobacco in small areas or allotments, with a ceiling at 175 acres (ca 75 ha) total in Gadsden. Maryland tobacco was briefly introduced in the county in the 1960s, but production declined shortly thereafter when pressure from Maryland legislators forced Gadsden farmers to include Maryland tobacco as part of their flue-cured allotment. This action effectively squelched any attempt by Gadsden farmers to adopt Maryland tobacco because they had been growing it to increase their production over and above their flue-cured allotment.

The lower taxonomic levels further specify different varieties of shade tobacco (Type 61, Type 62 or Florida shade), and different varieties of Florida shade (Rg, Dixie shade, Florida shade, and the hybrids). Partonomies or part–whole relationships then distinguish meaningful parts of the individual plant for the farmer: the roots, stalk, and leaves are important parts of the tobacco plant. Because the shaded leaves contain the plant's economic value, "sand" leaves (the bottom two or three marketable leaves) are distinguished from the "middles" (the next 4–19 leaves, among which the most desired leaves are usually found), and the "tops" (the upper 24 marketable leaves on the plant). The taxonomic structure can be carried one stage further in the marketability of specific kinds of leaves. For example, the most profitable of the "middles" were called *number one strings* and sold with no further grading, whereas the rest of the leaves went through a grading procedure developed by the tobacco companies.

The taxonomy of shade tobacco thus represents the knowledge structure Gadsden farmers have developed while growing shade. A farming-systems team can consult the taxonomy for possible substitute money crops. Indeed, the second level taxa — flue-cured tobacco and Maryland — would have been logical alternatives to shade if government controls had not prevented increases in the production of these crops.

Gadsden's farmers thus had to switch to money crops outside the domain of tobacco. How did they make that decision? In most cases, they searched for and found alternative crops (such as tomatoes, nursery crops, or pole beans with squash) that caused only a small disruption to the original, formerly successful crop plan or farming system. A knowledge of how they grow shade — their plan or script — would be essential in identifying a similar crop.

Plans and scripts

Instead of deciding how to do something every year, farmers develop a plan or inherit a plan already developed by their parents or grandparents. The plan, "how to do x," is a sequence of mental instructions or rules that tell the actors *who* does *what*, *when*, and for *how long* (Werner and Schoepfle 1979). The rules could be considered by the outsider to be a set of decision rules. To the insider or decision-maker, however, they are not *decision* rules, because he or she is not *aware* of having had to make a decision. The decision is made so frequently, so routinely, that the decision rules become part of a preattentive plan or "script," like the script in a play that tells the actor what to say and do (Schank and Abelson 1977). By means of these scripts, the farmers do not have to make a million decisions; they *know* how

Table 1. Gadsden County farmers' plan for shade tobacco (Kincaid 1960).[a]

Timing	Task
January	Plant seed beds
January – February	Prepare soil; fumigate; fertilize
March	Harrow soil into rows about 3 weeks before transplanting seedlings; install shade cloth shortly before planting
Late March – early April	Transplant and irrigate seedlings in the shade; replace missing or weak plants within a week; dust plants with insecticides every 7 days; plow the rows twice a week (discontinue near harvest time to prevent damage to the leaves)
April	String plants (starting when plants reach 0.3 m), spirally from the stalk near the ground, to the overhead wire above the row; continue to string, spirally between the leaves, once or twice a week depending on rate of growth
May	Water when needed using overhead irrigation system
June	"Top" plants to prevent budding if desired
July	Harvest 7 – 8 weeks after transplanting; harvesting consists of picking the desired leaves off each plant, i.e., "priming" (there can be 2 – 5 leaves per priming and 6 – 10 primings per plant); placing the leaves in the order picked and hauling them to the tobacco barn; stringing the tobacco in the barn; curing the tobacco in the barn (3 – 5 weeks); and delivering the tobacco to the packing house
August	Clean up and prepare for a fall crop (e.g., pole beans) if desired

[a] Labour force was primarily local blacks.

