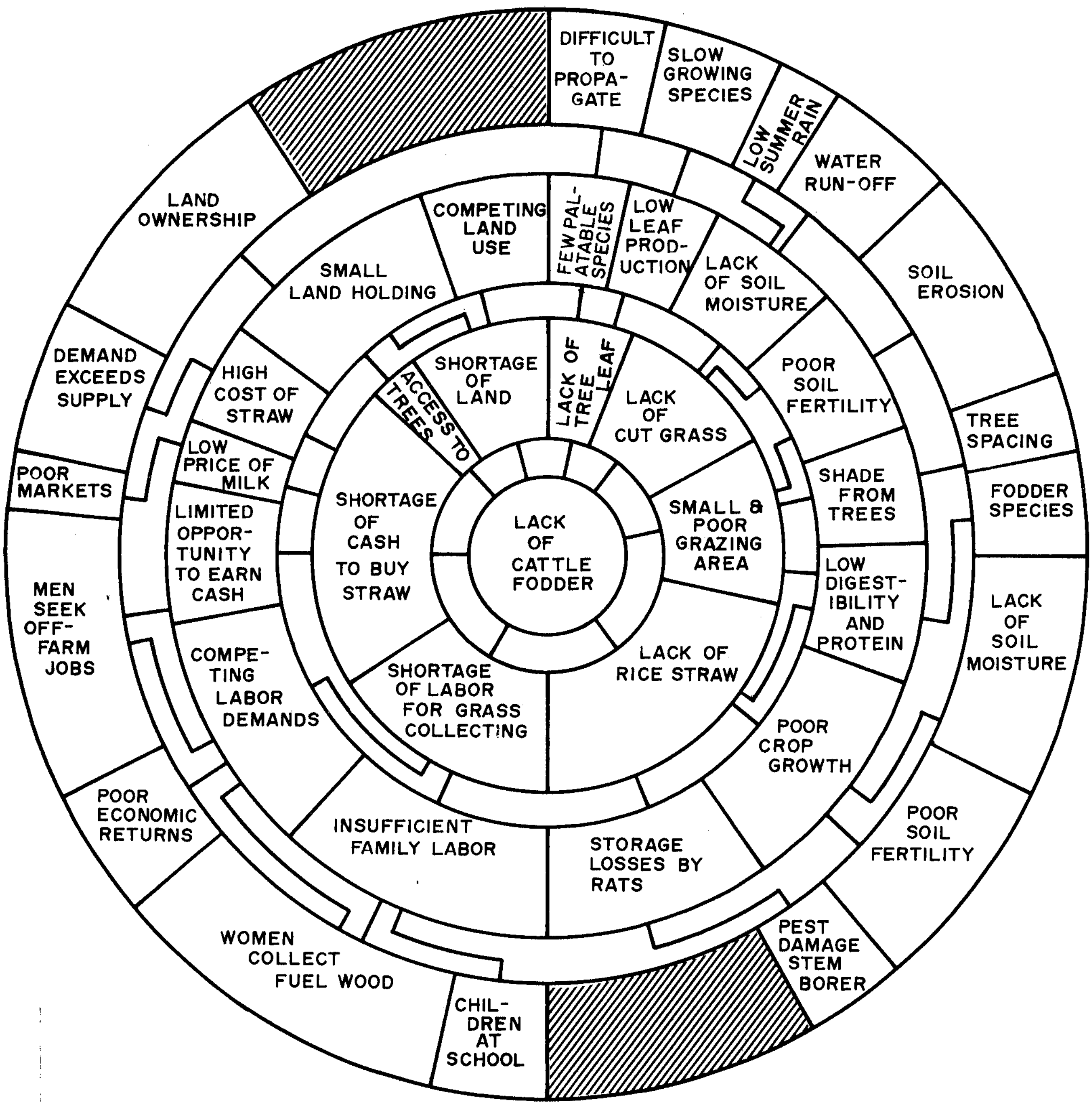
Training Resource Book for Farming Systems Diagnosis



International Rice Research Institute

International Center for Living Aquatic Resources Management

Training Resource Book for Farming Systems Diagnosis

Process Documentation of an Experiential Learning Exercise in Farming Systems Diagnosis of the ICAR/IRRI Collaborative Rice Research Project

held at Birsa Agricultural University
Kanke, Ranchi, Bihar, India

10–15 July 1989

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1990

ISBN 971-104-222-3

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Contents

Foreword

Now, perhaps more than in the past, agricultural scientists need procedures to understand farmers'problems from an ecosystem viewpoint. The biophysical causes of diminished productivity and the socioeconomic constraints farmers face in their reversal are little known. Undoubtedly, land and water rehabilitation will be an important element in sustainable farming. Nevertheless, experiments that address environmental rehabilitation are rarely found on agricultural research agendas. Whatever regenerative methods researchers may develop, millions of resource poor farmers will have to implement them for these to have any impact.

The focus of this training resource book is farmer participatory tools to understand the biophysical causes and socioeconomic constraints to agroecosystem-based problems and identifying experiments that address them. Although this volume provides some agroecosystem analysis, it concentrates on the diagnosis of farming systems problems. A more detailed treatment of agroecosystem analysis is given in a companion training resource book - *Training Resource Book for Agroecosystem Mapping* compiled by C. Lightfoot, N. Axinn, V.P. Singh, A. Bottrall and G. Conway, International Rice Research Institute, Philippines. 1989. In this volume we explain procedures that link agroecosystem analysis with on-farm experiments. Problems from agroecosystem transects are diagnosed in relation to all important biophysical and socioeconomic factors such that experimental hypotheses can be formulated. A style similar to that of a training resource book is used. Process documentation, case studies, overhead projection templates, and further readings, taken from an experiential learning exercise in Systems Diagnosis held at Birsa Agricultural University, Ranchi, 10-15 July 1989 are brought together under one cover. The case studies were generated by scientists of the Ford Foundation Farming Systems Research Network and the ICAR/IRRI collaborative project in eastern India.

This resource book aims to help scientists in Eastern India understand how agroecosystems work and see field-level opportunities or how ecosystems might be rehabilitated. As presented here these tools are, however, limited by more than just the training design. Our systems diagnosis is for agricultural scientists seeking technical solutions to agroecosystem-based problems. While we recognize the importance of socioeconomic constraints, we do not identify social or economic interventions. Similarly, policy implications may emerge but we do not develop policy instruments. Nevertheless, we hope that the procedures provided will assist scientists in the important task of improving the farming systems in eastern India.

Clive Lightfoot
Manila, Philippines,
April 1990

Acknowledgements

This training resource book would not have been possible without the cooperation of farmers from our case study villages, and the scientists from the Eastern India Farming Systems Research Network and the ICAR/IRRI Collaborative Rainfed Rice Research project. The exercise documented here was funded by the Ford Foundation in New Delhi and the International Fund for Agricultural Development to whom we express our gratitude.

We acknowledge the villagers of Baraudi and scientists Ms. Nibha Bara and Dr. D. Prasad, Birsa Agricultural University (BAU); Dr. B.T.S. Moorthy, Central Rice Research Institute (CRRI); Dr. U.P. Singh, Dr. R.S. Singh, and Ajay Kumar, Rajendra Agricultural University (RAU); Dr. J.K. Dey, Assam Agricultural University (AAU); who visited them.

We acknowledge the villagers of Murma and scientists Dr. D. Paul, Dr. V.S. Chauhan, and Dr. R.K. Singh, Central Rainfed Upland Rice Research Station Hazaribag; Dr. J.L. Dewedi, Dr. O.P. Singh, Narendra Dev University of Agriculture and Technology; Dr. R.A. Singh; Mr. R.D. Singh, and Dr. H.P. Singh, NDUAT; Dr. S.C. Prasad, Dr. K. Tirkey; and Dr. R. S. Singh, BAU, who visited them.

We acknowledge the villagers of Urguttu and scientists Ms. Celine Kerketta, Dr. K.P. Singh, and Dr. B.K. Singh, BAU; Dr. M.M. Das, CRRI; Dr. Jai Dev, NDUAT; Dr. V.K. Khosta, Indira Gandhi Agriculture University; Dr. A.N. Ray, Rice Research Station, West Bengal; Dr. R. Pattanayak, Orissa University of Agriculture and Technology; Dr. B. Guha, AAU; and Dr. C.S. Das, Rama Krishna Mission who visited them.

A special acknowledgement is due to our hosts at Birsa Agricultural University, Ranchi, Bihar, especially the Vice Chancellor Dr. H.R. Mishra, Dean of Agriculture, Dr. M.A. Moshin, Director of Research Dr. A. A. Khan and Dr. S.C. Prasad, Chief Scientist of the Rice Program.

From IRRI we would like to thank Dr. B.P. Ghildyal our liaison scientist and Dr S. Biswas our ICAR/IRRI Project Director in India for setting up, organizing, and facilitating this learning exercise. We also acknowledge Celeste Lacuna for editing the earlier drafts, Patrocino Agustin and Alberto Blanco for drawing the maps, and Ovidio Espiritu of ICLARM for drawing the graphs.

SECTION A

Process documentation

The generations.

Transition between upland and midland.

ACTIVITY 1: Introduction to the exercise

Twenty-five participants from the ICAR/IRRI East India Rainfed Rice Research project and 10 participants from the Ford Foundation East India FSR Network met from July 10 to 15, 1989, at Birsa Agricultural University at Kanke, Ranchi, to undertake an "Experiential Learning Exercise in Systems Diagnosis". Participants were assisted by seven resource persons: Dr. B.P. Ghildyal, Dr. S. Biswas, Dr. V.P. Singh, and Mrs. Thelma Paris from IRRI; Dr C.S. Das from RKM, Mr P. Mishra and Ahmad Salman from LMNI, and Dr. Clive Lightfoot from ICLARM.

After a morning of opening ceremonies on July 10, the participants reviewed the agroecosystems analysis they had done since the March workshop.

In the afternoon, Dr. Lightfoot gave an overview of the objectives *of the workshop*, exercises to be carried out, and the expected output from the participants. This lecture is reproduced in full in Section D. The exercise had these specific objectives:

- Participants will be able to define systems diagnosis and systems diagrams, explain their application in FSRE and discuss the steps in developing a systems diagram.
- Participants will conduct agroecosystems analysis through village mapping and transect exercises, rank the problems identified, and practice systems diagnosis and systems diagramming with farmers.
- Participants will be able to identify research opportunities and develop experimental hypotheses for on-farm research programs.

The use of maps and transects in agroecosystems analysis and systems diagrams were discussed in detail by Dr. Lightfoot while problem identification and ranking was discussed by Dr. V.P. Singh.

Additional reading materials and handouts were distributed to the participants and are included here in Section D.

In the evening, plans for the field exercises were discussed with the participants. Group assignments, specific tasks, expected outputs and process of data collection, transportation, etc. were planned in detail. Participants were divided into three groups (10-11 in each group) for the field visits. As much as possible, participants from the same institution and a female participant were in each group. Each group was further subdivided into pairs of biological and social scientists, one of whom could speak the local dialect. Specific topics were divided informally by the members of each group. Participants were briefed on the do's and don'ts of rapid rural appraisal after Rhoades (Rhoades, 1987).

The fact that time constraints inherent in a one-week training exercise would not allow participants to conduct all procedures suggested in the lectures was stressed. Specifically, problem ranking would not involve farmers and only rapid rural appraisal techniques would be used in the systems diagnosis. This short exercise would not be as rigorous as the research required.

ACTIVITY 2: Field exercise in agroecosystems analysis

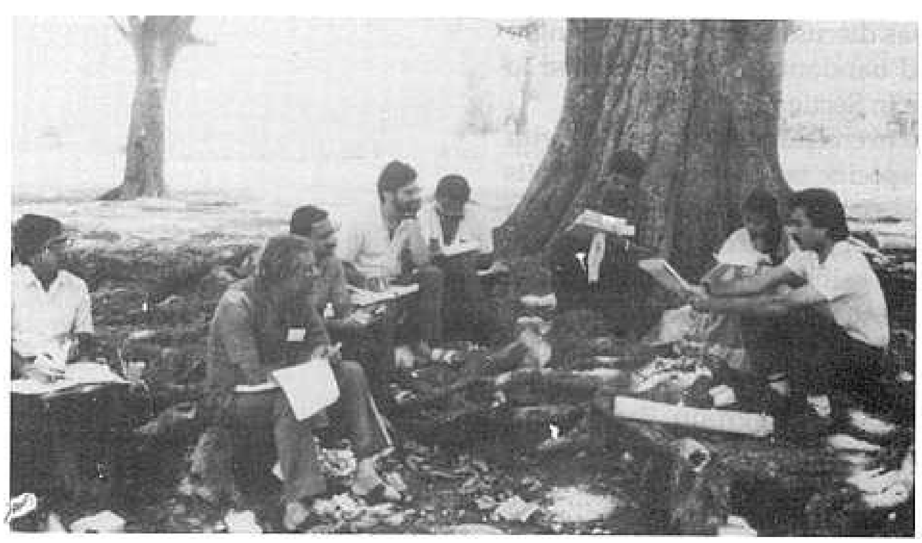
The following morning (July 11) each group visited one of the following villages: Urguttu, Murma, and Baraudi. To avoid afternoon rains, we interviewed farmers only in the mornings, catching them, including women, in the field.

Each group spent the entire morning defining, classifying, and mapping land types and enterprises. This field exercise consisted of informal interviews with farmers and other key informants in the village and walking to different land types and establishing their boundaries. The information collected included land type, soils, crops and trees grown, livestock and fish raised, problems and opportunities of the farmers. After collecting the necessary information for agroecosystems analysis, the group went back to the workshop venue. In all about five hours was spent in the village.

Each group spent the afternoon drawing their maps and transects. In the evening they ranked the problems they had identified in each land type using the procedure described on the first day. Each group then selected one main problem for the next day's field exercise in systems diagnosis.

ACTIVITY 3: Field exercise in systems diagnosis

The following morning (July 12), each group went back to its assigned village — its main problem already selected — ready to probe into the farmers' understanding of that problem. Rapid rural appraisal techniques were used to elicit the farmers' perceptions of bio-physical causes and socioeconomic constraints for the problem selected. The field exercise lasted about six hours.



The team take a break

Later in the afternoon, the group went back to the workshop venue and drew systems diagrams showing the interactions between bio-physical causes and socioeconomic constraints to the central problem.

ACTIVITY 4: Case study reports

In the morning (July 13) a brief lecture on how to prepare case studies was given by Dr. Lightfoot. Case studies should have the following components.

1. Land Type Map - This section should present a figure of the land types and a description of each land type from the largest to the smallest.
2. Agroecosystem Transect - This section should present a brief description of major enterprises in each land type, mention important details not represented in transect, and provide a brief survey of the problems identified.
3. Problem Ranking - This section should present the rationale for selecting top priority problems in each land type, and the reasons for selecting the main problem for systems diagnosis.
4. Systems Diagnosis - This section should present a brief statement of the key problem, explain important bio-physical causes and socioeconomic constraints so that readers can correctly understand the diagrams. It should also suggest several (5-10) areas for experimentation.

Washing weeds prior to feeding the cattle.

After this lecture the participants broke into groups to prepare their case study for the rest of the day.

In the morning (July 14) each group presented their case study for about one hour. After each presentation, points of clarification were raised, which brought about lively and sometimes heated discussion: a positive sign that most of the participants gained skills in the process.

Important points were raised on the degree to which selected problems were influenced by farmers' or scientists' perceptions and how to distinguish between causes and constraints. Many participants felt that time was too short for them to acquire accurate information from farmers. Gender emerged as an important issue in all villages but particularly in Baraudi where women are directly involved in fodder collection.

After the presentations, modifications were suggested particularly in linking systems diagrams to suggested experiments and linking biophysical and socioeconomic constraints to solutions for overcoming problems.

ACTIVITY 5: Debriefing

In the afternoon (July 14) debriefing session, various difficulties encountered during the training and help for future exercises were deliberated.

Participants expressed the following difficulties with using the research procedures suggested.

Land type maps are difficult to prepare when a) it is difficult to distinguish between types of lowland; b) farmers have different names for the same land types; c) many criteria are used to distinguish between land types; and d) farmers', scientists' and government criteria for land classification are mixed.

Transects are difficult to prepare when: a) more than one soil type can be found in a land type; b) variability is high in some parameters ie., water table; and c) conflicting responses in some enterprises occur.

Problem ranking is difficult when a) strong interactions make it hard to decide which is the top priority problem; and b) subjectivity in assigning weights becomes too great.

Systems diagnosis is difficult when a) cause and effect are hard to split and b) farmers' and scientist's perceptions are mixed.

Incomplete and biased information is obtained when a) key informants do not properly represent the diverse groups - rich and poor farmers, men and women farmers, different caste groups, etc b) responses are not verified through multiple visits to the field; and c) the team is not represented by both natural and social scientists.

Time becomes a severe constraint when a) there is high variability among responses from farmers interviewed; and b) sensitive questions are not directly answered by the farmers.

During the field trips it was noticed that womenfolk are important decision-makers in rural families. They carry out most of the farming activities, including collection of fodder and fuel wood, aside from their domestic roles. It is therefore, essential to include women interviewers in the team so that women's concerns can be included in problem diagnosis and research design.

The following guidelines were suggested to help others conducting this kind of exercise:

Researchers should help farmers draw their problem tree on the ground, moving from one cause or constraint to the next following from primary to secondary effects until the systems diagnosis completes itself.

Researchers should not be satisfied with a farmer's first answer but should encourage him/her to express as many ideas as he/she has.

A group photo with the farmers.

Researchers should be observant and use their eyes to direct questions and prompt lines of enquiry, particularly when unravelling land types and enterprises - they are all around.

Researchers should discipline themselves to remain focused on topics directly related to the problem under diagnosis. There is already plenty of information to gather for the short time available in rapid rural appraisal without going off at a tangent.

Researchers should question those directly involved in an activity be it woman or man, tenant or landlord — as only they can provide accurate information.

Researchers should cross check the diagrams they get with other farmers not only to verify facts but also to check commonality in usage of names and terms.

Activity 6: Participants evaluation

Participants wrote a few paragraphs giving their perceptions about the Experiential Learning Exercise in Systems Diagnosis:

"The new systems diagnosis method provides a unique opportunity for us to know and honor the farmer as they see things by themselves. The method is new and we wish to see how it works in our own place. I have been associated with extension and research work in the State of West Bengal since the late fifties and have found most of the methods not working efficiently. So let us take another chance with this method."

Amarnath Ray, RRS, West Bengal

"The workshop was educational to me and helpful in diagnosing farmers' problems in a scientific and rational manner. This also helps us in devising solutions. Further refinements can be made in the future. Let me congratulate the resource persons of the workshop." B.T. Moorthy, CRRI

"It is a modern tool which facilitates diagnosis of farmers problems through interaction between scientists and farmers. I think that problems are better diagnosed and alternative solutions to problems are better designed when these two groups interrelate with each other. I find this experiential learning exercise quite useful but training programs which extend over a longer period of time will be more beneficial to me." D. Prasad, BAU

"Systems diagramming of farmers' problems and identifying factors for experimentation is the best tool to understand the complex problems of farmers. Through this training, I am sure that it will be possible for us to design our experiments properly. However, more time is needed to understand the process of systems diagnosis in general." R.D. Singh, NDUAT

"Experiential learning exercise on systems diagnosis provided me with a very new and appropriate method of knowing the actual farmers' problem in farmer perception and identifying an experiment according to the actual land type and with the actual farmer constraints." Ajay Kumar, RAU

"Experiential learning exercises in systems diagnosis is helpful in diagnosing problems for constituting new experiments for the improvement of the whole farming system. This diagnosis gives an overall picture of the ecosystem analysis for which we can gather information regarding problems by which we can frame experiments to overcome the problems."

U. P. Singh, RAU

"The experiential learning exercise in systems diagnosis helps the scientist better identify the most important factors responsible for low production in a particular village along with related minor factors. This also helps researchers formulate experiments to solve the most important problem of the village. The workshop was organized in a nice manner." R.S. Singh, RAU

"All the exercises of this workshop were very helpful to me. With the methods I learnt from these exercises I think I will be able to diagnose the problems of farmers when I go back to my place." B. Guha, AAU

"The four-day deliberation on systems diagnosis was very interesting as it has given new direction and understanding in problem handling for the countryside of eastern India. I hope that the experience gained helps us to handle our jobs more successfully." J.K. Dey, AAU

"We developed skills in diagnosing farmers' problems, ranking them and designing experiments based on systems diagnosis. I think these skills are valuable to researchers, particularly biological scientists engaged in FSR work." K.P. Singh, BAU

"I personally feel that this experiential learning exercise in systems diagnosis will help much in conducting surveys, preparation of maps, transects and for setting priorities of research for different ecosystems. The feedback information received from farmers and also with self-perceptions will be helpful in planning and developing situation-specific technology for increasing the productivity of various ecosystems. This also offers an opportunity to understand socioeconomic problems, particularly the important role of women in farming systems." J. L. Dewedi, NDUAT

"Systems diagnosis is a unique tool for listing farmers' resources and constraints, which permits designing of experiments for solution of their problems. This will also help farmers in quick adaptation of technology in their fields." H.P. Singh, NDUAT

"The systems diagnosis methodology for identifying farmers' problems, diagnosing problems and identifying researchable solutions to problems is less costly than the other research approaches we have used."

D.K. Paul, CRURRS, Hazaribag

"This training workshop was quite informative and useful to the scientists of IFAD. From this training an actual picture of village problems can be drawn, with ideas for potential improvements. After going through this training workshop, I have acquired new skills in village mapping, making transects, identifying bio-physical and socioeconomic constraints to farmers' problems and most of all how to use the systems diagrams in developing solutions to farmers' problems." V.K. Khosta, IGAU

"This systems diagnosis method is helpful in deciding on research priorities and in designing technologies to increase farmers' production. The transect, map, and systems diagram can give at one glance an overall view of the village situation, environment, problems, and possible researchable work for scientists and policy implications for planners. The methodology can also be replicated in other areas." O.P. Singh, NDUAT

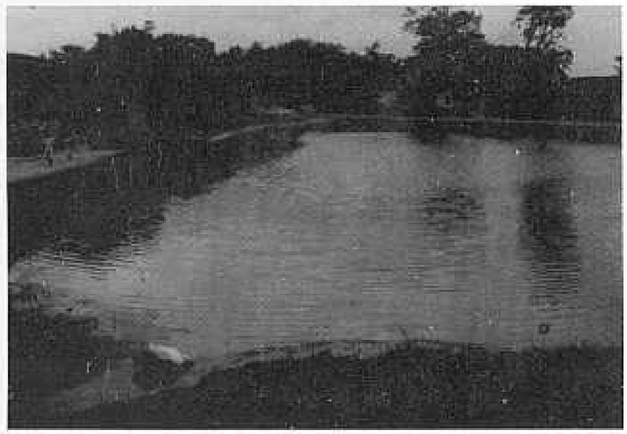
"From the first until the last day of this training program I found myself quite engrossed, however, I have two comments. First, I think that our field staff could have participated also in this training program especially in the survey work since this is beyond our expertise. We, scientists should be involved in diagnosis of problems only. Secondly, the survey of three villages is not sufficient for us to come up with conclusions in a given limited time. I would like to extend my thanks to the resource persons, organizers and funding agencies which made this training possible." Jai Dev, NDUAT

Cattle shelter around the homestead.

