

BASELINE STUDY OF SOCIO-ECONOMIC CONDITIONS AND DECISION MAKING PROCESSES WITH A FOCUS ON SMALL FARMERS, NUTRIENT MANAGEMENT AND MILLET PRODUCTION IN THE SEGOU REGION OF MALI

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Introduction

Population pressure and dependency on agriculture are the primary factors shaping social and economic conditions in the Sahelian, Sudanan and sub-Sudan ecosystems of Mali. The population estimate in 1993 was 8,538,000 and the annual rate of population increase for the period 1993-2000 is estimated at 3.1% (UNDP, 1996). The population is 74% rural and 86% of the national workforce are involved in the agricultural sector. A principal crop of the region is millet, and millet farming systems are based on traditional practices and varieties. GNP per capita is very low (US\$530/yr) and declining at a rate of 1.0%/yr for the period 1980-1993, attributable in part to misguided policies (of previous governments) and failure of economic gains (principally agricultural productivity) to keep pace with population gains. As a consequence Mali has been dependent on cereal imports (83,000 t), food aid (34,000 t) and ODA assistance amounting to 16.1% of GNP. Uncertainties about the degradation of the environment are clearly linked to concerns about the nutrient balances within agriculture. The Government of Mali plans to achieve regional food security and environmental protection through improved nutrient management of dryland resources. Specifically, the Government plan sets five-year targets for:

- increased millet productivity,
- increased area of millet production,
- food security, and
- environmental protection.

Achieving these targets will clearly depend on decision making and coordination from the policy level to the farm operator level.

Objectives

This is a case study that addresses specific questions in a specific region, but also illustrates the micro-level decision processes (at the farm level) that determine food security and environmental protection of the arid ecology. The focus is on collaboration and coordination among key actors in the rural sector. Specifically, the paper provides a perspective from small farmers, agro-industry and government. Based on surveys with each of these groups, we try to represent the current conditions in the field and reveal the current kinds of information and methods which are used by decision makers as they diagnose problems and evaluate alternatives for future action. The paper provides both a benchmark in time for the state of development and,

hopefully, a useful guide to future research and development. Ultimately, the impacts of development will be evaluated using four criteria (Emmy Simmons, 1997): people, food, trade and economic growth, and the environment.

Building Upon a Research Base

The case of millet research in Mali, illustrates how agricultural research can benefit small farmers, their villages and at the same time contribute to a more sustainable and environmentally balanced system. With leadership from agricultural scientists at the Institut d'Economie Rurale (IER), there is a 30 year history of research on millet and associated cropping systems. The research has addressed issues of breeding, cropping systems improvements, striga control, entomology and nutrient management for millet, cowpea and groundnut. Annual work plans for the station are based on farmer input during field days and meetings with farmer associations. Collaborative investigations with Texas A&M University, via the SM-CRSP, have documented a marked spatial variability in sorghum establishment, growth and yield within single fields. Greenhouse experiments on problems soils indicated that P deficiency is a major factor limiting sorghum growth (Doubbia, Hossner, Onken, 1991). Similar effects are expected for millet. The experiment station recommends farmers to delay compost applications to fields until the planting season, in an attempt to minimize nutrient losses by leaching and volatilization.

One strategy under investigation to improve soil fertility in sandy soils under continuous millet production includes using local reserves of Tilemsi phosphate rock (TPR) along with manure, crop residues and legumes. Adding phosphate rock to composts of manure and crop residues could promote TPR solubilization. For the farmer, application of TPR to compost is more acceptable than direct application in the field. These resources are combined with agroforestry, minimum tillage and early planting. The ultimate goals are to increase soil fertility, soil restoration, reduced environmental degradation, and increase production and socio-economic development.

IER research on food technology, with international cooperation including private sector support of Ciba Specialty Chemicals (formerly Ciba Geigy Ltd.), has addressed topics related to consumer acceptance of new sorghum and millet varieties. In project PROCELOS, food scientists are helping crop breeders to select varieties for acceptable organoleptic properties (grinding, pericarp removal, taste, color and stability). A goal is to reduce imports of processed foods and enhance the nutritional value of products using composite flour of legumes (cowpea) and millet. Research is also contributing to diversify product use in local dishes through sun drying, packaging in paper and plastic, processing, particle size in grits (used for porridge) and stability/rancidity problems. This research is part of the food technology network, 'Accion du Valorizacion du Savior fair Locaux' (AVAL), which exchanges experiences with ITA-Senegal, LBTA-Bukina Faso and Benin. Also involved are the West and Central Africa network 'Transformacion du Product Alimentar en Afrique' (TPA).