Table 2. Gadsden County farmers' plan for staked tomatoes.[a]

Timing	Task
December–January	Prepare the soil, add lime; order plants
February	Lay plastic mulch on the rows; fumigate; fertilize
March	When plants arrive, transplant them into the fields about 15 March (plants are watered through trickle irrigation that is under the plastic; soil treatments are applied under the plastic as well; plant treatments are applied through overhead irrigation if available, or by portable sprayers); spray plant treatments on every 5–7 days to prevent insects and disease
April	Stake plants about 2 weeks after planting; start horizontal stringing 2 weeks after staking and continue every 2 weeks until there are four horizontal rows of string per row of tomatoes
May	Complete stringing; irrigate as needed
June	Start hand-harvesting the "green" tomatoes; delivering them to the packing house for shipment; harvesting involves picking through one field, moving to the next field, and allowing the tomatoes to mature before beginning to pick again; start picking "pink" tomatoes when they represent about 10% of the tomato population — about 2–3 days after harvesting begins (the "pinks" are harvested by independent migrants who pay the farmer a flat rate per box of picked tomatoes and then sell the tomatoes at farmers' markets)
July	Open fields for "you-pick" operation at the end of harvest and before cleanup operations ("you-pick" is saved for last to prevent damage to the plants and the spread of disease from other fields)
Late July–August	Clean up: burn the plastic string off the old plants with a 2-row propane burner; pull up the stakes and store them; mow the old plants down and harrow them into the ground; and prepare for a fall crop (e.g., pole beans) if desired

[a] Labour for land preparation, transplanting, staking, and stringing is supplied mainly by local black residents; harvesting is done mainly by migrant workers of Spanish descent from south Florida, Texas, and Mexico.

and when to plant shade tobacco, probably because they were taught by their parents.

Eventually, this knowledge will be passed to a new generation as a "traditional" way of doing things. When the new generation of farmers is asked *why* they do things the way they do, they may reply, "It is the custom." Some of them may even forget the original decision criteria; they only know that, for some reason, the traditional way is "the best" way to do x, given the original constraints or criteria used or faced by their grandparents and parents. Examples of such inherited scripts or "adaptive" strategies abound in the literature for economic and ecological anthropology (Bennett 1969; Johnson 1971; Cancian 1972; Brush 1976; Mayer 1979; Moran 1979; Barlett 1980; Chibnik 1981).

The Gadsden farmers' plan or script for shade tobacco (Table 1) (Kincaid 1960) was quite similar to that for staked tomatoes (Table 2). For example, tobacco seed beds are planted and maintained in the same months when plastic is put out for rows of tomatoes. Tobacco seedlings and tomato plants are transplanted in March in a similar, labour-intensive way. In June and July, both tobacco and tomatoes are harvested by hand; and, in August, fields are cleaned up after harvests of both crops. Given the similarity of these plans, it is not surprising that many ex-shade producers decided to become tomato producers.

By means of these internalized plans or scripts, therefore, the Gadsden farmer does not have to make a million decisions; he or she knows *how* and *when* to plant and transplant tobacco seedlings, string plants, cure tobacco, and pick "pink" tomatoes. Eventually, this knowledge will be passed to a new generation as a "traditional" way of doing things. The plans and scripts that evolve then remain a part of the traditional way of life until the original conditions or sequence of activities of the plan is interrupted, or the desired goal is changed. To quote one Gadsden producer: "We weren't accustomed to the thought that (shade) tobacco was going out because it had gone through cycles all the time, and we were not entirely sure that it wasn't going to come back; and we hated to lose the entire organization if it was possibly going to come back." This farmer cut tobacco production but continued growing the crop and losing money for 3 more years before stopping production entirely.

The importance of a plan or script as a tool in farming-systems research and extension is that it tells the investigator something specific about the person or group of people carrying out a particular action sequence. Plans are the highlights that show the outsider the insiders' methods to achieve their goals and satisfy the roles that place them within their culture.

Hierarchical decision models

A knowledge of farmers' traditional cropping plans or scripts, however essential to an FSR/E team designing on-farm trials, does not always tell the team what happens when the script or plan is interrupted or the desired goal is changed. A knowledge of farmers' decision criteria and perceived alternatives and options is, therefore, necessary to a team that wants to design adoptable technology or evaluate technology already generated.

With this information, they can build models of the decision-making process that incorporate farmers' decision criteria and constraints. The models of decision-making are hierarchically (Gladwin 1976, 1980) ordered on the basis of the characteristic to be maximized, incorporating alternative branches based on the constraints and criteria of the farmers. As Shoemaker (1982) noted:

> . . . most decisions are made in *decomposed* fashion using *relative* comparisons. Evaluations of multidimensional alternatives are seldom holistic in the sense of each alternative being assigned a separate level of utility. It is cognitively easier to compare alternatives on a piece-meal basis, i.e., one dimension at a time. . . .