SECTION B

Village case studies

A plow team takes a rest.



Village tank for fishing.

SECTION B

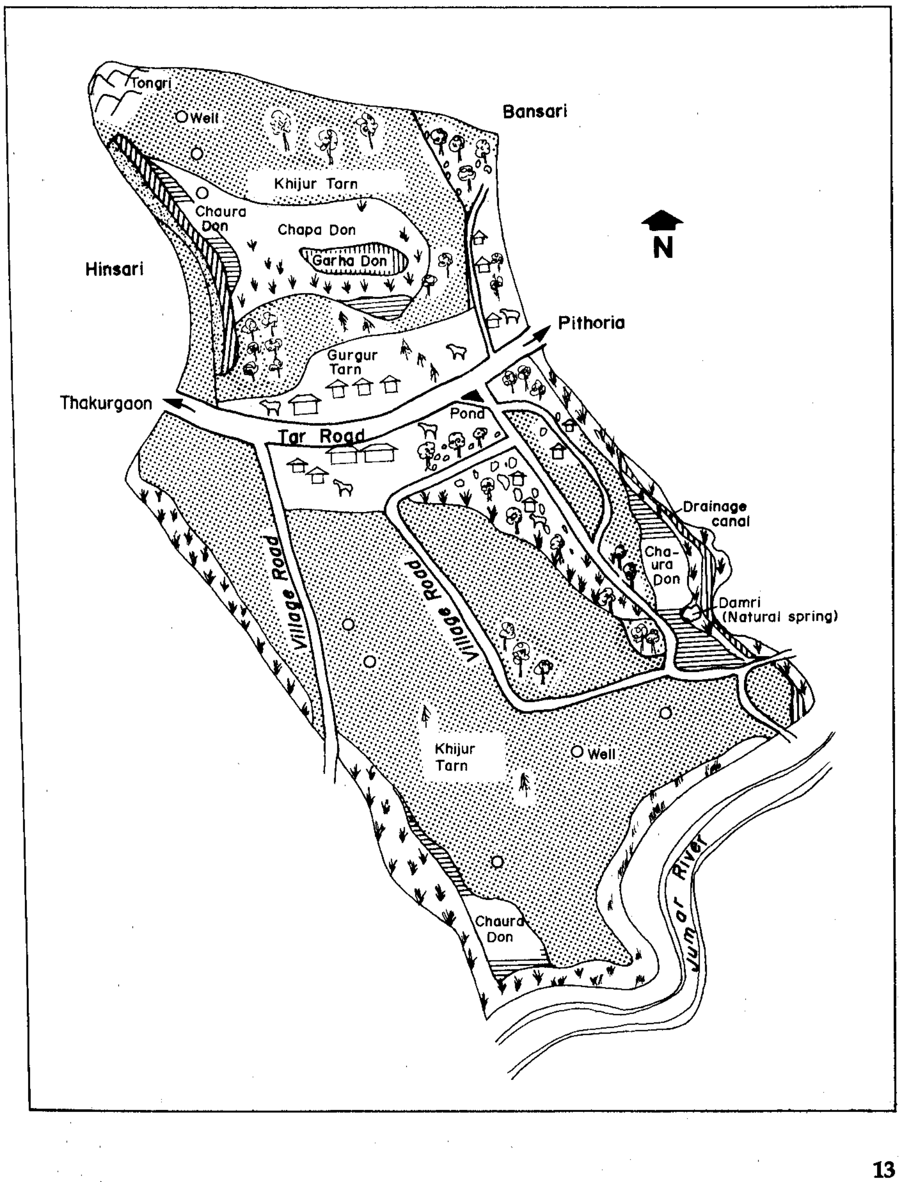
Village case studies

Baraudi

Dr. Ajay Kumar, RAU; Ms. Nibha Bara, BAU; Dr. B.T.S. Moorthy, CRRI; Dr. U.P. Singh, BAU; Dr. R.S. Singh, RAU; Dr. J.K. Dey, AAU; Dr. D. Prasad, BAU; B.P. Ghildyal, IRRI; Mr. Ahmed Salman, LMNI; and C. Lightfoot, ICLARM

Agroecosystem analysis

Baraudi village sits about 20 km from Kanke on the Pithoria-Thakurgaon road. Bansari, Hinsari, Kyotia and the Jumar River surround the village (Figure 1). The total geographical area of Baraudi is 162 hectares. Baraudi farmers classify their land types into two classes of

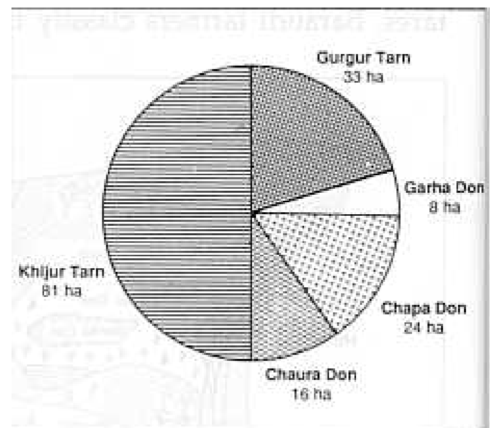


1. Baraudi land type map.

The research team at Baraudi.

upland and three classes of lowland. Upland classes are *gurgur tarn* and *khijun tarn*, while lowland classes are *chaura don*, *chapa don* and *garha don*. These classes roughly approximate government classes (tarn 1 and 2, don 1,2, and 3) for land tax purposes.

Gurgur tarn, the uncultivated land of homesteads, school, health centers, orchards, cattle sheds and fishponds, occupies 20% of the total area (Figure 2.). There are a few wells and hand pumps in this land type and some vegetables and cereals are grown near the home. Compost pits are located near these kitchen gardens. Some upland, the *gair majirua* is reserved for communal grazing and as children's playing area. *Khijun tarn*, the cultivable upland dominates the village at 50% of the total area. It supports a wide range of crops and vegetables in its unbunded fields. Some irrigation is given. Flat rice terraces at three levels - *chaura don*, or midland (10%), *chapa don* or lowland (15%), and *garha don* (5%) the lowest land type in this toposequence takes up the rest of the village area. Other minor features of Baraudi's land type map are small rocky hills or *tongri* and a small drainage channel next to a natural spring *danri* on the eastern side near the village road.



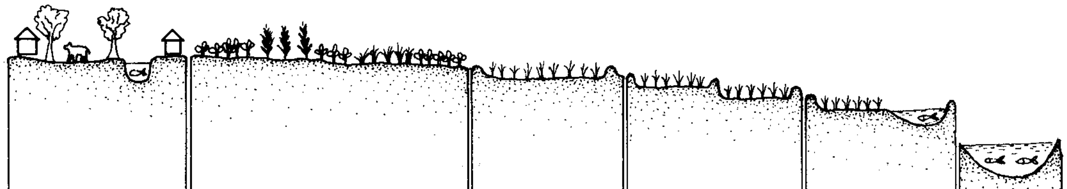
2. Distribution of land types.

An agroecosystem transect of land types including the river presents soils, water resources, crops, trees, livestock, fish and problems for each type (Figure 3.).

The course sandy loam of *gurgur tarn* uncultivated upland is where the homesteads, wells, ponds, shops, cattle sheds, etc. are located; it also supports orchards and vegetable gardens. Poultry, ducks, sheep and goats, which are managed by women, are also found in this land type.

The cultivated soils of upland *khijur tarn* are coarse sandy loams, acidic and highly permeable with low water-holding capacity. This land is largely devoted to Gora rice, vegetables, cereals and pulses. Mixed cropping patterns like rice and arhar, corn + cowpea and arhar are popular. During the off season, these lands serve as pastures and fodder sources for cattle and buffalo. Most often women collect grass and weeds from the upland rice areas.

Sandy loams of light texture and poor water holding capacity typify *chaura don* lands. Soil erosion problems make these soils less fertile compared than those of *chapa don*. Direct seeded rainfed rice dominates these areas during the kharif season. Rabi season crops like vegetables and wheat are grown only when irrigation is available. Otherwise lands are left fallow for grazing.

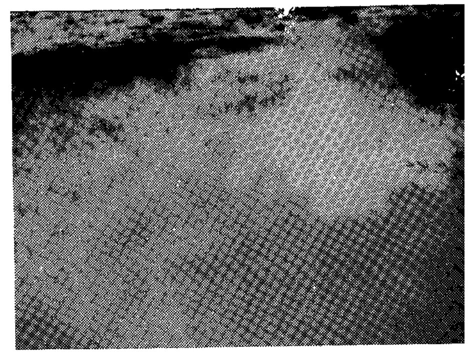


LAND TYPE	UPLAND (GURGUR TARN)	UPLAND (KHIJUR TARN)	MIDLAND (CHAURA)	LOWLAND (CHAPA DON)	LOWLAND (GARHA DON)	RIVER
SOIL	Gravely coarse sandly loam (Gurgur)	Coarse sandy loam (Baia)	Sandy loam (Bala-Krirsl)	Loam (Khirsl)	Silty clay loam (Nagra)	
WATER RESOURCES	Wells, Hand pump Ponds	Wells		Danri		
CROPS VEGETABLES	Vegetables Maize	Rice arher,maize, ragi, black gram cowpea, gundii, vegetables(potato, radish, tomato, okra) Wheat, vegetables in rabi season	Rice, wheat vegetables	Rice, vegetables	Rice	
TREES	Mango, jackfruit emili, papaya bamboo, karanj udukul, ghamar pipal, neem mohua, galachi jamun, bair putukal, sal kadam, katal eucalyptus Bargad					
ANIMALS FISH	Cow, goats, sheep, poultry, ducks, pigs, fish, honeybee buffalo	Cut and carry grasses Grazing - Grasses	Cut and carry Grazing in rabi season	Cut and carry grass Grazing in rabi season	Fish	Fish
PROBLEMS	Shortage of fodder Insufficient irrigation Disease & pest in horticiture & vegetable crops Disease in animals esp. in cattles, poultry Lack of input delivery system, fertilizer and seeds	Drought and lack of irrigation Low soil fertility Gandhi bug in rice Stemborer and other insects in maize Soil erosion Insufficient supply of seeds Soil acidity	Lack of irrigation Rice hispa Low soil fertility Soil erosion Stem borer in rice Lack of good seeds Assured fertilizer supply	Lack of irrigation for rabi crop Weeds Lack of input delivery Rice pests	Lack of assured supply of good seeds & fertilizers Flooding	

3. Baraudi agroecosystem transect.

Extensive bunded rice fields characterize the fertile loams of the *chapa don* during the kharif season. Farmers with access to natural springs (*danri*) grow vegetables during the rabi season.

Garha don land floods so frequently that even the single rice crop is often lost. In small depressions or *dari* that are found here, farmers often catch migratory fish. Fish are also caught in the Jumar River, which flows along the eastern border of the village.



Flooding problems in the Garha don land.

Problem ranking

Normally, we would ask farmers to rank their problems by land type according to distribution of the problem, importance of the enterprise, and seriousness of the problem. However, as there was no time for this during our exercise, what follows is the researchers' rationale for ranking farmers' problems (Figure 4).

Draft power, milk, farmyard manure, and a form of investment make cattle a very important enterprise in Baraudi. Draft animals were observed to be in poor condition because of the low quantity and quality of their grass and rice straw diets. Many women indicated that there was an acute shortage of fodder for cattle. They know this because collection of fodder is women's work. Women take long walks, particularly during dry months, to find fodder for the animals. During the rice season they work as hired labor to collect weeds for the cattle

4. Baraudi problem ranking table.

Problem	Distribution of Problem	Importance of Enterprise	Seriousness of problem	Relative importance of problem
Upland				
Insufficient irrigation	XXX	XXX	XXX	1
Weed	XXX	XX	XX	2
Soil erotion	XXX	XX	X	3
Pest and disease in crop	XX	X	X	5
Low soil fertility	XX	XX	X	4
Soil Acidity	X	XX	X	6
Poor input delivery	X	X	X	7
Animal disease	XXX	XX	XX	2
Shortage of fodder	XXX	XXX	XXX	1
Midland				
Insufficient irrigation	XXX	XXX	XX	1
Soil erosion	XXX	XX	X	2
Pest in rice	XX	X	XX	3
Low soil fertility	XX	X	X	4
Soil acidity	X	X		5
Poor input delivery	X	X	XX	6
Lowland				
Insufficient irrigation	XX	XX	X	2
Weed	XXX	XX	XX	1
Pest in rice	XX	X	X	3
Poor input delivery	X	X	X	4
Flooding	XX	XX	XXX	1

they raise. Women carrying about 20 kg load of bundled grass on their heads on their way home from the fields is a typical sight.

In the cultivated upland, vegetables and other cash crops are grown on residual moisture after the main rice crop. Thus, the high risk of water stress during the rabi season is a major constraint to generating cash. Irrigation for rabi season crops is beyond the means of most farmers. Since the water depth is very low (30 - 40 feet) a Rp 25,000 well and pumping set is necessary. Because crops cannot be grown during the rabi season without considerable risk, men migrate in search of more assured incomes. Migration leaves the women with sole responsibility for household and farm activities during the rabi season.

Lack of water during the dry season leads to frequent crop failure and is also the major problem in the midland. Growing a second crop after rice becomes even riskier when the rice crop is a long- or medium-maturing variety.

Weeds during the rainy season are the main problem in the lowland. This is partly because lowland soils are fertile, and partly because upland and midland are weeded first. Weeds from uplands and midlands are used as fodder, while those from lowlands are not. By the time weeders reach the lowlands weed competition with rice is so high that most of the damage has already been done. In the lowest rice terraces, flooding reduces production and increases risks to levels of some importance.

Woman carrying cattle fodder.

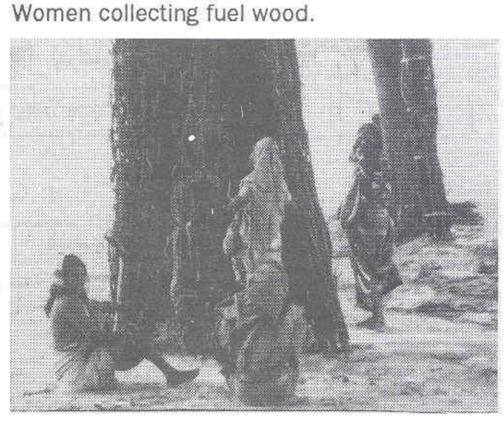
Systems diagnosis

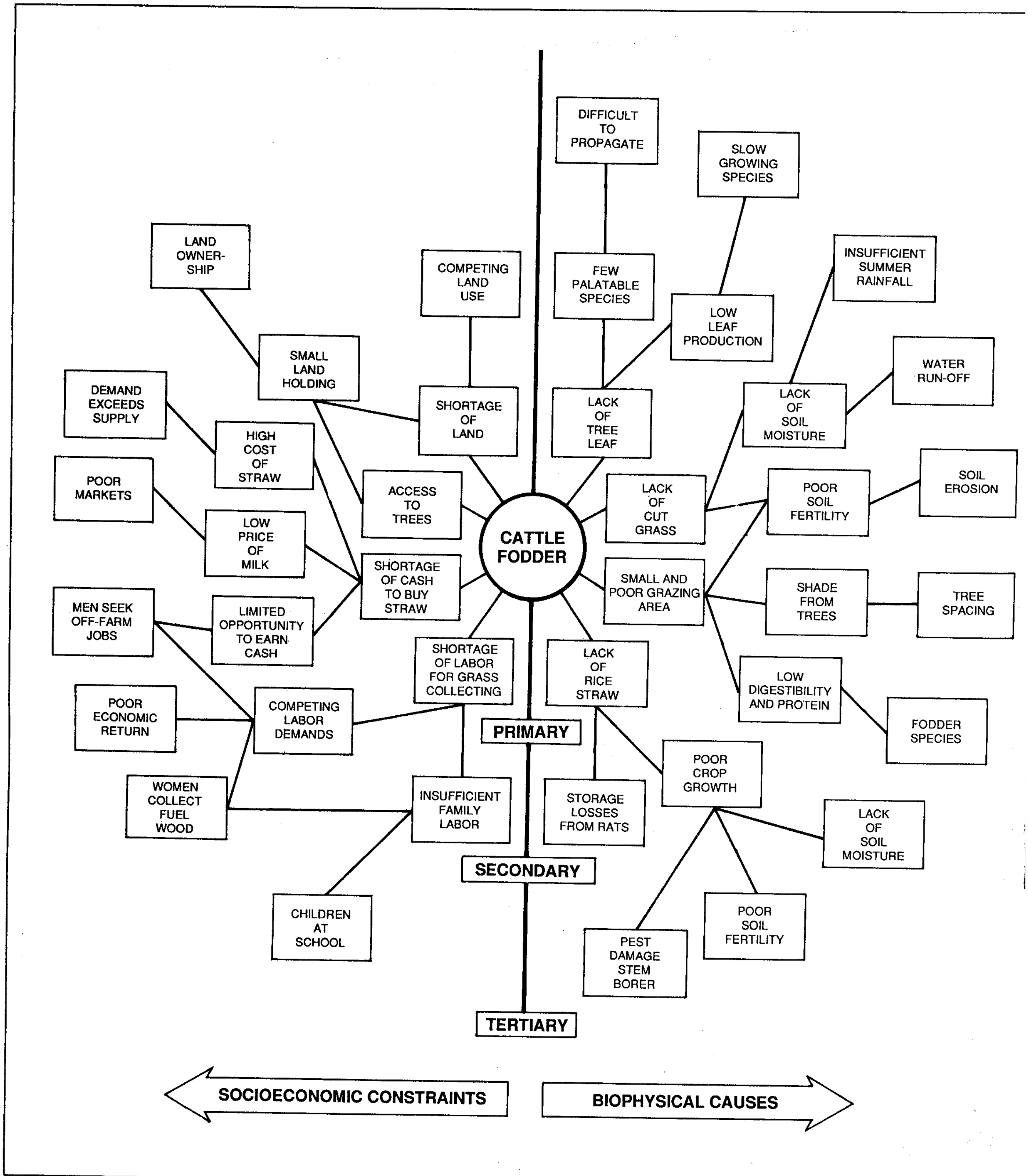
The central problem in our case study is lack of cattle fodder (Figure 5.) Of the 180 households in Baraudi, about 100 have draft or milk cattle or both. However, most households have more draft animals than milk cattle. Only a few richer families keep cattle solely for milk sales. Seventy percent of the approximately 300 cattle in the village are owned by backward caste families (*mahto*). The general health of the draft animals is poor because of heavy workloads and poor quality diets.

Draft cattle are fed nutritionally low-quality rice straw, grass, and tree leaves. Rice straw is available from January to July, after which

Small water bodies for many purposes including fishing.

Women collecting fuel wood.





5. Baraudi farmers problem tree for lack of cattle fodder.

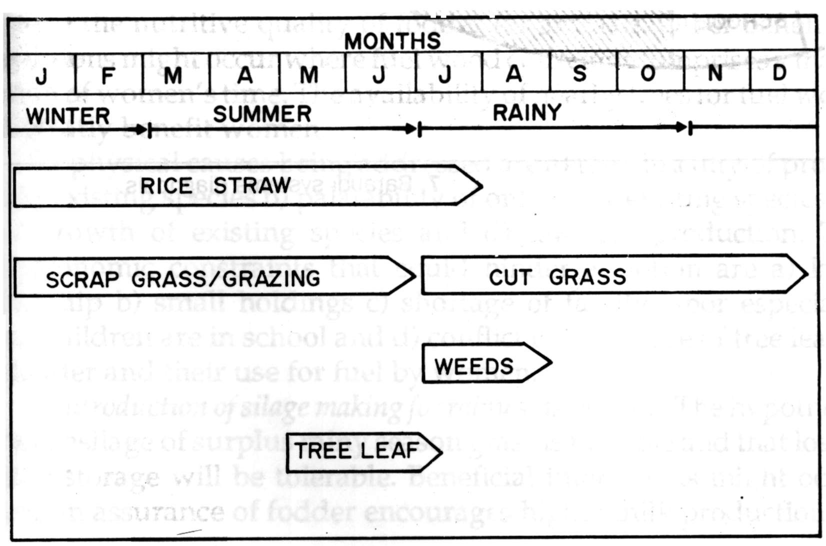
Underfed cattle.

farmers resort to weeds and grass (Figure 6). In times of scarcity, the few farmers who can afford it buy straw. Tree leaves supplement straw during May and June. Even in a good year these feeds are insufficient to maintain a healthy herd. A few wealthy farmers, who do not concern us here, feed concentrates (rice bran, corn, and gur) to their milk cattle.

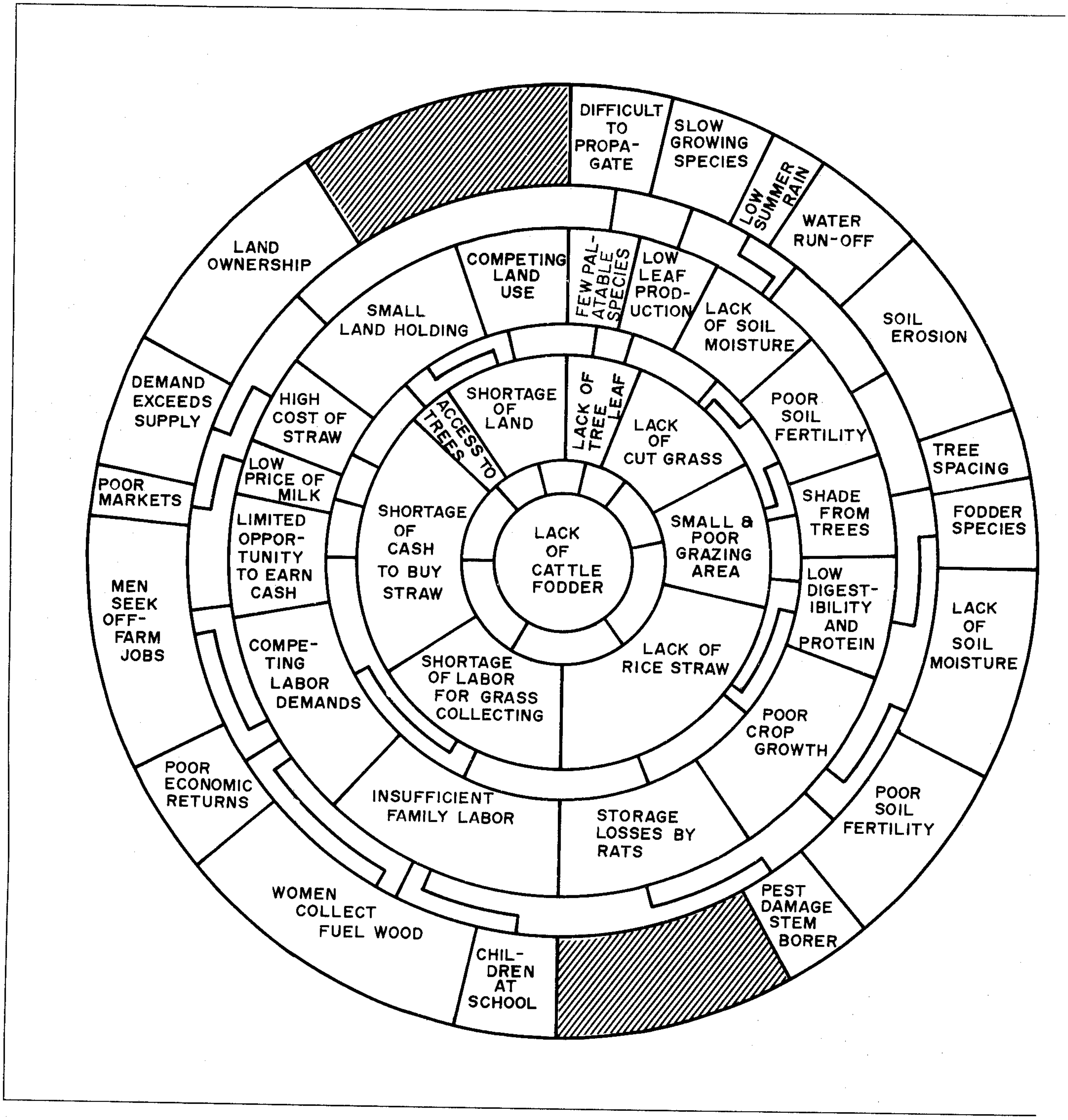
Biophysical causes. The primary biophysical causes of the cattle fodder problem are inadequate forage supply from cut and carry grass, tree leaves and rice straw (Figure 7). Moreover, grazing land, both private and public, is insufficient. Supplies of rice straw are reduced when the rice grows poorly. Poor soils, water stress and pests, particularly rispa and termites, all reduce crop production. Losses are also incurred when storing straw. Tree leaf supplies run out because the only two species of big trees - putkol and bargad that are used for fodder grow and produce leaves slowly. The weeds from *khijur tarn* and grasses from fallow areas are used for fodder, but their availability is limited by rainfall and lack of soil moisture. Moreover, the cost of weeding is high and the quantity of weeds obtained is not enough to feed the animals.