With international cooperation, the local institutions have built a capable team of scientists representing the various disciplines. The benefits of this local capacity, built through research and training, are the foundation for future development. The future prospects depend on careful coordination and decision-making by key actors in the system. The millet system combines production, processing and marketing. Various opportunities are provided for employment of both men and women. Economic values are generated through the stream of

value-added activities. Intermediaries are important for collecting the material at the farm and moving it to processing centers and markets.

Favorable Characteristics of Millet

Millet is well adapted to the arid tropical ecology, in an area which is marginal for other agricultural activities. The crop can be managed by small farmers working with limited resources and hand tools on sandy soils. Millet is the mainstay of the local diet and most of the local production is consumed by the subsistence farmer. There is a single growing season corresponding to the short rainy season. Millet is stored throughout the year in small granaries. Surplus millet has a ready market and is sold to generate cash income for the household. Production rates are influenced by nutrient management practices.

Both men and women are active participants in the systems of millet production, processing, transport, and marketing. However, their activities, their plots and even their granaries tend to be separated in the Cinzana region. Millet is being used in nontraditional, value-added formulations for infant feeding, for malt products and as an ingredient of composite flour for bread, cookies and spaghetti.

Coordination of Millet Research and Development

Government, private producers, village associations, intermediaries and marketing agents are involved in different aspects of millet production and marketing, as follows:

- The 'Ministere du Developpement Rurale et de l'Eau' promotes a macro-economic policy of sustainable development. The government engages in some price support activities by buying millet. There is also government support for development of local phosphate rock.
- Research is coordinated by a National Millet Research Program based at Cinzana.
- Local extension services are provided by the Ministry's 'Agents de Vulgarisation de Base' (avb=village extension workers). In the Segou region 136 avbs assist farmers with on-farm research, meetings, training, demonstration plots, create a cereals germplasm bank, manage the village environment, train women on child nutrition and production of cloth and soap.
- NGO's including 'Voisins Mondiaux' (with 10 agents in the Segou area) and 'Vision Mondiale Internationale' (with 8 agents).
- Credit is available to local farmers through the BNDA ('Banque Nationale de Développement Agricole').
- 'Fonds International de Developpement Agricole' (FIDA) is a credit fund established with FAO cooperation for village development
- Farmer associations (Assoc./Ton Villageois) is the primary form of organization at the village level. The advanced farmer associations can be registered as cooperatives and thereby have access to credit and pooled marketing arrangements. Each cooperative has a management committee. The village cooperatives generate money buying cereals from the farmers and selling to intermediaries and to the national security stocks. The village uses the cash to buy amenities for the community (e.g. electric generator, tv).
- Intermediaries sell factor inputs (fertilizer) and other intermediaries buy products (millet).
- Research institutions provide for chemical characterization of the products, thermal treatments, processing and consumer use.

The above mechanisms need to be strengthened and coordinated. The linkages between the various actors are weak and system information is scattered among different sources and not coordinated in an effective manner.

Three times a year, meetings are convened involving all the research scientists and extension specialists to review problems in the field and prepare research and extension work plans that correspond to the priority needs of farmers. This mechanism appears effective in building a team approach and mutual respect between research and extension professionals.

Coordination between research and policy-making is provided through the participation of the Director General, the Deputy Directory General and the Scientific Director of IER in periodic meetings of the Ministerial Council. The linkages between research and policy appear to be formally prescribed. We were unable to determine the kinds of information used and the processes of decision analysis at the policy level. Interaction between individual researchers and policy makers is minimal.

The Segou region of Mali

The Segou region of Mali was selected as an intensive research site for the SM-CRSP's IntDSS project by the Mali/U.S. collaborative team (Reid et al., 1997). It represents a transition zone between the desert ecology of the North and the more intensive agriculture zone of the South. A transect of the region includes Sahelian, Sudanan and sub-Sudanese ecologies. The Sahelian zone is 281,000 km² which ranges from a growing season of 45 to 90 days with 350 to 600 mm rainfall in the South down to 25 to 45 days and 150 to 350 mm rainfall in the North. The North Sudanese zone of 215,000 km² has a growing season of 80 to 120 days with rainfall of 550 to 800 mm (M.V.K Sivakumar, M. Konate and S.M. Viramani, 1984). The principal crops are early and semi-early cereals and legumes. The average yields of millet in the Segou region are 650 kg/ha which is below the national average of 735 kg/ha in 1995 and below the goal of 825 kg/ha set for 2005. Figure 1 is a local map of the general area with indications of road infrastructure and local communities. Most roads are generally unimproved.