Hierarchical decision models (HDMs) are decision "trees," flowcharts, lists, a set of rules, etc. For example, alternative money crops (Fig. 2) for shade producers in Gadsden would be hierarchically ordered on the basis of an activity's similarity to growing shade tobacco. The decision-maker mentally moves through a series of options that begin with those that are as close as possible to shade in managerial style and use of resources of land, labour, equipment, and capital and end with the option that is the most dissimilar to shade growing — that is, livestock, mainly beef cattle. Tomatoes, nursery crops, flue-cured tobacco, fruit orchards, pole beans and squash, and confinement hogs are similar to shade tobacco in that they are labour-

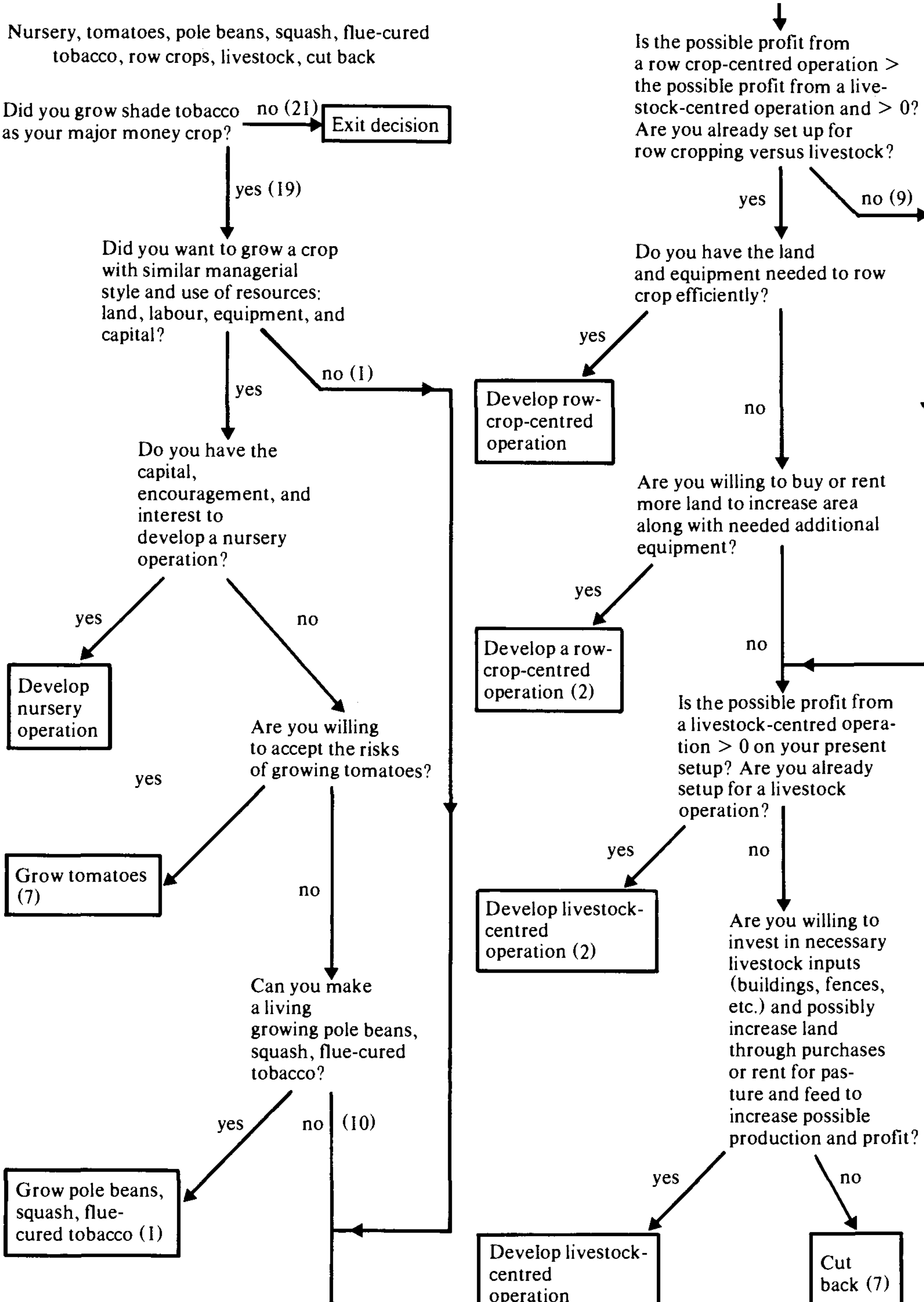

Fig. 2. Decision tree for tobacco farmers forced by economics to change production activities: alternatives are denoted at the top; outcomes are in boxes; numbers of farmers choosing a particular branch are in parentheses.

and capital-intensive and use less land than do other crops — important criteria because of Gadsden's small fields.

The criteria that would motivate farmers to choose an activity that is less similar to shade tobacco include a change in goals (such as wanting to avoid the hassles involved in hiring migrant, seasonal labour) and lack of resources (such as not having enough capital to invest or to take the risks involved in marketing an alternative crop). Row crops like soybeans, corn, wheat, and peanuts that require relatively more land than labour or capital input become the options. If the requirements (economically efficient quantities of land, access to equipment, etc.) are beyond the resources of the farmer or if the profitability of raising livestock is perceived to be greater than row-crop production, a livestock-centred farming system would be chosen. Using more land and less labour and capital than tomatoes or row crops, beef-cattle systems as alternative "money crops" resemble shade-tobacco production very little and are the last option or suitable substitute for shade tobacco. Without a major source of income, the farmer has to cut back production or go out of business entirely, a decision related to "structure" issues described elsewhere (Gladwin and Zabawa 1983).

Knowledge of the decision criteria that farmers consider important (riskiness, capital-intensity, equipment and land requirements) is vital for a team trying to identify a suitable substitute money crop, as is a knowledge of their plan or script. Further, it is knowledge that cannot be picked up for all possible substitute crops on a "quick and dirty" 5-day reconnaissance survey (Franzel 1983; Gladwin 1983); it requires a follow-up survey using careful procedures to elicit information from farmers in a systematic way (Gladwin 1979a).