Socioeconomic constraints. Socioeconomic constraints faced involve levels of and access to key resources. Locally available fodder

Women gather weed for cattle fodder.



6. Calendar of fodder type and availabilty in Baraudi.



7. Baraudi systems diagnosis.

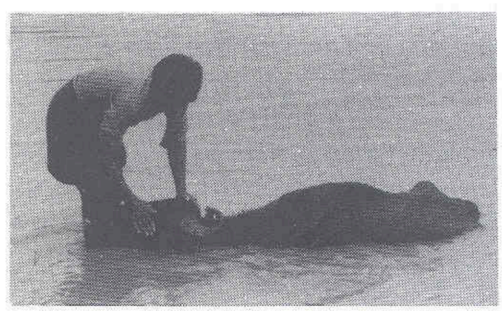
Lowland with midlands in the background.

such as rice straw costs more than most farmers can afford. Not only are there limited opportunities for farmers to earn cash, but also the prices they get for their milk is low. This is partly due to inadequate markets. Access to grazing land and trees is limited because of competition not only between food crop and fodder, but also from large landowners. Labor is another overstretched resource. Collecting grass and leaves competes with other activities like fuel wood collection and obligations like schooling of children.

Suggested research

l. Identification of more nutritious fodder grasses and legumes suitable for the system. The hypothesis is that more nutritious fodder grass and legumes crops can be found to fit in existing systems. This will increase not only availability of fodder but also its nutritive value. Other benefits may also accrue if these grasses and legumes are planted in such a manner as to arrest soil erosion.

The biophysical causes being addressed here are a) fodder species b) low digestibility and protein content of fodder and c) small and poor grazing land. The socioeconomic constraints that could hinder adoption are a) land ownership b) small land holdings c) shortage of family labor and d) alternative job opportunities for male labor.



Taking care of buffalo.

2. *Establishment of quick-growing trees of high leaf production and nutritional value on uncultivatable uplands.* The hypothesis is that quick-growing trees of high leaf production and nutritional value will improve the nutritive quality of fodder for animals. Other beneficial interactions might occur where fuel wood collection comprises a major portion of women's time. The availability of nearby trees for fuel wood will greatly benefit women.

Biophysical causes being addressed are a) the difficulty of propagating existing species b) palatability of only a few existing species, c) slow growth of existing species and d) low leaf production. The socioeconomic constraints that could hinder adoption are a) land ownership b) small holdings c) shortage of family labor especially when children are in school and d) conflict between use of tree leaves for fodder and their use for fuel by women.

3. *Introduction of silage making for rainy season grass.* The hypothesis is that ensilage of surplus rainy season grass is possible and that losses during storage will be tolerable. Beneficial interactions might occur where an assurance of fodder encourages higher milk production.

The biophysical causes being addressed are a) the shortage of grass from cut and carry because of slow growth during dry season b) insufficient rice straw and tree leaf during dry season and c) insufficient grazing. The socioeconomic constraints that could hinder adoption are a) the shortage of labor for scrapping and collecting fodder and b) smallness of landholdings from which grass can be taken.

4. *Experiments on short-duration summer and rabi season fodder crops.* The hypothesis is that short-duration summer and rabi season fodder crops could be established under drought-prone soil moisture conditions. Beneficial interactions might occur where fodder crops also serve as cover crops to check erosion.

The biophysical causes being addressed are a) insufficient grazing b) shortage of grass from cut and carry c) insufficient tree leaf and d) lack of soil moisture. Socioeconomic constraints that might hinder adoption are a) small landholdings and b) shortage of family labor especially when children are in school.

5. *Experiments on agro-forestry to meet fodder demand especially on cultivable uplands.* The hypothesis is that leguminous trees can be established and managed in contour alleys to provide fodder but without significantly reducing annual crop production. Beneficial interaction might occur where these contour hedgerows check soil erosion and provide wood for fuel.

The biophysical causes being addressed are a) slow-growing tree species b) species difficult to propagate and c) species have low leaf production. Socioeconomic constraints that might hinder adoption are a) small land holdings b) land ownership and c) shortage of family labor.

Uruguttu

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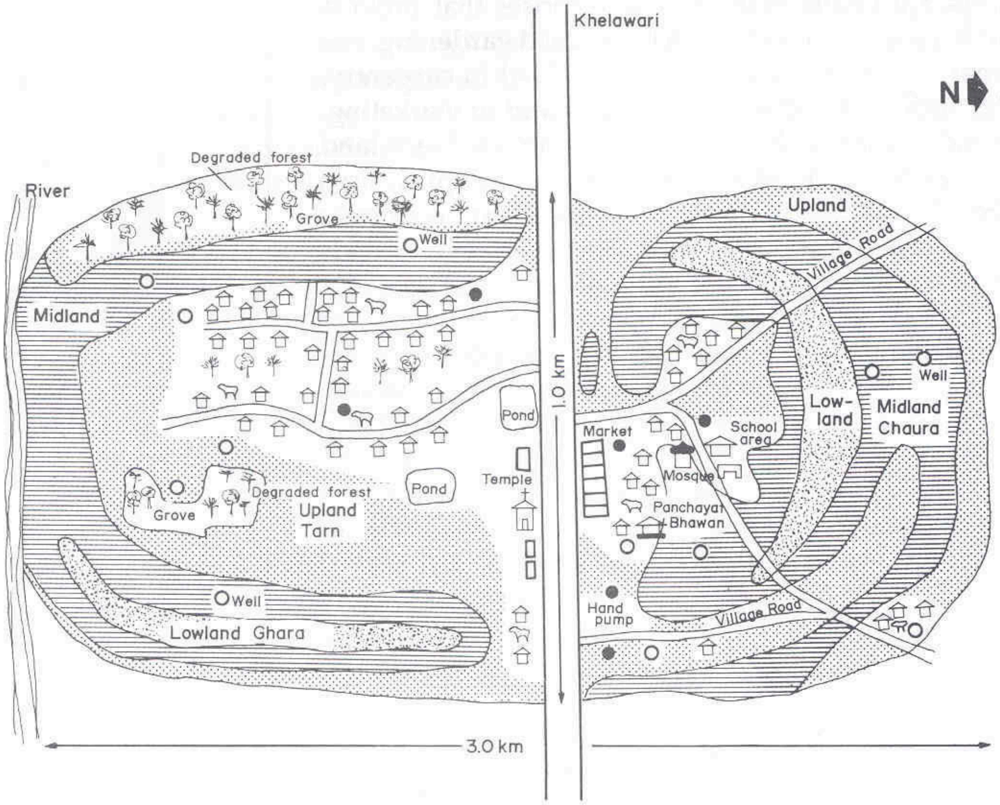
Agroecosystem analysis

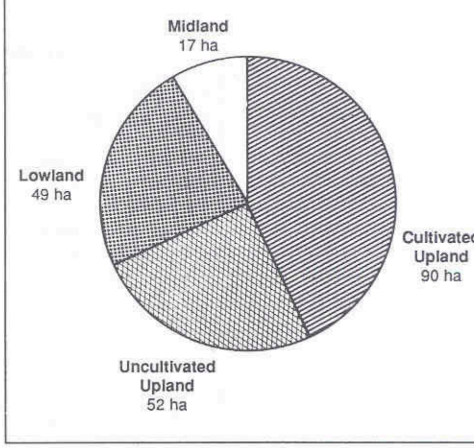
Uruguttu is bisected by the Pithoria-Thakengaon road (Figure 1). Farmers generally divide their cultivated lands into three major types based on elevation. In this classification they recognize upland tarn,

The Urguttu team.



1. Urguttu land type map.

medium land chaura and lowland garha. These cultivated lands are bordered in the south by a river and in the southwest by a strip of woodland. The total geographical area of Uruguttu is about 595 acres out of which 380 acres are under cultivation (Figure 2). Major cultivated land types are upland, medium land and lowland. Out of the 100 wells in Uruguttu, half are located in the upland and each can irrigate 2.5 hectares of rabi season vegetables. Two small tanks and five tube wells provide drinking water to some 350 households. Like most villages in Eastern India it is dominated by farmers with landholdings

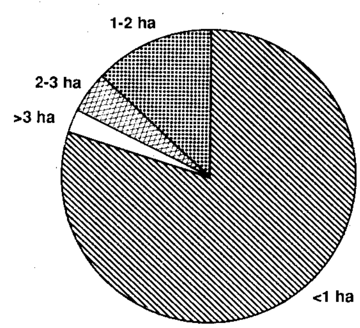


2 Distribution of land types.

The homesteads.

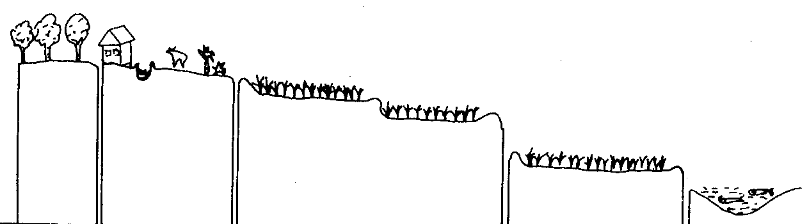
of less than 1 ha (Figure 3). Aside from cropping, animal production, and fishing, families are involved in other enterprises that provide additional income. Women are involved in homestead gardening, rice processing, and mat weaving while men are involved in carpentry, blacksmithing, etc. Both men and women are involved in marketing.

The uplands include forest, homestead and cultivated tarn land types (Figure 4). In the forested areas, trees such as eucalyptus, sisso and teak can be found. Near the homesteads women plant fruit trees and vegetables using water from nearby wells and ponds. These ponds are also used to raise fish. Families raise buffalo, cattle and goats for draft, milk, and cash. Taking care of animals and collecting of fodder are women's responsibilities. Rice and ragi replace the vegetables during the kharif season. These crops, however, suffer from nutrient deficiencies and water stress on the eroded, red, acidic (pH 5.5), sandy, infertile upland soils. Low organic matter (0.5%), low water-holding capacity and high porosity ensure quick runoff and rapid infiltration of rain. Soil erosion has been exacerbated as trees are continually cut for fuel. The increasing scarcity of sources of fuel near the homestead



3. Distribution of landholding size.

4. Uruguttu agroecosystem transect.

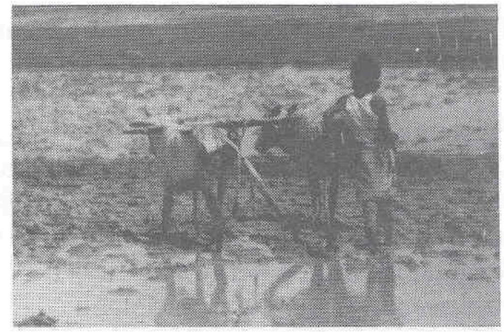


LAND TYPE	Forest	HOMESTEAD UPLAND TARN	MEDIUM LAND CHAURA	LOWLAND GARHA	RIVER
SOIL	Sandy	Sandy Sandy loam	Loam	Clay loam	
WATER RESOURCE		Well Hand pump pond	Rain, well		
CROPS TREES	sisso gamhar sal teak eucalyptus	Vegetables rice, ragi, mango, and other fruits	Rice, wheat, gram vegetables	Rice (monocrop)	
LIVESTOCKS		Cattle Goat Poultry			
FISH		Rohu other species			Fish
WATER TABLE	30-40' 10-15'	30' 10-15'	20-25' 8-12'	10-15' 6-10'	
SOIL MOISTURE	Medium	Poor	Good	Good	
PROBLEMS	Highly acidic soil Eroded soil Poor fertility Moisture stress		Moderately acidic soil Less eroded soil Limited moisture stress	Poor drainage	

results in degradation of the forest and increases women's time in fuel wood collection from the forests.

The slightly acidic and infertile sandy loam soil of the chaura exhibit low water capacity and low organic matter content. Medium lands support rice, wheat, and many vegetables. Vegetables are restricted to areas where irrigation is possible from nearby wells. Similar kinds of problems plague the midlands but they are less severe than in the uplands.

The clay loam soils of the lowland garha are deficient in organic matter, nitrogen and phosphorus. Moreover, there are drainage problems. The soil does not dry out until January and therefore rabi cultivation is not possible although this land is relatively more fertile than the upland and medium land types. Thus only a monocrop of medium- or long-duration maturing rice is grown in the lowland areas. Poor water drainage is the major problem in this area.



A underfed team takes a break.

Problem ranking

As upland areas comprise about 60% of the total land area in the village and the majority of poorer households who comprise 80% of the village have access only to this land type their problems were given highest priority (Figure 5). Upland landholdings are small and rice cropping intensity is low. Cash is generated from vegetable sales, however, vegetable production during the rabi season is afflicted by drought except for the relatively well-off farmers who have access to wells and ponds.

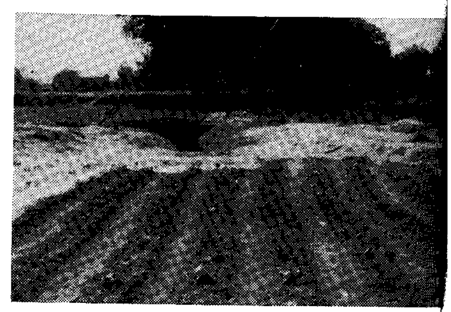
Biophysical factors such as inadequate groundwater, poor irrigation, erratic rains with long dry spells and low water-holding capacity of soil explain the problem. Weeds and waterlogging that affect the lowlands were given lower priority because lowlands comprise only 10% of the total cultivable area. After ranking the problems in all land

5. Uruguttu problem ranking table.

Problem	Distribution of problem	Importance of Enterprise	Seriousness of problem	Relative importance of problem
Poor production and cropping intensity due to moisture stress in uplands	XX	XX	XX	I
In uplands, broadcast rice suffers from severe weed infestation	XX	X	X	3
Poor soil fertility due to soil erosion, poor water-holding capacity and acidic soil	XX	X	X	3
Rainfed rice depends on monsoon and is highly erratic, e.g., late onset, long break, early cessation	XX	XX	X	2
Weed infestation in medium lands	X	X	X	4
Waterlogging in lowlands	X	X	X	4

types, particularly in the upland areas, moisture stress was ranked number one.

Orchards in the uplands.



Vegetables next to a well in the uplands.

Systems diagnosis

Farmers reported that as rice is produced only for consumption and vegetables are an important source of cash, factors that limit vegetable growth such as moisture stress are of central importance (Figure 6). Vegetables can be harvested three times a year, but water stress in the rabi season is the major problem.

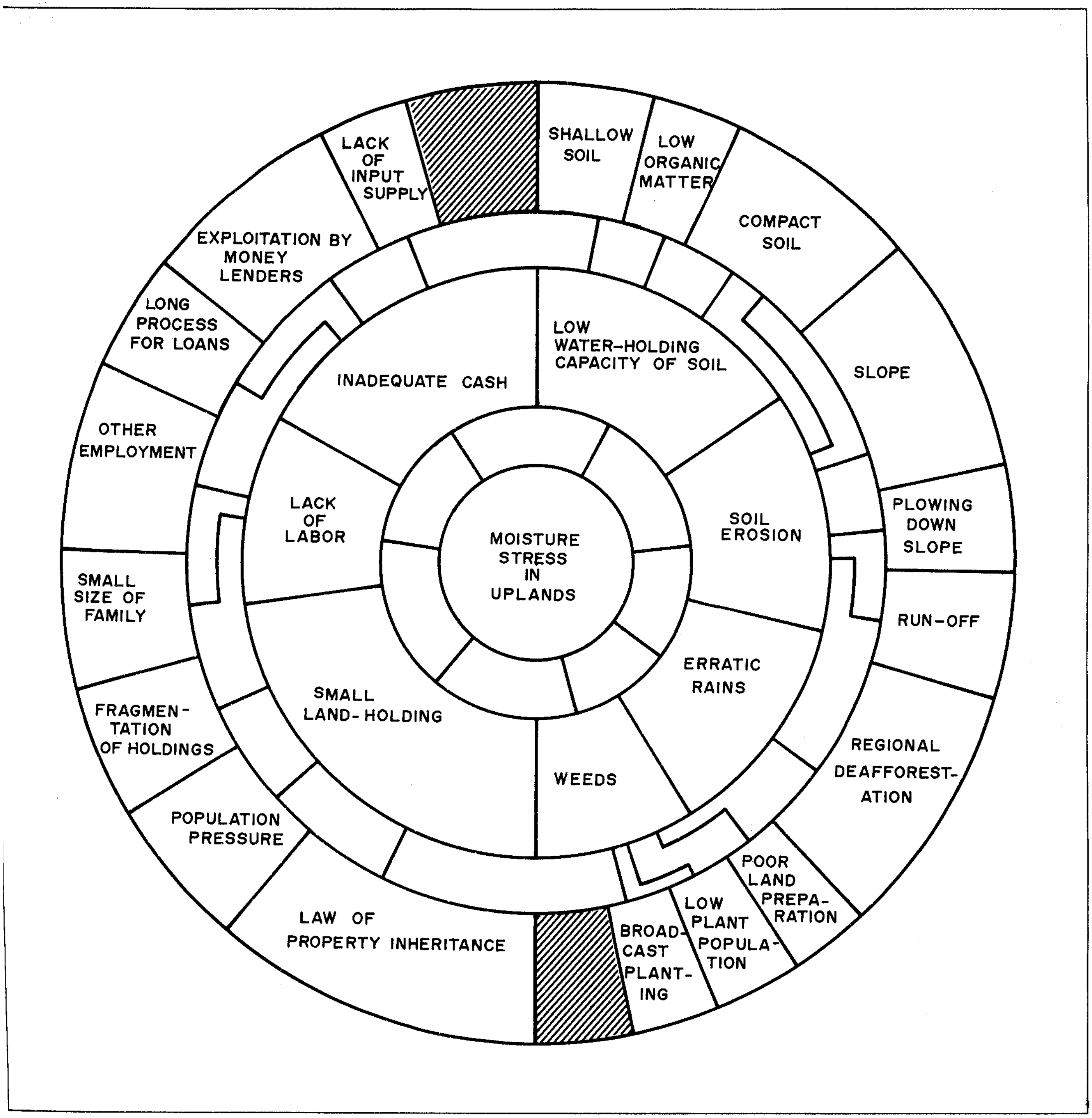
Biophysical causes. The primary biophysical causes of moisture stress in the uplands are a) low water holding capacity of soil b) soil erosion c) erratic rains with long dry spells d) inadequate ground water and e) high weed infestation. Low water holding capacity is due to the soil's light texture and shallow depth. Low organic matter is another factor contributing to erosion. Others are high run-off rates, sloping topography, deforestation, and inappropriate methods of cultivation like plowing down slopes. Although the rainfall of the area is not very low, crops suffer from moisture stress because rainfall is erratic with long dry spells. Farmers believe erratic rainfall is due to rapid wide-scale deforestation in the region. Weeds, a menace in kharif, reduce soil moisture and in turn, productivity and quality of crops. Weeds thrive because of inadequate land preparation, especially omission of summer plowing and low plant population in broadcast planted crops.

Socioeconomic constraints. The major socioeconomic constraints to the solution of water stress problems are a) scattered & fragmented land holdings and b) inadequate cash. Land is highly fragmented and scattered in small areas mainly because of population pressure and inheritance patterns. People of the village are generally very poor and do not have means to dig wells. Undulating topography increases the costs of canals and the presence of hard rock at shallow depth (2-3 m) and a deep water table at about 10-15 m below the surface increases the cost of the well. Farmers' access to cash is frustrated by financial institutions which adopt very complicated procedures for granting loans, especially to women borrowers. Therefore, farmers are forced to borrow money from local moneylenders at very high rates of interest (300% per annum).

Suggested Research

I. Identification of suitable leguminous trees that can be grown in contour hedgerows in upland areas to reduce soil erosion. The hypothesis is that planting suitable leguminous trees will improve soil conservation, check soil erosion, and thus help build soil fertility. Other benefits might occur if these trees can be used as fuel wood and fodder for animals and consequently save women's time in collecting fuel wood and fodder.

The biophysical constraints addressed are a) low water- holding capacity and b) soil erosion. Contour hedgerows of legume trees should reduce run-off, encourage contour plowing, and reduce slopes as terraces form. Applications of tree leaf to the soil should increase organic matter and improve soil structure. Socioeconomic constraints that might reduce adoption are a) size and distribution of landholdings and b) lack of labor and competition for labor.



6. Uruguttu systems diagnosis.

Scientist and farmers exchange ideas.

2. *Establishing optimum seed rate for broadcast rice for higher plant population and reduced weed growth.* The hypothesis is that higher seed rate for broadcast rice will increase plant population and reduce weed population.

The biophysical causes addressed are a) poor plant population and b) low seeding rates. Socioeconomic constraints that might reduce adoption are a) lack of seed suppliers and b) lack of cash to buy expensive seeds.

3. *Mulching vegetable with organic mulch during the dry season.* The hypothesis is that vegetable production during the dry season is possible with the use of organic mulch such as rice straw, crop residues, and tree leaves. Benefits might occur if the organic mulch will check weed growth, reduce soil erosion, and also add organic matter to the soil.

Biophysical constraints addressed are a) Low water holding capacity and b) high water run-off rates. Socioeconomic constraints that may reduce adoption are: a) lack of labor and b) competing uses of leaves and straw for fuel or fodder.

4. *Introduction of drip irrigation in upland vegetable production.* The hypothesis is that drip irrigation will make vegetable production under rainfed condition possible with far less water than in conventional flood systems. Drip irrigation consists of putting porous earthen pots filled with water in between rows of crops.

The biophysical constraint addressed is an erratic rainfall with long dry spells. Socioeconomic constraints that might hinder adoption are a) labor, as this method requires each pot to be filled regularly and b) cash for purchase of the earthen pots.

Terraces of rice paddies.

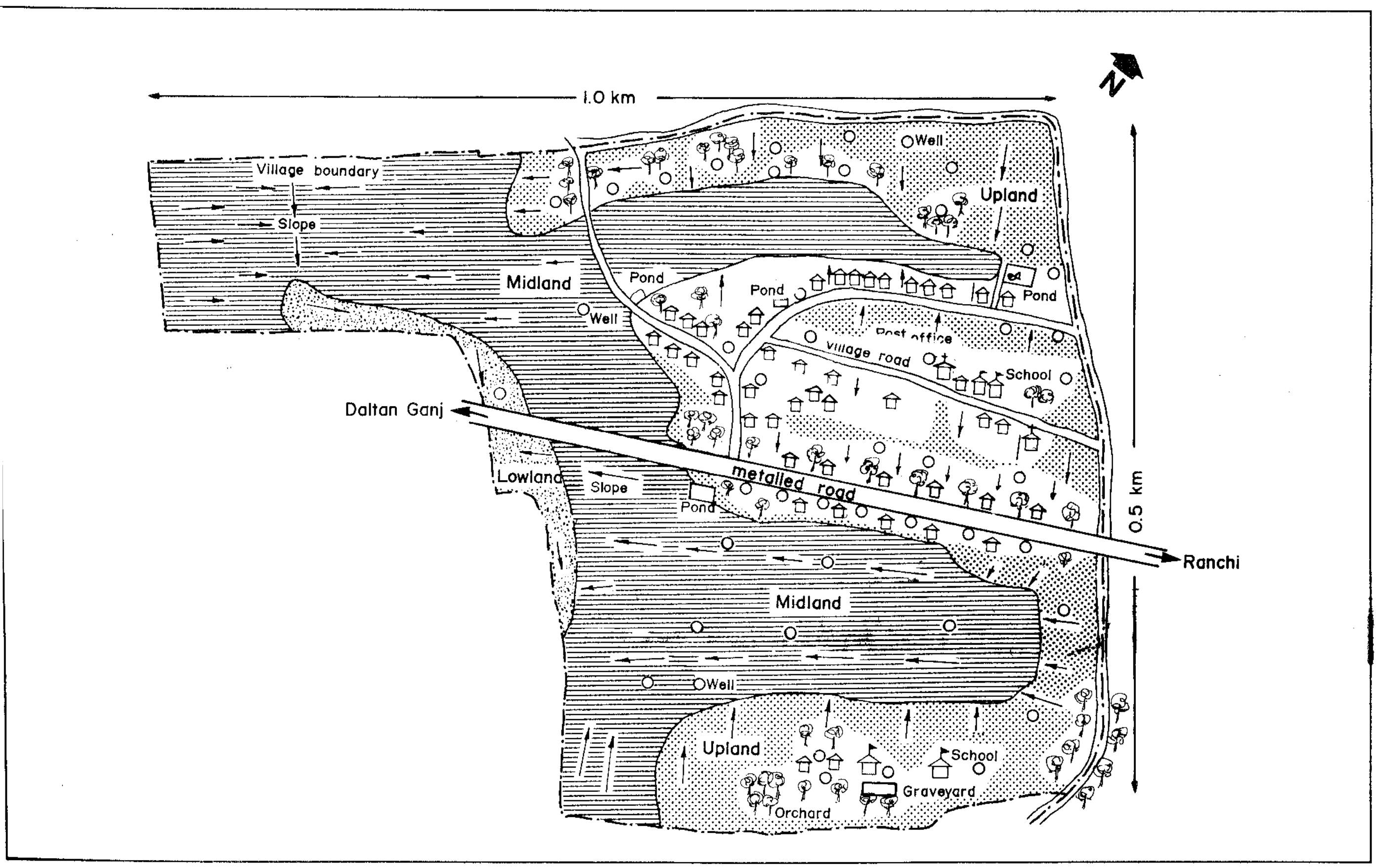
Murma

Dr. S.C. Prasad, BAU; Dr. K. Tirkey, BAU; Dr. D. Paul, Dr. V.S. Chauhan, CURRRS, Hazaribag; Dr. J.L. Dewedi, NDUAT; Dr. O.P. Singh, NDUAT; Dr. R.A. Singh, NDUAT; Ir. R.D. Singh, NDUAT; Dr. H.P. Singh, NDUAT; Dr. R.S. Singh, BAU; Dr. S. Biswas, IRRI; and V.P. Singh, IRRI.

Agroecosystem analysis

Murma village straddles the Ranchi to Daltan Granj road about 22 km away from Ranchi (Figure 1). The total area of the village is 260 hectares, of that 198 is under cultivation or fallowed while homesteads and grazing sites occupy the remaining area (Figure 2). Homes and

1. Murma land type map.



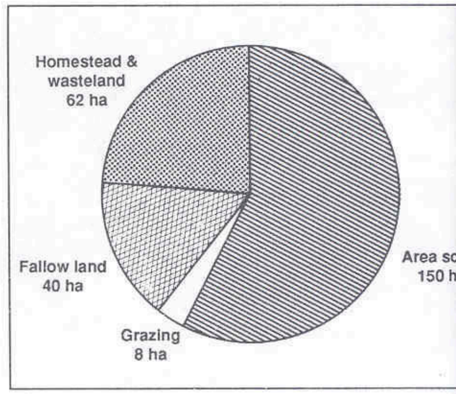
other buildings are all located near the road in the upland tarn. There is also a pond where animals bathe and fish are raised. With the exception of a small strip of lowland don on the southern border the rest of the village is midland don. The major portion of the total area is under upland followed by midland and the smallest is lowland (Figure 3). As one would expect land is not distributed evenly between castes. The five Brahmin families have access to 26 hectares while 215 scheduled tribe families must make do with 117 hectares (Figure 4).

Upland tarn soils are mostly red sandy loams derived from lateritic parent material on slopes that range from 1.5 to 5%. High percolation rates and low water retention capacity of the 1200-1500 mm of rain that falls each year often result in stressed crops. Orchards, vegetables, livestock raising and fish comprise the main upland tarn enterprises (Figure 5). On the half acre of upland that is available to most families, women grow vegetables, pigeon pea, and ragi in the kharif season; those who have access to irrigation wheat and vegetables in the rabi season. Livestock are a very important source of income for poorer families. A bullock can fetch as much as Rp 8,000 while Rp 5,000 will be given for a milking cow, Rp 300 for a goat, and Rp 280 for a pig. Families raise cows for milk and buffalo for draft. Important operations like collecting fodder, grazing, milking, cleaning the animals, and collecting manure for fertilizer and fuel are the responsibilities of tribal women. Similarly, goats and pigs are reared by women from scheduled castes and tribes.

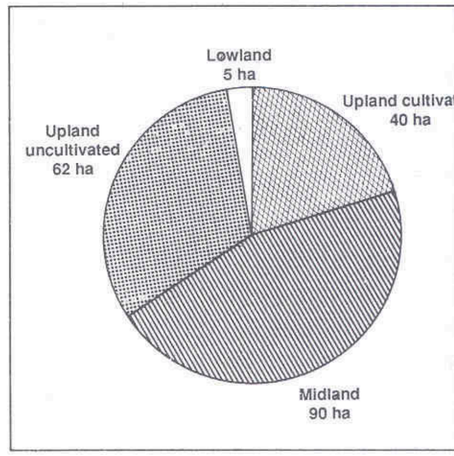
On the sandy to clay loams of the slightly sloping and flat midland and lowland don only rice grows in kharif with wheat and lentil in some places on midland during the rabi season. In rice production tribal women play a crucial role in transplanting, weeding, harvesting, threshing, and storing of crops. Cattle graze on fallow areas during the rabi season. Migrating fish are caught in small depressions in the lowland don. Tamarind and jackfruit dominate orchards that also include neem, bamboo, litchi and banana trees.

Problem ranking

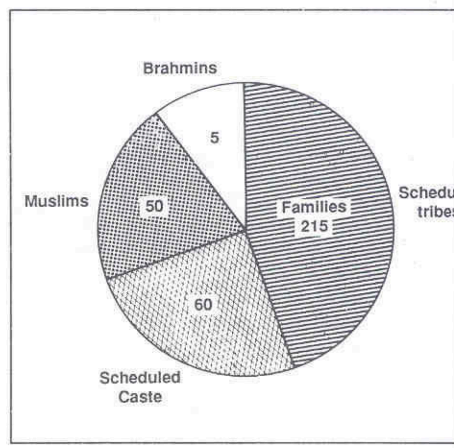
Farmers feel that if their lives are to improve they must get more food and cash from their agricultural land. Farmers report that while rice productivity is quite good, much of their land is idle during the rabi



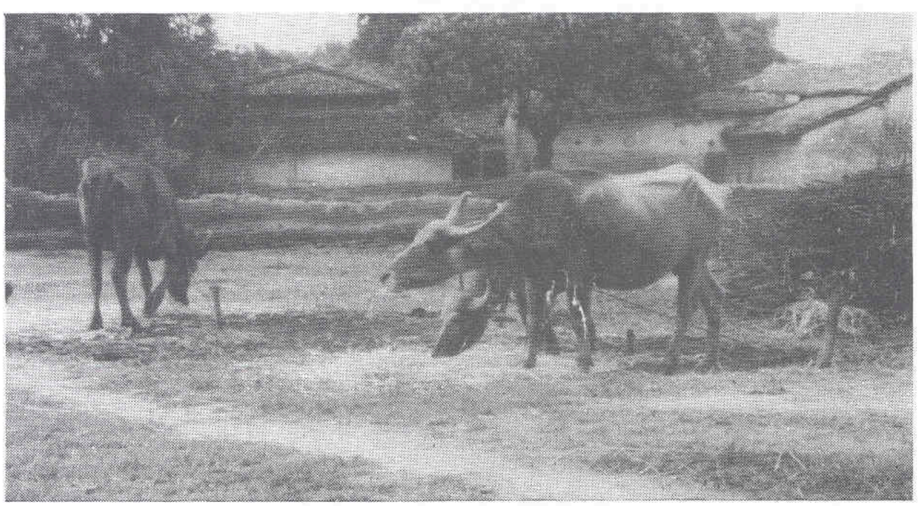
2. Distribution of land use.



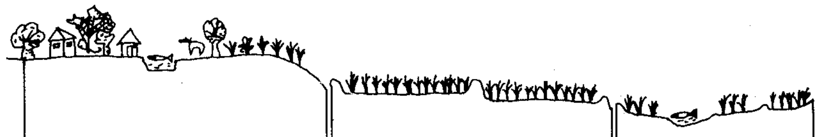
3. Distribution of land types.



4. Distribution of land by caste.



Feeding cattle near the homestead.



LAND TYPE	UPLAND TARN	MEDIUM LAND (DON)	LOWLAND (DON)
SOIL	Sandy Loam 5-15% slope	Sandy loam-Silty loam 1.5% slope	Sandy clay loam Flat
WATER TABLE	2-8.0 m	0-5 m	0-4 m Occational water stagnation
CROPS	KHARIF: ragi, pigeon pea vegetables RABI: wheat, vegetables (only in irrigated areas)	Rice Wheat (in 5% area) Lentil	Rice
TREES	neem, bargad, peepal bamboo, karang eucalyptus, mango, jackfruit, tamarind, banana, jamund, lichi		
LIVESTOCK	Cattle, goat, pigs	Cattle grazing	
FISH	Poultry, ducks, fish		Fish
PROBLEMS	Inadequate irrigation facilities Soil erosion Poor soil fertility High intensity of weeds Shortage of draft cattle Shortage of green fodder Stray cattle	Under utilization of land Manpower shortage during rabi season Drought Weed problem Poor water retention capacity Lack of green fodder Cattle damage rabi crops	Moderate water retention Stray cattle Inadequate use of land resources Flooding

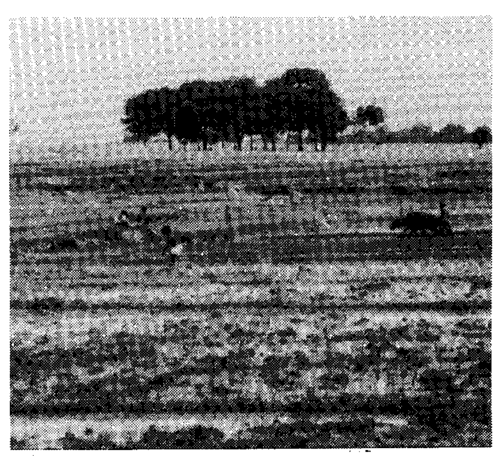
5. Murma agroecosystem transect.

season. Out of the cultivated 198 ha, only 8 ha area is sown more than once. The largest expanse of underutilized land occurs in the 90 ha of midland don (Figure 6). Moreover, if ways can be found to work the land during the rabi season, this may stem seasonal outmigration of male workers.

Because the midland don is rainfed, even a good rice variety still suffers from drought. Yield is also lost from weed competition and cattle damage. Since transplanting of midland rice and weeding of upland crops coincide, a temporary labor shortage is created especially among women. Transplanting and weeding tasks are predominantly done by women.

In the upland tarn inadequate irrigation facilities severely restrict the area of rabi season cropping. Slopes of 1.5 to 5% and light-textured soil make erosion a serious problem. Poor crop productivity is also due to low moisture retention and low inherent fertility. Despite their low numbers cattle damage crops and their poor health do not allow them to meet draft power needs.

In the lowland don flooding reduces kharif season rice production. Insufficient drainage causes water stagnation problems even



Plowing teams in the "Don" lands.

Problem	Distribution of problem	Importance of problem	Services of problem	Relative importance of problem
Upland				
Inadequate irrigation facilities	XXX	XX	XXX	1
Soil erosion	XXX	XX	XX	2
Poor soil fertility	XX	XX	XX	2
Intensity of weeds	XX	XX	X	4
Stray cattle grazing	XX	X	XX	4
Shortage of draft cattle	XX	X	X	5
Shortage of green fodder	X	X	X	6
Midland				
Inadequate land resource use	XXX	XXX	XXX	1
Soil erosion	XXX	XX	XX	2
Poor soil fertility	XX	XX	XX	3
Intensity of weeds	XX	XX	X	4
Stray cattle grazing	XX	X	XX	4
Shortage of draft cattle	XX	X	X	5
Shortage of green fodder	X	X	X	5
Lowland				
Water stagnation in kharif	XXX	XXX	X	
Stray cattle grazing	XXX	XX	XX	3
Flooding	XXX	XX	XX	2

6. Murma problem ranking.

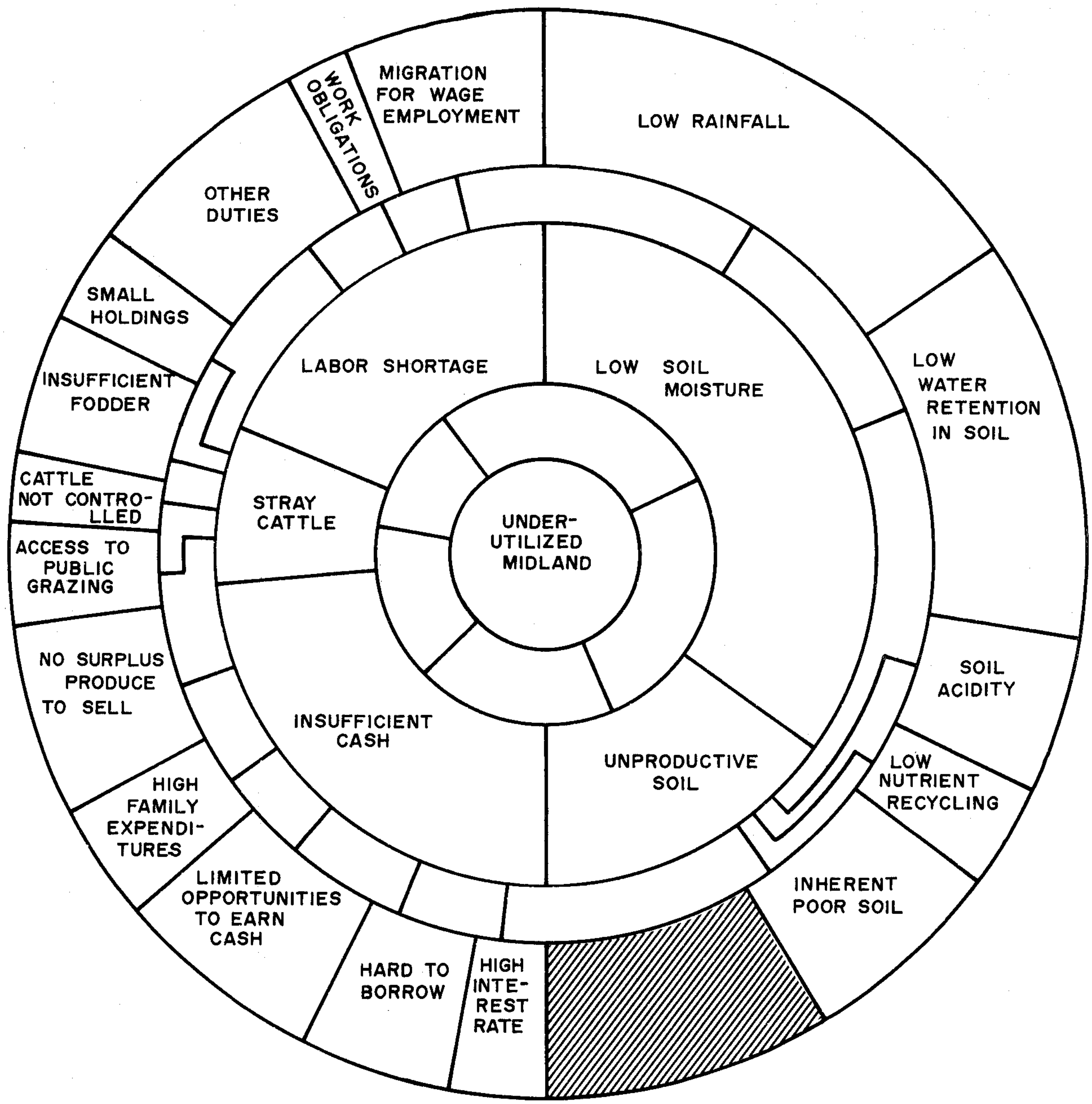
during the rabi season. Such soil moisture regimes not only damage kharif rice but also prevent rabi crops from being cultivated.

Cattle feeding on rice straw

Systems diagnosis

Presently, farmers only use the midland don for one crop of kharif rice. The only exception is a small area of about 8 hectares on which a wheat crop is taken. Underutilization of land was selected as the central problem for Murma (Figure 7). Even if average rainfall is 1450 mm/ annum, more than 50% is lost as runoff. There are few rainwater harvesting structures like tank or dams. Rainwater harvesting needs some submergence area which would have to belong to many farmers. Even if farmers did unite and build a common water resource, the lack of credit facilities and bureaucratic difficulties discourage them from approaching lending organizations.

Biophysical causes. The primary biophysical causes of underutilized land are low soil moisture and unproductive soil. Soil moisture is low because the entire area is rainfed and there is little rain in the rabi season. Furthermore, the water retention capacity of the soil is small. Soils are unproductive because they are acid, they recycle nutrients slowly and they are inherently infertile.



7. Murma systems diagnosis.

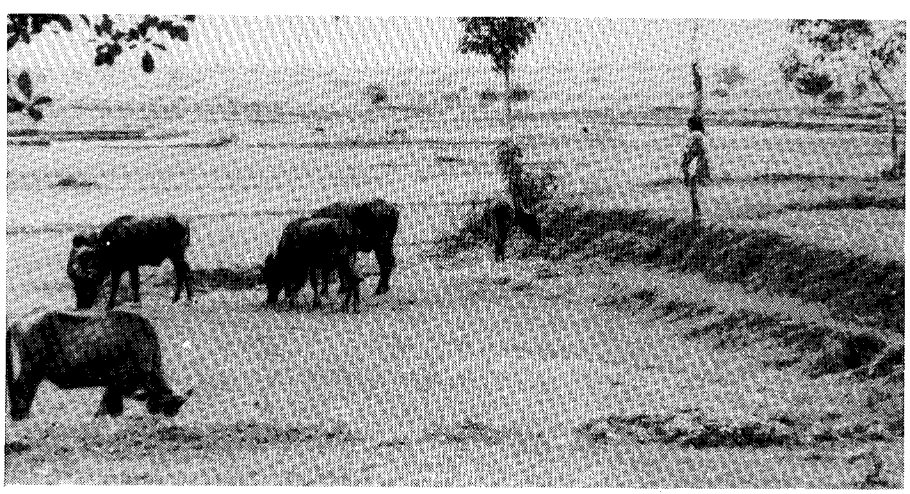
Socioeconomic constraints. Greater utilization of land is constrained by damage from stray cattle and shortage of cash and labor. Cattle stray onto don land because farmers do not control their animals, they do not have enough fodder, their own landholdings are too small, and there is insufficient public grazing land. Most orchards and public lands in the village are controlled by higher caste people, thus scheduled castes and scheduled tribes cannot graze their animals on these lands. Cash to finance water impounding structures like open wells or small tanks is short because there is little cash in the household and few opportunities to earn it. Moreover, it is hard to approach lending agencies and informal lending entails high interest rates. Farmers are reluctant to prepare feasibility studies for irrigation loans. Labor constraints to build wells exist because of labor migration in search of employment, other duties on the farm, and various obligations to provide labor for higher caste families.

Suggested research

1. *Introduction of dual-purpose crops for food and green manure.* The hypothesis is that these crops will provide a food source and enrich the organic matter of the soil. Other benefits might occur if the residues of these crops when incorporated in the soil also improve water retention capacity. Water loss may also be reduced if residues are used as dry mulch for some cash crops such as garlic and onions. Moreover, cowpea and *Vicia faba* can be used as fodder as well as food in the form of dry or fresh beans. Lathyrus varieties with low BOAA content are recommended for feed.

The biophysical cause addressed is the low nutrient recycling in the infertile soils. Crops like cowpea, *vicia faba*, lentil, Lathyrus and linseed are known to grow well on acidic and physically poor soils. They require low amount of water and produce substantial amount of biomass. However, non availability of cash to buy seeds and crop losses due to grazing of stray cattle may be a serious socioeconomic constraint to the adoption of this solution.

2. *Establish rainwater harvesting structures.* The hypothesis is that rainwater can be harvested during the kharif season and stored for distribution during the rabi season. Open wells may replace tanks in areas with sufficiently recharged water table and adequate aquifer



Cattle grazing the midland terraces.

strata. Benefits might occur where tanks could also be used for raising fish. Fishing would create additional employment during lean periods and provide additional income.