Using HDMs in technology evaluation

Although decision trees are most appropriately used at the *diagnostic* stage of a farming-systems research program to describe farmers' plans and explain farmers' reasoning and logic in using traditional practices, they are also useful in the testing stage, to evaluate technological packages ex-ante, i.e., before they become official recommendations of an institute or centre (Ashby and de Jong 1980). Examples of ex-post evaluations of a technological package 7 years after the design stage are given by previous evaluations of the Pueblo Project in Mexico (Gladwin 1976, 1979a, b) and so do not require further explanation here.

An example of an ex-ante evaluation via decision-tree models, however, can be taken from a project sponsored by the Florida legislature to increase the pounds of beef sold by Florida cattle raisers via an increase in the finishing and slaughter of cattle in Florida (Baltensperger et al. 1982). The project was multidisciplinary, including economists, agronomists, animal scientists, and extension agents. A beef-cattle package, developed by the Institute of Food and Agricultural Sciences (IFAS), was to be compared with traditional beef-cattle systems in northwest Florida, an area considered particularly important because of its ability to support cool-season pastures and produce other crops used as cattle feed.

One portion of the research focused on farmers' beef-cattle systems and farmers' decisions whether or not to use recommended practices (such as controlled breeding, worming, and implantation of growth stimulants) in a cow–calf operation. In addition, farmers' traditional choice of a cow–calf operation over a "stocker" operation was studied, where stockers are calves that are bought as weanlings and "backgrounded," i.e., brought to weights high enough to "finish" them in a feedlot.

Some beef-cattle producers in northwest Florida did not use controlled breeding, i.e., limiting the length of the season to 3–4 instead of 6–8 months. Controlled breeding is a key recommendation upon which efficient exploitation of other recommendations depended. For example, implantation of growth stimulants depends upon a short, predictable calving season. Yet a large minority of producers did not impose a limited breeding season on their herds, perhaps dooming the entire IFAS "package" to failure or at least to only limited success. Finding out the reasons for nonadoption was the means for determining whether anything could be done to improve the potential for success of the program (Gladwin 1976, 1979a, b).