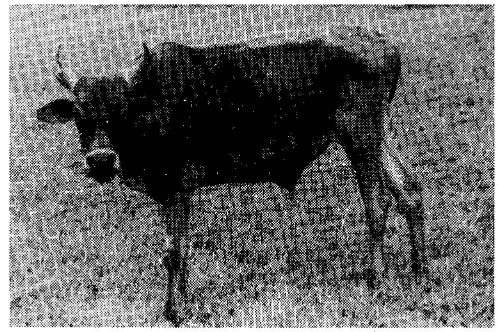
The biophysical cause of underutilized land being addressed here is low rainfall. Whether rainwater is stored in tanks on individual farms or collectively by several farmers, socioeconomic constraints to adoption arise. Firstly, a portion of cultivable land will have to be allocated to the tank. Furthermore, costs of construction with hired labor may conflict with availability of cash and credit in the village.

3. *Dry soil mulch tillage for rabi season cropping.* The hypothesis is that dry soil mulch will conserve moisture from rain or dew in sufficient quantities for successful rabi season cropping. Dry soil mulch entails repeated plowing in the afternoon and planking close to furrows in the early morning. Benefits might occur if such operations would also reduce weed infestation in subsequent rice crops.

The biophysical causes addressed by mulching concern soil moisture regimes. Socioeconomic constraints that might hinder adoption are availability of labor during turnaround time between rice harvest and sowing of second crop.

4. *Testing crop-livestock integration technologies.* The hypothesis is that residues from short-duration drought- tolerant forage crops after rice can improve soil fertility and can be used as fodder for animals. Benefits will accrue where additional fodder increases milk from cattle and goats which can be sold to benefit the women who take care of animals.

The biophysical causes of underutilization of midland don being addressed concern low soil fertility. Socioeconomic factors that may constrain adoption are lack of cash for the purchase of seeds and lack of labor to gather the fodder produced.



Poor condition of cattle.

SECTION C

Systems diagnosis training templates


Open wells for irrigation.


RRA can be fun.

TEMPLATE 1

Learning objectives

- **Participants will be able to define systems diagnosis and systems diagrams, explain their application in FSRE, and discuss the steps in developing a systems diagram.**

- **Participants will conduct agroecosystems analysis through village mapping and transect exercises, rank the problems identified, and practice systems diagnosis and systems diagramming with farmers.**

- **Participants will be able to identify research and extension opportunities, and develop experimental hypotheses for on-farm research programs.**

TEMPLATE 2

Training activities

Activity One - Introduction to the Exercise

Activity Two - Field Exercise in Agroecosystems Analysis

Activity Three - Field Exercise in Systems Diagnosis

Activity Four - Case Study Reports

Template 3
Definitions

Diagnosis is a series of consultations and measurement activities to obtain an adequate understanding of farmers' problems so that test solutions can be designed.

Systems diagnosis is the process by which farmers draw out or diagram the interactions between biophysical causes and socioeconomic constraints to the farmers' problem.

A systems diagram is a simplified pictorial representation of how biophysical causes of the farmers' problem are linked together and how the socioeconomic constraints interact and give rise to the farmers' problem.

Key points

Agroecosystem analysis provides an ecology-based framework for understanding farming systems and identifying problems by land type.

Diagnosis provides sufficient understanding of the farmers' problem and how it interacts with system components so that solutions can be designed.

Problems can be ranked considering the number of farmers affected, the importance of the enterprise involved, and the losses in production and income entailed.

A systems diagram is a tool for analyzing relationships among factors affecting a problem, ordering the causes and effects of problems, and providing ideas for intervention points where specific technologies may solve the problem.

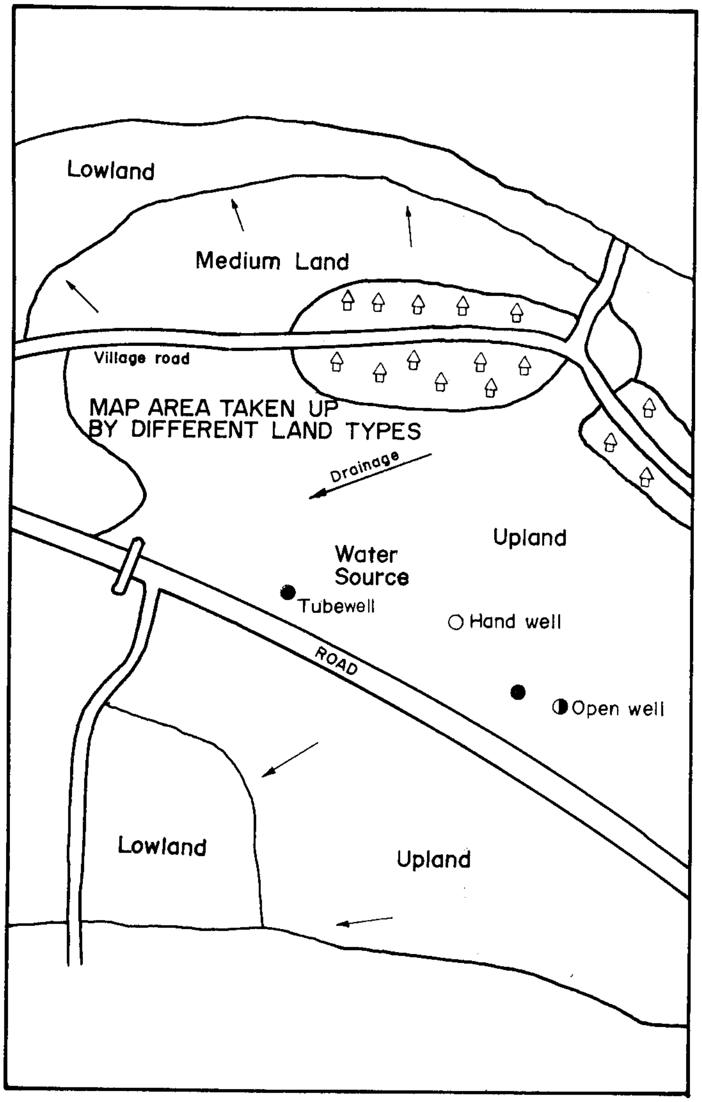
TEMPLATE 5
Processes

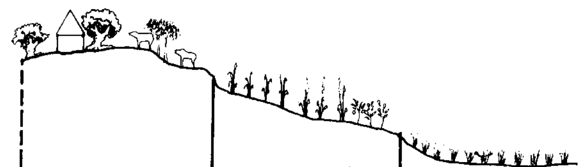
1. Agroecosystem analysis

The problem to be diagnosed is identified through agroecosystem analysis. Maps and transects of land types and enterprises are prepared. Problems are listed at the bottom of the transect. As there are, of course, many problems a procedure for ranking them should be followed.

Template 6

Agroecosystem map and transect





LAND TYPE	UPLAND	MIDLAND	"CHAUR" LOWLAND
SOIL		Silty loam	
CROPS		Rice Wheat Mungbean	
TREES	Mango Litchi Citrus		
LIVE-STOCK & FISH	Bullocks Goats Cattle		Fish
PROB-LEM	Soil Fertility		Drainage
OPPOR-TUNITIES	Crop storage facilities	High quality seeds	

2. Ranking problems

Problems are ranked using three criteria (after Tripp & Woolley, 1989).

1. **The distribution of the problem.**
2. **The importance of the particular enterprise to the farming system.**
3. **The loss of production or income for which the problem is responsible.**

TEMPLATE 8

Table of ranked problems

Problem	Distribution of problem	Importance of enterprise	Seriousness of problem	Relative importance of problem
Upland				
Weed	XXX	XX	XX	I
Soil erosion	XXX	XX	X	2
Pest	XX	X	X	3
Land type 2				
Kind of problem				

place farmer's score of importance

calculate rank

3. Informal interview

When conducting interviews the following points should be kept in mind.

1. **A target group of farmers should be identified.**

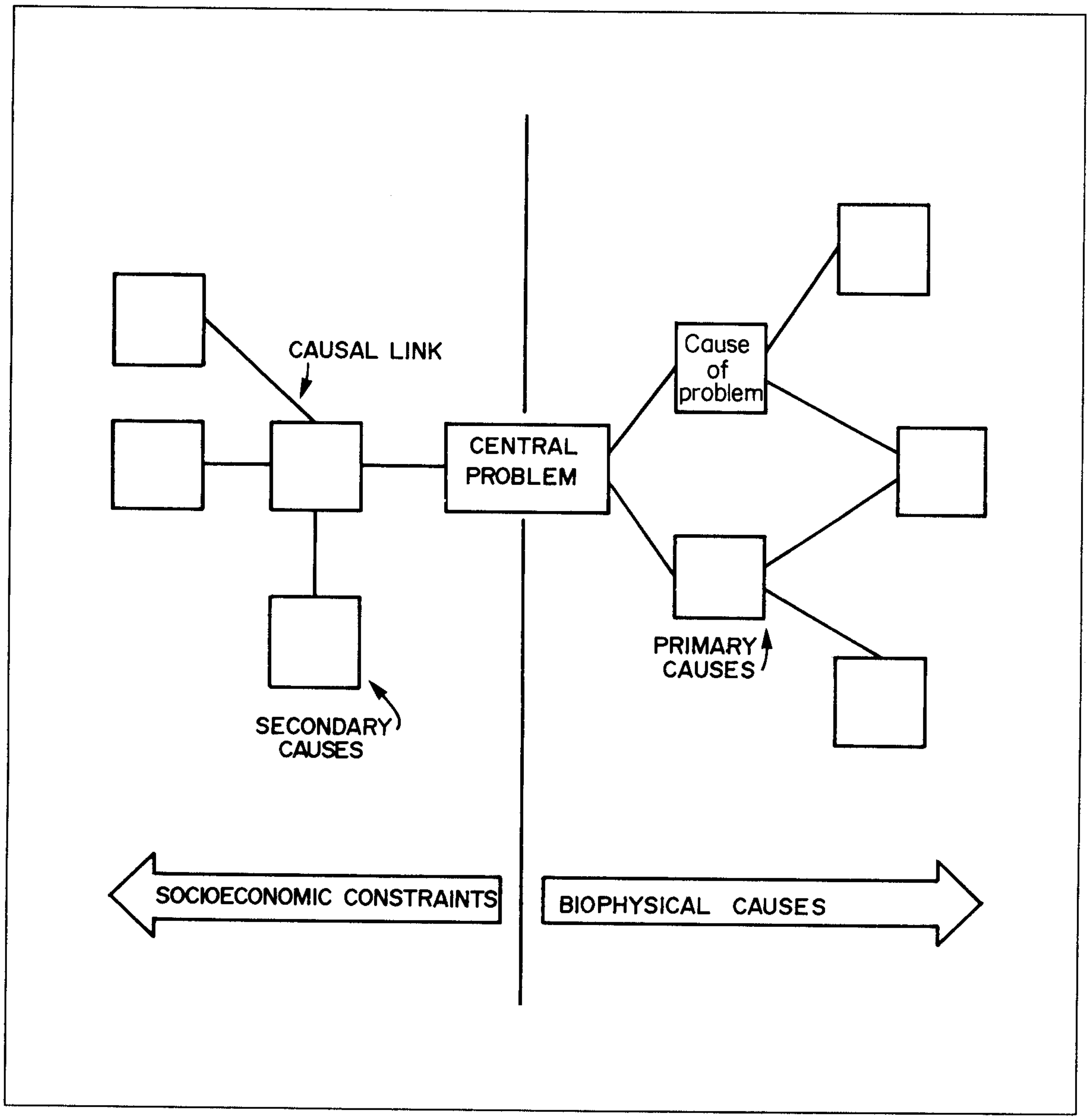
2. **Where possible, respondents should be encouraged to draw out their problem tree on the ground.**

3. **The order of questions is determined by the flow of conversation and not by the guide topic listings.**

4. **Questions are best asked in the field because farmers answers are more detailed when they can show what is happening.**

5. **Questions to guide researchers as they seek a greater understanding of the problem are developed using Rapid Rural Appraisal techniques. Typically, questions cover a) farm typology b) descriptions of processes c) rationale or difficulties and d) estimations of key economic and biological parameters.**

Template 10
Farmers' problem tree



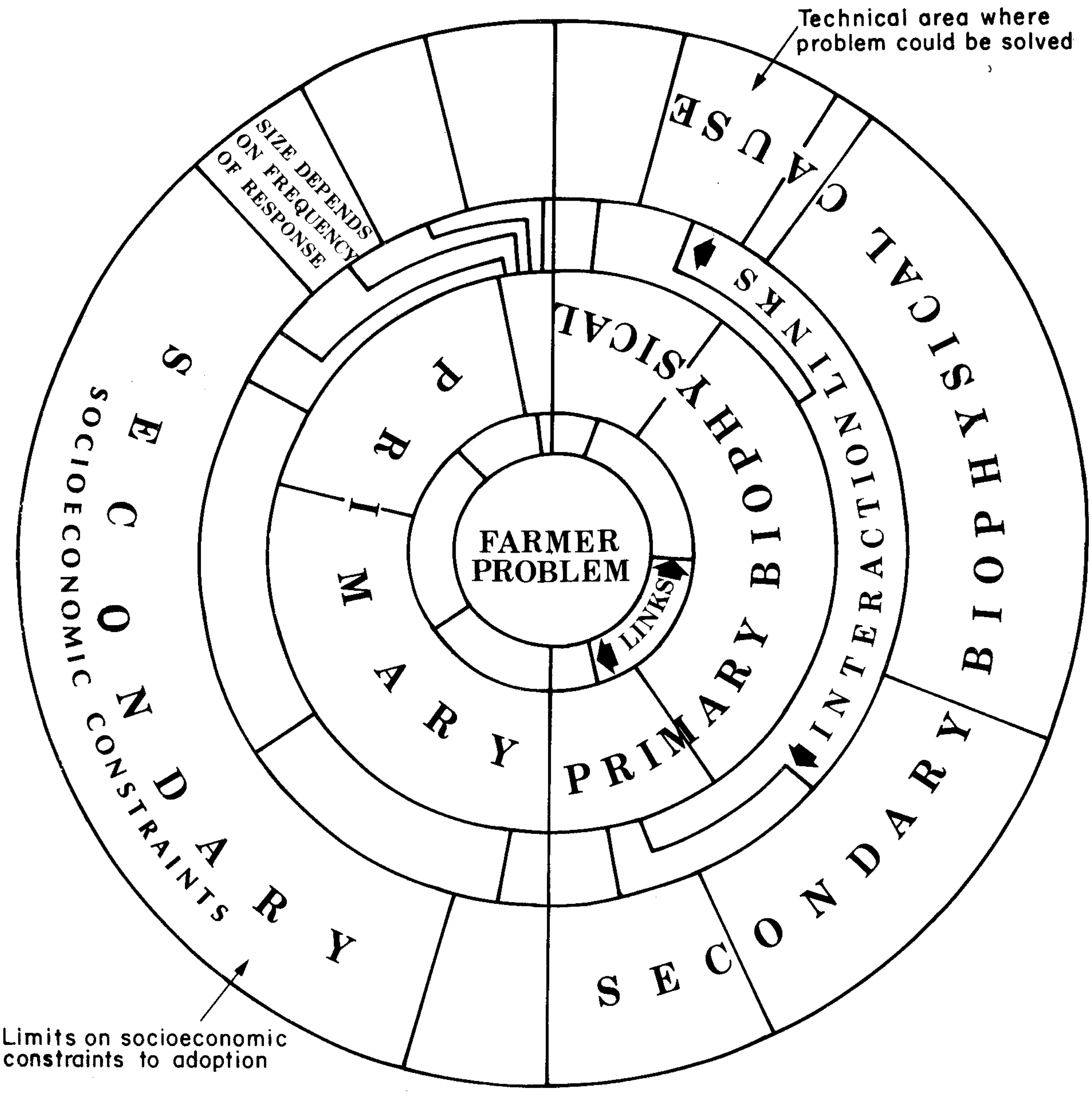
4. Systems diagramming

A systems diagram is constructed by

1. **Placing the farmer's problem in the center.**
2. **Assigning each primary biophysical cause of that problem to a box and linking that to the right-hand side of the central box.**
3. **Assigning each secondary cause a box and linking that to with the appropriate primary cause.**
4. **Following the same procedure for each socioeconomic constraint.**
5. **Arranging primary and secondary causes and constraints into a circle surrounding the central problem with bio-physical causes on the right-hand side and socioeconomic constraints on the left. The size of each segment is determined by the number of responses.**

TEMPLATE 12

Systems diagram



5. Using the system diagram

When properly constructed, the outer circle of biophysical causes presents farmers and researchers with opportunities to solve the central problem. To find technologies to modify those circumstances, researchers must

1. Elicit what experiments, ideas, or experiential knowledge farmers have to offer.

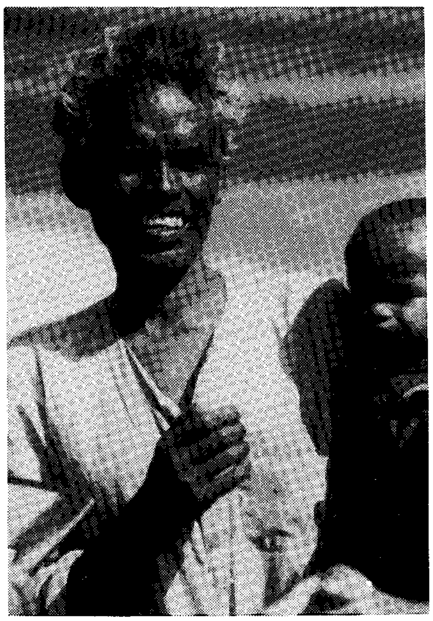
2. Find out what technologies are available from the agricultural research and extension services.

3. Screen each potential solution against critical socioeconomic constraints identified on the left-hand side of the systems diagram.

4. Hold group meetings to discuss which ideas farmers would like to test on their fields, which leads farmers and researchers straight into experimental design.

SECTION D

Further reading


Present and future farmers.


Woman weeding rice

SECTION D

Further reading

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RESOURCE PAPERS

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Systems Diagnosis of Farmers' Problems [1]

Objectives, Definitions, Key Points and Content Overview

LEARNING OBJECTIVES

After completing this lecture, participants will be able to:

- Define systems diagnosis and systems diagrams.
- Explain their application in FSRE.
- Discuss the steps in developing a systems diagram.

DEFINITIONS

- Diagnosis is a series of consultations and measurement activities to obtain an adequate understanding of farmers' problems such that test solutions can be designed.
- Systems diagnosis is a process by which researchers and farmers draw out or diagram the interactions between biophysical causes and socioeconomic constraints to the farmers' problem
- A systems diagram is a simplified pictorial representation of how biophysical causes of the farmer's problem are linked together and how the socioeconomic constraints interact and give rise to the farmers' problem

KEY POINTS

- Diagnosis provides sufficient understanding of the farmers problem and how it interacts with the system components such that solutions can be designed.
- Problems can be ranked in consideration of the number of farmers effected, the importance of the enterprise involved, and the losses in production and income entailed.
- A systems diagram is a tool for analyzing relationships among factors affecting a certain problem under diagnosis.
- When used judiciously, a systems diagram is very useful for ordering the causes and effects of problems.
- A systems diagram provides ideas for intervention points within the system. It shows where specific technologies may have an effect in overcoming the problem.

CONTENT OVERVIEW

The Diagnostic Stage in FSRE

The diagnostic stage is where researchers, through a series of consultations and measurement activities, obtain an adequate understanding from farmers of their problem such that test solutions can be designed.

The objective of diagnosis is to understand fully the farmers' complex system of activities associated with the problem, and to identify researchable areas for appropriate on-farm experimentation.

The problem to be diagnosed should have already been identified through the agroecosystem analysis. Problems are listed at the bottom of the transect. There are, of course, many problems; so a procedure for ranking them should be followed. An adequate understanding means that we do not have to learn everything about the problem but just enough to see how it interacts with the system's components and how it might be solved.

Ranking Problems[2]

Problems are ranked using three criteria:

- The distribution of the problem.
- The importance of the particular enterprise to the farming system.
- The loss of production or income for which the problem is responsible.

[1] Lightfoot. C. Lecture for Experiential Learning Exercise in Systems Diagnosis. Birsa Agriculture University, Ranchi, India. July 1989. 6p.

[2] Tripp. R, Woolley. J. The Planning Stage of On-Farm Research: Identifying Factors for Experimentation. CIMMYT Mexico, D.F. and CIAT Cali, Colombia. (1989). p:26-33.

How many farmers conducting that enterprise and experience that problem is the number needed to estimate the distribution of a problem. How important an enterprise is depends on its relative contribution to the households food supply and/or income. Severity of loss is determined by estimates of how much and how often losses occur. These estimates are usually subjective (very important, not much loss, etc.) with researchers depending largely on their and farmers judgement.

Systems Diagnosis[3]

Systems diagnosis is a process by which farmers draw out or diagram the interactions between biophysical causes and socioeconomic constraints of their problems.

The systems diagram places the farmers problem in the center, then in concentric circles linked by their interactions lays out primary and secondary biophysical causes on the right hand side, lastly, on the left hand side socioeconomic constraints are laid out.

Each cause and constraint occupies a segment of the circle whose size is determined by the frequency of farmer response.

Development of a Systems Diagram

A systems diagram is a pictorial representation of how biophysical causes of the farmers' problem are linked together and how the socioeconomic constraints interact and give rise to the farmers' problem.

The biophysical causes and socioeconomic constraints are arranged in concentric circles by virtue of their level of affect around the centrally placed farmer problem.

This diagram serves to show farmers and researchers:

- The precise technical areas where their problem can be solved or technologies tested.
- The limits on specific critical socioeconomic resources that might be required by any technology.
- A visual summary of the diagnostic survey.
- The natural progression into finding and designing solutions worthy of on-farm testing.

A systems diagram is developed in four distinct stages after the farmers' problem has been selected.

STAGE ONE: Developing guide topics

Topics to guide researchers as they seek a greater understanding of the problem are developed using Rapid Rural Appraisal techniques[4]. Usually, a series of farm visits are necessary before the topics are understood. Typically, topics cover:

- Farm typology.
- Descriptions of processes.
- Rationale or difficulties.
- Estimations of key economic and biological parameters.

STAGE TWO: Informal interviews

Respondents for the informal interviews are selected in two stages.

- First the target group of farmers is identified from village household spot maps which facilitates the exclusion of non-farmers like teachers, store owners, etc.
- From the target group around 30% are then selected at random for interview.

When conducting interviews the following points should be kept in mind.

- Respondents should be encouraged to draw out their problem tree on the ground.

[3] Lightfoot. C, De Guia. Jr. O, Ocado. F. A Participatory Method for Systems-Problem Research: Rehabilitating Marginal Uplands in the Philippines. Experimental Agriculture. (1988) Vol. 24, p:301-309.

[4] Rhoades. R.E. Basic Field Techniques for Rapid Rural Appraisal. (In) Proceedings of the 1985 International Conference on Rapid Rural Appraisal, Khon Kaen University, Thailand. 1987. p:114-128.

- The order of questions is determined by the flow of conversation and not the researchers listings.
- Questions are best asked in the field because farmers answers are more detailed when they can show what is happening.

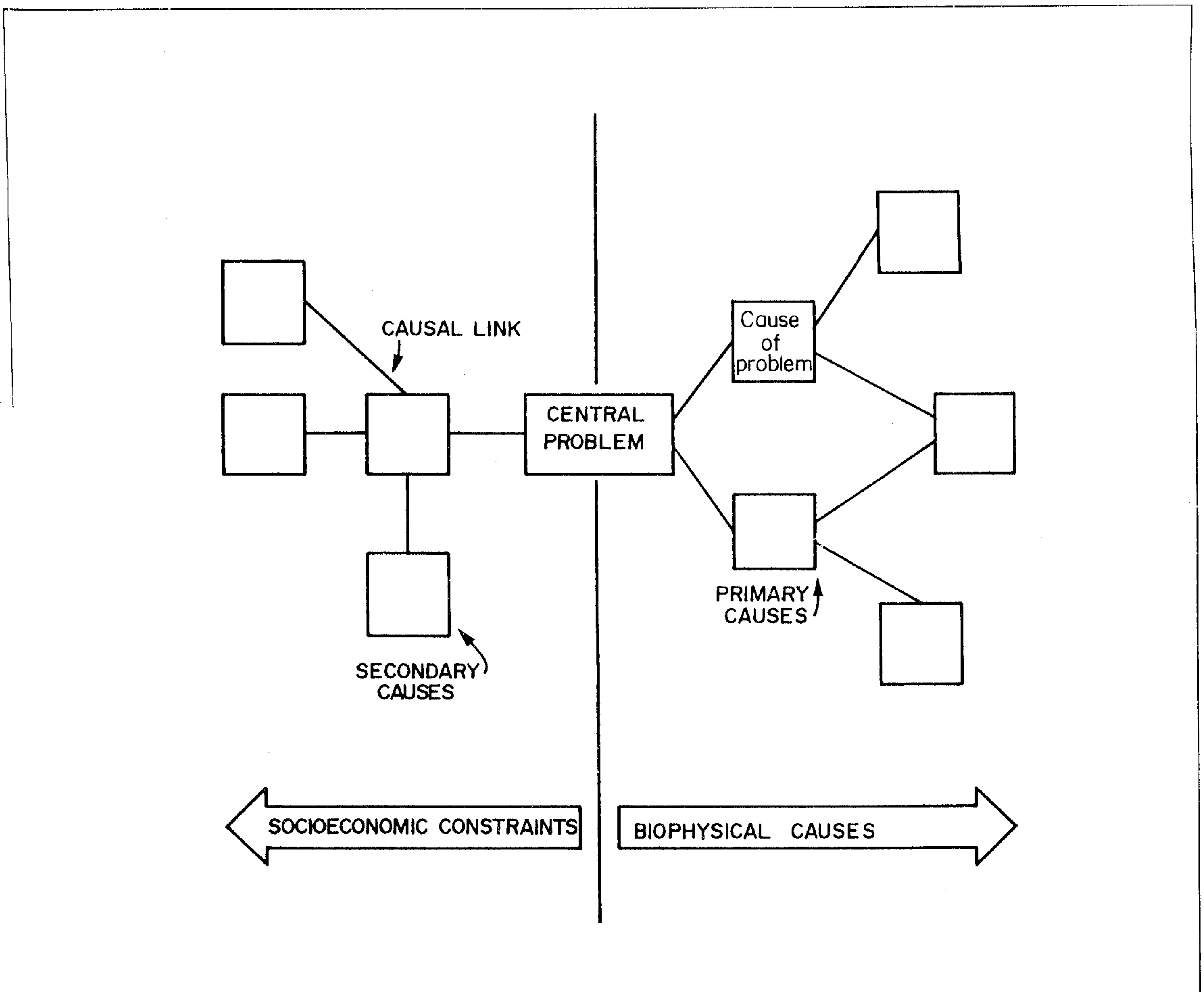
STAGE THREE: Systems diagramming

Interview responses provide information on the biophysical causes and socioeconomic constraints. Farmers quickly become adept at drawing on the ground the boxes and linkages showing cause and effect relationships and help researchers interpret interactions and determine primary, secondary and, if any, tertiary relationships. The frequency of responses gives the relative importance of each factor which determines the size of each segment. Each factor is assigned to a box that will eventually form the farmers' problem tree.

The problem tree is constructed by:

- Place the farmer problem in the center (Fig. 1).
- Assign each primary biophysical cause of that problem to the right hand side of the central problem box.
- Assign each secondary cause a box and link each with the appropriate primary cause.
- The same procedure is followed for each socioeconomic constraint.

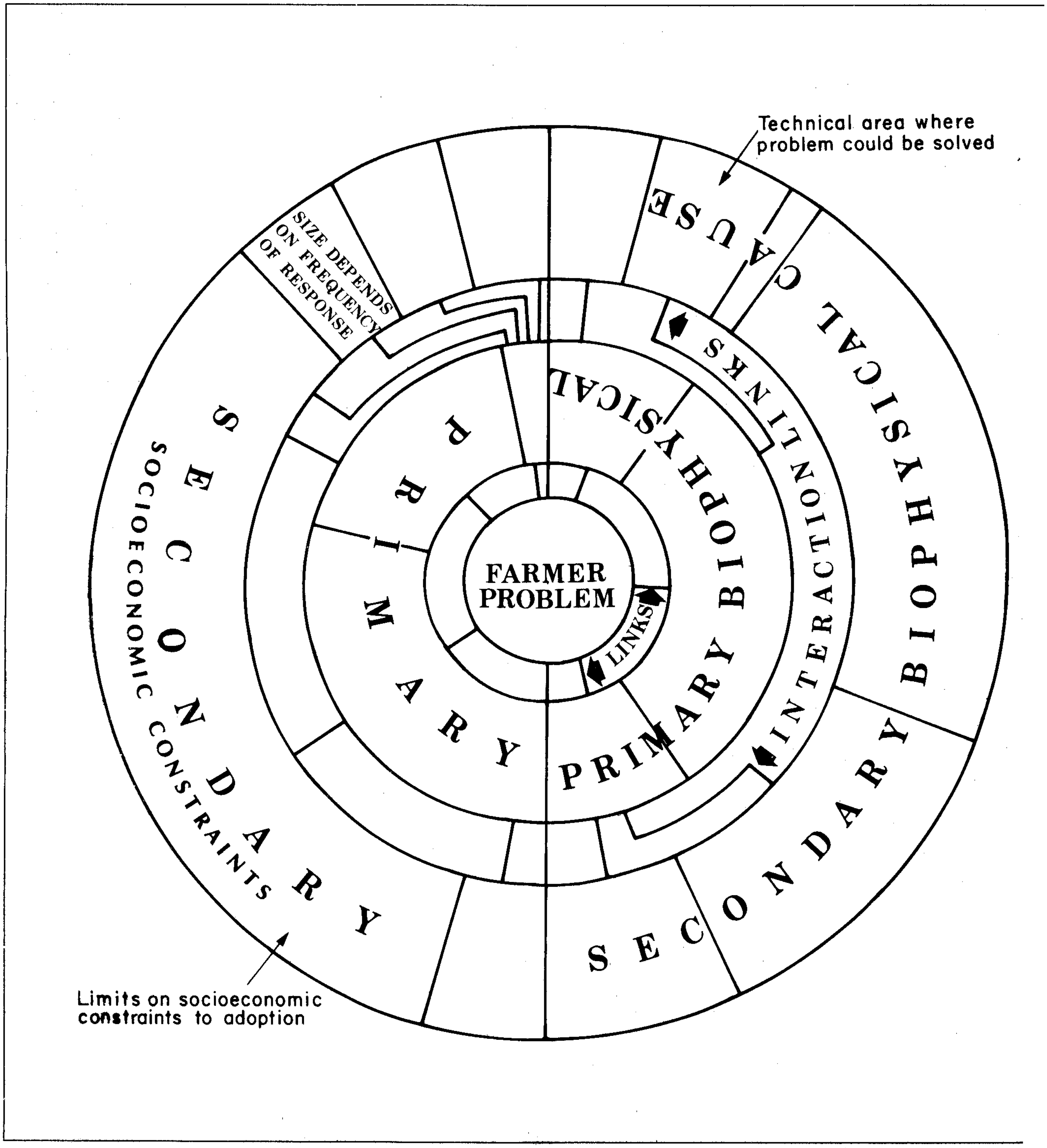
1. Farmers problem tree.



The systems diagram is constructed by:

- Arrange primary and secondary causes and constraints into circles surrounding the central problem with biophysical causes on the right hand side and socioeconomic constraints on the left. The size of each segment being determined by the number of responses (Fig.2).
- A group meeting of all respondents is called to obtain agreement, understanding and consensus that the systems diagram faithfully represents what is happening on their farms.

2. Systems diagram.



STAGE FOUR: Using the systems diagram

When properly constructed the outer circle of biophysical causes presents farmers and researchers with opportunities to solve the central problem. In other words, if any of those biophysical circumstances were suitably modified the problem would be lessened.

To find technologies to modify those circumstances researchers should:

- Elicit what experiments, ideas, or experiential knowledge farmers have to offer.
- Find out what technologies are available from the agricultural research and extension services.
- Each potential solution is screened against the critical socio-economic constraints identified by the farmers and shown on the left hand side of the systems diagram (i.e. if a technology demands large amounts of cash and cash is scarce it is unlikely to be adopted).
- A series of group meetings are held to discuss which ideas the farmers would like to test on their fields which leads farmers and researchers straight into experimental design.

Proceedings of the 1985
International Conference
on
Rapid Rural Appraisal
(1987) pp. 114-128

BASIC FIELD TECHNIQUES FOR RAPID RURAL APPRAISAL[1]

Robert E. Rhoades

INTRODUCTION

This paper discusses the ethnographic techniques and methods valuable for the informal or exploratory agricultural survey, the first and crucial stage for many rural development projects. Agricultural development or crop improvement projects in developing countries can rarely afford the expense or time of the traditional ethnographic study or the equally expensive, bulky and hard-to-process questionnaire survey (Hildebrand 1981; Collinson 1980). As a result, agricultural research teams have often opted for the informal survey or *sondeo*. The informal survey can produce at minimum cost a rich description of life in a farming community, an understanding of local ecology, cropping systems and how farmers, merchants, extension workers, and others perceive their conditions and make decisions.

As the springboard of planning, the informal survey has the advantage of placing project implementors in contact with their clients for the first time and on the client's home ground. In this early phase the researcher is like an explorer, making a rapid survey of the horizon before plunging into the thickets from which the wider view is no longer possible. If the researcher observes keenly at the start, the remainder of his journey stands a better chance of success. However, if he gathers faulty information he may wander aimlessly throughout the project or lose precious time and funds backtracking. This paper, therefore, discusses basic survey techniques necessary to guarantee the efficient and successful execution of the informal survey.

WHY CONDUCT INFORMAL SURVEY?

Feasibility Study

Informal surveys can function to provide basic information on the feasibility of beginning a project in a region. This is especially the case when dealing with target areas or farming systems about which little is known. In this situation, the informal survey may be of more immediate use to policy makers than field agronomists, and it will probably be less concerned with specific production problems than with a balanced overview of the region, unless the introduction of a specific technology is under consideration.

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1. Adapted and condensed from an earlier paper, "The Art of Informal Agricultural Survey," produced as Social Science Department Training Document 1979-1, International Potato Center, Lima, Peru.

Reconnaissance to Prepare Formal Surveys

The informal survey can be used to quickly obtain basic information specifically for the design and execution of formal surveys or more in-depth investigations. Thus, the immediate purpose is to help focus a subsequent formal survey that will utilize random sampling and quantify critical aspects of rural life or the production system. The need is not simply to get a "feel" of the area, but to discover important, albeit tentative, organizing concepts upon which to base future research. For example, we may want to map agroecological zones, develop a working typology of farmers or find out how people feel about their problems. The exploratory, informal survey can also help insure that the questionnaire is written in a manner understandable, sensitive, and relevant to local issues.

Planning Tool for Agricultural Experiments

In this case, the formal survey stage is omitted and on-farm experiments or projects are designed on the basis of a rapid survey which pinpoints specific production or post-harvest problems. Most developing country projects will, out of financial necessity, opt for this approach. In cases where the informal survey is the only investigation for planning, the team should be interdisciplinary, made up of at least one technical person and one social scientist (Hildebrand 1981). If this is not possible, team members should try to incorporate the missing perspective, be it social or biological, into the research.

THE FRAME OF MIND

The informal survey is methodologically simple but usually physically tough. It normally cannot be accomplished by driving along a main road looking at fields, although a "windshield survey" may be a way to begin. The successful survey may require sloshing through muddy fields, scrambling along rocky paths and dangerous slopes, or whiling away hours in fly-ridden tea shops casually talking with farmers. The surveyors must be country-oriented, grubbing out information in fields, market places, bars, ~~or wherever~~ farmers' daily routines carry them. Those unwilling to face a few village hardships have no business doing informal surveys.

The successful informal survey also requires mental and methodological flexibility. It does not proceed like the formal questionnaire survey where predetermined hypotheses are tested. Instead, important questions and the direction of study emerge as information is collected. This is not to say the informal survey lacks logic, but that one must be able to accommodate new information and adjust research plans accordingly. As the survey advances, the team will pass initial vagueness to a mid-way focussing and finally arrive at a stage where the threads can be pulled together and specific ideas tested.

GETTING READY: PRE-FIELDWORK PREPARATION

Literature Review

Before going to the field, researchers should assemble and review any relevant secondary socioeconomic and production information about the general area to be studied. A surprising amount of data can be found if an effort is made to dig it out of libraries, research stations, and government offices. Secondary materials, especially government statistics, should be taken as suggestive of possible lines of inquiry and not as absolute truth. An attempt should be made to acquire secondary data on rainfall, soils, population, market and prices. Studies conducted by other disciplines should be consulted. It is a mistake for an anthropologist to read only anthropology, an economist only economic studies, or an agronomist to consult only agronomic reports.

Defining the Region

The most difficult early decision in the informal survey centers on delineating the geographical region to be studied. This depends, of course, on time, available manpower, and the project's aim. One must be careful, however, not to define the study region too broadly or narrowly. If the target area is vast, covering more than 300 square kilometers, it will be better to plan mini-surveys in representative areas.

In agricultural research, a target region will generally share common physical and economic characteristics or linkages. In Peru, for example, the highland area selected for on-farm research was the Mantaro Valley, a high intermontane river valley marked clearly by right and left marginal slopes (Mayer 1979). On the arid coast, research was conducted in Canete, a lowland valley the territory of which is defined precisely by its irrigation system. In the Peruvian jungle, however, the informal survey was carried out in selected farming communities located at various points along the major river which served to link communities with the nearest commercial center. In this case there was no concept of a valley or plain but a broad study area linked by transportation arteries.

Using Aerial Photos and Maps

The best way to get a rapid overview of a region is to acquire aerial photos, land-use, relief, or ecological maps. In fact, one should not think of going to an area without at least one map, preferably a topographic map. A few hours studying such visual materials can reveal more than years on the ground trying to figure out agroecological zonation or land use patterns. Contrary to popular belief, excellent maps and aerial photos now exist in the geological or military survey offices of most underdeveloped countries. Satellite imagery already provides excellent coverage for some of the most remote areas of the world.

The ability to read maps and aerial photos is of greatest importance for conducting informal surveys. The images on an aerial photo may at first seem strange because one is not accustomed to a view from the air. With a little practice, however, the kaleidoscopic patterning of an aerial photo can reveal a great deal about both the historical and present structure of man-land relationships. By tracing field distribution and size, shadows and tones which reflect variations in crops or soil texture, irrigation channels, location of towns and roads, the regional organization of agriculture can rapidly be understood.

Later, on the ground, the reality of the photo (called "ground truth" in satellite imagery interpretation) can be checked. For example, in planning on-farm research in Canete, an International Potato Center survey team examined aerial photos of the valley. Three outstanding images were observed: (1) marginal belt circling most of the valley's edge made up of tiny fields, (2) center region made up of medium to larger fields, (3) area of seemingly mixed field sizes and perhaps wasteland reflecting a light tone. The team hypothesized that these images may represent distinct agroecological belts.

With additional data on communities in each zone and soil maps from the national resources office, the team conducted a windshield survey of the valley for two days and talked to farmers. By using aerial photos, field clusters were located. It was discovered that the zonation reflected in the photos did correspond to ground level reality, although some modification was required. The marginal zone, characterized by poor, rocky soil, was inhabited by small-scale producers. The center zone, historically the location of large states, turned out to be a zone of large fields and the best soil in the valley. The third zone was mixed in terms of landholding size but was characterized by a common problem of extreme soil salinity and poor drainage and thus better suited for livestock and saline adapted crops such as sweet potato, peppers, and cotton. Field observations and interviews with farmers revealed that each zone was characterized by distinct combinations of crops, farming practices, and production problems. The differences between zones and similarities within zones were taken into consideration in implementing on-farm agronomic trials.

Basic Questions and Techniques

Before setting foot in any farmer's field, the research team needs to go to the drawing board and decide: what kinds of information is needed and for what end? General objectives should be clear, even though the relevant questions may not be known. A list of tentative topics for investigation should be drawn up. The questions should cover socioeconomic, ecological, and technical areas.

- What are the agro-climatic zones?
- What are the principal crops and cropping systems?
- What are the types of farm households?
- What is the social organization of agriculture?
- What are the farmers' practices?
- Why do farmers follow these practices?
- What do they feel are their main problems?

IN THE FIELD

Armed with the tentative questions and available secondary material, field research can begin. At first, everything will seem confusing in the field, an initial disorientation that is inevitable. However, before long the region can become comprehensible if researchers follow three simple techniques of fieldwork.

Observe Keep the eyes open for patterns in crop production, land use, and farm behavior.
Converse Talk *with* people and *listen* to their concerns and views.
Record Discretely write everything down. Complete fieldnotes are crucial. This is especially essential in the early stage to help organize thinking.

Interviewing Farmers

The key to a successful informal survey, especially in relation to understanding how farmers see their problems, is the successful interview. It is important to decide early who is to be interviewed. A frequent bias in agricultural development is to think in terms of "the farmer." Farmers, however, usually do not live in isolation. They belong to groups – families, communities, nations – and decisions about farming are often made by these groups. Although an interview may be with an individual, it is necessary to place his or her comments in the context of social pressures and beliefs. Interviews with groups of farmers are frequently more lively than with only one person. Local leaders should know why the research is being conducted. Informal does not mean incognito. In fact, in many parts of Asia and Africa one *must* go through the local headman or village leader to gain cooperation. Shortcutting the local chain of command can only cause difficulties later. However, it must be realized that local leaders will often selectively introduce researchers to the people that support their biases.

The importance of community decision-making in peasant agriculture must not be overlooked. Enrique Mayer (1979:78) in writing on the Andes stresses how important this aspect can be:

> Many of the modifications an extensionist might recommend with regard to changes (e.g., seed, varieties, planting dates, rotation and fertilization practices) must be communally approved and generally accepted before they can be put into practice by any farmer."

One way to understand the total farming system (not just on-farm production) is to construct a chain of "key informants." The key informant is an individual who is accessible, willing to talk, and has great depth of knowledge about an area, crops, credit, marketing and other agricultural problems. One should not believe everything key informants say but likewise should not disregard the old-timer who enjoys talking. In any community it will not take long to construct a chain of key informants: banker or money-lender, landlord, ministry official, extension agent, farmer, merchant, and middlemen. Each person in the chain may see the problem differently.

It is generally believed that 'key informants' provide only qualitative data. However, if the interview is properly handled, most "key informants" can give in informal discussion an enormous amount of quantitative data. Tremblay (1957:688) gives an example of interviewing a sawmill operator:

> "One is likely to get a large amount of specific data such as the number of thousand feet of lumber sawn in a day, the number of workers required to maintain a certain rate of woodcutting, the predicted production of a piece of woodland, and so forth."

Gaining quantitative data in rural areas through key informant interviewing is equally feasible but local measurements, units, weights, and concepts must normally be used.

Executing the Interview

The mechanics of the informal interview itself can be arbitrarily divided into five stages (Rhoades 1980): 1. *Approach*, 2. *Warm-up*, 3. *Dialogue*, 4. *Departure*, and 5. *Recording*.

Approach

It is best to keep as low a profile in the rural setting as possible. Oversized vehicles bearing official looking numbers driven by chauffeurs should, if possible, be avoided. Researchers should walk as much as possible and in small numbers. Two in a team is often best. If the team is large it is advisable to divide the study area into a number of zones in order to avoid duplicating efforts or interviewing the same farmers. Once a man is spotted in a field or a woman in her garden who appear as persons to be interviewed, it is best not to drive around indecisively creating suspicion. They should be approached directly. However, we should avoid the "opinion poll syndrome," where the farmer is startled by the researchers driving up to him in his field and jumping out with notebook in hand ready to interview. Blending into the local context as much as possible is obviously the best strategy. We should always be sensitive to the fact that people may be suspicious of outsiders.

Timing is extremely important. One should be aware of the daily work schedule, seasonal activity, work habits, climate, and how in these Peru's highlands, for example, interviewing is acceptable early in the morning before the day's activities get underway. In Indonesia, however, the best time for interviewing is between 4 pm., after prayer, and the evening meal when people are in their homes.

By taking the time and physical effort to walk in the field, interviewing will be more successful since discussions can center around ongoing agricultural activities. If appropriate, one can lend a helping hand without getting in the way (Hatch [1976] illustrates an interesting variation on this idea). The slack season is also an excellent opportunity for informal interviewing.

Warm-up

Informal interviewing is a dynamic process in which importance develops out of casual conversation. The first interviews may be very simple but soon, as knowledge of an area increases, questions will become more penetrating and valuable. It is not advisable to go directly to the subject at hand. The farmer should first be greeted accordingly to local custom and treated with courtesy and respect. If the local language requires it, use the "polite" form of address. The researcher should avoid positioning himself above the farmer or conducting an interview from a vehicle. The conversation should begin with locally accepted polite talk about the weather, how the crops are doing, or the price of potatoes. The farmer must know exactly who the researcher is and the nature of the work.

The situation should be observed to make sure the context is conducive to an interview. For example, if the farmer is irrigating and receives water only once a week for an hour, he may not be interested in small talk. It may be better to set up an appointment. Sometimes farmers can suggest the best time and place to continue.

Dialogue

Burgess (1982) writes: "The unstructured interview may, therefore, appear to be without a structure, but nevertheless the researcher has to establish a framework within which the interview can be conducted; the unstructured interview is flexible, but it is also controlled." The key to the successful informal interview is to be natural and relaxed while guiding the conversation to a fruitful end. At first sensitive questions should be avoided. People should be allowed to stray onto another topic or tell stories since what is said may be revealing of local customs and psychology. One can return to the main line of thought later. By all means, too many questions back-to-back are confusing. The conversation should be interspersed with the researcher's own personal comments.

One method that gains farmer cooperation anywhere in the world is the straightforwards, honest admission on your part that the farmer is the "expert" about farming in his area and you are the learner.