Each of the criteria in the decision-tree was a factor limiting adoption mentioned by the producers (Fig. 3). Indeed, of the 10 producers who could have used a controlled-breeding program but did not, 5 stated that they were satisfied with the present calving rate and saw no need to improve it. According to another farmer, controlled breeding would not improve the calving rate. Two additional producers stated that they did not have enough pasture to separate bulls and cows. One producer lacked know-how, whereas another wanted a consistent cash flow from the operation spread over the year.

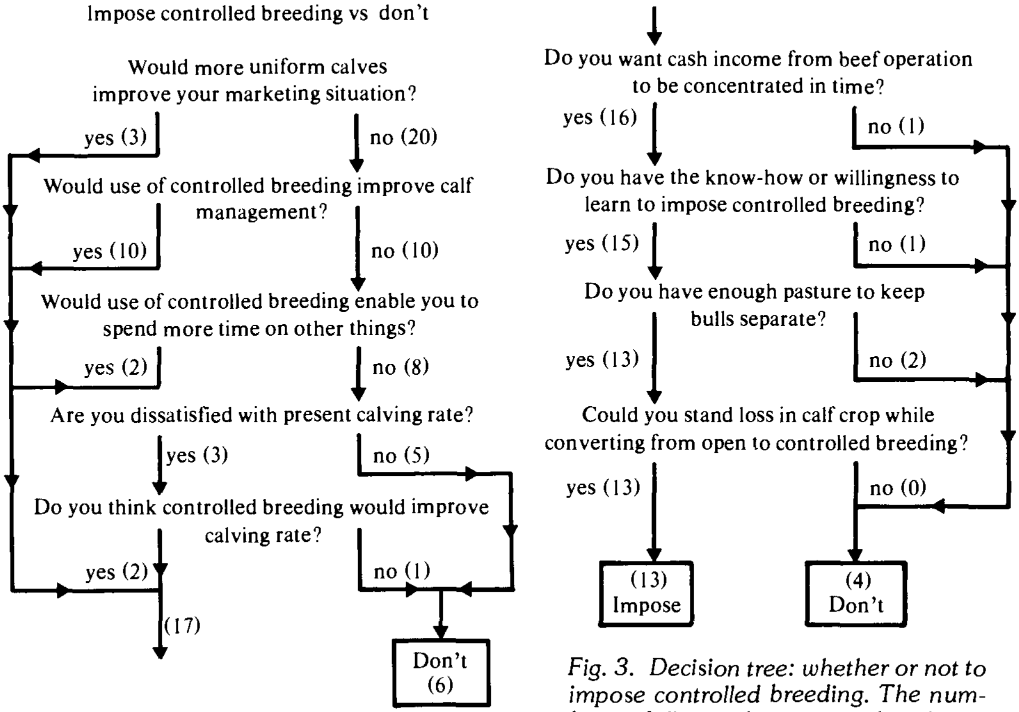

Fig. 3. Decision tree: whether or not to impose controlled breeding. The numbers of livestock owners choosing a particular branch are in parentheses.