If a question is asked that causes silence or it is obvious the farmer cannot answer, the Socratic method of suggesting answers to lead the conversation along the researcher's biases should be avoided. The question should be rephrased It is generally best to use plain, understandable language with farmers although sometimes their scientific understanding is quite sophisticated. Farmers have a rich vocabulary tied to their profession and area, but they normally do not understand esoteric scientific jargon. Questions that are too abstract or sensitive should be avoided. The interview should not be extended beyond 30 to 45 minutes unless the farmer is in a talkative mood. Throughout the interview facial expressions should be observed as they may reveal a great deal about farmers' concerns or reservation. Frequently, information on sensitive matters may be obtained through indirect questioning. However, it should be remembered that what people say and do may be two different things.

Departure

After all relevant topics have been covered or the farmer's time exhausted, the conversation should be brought to an end. If the weather is unfavorable (too hot, raining) or the farmer seems pressed for time it is probably best to prematurely stop the informal interview. It is best done gracefully, naturally, and not too abruptly. The "gringo syndrome," the business-like "gotta go" departure should be avoided. The farmer should be thanked for his time and given the proper local farewell.

If culturally acceptable, the camera can be an important research tool. Photo analysis can be used later to help design formal surveys or experiments. Sometimes a favor can be done for the farmer by sending or returning with photos of the farm or family. The farm family should not be let down by failing to send promised photos. Also, in most world areas farmers appreciate receiving small packages of vegetable seed for their gardens or technical brochures written in plain language.

Recording of Information

Immediately after (or if permissible during) the interview, memory-prompting notes should be made. Agricultural scientists, in particular, tend not to write down what farmers say or their own personal observations. However, it is amazing how facts, ideas, and important observations that one "will never forget" quickly slip away. My observations reveal that 50 percent of the details of an interview are lost within 24 hours and by the end of the second day, over 75 percent. After that, only skeletal notes can be salvaged (Rhoades, forthcoming). Jotted notes will serve to aid memory later when full field notes on interviews and a day's observations are written up.

Whether one should take notes in front of farmers depends on the situation. The main point is that we should be sensitive to our actions. The best rule is to abstain from using pencil until the team feels the situation is truly relaxed. Informal interviews lasting more than 30 minutes will usually be causal enough to allow the writing of some notes. An official-looking questionnaire should not be pulled out in any case. This will surely destroy confidence. The ground should first be tested by "interacting" with the farmer on paper by drawing a field layout or cropping pattern. If he does not react suspiciously to the pen and paper, we can probably continue to take notes. However, if issues turn sensitive, it is imperative that we stop writing. Try to get the farmer's name and address unless he prefers not to give it so that you can contact him or if you visit the area again you can make specific personal reference to your previous visit.

How long one waits before jotting down notes or writing full field notes depends by and large on the setting, people interviewed, and personal style. In cases of team research, it may be best to appoint a scribe, a person whose job is to write everything down. After interviewing farmers in the morning, for example, we should stop around midday and write out field notes while they are still fresh in mind. It is also valuable for the research team to meet daily in the evening to go over notes and plan for the next day (Hildebrand 1981).

Organization of ideas can come through writing in the field notebook. One method of recall is to think in terms of a "sequence of event," that is writing while remembering the activities surrounding an interview. If it is discovered that the questions are not yielding new information it may be time to ask them in a new way or change the questions themselves. Through this rethinking process and "brainstorming" among team workers, there will result analytical flashes where sudden realizations will consolidate into a pattern. For example, when once only isolated fields and crops were seen, now we can see how they associate to form agroecological zones.

INFORMALLY ORGANIZING DATA: TYPES OF FARMERS AND CROPPING SYSTEMS

One purpose of the informal survey is to define relatively homogeneous types of farmers and agroecological or production zones. Technology is frequently locational and group specific. What works for one group of farmers in one ecological zone may not work elsewhere. This fact is complicated through a widespread tendency of technical agriculture scientists to select larger, "better" (more successful) farmers for experimental research since this group is more accessible and has resources to carry out experiments. Also agronomists have been known to prefer level fields with quality soil near roads rather than perhaps more representative sloping, rocky, fields located far from the main road. Thus, one should be sensitive to the representativeness of the farmer or the experimental plot for extrapolation of research results.

Types of Farmers

Early in the informal survey a working typology of producers can be developed. Typically, such groupings are based on a predetermined and quantifiable landholding size (e.g., 1-5 hectares is small farmers, 5-10 hectares is medium, over 10 hectares are large farmers). However, care must be taken not to assume size is necessarily correlated with specific cropping patterns or even economic status. Often large and small farmers in the same area pursue similar cropping strategies. And it may be that the "small" farmer with his limited farm size is more efficient or a better farmer because he must be able to subsist on a much smaller landholding. Thus, multiple factors have to be considered in developing a typology of producers, e.g., size of holding, purpose of production, and cropping system. In terms of potatoes, for example, one might develop a typology involving large to small commercial seed growers, small scale subsistence farmers and large, medium and small-scale commercial growers of ware potatoes. However, it should be stressed that typologies are merely ways of organizing thinking and that farmers cannot be so easily stereotyped. It cannot be automatically assumed that all farmers in a type will behave the same.

Agroecological Zones

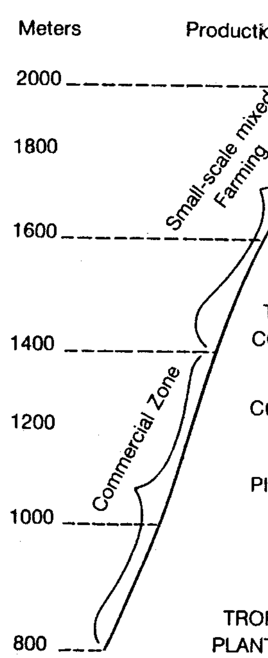
An agroecological zone represents an association between a set of natural conditions (climatic, topographic, soils) and agricultural activity (farming, herding) utilized to exploit that environment. The usefulness of zones resides in the possibility for extrapolation since conditions within zones are more similar than between zones. Presumably, farmers living in the same zone would have similar problems and technological needs. Studying agroecological zones can be facilitated by two simple techniques: agroecological transects and field plotting.

The transect is simply a cut-cross section of a territorial expanse wherein fields are mapped, cropping patterns and practiced observed through space, and the boundaries of agroecological zones defined. Transects are relatively easy to do, depending on the ruggedness of terrain and visibility as affected by topography and vegetation. The transect is especially appropriate when relatively rapid changes in topography and natural conditions are found such as mountainous regions. For example, a transect was made in Peru's Chanchamayo Valley to determine agroecological zonation and crop distribution (Figure 1). The Chanchamayo stretches between Peru's high jungle on the eastern Andean slopes down to the lower Amazon Basin. The region ranges in altitude from 500 to 800 meters on the valley floor up to surrounding 2,000 meters ridges.

Using an altimeter, aerial photos, and topographical maps, the survey team started walking from the valley floor along an access road toward higher elevations. Detailed notes were periodically taken of natural vegetation and sketches of field shapes and crop associations made. Technological observations were likewise taken and, whenever possible, farmers interviewed. It is important to observe settlement patterns, distance between fields. These aspects might be important, for example, in determining labor or time requirements in getting to fields or transporting the harvest to market. Agroecological transects similar to this were made in several parts of the valley and later the information assembled to give us a general idea about land use in the region.

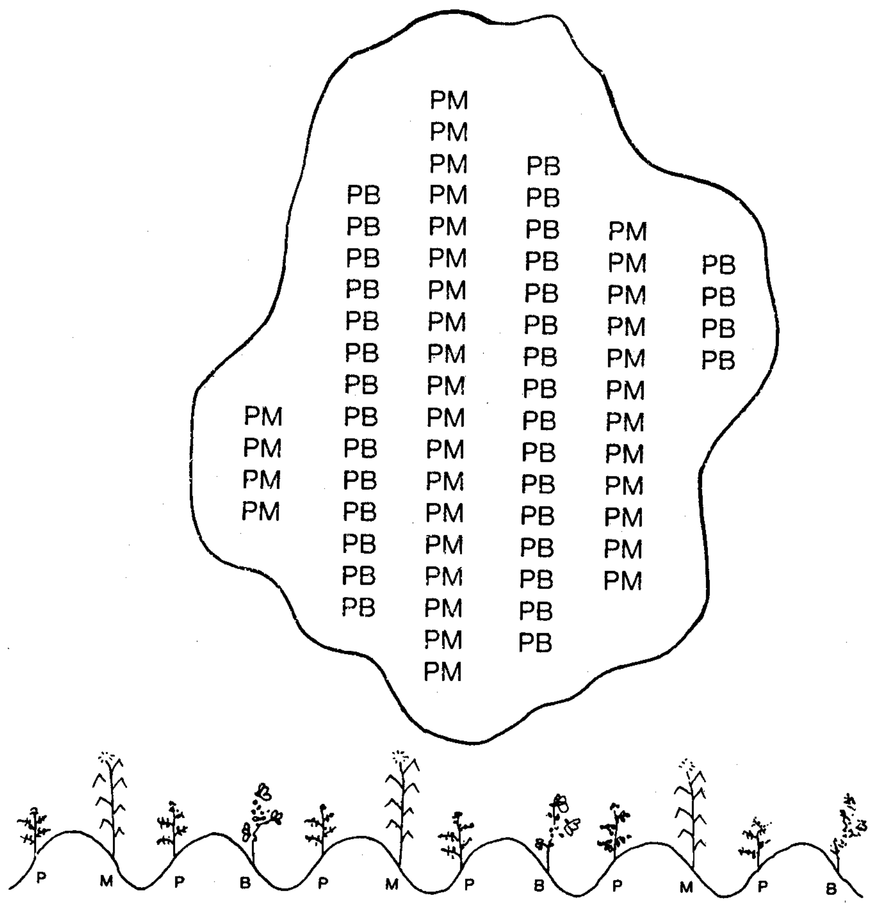
Field plotting is a second technique for rapidly understanding cropping patterns and practices in a region. It can be conducted in relation to the transect exercise or while systematically driving through a region. Periodically, especially if it is sensed that the ecology has altered, the team should stop and plot a field in terms of its crop associations and observed farming practices (Figure 2). One does not even have to talk to a farmer to learn a tremendous amount. In a single day, data on several hundred fields in an area of open terrain with good roads can be recorded. For example, agronomists at the International Potato Center were considering trials related to intercropping in the Peruvian highlands. A subsequent informal survey conducted in one day yielded data on 275 fields. Field plotting was done for representative types. The results showed that 86% of the surveyed fields were monocropped and that potatoes are rarely intercropped even in the remaining 14 percent. Agronomists dropped the idea of conducting on-farm intercropping trials for this region (Werge, n.d.).

Figure 1 Agro-Ecological Transect. Chanchamayo, Peru.



Zones	Landholding (OBSERVATIONS)	Cultivation Type	Associated Crops	Origin of Farmers
MIXED FARMING: SUBSISTENCE MARGINAL ZONE	Family units 8-10 hectares	Semi-shifting cultivation Vegetable garden No pesticides No fertilizers Mixed cropping	Vegetables (potatoes) Livestock Maize Bananas	Recent settlers from highlands
MIXED FARMING: TROPICAL TREE CROPS, COFFEE, SUBSISTENCE	Families tied to Cooperatives	Semi-shifting (until permanent crops put in)	Papaya Palta Banana	Recent migrants from highlands
COFFEE PLANTATIONS (West Slope)	Cooperatives Large units	Hired labor pest - fertilizer	Banana Palta Papaya	Long-term residents
PINEAPPLE FARMS (East Slope)	Household; private	Hand cultivation	Yuca	Second generation settlers
TROPICAL FRUIT PLANTATION ESTATES	Large units; coops (haciendas)	Permanent, mechanized, pesticides, fertilizers	Banana Palta Papaya	Old-timers

Figure 2 Field Plotting



PM = Potatoes-maize (same row)
PB = Potatoes-beans (same row)

Description: at 3,175 meters we encountered a field with intercropping of maize, potato, and broad beans. Appears potatoes planted first and with first hilling up, then maize and broad beans planted. This was confirmed by farmer met later on the trail. Apparent reason is to save labor by planting maize and beans while hilling up potatoes. Also, farmers spreading risks; in case one crop fails, will have others to fall back on.

Source : Rhoades (1979). Chanchamayo field notes.

The sampling may not be random but after two to three hundred fields are covered, the cropping pattern should be generally understood. This, for example, can indicate whether crop experiments should be done with intercropping, monocropping, or what field trials might be considered.

The problem is that such field observations are time frozen. To gain a long term view of field or zone, interviews with farmers are necessary. This can be done, however, by having the farmer tell the history of a few parcels of land as far back as memory and time allow. It is important to gain an understanding of rotations and the overall cropping system so as to determine how a farmer views the role of different fields in his farming strategy.

Moving toward Quantification: Satisfying an Impulse

If the informal survey lasts more than one week, the team may feel the need for some degree of quantification, a first step toward a formal survey. It is at this point that the development of a simple one-page interview schedule is suggested. The purpose of this is to gather some very basic data, perhaps on size of operation, rotations, crops, and farmer opinions on primary production problems. By this simple quantification, it can be seen if patterns emerge in different zones and among different types of farmers. It can also be used as ammunition with colleagues who will never be convinced unless they see numbers. However, it is still not recommended that the interview schedule be pulled out in front of farmers. Generally, when a questionnaire comes out, farmers turn passive, timid, and quiet. Their boisterous, talkative mood turns serious. As with the open-ended interview, the information should be recorded later.

One valuable technique is the farmers' ranking scale developed from responses to the open-ended questions: "What is the most important problem you have in producing potatoes? The second most important, the third, and so on." Although these are abstract questions, we have found that farmers always have three or four major technical problems on their mind. After the interview, write down farmers' perceived production problems, ranking them numerically. Later a ranking table can be constructed and the data used to select technology for on-farm experimentation which relates to farmers' felt needs. It should be remembered, however, that concerns are very seasonal. In Canete, Peru, potato farmers in March always see cost or quality of seed as their main problem (because they are getting ready to plant); in August (just before harvest) it is the *mosca minadora*, an insect pest.

A table drawn from one of CIP's informal surveys is given in Table 1. Farmers were asked to rank their first four problems in order of importance. Such tables are easy to construct and useful as a sort of intermediate step toward quantification and the design of a formal survey.

USE OF MATERIALS: WRITING IT UP

Immediately after field work, the team should sit down and quickly write a summary report even if it lacks professional polish. It is not important to worry too

Table 1 Farmers' Perceptions of Production Problems Ranked in Order of Importance: Mantaro Valley

Problems	Number of Farmers' Responses				Total Responses
	Most Important	Next Most Important	Third	Fourth	
1. Climate	10	11	12	2	35
(frost)	(3)	(4)	(5)	(0)	(12)
(hail)	(3)	(6)	(3)	(0)	(12)
(drought)	(4)	(1)	(4)	(2)	(11)
2. Insects	9	6	5	0	20
3. Lack of Capital	8	2	6	3	19
4. Plant disease	5	7	3	2	17
5. Cost of Inputs	1	3	3	1	8
6. Lack of Land or Poor Land	2	1	3	0	6
7. Cost of or Lack of Labor	0	2	1	0	3
8. Lack of Irrigation	0	2	0	0	2
9. Lack of Technical Knowledge	1	0	0	0	1
10. None	1				

much about grammar and style. Re-writing can come later. It is crucial to get the information down while still fresh in everyone's minds. The exact format or outline will depend on the purpose of the survey but it is important that it is written in a language understandable to everyone. If the report is to be used to implement on-farm experiments, summarize only directly relevant material. Recommendations should be kept brief. Copies of summary and final reports should be sent to all offices, institutes, or interested individuals, especially those who assisted in the research. This final reciprocity is only fair. The people of the region have given their time. The least that we researchers can do is give them a copy of the study which they have so kindly helped prepare.

It is imperative not to let the report be shelved away to gather dust. It should be a guide for future activities and constantly upgraded as a project progresses. It should serve to keep us honest (or at least caution us against slipping into our prior biases without reason). If, for example, a survey shows that the majority of producers in a target region are resource-poor, small growers located in a high, marginal zone 1-hour walk from the main road, the team should fight off the understandable desire to carry out agronomic trials with a few large-scale producers located on fertile valley floor lands (unless the technology being tested is relevant to all growers, large or small in either zone). The informal survey is for immediate utilization, not a historical document.

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Expl Agric. (1988), volume 24, pp. 301-309 FARMING SYSTEMS SERIES - 13
Printed in Great Britain

A PARTICIPATORY METHOD FOR SYSTEMS-PROBLEM RESEARCH: REHABILITATING MARGINAL UPLANDS IN THE PHILIPPINES

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(Accepted 25 January 1988)

SUMMARY

A participatory method that promotes farmer involvement in systems-problem research was developed in response to the failure to adopt improved cropping patterns among upland farmers. Techniques to identify systems problems involved group and individual farmer meetings. Problems concerning the cultivation of marginal cogonal (*Imperata cylindrica*) uplands were identified. An informal random sample survey, guided by topics of inquiry and biological measurements that employed systems analytical tools, was used to obtain a farmers' perception of 'systems-problems'. Systems diagrams also provided a framework for searching and screening solutions. A sequence of vining legumes was tested in rehabilitating the marginal uplands. For this experiment farmers elaborated hypotheses on control of *Imperata*, recovery of soil fertility, and reduced labour costs in re-cultivation. Extensive research activity among the farmers indicates the value of this participatory method.

C. Lightfoot, O. de Guia jn y F. Ocado: *Método participatorio para la investigación de problemas de sistemas: Rehabilitación de las tierras altas marginales en las Filipinas.*

RESUMEN

Se desarrolló un método participatorio que fomenta la participación del agricultor en la investigación de problemas de sistemas como respuesta al hecho de que no se adoptaran nuevos patrones de cultivo por parte de agriculores de las tierras altas. Las técnicas para identificar problemas de sistemas implicaron reuniones con individuos y grupos de agricultores. Se identificaron problemas referentes al cultivo de las tierras altas cogonales (*Imperata cylindrica*) marginales. Se empleó una encuesta informal de muestreo al azar, guiada por temas de investigación y medidas biológicas empleando herramientas de análisis de sistemas, para establecer la percepción del agricultor de los 'problemas de sistemas'. Diagramas de sistemas también facilitaron un marco para la búsqueda y selección de soluciones. Se probó una secuencia de legumbres de parra para rehabilitar las tierras altas marginales. Para este experimento, los agricultores elaboraron hipótesis sobre el control de *Imperata*, la recuperación de la fertilidad del suelo, y costos reducidos de la mano de obra en el recultivo. La gran actividad investigativa por parte de los agricultores indica el valor de este método participatorio.

INTRODUCTION

Cropping pattern research methods have failed to solve the problems of upland subsistence farmers in the Philippines (FSDP-EV, 1985). This is not to deny the successes that cropping pattern research has brought the lowland irrigated rice farmers for whom this method was principally developed (Zandstra *et al.*, 1981). For upland farmers, however, improved cropping patterns were too demanding in the time required to plant additional crops; too demanding on easily exhausted soil; and too expensive in fertilizer and pesticides. Apart from

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the problems of marginal soils, drought, floods, typhoons, and stray animals make cash investments in the uplands very risky. In addition, where there is a large land to labour ratio intensive cropping is less important than the efficient use of labour and cash. Finally, cropping patterns must continuously change in step with changing weather, household food needs, market opportunities, and land quality. Under such circumstances intensive, high input cropping patterns are rarely adopted, although occasionally one component such as a variety may be (Alcober and Balina, 1986).

To improve the adoption of research findings by resource-poor farmers, Farming Systems Research (FSR, Norman, 1980) and its variants Farmer-First-and-Last (Chambers, 1986) and Farmer-back-to-Farmer (Rhoades and Booth, 1982) provide an alternative approach. What sets this approach apart is greater farmer involvement and more holistic systems logic.

Farmer participation is called upon to 'Encourage and enable resource poor farm families themselves to identify priority research issues' (Chambers and Jiggins, 1986). Technology generation should also be geared to meet farmers' perceived problems and to 'Encourage farmers to think of the experiments as their own . . .' (Kirkby and Matlon, 1985). Rapid rural appraisal has been developed to understand the circumstances of resource-poor farmers but does not help farmers to identify issues for experiment.

Rapid diagnostic methods have been developed but do not use systems tools to link biological and socio-economic relationships (ICRAF, 1983). Systems tools are especially important to FSR because farmers' problems are systems problems. That is, they usually involve many components of the whole-farm system. As such, solutions need to consider component interactions. For example, agronomists have experimented with legume trees to improve soil fertility. However, farmers have adopted these trees as sources of fodder, cash and fuel-wood, and so have often removed the potential benefits to soil fertility.

Methodological questions remain on how exactly one goes about identifying farmer systems-problems, how these systems problems can be analysed and how this understanding leads to experiments.

MATERIALS AND METHODS

The methods developed first identified farmer systems-problems, second, analysed a key problem and third, elaborated experimental hypotheses. Farmers participated throughout. They decided what problem to explore and what solution to test. They explained how their system worked, and their indigenous knowledge. Initially, farmers were self-selected but later on random selection was used. While the methods are presented as three stages, in practice they flowed uninterrupted.

The research was carried out in three villages in the Philippines, Natimonan, Sto. Nino and Simun, in the Municipality of Gandara on Samar. These villages, whose combined population does not exceed 150 households, are located among rolling hills of infertile Alfisols. This brown acid soil is very poor in organic matter (3.0%) and phosphorus (29 ppm). Although the annual rainfall reaches 3000 mm an irregular dry season occurs between January and June. Between valleys of bunded rice, small plots of upland rice, corn, cassava, sweetpotato, coconut and banana break up the hills that are otherwise dominated by *Imperata cylindrica*, locally known as cogon.

Identifying systems-problems

Systems-problems were identified by assisting farmers to list issues they talk about, to select one issue for further exploration, and to decide which systems-problem they want resolved.

Group meetings between researchers and some twenty farmers listed subjects of conversation. Asking farmers what they talk about stimulated more dialogue and proved a better entry point than asking direct questions about problems. While the range of topics was not restricted, farmers tended to focus on agricultural issues. Indeeed, in order to build an atmosphere of free thinking and open exchange many topics were elicited. From these issues farmers selected topics they wanted to elaborate further. During these elaborations some farmers suggested a visit to their fields as adequate explanations could not be given in the office.

Issues were elaborated further in one or two hour discussions on the farms of four key informants. These discussions produced several problems for further study.

Another group meeting with the same twenty farmers obtained consensus on which problem should be studied first. Broad agreement was vital here as without it interest and cooperation would soon wane, though waning interest would be a useful check for researcher error. Whether this problem was of wider interest among neighbouring communities was checked through a random sample informal survey.

Analysing systems-problems

Systems-problems were analysed using systems diagrams based on those of Spedding (1979). Four key informants suggested guide topics for the random sample informal survey and interpreted relationships for the diagrams. Guide topics were then tried out on five farmers before finalizing the diagrams. Guide questions covered farm typology, description of processes, and reasons for the problem's existence. Vegetation composition, cash, labour, and draught power used in bringing marginal areas back into cultivation were also estimated.