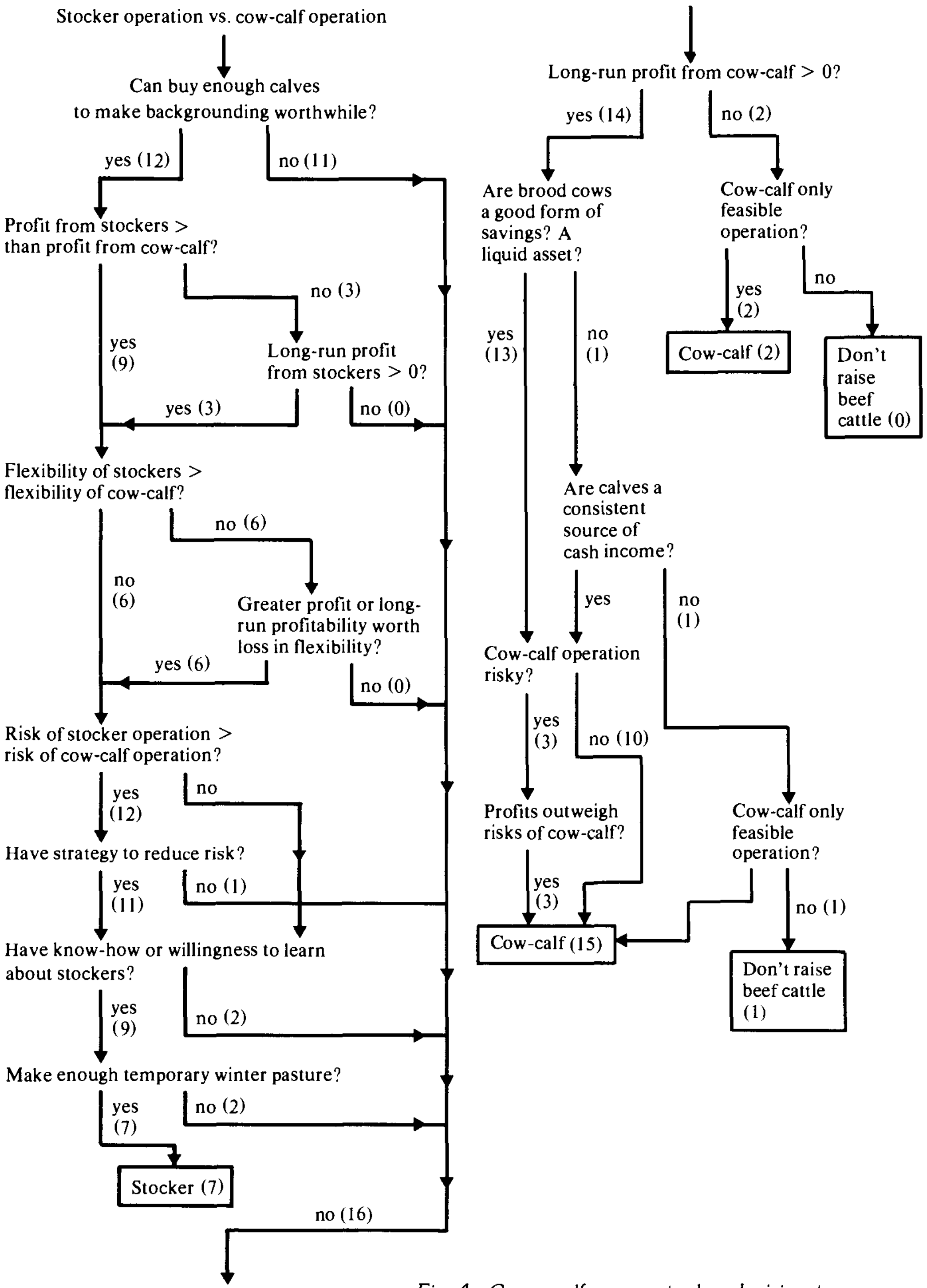

Fig. 4. Cow–calf versus stocker decision tree; numbers of farmers choosing a particular branch are in parentheses.

A decision-tree was also used to determine why some profit-oriented cattle raisers sold weanling calves rather than holding them till they reached the weight considered suitable for a finishing program. In Florida, as in other southeastern states, raising stockers — backgrounding — is potentially more profitable than owning a cow–calf herd (Ross et al. 1983), but, as the decision tree (Fig. 4) showed, it has some disadvantages as well. Also, there were key advantages to cow–calf herds that are overlooked in a simple examination of budget data.

First, size is a barrier to entry to backgrounding and, therefore, must be considered first. It is a barrier because returns/animal are small and marketing costs/animal, especially hauling animals to and from the farm, increase as the number of animals decreases. Several farmers claimed that hauling fees with less than half a truckload of animals (i.e., 25–30 animals) are excessive. Another disadvantage to backgrounding is that it is risky. Because stocker prices fluctuate more than weanling prices during a single year and weight gain — the critical factor in a successful backgrounding program — depends on variable weather conditions, the risks in raising stockers are greater than those of a cow–calf operation. Some farmers are not willing to assume the greater risk.

Disadvantages inherent in backgrounding are not the only reasons that more backgrounding does not occur. There are also requirements for successful backgrounding. A producer must know how to run a successful operation. Obviously, animal nutrition and health needs are important in this regard. Most producers, especially those with a farm background, have a reasonable understanding of these needs, and producers originally lacking this knowledge can obtain it easily from a number of sources. Marketing know-how is another matter. There are two marketing aspects related to the management of a stocker herd. First, the right kind of animal must be purchased; second, the animal must be sold. The former is critical as animals that will gain weight efficiently are keys to success. The ability to purchase such animals has been described as a learned art and is not just "picked up." Being able to produce an adequate supply of temporary winter pasture is also critical. If a producer has a winter backgrounding program, he or she must be able to produce such pasture in a timely fashion to get good weight gains. Thus, producers must ask themselves whether they have enough time, proper machinery and equipment, and know-how to plant combinations of rye, ryegrass, oats, and clover. If the answer is no, winter backgrounding is not an optimal choice.

Besides greater profitability, the stocker operation also has the advantage of greater flexibility. In stocker operations, the producers can change the size of their herd to satisfy anticipated market conditions and available time and pasture. In contrast, the cow–calf herd operators invest a good deal of time and management in a breeding program, trying to develop a brood cow herd that does well under the conditions of their farms. They are reluctant to sell part of their breeding stock in a bad year and decrease herd size. Similarly, increasing herd size in the short run is more difficult to the cow–calf operator, because finding the "right" brood cows or raising heifers of good quality is a long-run proposition.

On the cow–calf branch of the tree, profit in the long run rather than the short run is satisfied. Cow–calf operators, more than stocker operators, justifiably believe they will lose money for approximately 3 years while starting up the operation. While heifers mature, management experience is gained, and a production system is established, they lose money. In contrast, stocker operations lose money maybe for 2 years while managers gain experience and establish a production system. The question for both would be: Can I sustain such losses?

As viewed by the producers interviewed, a cow–calf operation does have some advantages. Because brood cows are owned for more than a short time while income is generated from their calves, the cows are viewed as a form of savings. They can also serve as collateral on loans as well as a source of capital. Another advantage is that the calves can be sold at almost any stage in their development, whereas stockers should be kept until they reach a profitable weight. Even under the most constrained conditions (e.g., calves are held until weaning and controlled breeding is used), calves are available for sale for 3–4 months compared with a few weeks for stockers. Further, the potential sale period of calves when controlled breeding is *not* imposed is approximately twice as long. Thus, there is greater potential for more consistent cash income from a cow–calf operation that does not incorporate controlled breeding. Cow–calf operations, however, are not necessarily profitable. Nor do all producers find the advantages of a cow–calf operation to be attractive. Yet, some have brood cow herds, because they think that beef cattle are the only or the least-cost way to use the land and not lose their agricultural tax exemption.

Results showed that only 7 of 23 farmers decided to raise stockers, whereas 15 decided on a cow–calf herd. Limiting factors to potentially profitable backgrounding operations in north Florida included:

- Capital to buy a sufficient number of calves;
- Know-how to run a stocker operation;
- Riskiness of a stocker operation; and
- Ability to make enough temporary winter pasture to get good gains on stockers.

In conclusion, profit-motivated small producers who do not have the cash or credit necessary to buy enough calves for backgrounding opt for the less-risky cow–calf alternative. Producers with enough credit or capital accumulated to buy stockers will do so only if their cow herd will not suffer from competition with stockers for scarce resources such as winter pasture. Given these decision criteria, it is understandable that the traditional beef-cattle production system of the limited-resource farmer in north Florida is a cow–calf operation without controlled breeding.

Conclusion

This paper has presented examples of the use of ethnoscientific tools and hierarchical decision models in programs designed to generate appropriate technology for small-scale family farmers through a multidisciplinary team effort. In designing on-farm trials, farming-systems researchers can benefit from knowledge of farmers' indigenous classification systems, plans or scripts, and cropping decisions. The case of Gadsden County in the 1970s, when full-time farmers had to switch from shade tobacco to tomatoes or go out of business, and the case of Gadsden today, when some farmers are trying to switch from risky tomatoes to other cold-weather vegetables, shows the utility of an in-depth knowledge of how farmers make cropping decisions and plans. Hierarchical decision models are also applicable in both ex-ante and ex-post evaluations of technology generated by a research team. Such evaluations are most useful, however, ex-ante — in the testing stage of the project. At all stages of farming-systems research and extension, an ethnoscientist has a more important role to play than that of "trained observer" (P. Hildebrand, personal communication). Specifically, decision modelers have a role to play in helping the team in an FSR/E program, and not just policy planners in an FSIP program, understand traditional farming systems, in contrast to conclusions reached by Hildebrand and Waugh (1983).