Guide topics were administered to 24 randomly selected households from a total of 150 in three villages. Interactions between farmers and researchers were more like informal conversations than formal interviews. Conversations flowed freely because topics were neither discussed in order nor finished in one session. Return visits were often necessary, particularly when time consuming field visits were needed.

Survey responses provided information on bio-physical causes and socio-economic constraints surrounding the problems. Drawn on a blackboard, each cause and constraint was ascribed a box. Five key informants then explained relationships between boxes and problems. Arrows were drawn to show these relationships. From the boxes and arrows a circular systems diagram was constructed with bio-physical causes occupying one side and socio-economic constraints the other (Fig. 1). Each box formed one segment in the concentric rings surrounding the central problem. Segment size equalled the proportion of farmers who responded to that point against all points in that ring. All respondents were given an opportunity to comment on the diagram before it was finalized.

Elaborating farmer experiments

Experiments were elaborated by searching for potential solutions, screening out one that was worth trying, and defining hypotheses for testing.

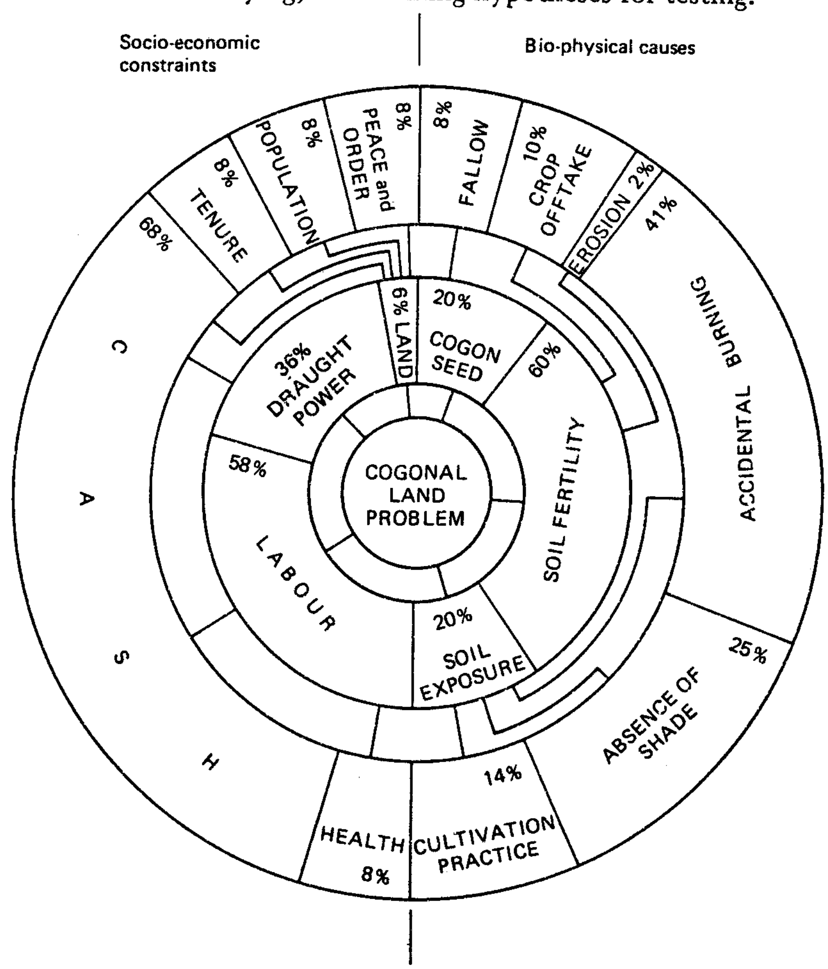

Fig. 1. Systems diagram of the economic constraints and bio-physical causes concerning the cogonal land problem as perceived by farmers from 24 households in Gandara, Samar, Philippines (showing proportion of farmers who selected each factor in each half of the two concentric rings).

Potential solutions were sought using the systems diagram. The outer circle of bio-physical causes indicated where interventions could be applied to solve the central problem. For each bio-physical cause four key informants suggested interventions based on their observations, experiments, and indigenous knowledge. It had already been determined that farmers conduct experiments in Gandara (Lightfoot, 1987). Farmers' ideas were supplemented by formal research findings. All these ideas were presented to the group for screening.

Technologies were screened through group meetings using the systems diagram. Potential solutions must address bio-physical causes of the problem and at the same time not conflict with socio-economic constraints. Key informants and researchers presented their ideas and the group debated advantages and disadvantages. Before one intervention was unanimously chosen a few farmers required a field trip to see some ideas in action. If consensus cannot be reached it is better to review past findings than to push through an unpopular experiment. After the trip farmers chose one idea but many questions remained as to how it would work in their system.

Experimental hypotheses were defined to address unanswered questions. At a group meeting unknowns in performance and systems fit were elaborated into hypotheses. Hypotheses were developed about several components of the system. The purpose of the experiment was to find answers to what the farmers did not already know.

RESULTS

Farm typology

Farm typology grouped farmers by sources of income, crops and livestock raised, number and size of cultivated parcels of land, and land tenure arrangements.

Incomes were those derived from both on-farm and off-farm activities. Only 13% did not have off-farm work. Half the farmers earned money from ploughing and or harrowing other peoples' fields. Weeding and harvesting provided incomes for 33% but only 4% received remittances from family in town. On-farm enterprises included raising livestock and cultivating several parcels of land. Between two and six parcels were cultivated by each farmer, 42% cultivating three parcels. About half the farmers raised buffalo and pigs, and 30% raised chickens. Only 18% had no animals at all.

Crop enterprises were complex. Four distinct agro-ecological zones were cultivated: sloping forested areas; rolling fallow land dominated by *Imperata cylindrica*; flat upland areas; and bunded areas. Each agro-ecological zone had its own unique collection of crops (Fig. 2). Even though crops did cross zones they normally dominated one zone. Root crops, for instance, were found in forest, cogonal and flat areas but dominated cogonal areas. More than 60% of all cultivated areas, and all of those in the forest zone, were of less than half a hectare but there were a few plots of up to two hectares in the flat zone.

These small cultivated parcels, scattered across the four agro-ecological zones,

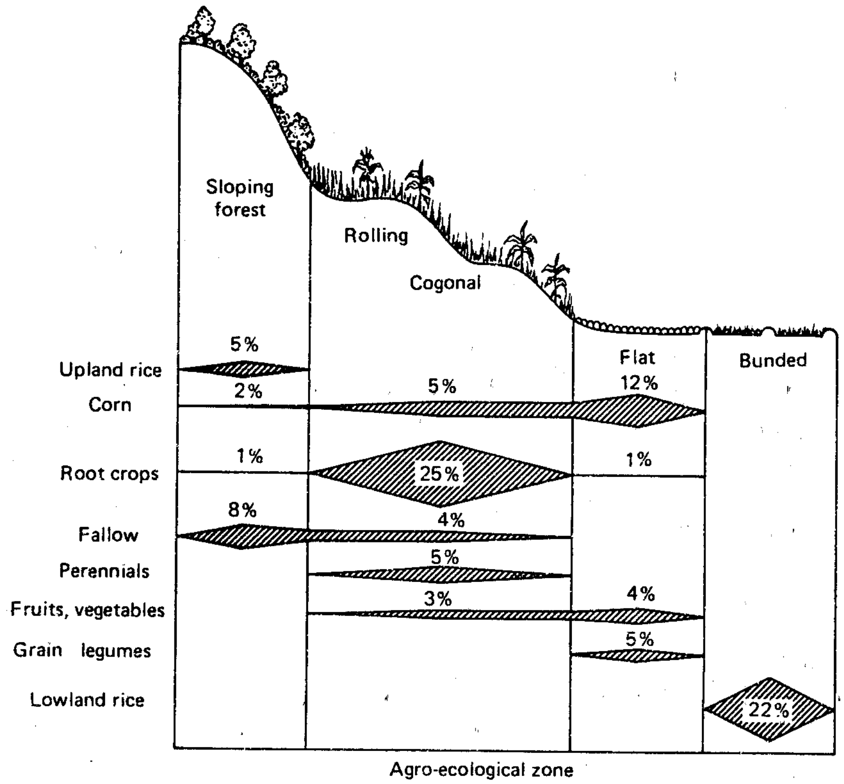

Fig. 2. Distribution of crops grown and fallow plots by agro-ecological zones for 113 parcels of land in Gandara, Samar, Philippines.

were held under an assortment of tenure arrangements. Most forested land was rented (52%) or 'in-the-family' (40%). Flat and bunded land was 'operated' by the owner (52% and 35%, respectively) or in the case of bunded land operated on a shared basis with the landlord (45%). Access to cogonal land was more or less evenly split between 'owner-operated' (35%), rented (35%) and 'in-the-family' (25%). A few odd parcels were either tenanted or mortgaged.

Bio-physical and socio-economic constraints

The systems-problem centred on marginal cogonal lands (Fig. 1). The bio-physical causes advanced by the farmers were that *Imperata* was present because seed blew in from surrounding fallow areas and germinated easily on the exposed infertile soil. Soils were infertile because too many crops had been taken off and erosion occurred when it rained. Moreover, soils were exposed because accidental burning and cultivation practices kept the area bare. Socio-economic constraints were lack of labour, draught power and land. Underlying the labour shortages were poor health and limited cash to hire labourers. Cash also affected farmers' ability to hire draught animals. Although land appeared underutilized, access to it was restricted by tenure arrangements, cash to pay rents, insurgency, and population pressure.

More than half the farmers had fallows where 70% of the area was covered in *Imperata.* Elsewhere other grasses, such as *Saccharum spontaneum, Sorghum halepense* and *Pennisetum purpureum*, dominated all but the 29% forested areas.

Grass seed invaded crop areas making cropping impossible after only a few years. Hence in cogonal zones farmers practised a crop-fallow rotation. Cropping started with one or two years of upland rice and corn. Root crops were planted for a further two years or until adequate yields were no longer supported. As *Imperata* invaded, the area was left to fallow.

Fallow species succession and soil restoration was halted by frequent burning. Even without this set-back farmers did not have access to enough land to permit decade-long rests. Most cultivated parcels were less than one half hectare, of which only 35% were owner-operated and 25% belonged in the family. The rest were rented (35%) or tenanted (5%). Thus farmers were forced into cultivating *Imperata* infested land.

Farmers brought cogonal land back into production using hand cutlass or plough cultivation. Plough cultivation for one hectare entailed ten man-days cutting at a cost of 360 Pesos (at 20 Pesos to the US Dollar), burning, twelve man-days ploughing at 360 Pesos, and eight man-days harrowing at 210 Pesos. Another round of ploughing and harrowing, and a final two man-days of furrowing at 90 Pesos completed the task. Hand cultivation operations - cutting, chopping, underbrushing, gathering, and burning - took twice as long at 120 man-days but were cheaper. Whatever the method, two or four months of labour costing 1200 or 1600 Pesos for one hectare was an enormous outlay for a person whose annual income was around 3000 Pesos. Moreover, labour was scarce because farmers worked not only on the farm, but also on a wide range of off-farm activities.

Farmer experiment

Farmers decided to experiment with a sequence of vining legumes. Ploughing and herbicides were deemed inappropriate because farmers judged that ploughing would require too much labour and draught power and herbicides would cost too much money. Money and labour constraints did not, however, severely conflict with technologies involving vining legumes which offered a solution affecting several components of the system, namely weeds, soils, and labour for cultivation.

Most farmers knew that *Imperata* neither grew nor germinated under shade. Some had observed that *Imperata* was 'suffocated' by vining plants like Kurumput (*Passiflora foetida*). Formal research supports these observations; Mercado (1986) emphasizes the importance of shade in *Imperata* control and Sajise (1984) reports similar results in work on plant succession.

Legumes may also directly improve soil fertility. Jaiyebo and Moore (1964) found that *Pueraria* fallows increased soil organic matter and yields of subsequent corn crops compared to grass fallows. Farmers also thought that a flat bed of legume would be less laborious to cultivate than tall grasses and shrubs.

Thus farmers suggested that *Pueraria* and *Centrosema* species, established by broadcasting seed over underbrushed or burned fallows, would smother and control *Imperata*. The resultant legume-dominated vegetation would then be underbrushed and seeded with *Desmodium ovalifolium* which, with its higher nodulation activity, would regenerate soil fertility. In addition, this legume-dominated sward would require less labour than that needed to recultivate dense stands of *Imperata*.

To date, eight months later, thirty farmers have demarcated experimental plots, all have established the legumes *Pueraria* and *Centrosema*, and twelve have started nurseries of *Desmodium ovalifolium*. Even though prolonged drought has slowed legume growth – legume cover is still less than 25% – interest remains high. Indeed, ten farmers have re-seeded their droughted plots and seven are replanting their wilted nurseries. Moreover, farmers from neighbouring villages want to participate.

DISCUSSION

The method described encourages farmer participation. It also encourages the use of systems logic in identifying systems-problems, analysing systems, and elaborating experiments. Consequently, these experiments are very different from typical cropping pattern trials which place priority on maximizing crop grain yield per hectare with high cash inputs. Upland subsistence farmers are uninterested in immediate increases in crop yield and cash input, instead their priority lies in the long term rehabilitation of cogonal land and in saving labour.

A more holistic systems logic also leads to differences compared to conventional cropping pattern trials. Cropping pattern trials usually focus on one or two crops and assume they will be grown every year. A wider view of upland farming systems reveals that upland farmers not only cultivate many agro-ecological zones, but they do so on a crop-fallow rotation. Thus farmers are interested in the management of cogonal fallow land and not just the cropped areas.

Having farmers define system boundaries and relationships in a systems diagram has both advantages and disadvantages. On the positive side system boundaries are defined before they become unmanageable. On the negative side some relationships are not plotted, especially those between boxes at the same level. For example, in the outer ring of our systems diagram cultivation practices that keep soils bare increase erosion yet farmers do not link the two. In keeping with this systems logic farmers in their own farmer-managed and farmer-implemented experiment are testing hypotheses in several components of their system.

On this occasion more participation and a wider systems view than in conventional cropping pattern research undoubtedly produced important differences in both research topic and orientation of intervention. More important from a methodological standpoint is the fact that on other occasions this method has led to unusual experiments. Legume enriched fallows are being tested to enhance soil fertility recovery and reduce labour costs in coconut fallow rotation systems. Legume live mulches are being tested to sustain cereal productivity and reduce labour costs in shifting cultivation systems (Repulda *et al.*, 1987). Participatory methods that use farmer knowledge and systems logic are now solving problems that conventional cropping pattern research was incapable of addressing.

Acknowledgements. The Director, Farming Systems Development Project, Eastern Visayas is thanked for permission to publish, and the US Agency for International Development for funding the research.

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Step Two. Rank the Problems

Although it may be fairly easy to describe many problems encountered in a given research area, it is usually impossible to investigate more than a few at a time. Research programs have limited budgets and priorities must be set. Furthermore, the idea of investigating a few priority issues at one time is consistent with the strategy of on-farm research, which is to make gradual changes in farming systems. It is therefore important to evaluate problems that may become research topics to determine which should receive priority.

Step 2 is only an *initial ranking* of the problems listed in Step 1. If the list of problems is very long (greater than 10 or so), it may be possible to eliminate some. But even if no problems are eliminated, an initial ranking helps establish a sense of priorities. Problems that receive a low ranking but which have important relations to other problems (see Step 4) or which have easily accessible solutions (see Step 6) may certainly be addressed in the experimental program being planned. Problems that receive low rankings in this review and lack either obvious interactions with other problems or easy solutions may be eliminated from consideration altogether.

Recall that some problems considered in Step 1 may not be well defined. Even so, they should be reviewed. A tentative problem may still be sufficiently important to warrant investigation either through experimentation or other techniques for gathering data.

Problems should be ranked every year. The ranking assigned previously should be reviewed in light of new evidence from experiments and other sources. Over time the importance of certain problems may diminish, whereas others may be assigned higher priority for future work. Maintaining consistency in the experimental program is an important consideration when researchers rank problems. *Priorities* may change from one year to the next, depending on the results of the research program, but the *content* of the on-farm experiments should exhibit a logical progression from year to year rather than skip from one topic to another.

There are numerous ways of assigning priorities to a set of research problems. The method suggested here employs three criteria to do so:

- The distribution of the problem;
- The importance of the particular crop enterprise to the farming system; and
- The loss of yield or income for which the problem is responsible.

The application of these criteria to the example is presented in Table 2 (pp. 28-29).

Distribution of the Problem

It is necessary to specify which farmers are affected by the problem. How many farmers in the research area grow the crop (or crops) in question? Of those farmers, how many have crops affected by the problem? Finding the answers to those questions may require only a straightforward estimate of the proportion of farmers in the area who grow the crop. All tobacco farmers seem to have nitrogen deficient crops (problem 11, Table 2), but few farmers grow tobacco and the problem gets a very low rating.[10]

A rough estimate of the number of farmers who grow the crop *and* have the problem is necessary. If only certain farmers seem to have the problem, a description of that group should be made. Most maize farmers have the problem of nitrogen deficiency, so it gets a high ranking. On the other hand, drought is primarily a problem for maize farmers in the north, so its rating is lower. Few farmers have waterlogging in their beans (10), so it gets a low ranking. The problem of root rots in beans is still unconfirmed and only tentatively identified as corresponding to a particular group of farmers.

Importance of the Crop Enterprise

In some cases a target crop or crops will already have been selected for on-farm research because it is either included in the mandate of the research organization or in national agricultural development

10 Specifying which farmers are affected by a particular problem may also involve weighting the estimate in favor of particular kinds of farmers. For example, government policy may give higher priority to a problem affecting a crop grown by small-scale farmers than to a problem found in a crop produced by larger scale farmers.

Table 2
Rank problems (Step 2)
(XX = very important; X = somewhat important; 0 = not important)

Problem	Distribution of problem	Importance of crop enterprise	Seriousness of problem	Relative importance of problem
1 Nitrogen deficiency in maize	Most farmers. XX	Maize XX	XX	1
2 Phosphorus deficiency in maize	Most farmers. XX	Maize XX	X	2
3 Drought stress in maize at ear filling	Farmers who live in the northern part of the research area, which is more prone to drought. X	Maize XX	XX	2
4 High cost of weeding maize	Most farmers. XX	Maize XX	X	2
5 Nitrogen deficiency in beans	Most farmers. XX	Beans X	X	3
6 Anthracnose attack on bean pods (about one year in three)	Most farmers. XX	Beans X	X	3

Problem	Distribution of problem	Importance of crop enterprise	Seriousness of problem	Relative importance of problem
7 Root rots of beans during crop establishment (?)	About half of the farmers (?). (Those who plant beans every year on the same field are probably affected most.) X	Beans X	XX(?)	(3)*
8 Low plant population in beans	Most farmers. XX	Beans X	XX	2
9* Broad-leaf weed competition in beans (?)	Most farmers (?). XX	Beans X	X(?)	(3)*
10 Waterlogging in low-lying bean fields	A few farmers who have low-lying fields. 0	Beans X	X	5
11 Nitrogen deficiency in tobacco	Farmers who grow tobacco (less than 10% of all farmers). 0	Tobacco X	XX	4

* Tentative problem; more evidence required

policy. But in other cases research topics must be selected from among the problems affecting various crops. To do so, researchers must determine whether the crop enterprise is a significant source of income or subsistence *for the farmers who grow it*, and/or if it utilizes significant amounts of farmers' land, labor, or capital. In other words, if changes were made in the productivity of the resources devoted to the enterprise, how much of a contribution would they make to the system's overall productivity? Sometimes a problem extends to more than one crop (e.g., a problem related to effective tillage) and merits a higher ranking than is given to a problem affecting just one crop. At other times the problem relates to a new or recently introduced crop, and researchers may want to cautiously estimate the crop's potential importance.

In the research area, maize occupies more land than beans and is the principal item in the diet. It has the highest ranking. Beans, which are important in the diet and increasingly important as a source of cash income, receive a medium ranking. Tobacco also gets a medium ranking, because although few farmers grow this crop, it makes a fair contribution to the incomes of those who do. (Remember, the number of farmers growing each crop was accounted for when the distribution of the problem was determined.) Most farmers grow a few tomatoes in their gardens, but tomatoes are unimportant in local incomes or diets, so problems in tomato production were not considered.

Seriousness of the Problem
Researchers should estimate whether the problem is responsible for a significant yield loss or serious inefficiency in resource use. That judgment may be difficult, especially if a problem is not well defined, but an estimate of a problem's potential importance should be attempted. In making the estimate, two elements of the problem are considered:

- **The severity of the loss.** For farmers whose crops are affected by the problem, how much yield per hectare is lost because of it, or how much income per hectare is lost because of inefficient resource use?
- **The frequency of the problem.** Does the problem occur every year, or only in a certain percentage of years?

The product of these two elements (severity times frequency) gives an estimate of the seriousness of the problem.

In the example, nitrogen deficiency (1) leads to more serious yield loss than does phosphorus deficiency (2). Broad-leaf weed competition in beans (9) may be moderately important, but researchers are not yet certain of that conclusion (hence the "?"). Drought stress (3) is responsible for sizeable yield losses in maize (again, note that the number of farmers with the problem was determined along with its distribution). More information is required on the frequency of drought: if it does not occur every year, its ranking may drop, as is the case with anthracnose in beans (6). Although it causes serious yield loss, anthracnose occurs only one year in three, and when both severity and frequency are considered, the problem receives a medium rating for seriousness.

Relative Importance of the Problems
When assessing the relative importance of problems researchers should take account of all three criteria (distribution, importance, and seriousness). Rankings should be assigned for each criterion. In certain cases some criteria might be given extra weight. This procedure obviously provides only a rough ranking, but it is an important start at setting priorities for the on-farm experimental program. In the example in Table 2, rankings are given using a simple system of Xs and Os, in which the highest priority is assigned to problems with the greatest number of Xs, but other methods of reviewing the rankings are also possible.

In the example, the problems of nitrogen deficiency in tobacco (11) and waterlogging in beans (10) were eliminated from further consideration. But note that a decision to postpone or abandon research on a particular problem does not depend only on its ranking. It is also necessary to ask:

- How is a problem related to other problems? (See Step 4.)
- Are solutions readily available? (See Step 6.)
- What resources are available for on-farm experiments?

As these factors are taken into account they can be compared with the ranking given to problems in order to decide the final composition of the experimental program.

Summary

Step 2 ranks in rough order of importance the problems that have been identified. Even problems that have been only tentatively identified should be considered here. If researchers have identified a large number of problems they will eventually have to eliminate some from immediate consideration. The initial ranking carried out in this step is not precise, but it will help researchers decide which problems have a higher priority for the research program.

Problems should be ranked using well-defined criteria. The criteria suggested here are: 1) the distribution of the problem, including a definition of which farmers in the research area are affected; 2) the importance of the crop enterprise to the farming system; and 3) the loss of yield or income for which the problem is responsible.

After the ranking in Step 2, problems that researchers feel are of sufficient importance, and for which sufficient evidence is available, are passed to Step 3, where their causes are analyzed. Problems that are potentially important but for which more evidence is needed generally do not receive attention in Step 3. Instead, researchers note the type of experimental evidence (in List A) or information from other diagnostic techniques (List B) that is required.