Methods and Procedures for the Study

A participatory rural appraisal was planned and conducted within the Segou region. Coordination of the team activities was by the 'Direction Scientifique' of IER. The survey was planned to answer many of the unknowns about small farm systems, farm level decision making and coordination of on-farm and off-farm activities. As a first step in the design of the survey format, research investigators were asked to rate the importance of different kinds of information for building and eventually for evaluating a nutrient decision support system. The next step was to draft a set of questions appropriate for small farmers, that would elicit the kinds of information deemed most important. Additional questions were added to address other important matters that emerged in discussions with policy makers and others. The survey focus on small farmer and decision practices was new to most of the educators, researchers and policy-makers. The new perspective led to suggestions by the team for additional questions to address gaps in knowledge or to confirm ideas that are held but not verified by field data. The final version of the survey, therefore, reflect the priorities and concerns of the diverse team. The survey was prepared in the local language (Bambara) in terms comfortable to the local population. An English translation of the survey questions are attached in Appendix A.

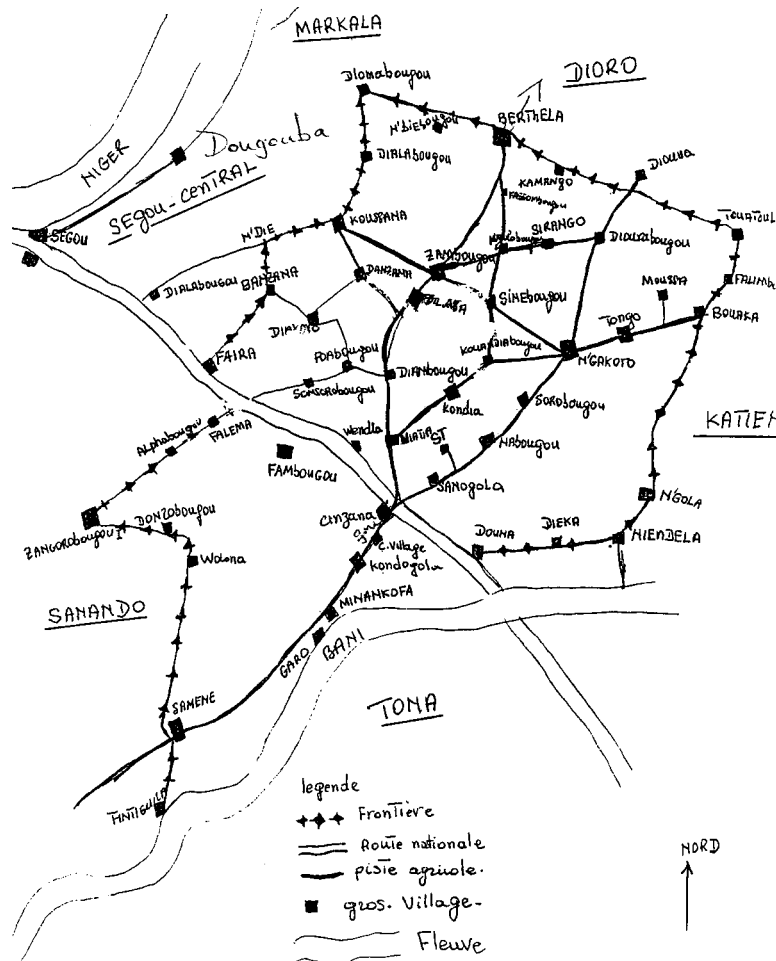


Figure 1. Delineation of the Segou region in Mali and distribution of road infrastructure and villages.

The sampling was based on a transect of the region which provided variation in the arid ecology, soil depth and social custom. Villages along the transect were selected and approached by local extension specialists. According to local custom, meetings with the chief of each village lay the foundation for the interviews with individual farmers. Farmers were selected and were given a brief explanation of the purpose of the survey and asked if they would be willing to participate. Kola nuts were purchased as a goodwill offering consistent with local custom. One hundred percent agreed and participated. The interviews were conducted at the village site. The sampling design can then be fairly characterized as a quasi-random sample within quasi-random villages (clusters). The Doucouba village was very old (more than 1000 years) and had a history of being very closed to external influence. Neither the government extension agents or NGO's had been accepted by the village. The village, however, is very interesting because of its indigenous knowledge and practices of manure recycling. The Dilaba village was a traditional village served by the extension agents and a site of various project activities (e.g., solar energy generation, etc). The Cinzana villages were also open villages with significant number of recent

settlers. Other surveys were completed by agents of local fertilizer distributors, credit institutions, and intermediaries.

Five technicians, each fluent in French and the local language (Bambara), were selected and trained in administering the survey to the farmers. The survey technicians were supervised in the field by the farming systems specialist and the international collaborating scientist. In the course of the survey observations were recorded, to flag potential problems with the survey instrument, questionable responses, or general disinterest of the farmer. There were only a few isolated indications of problems with data. Overall, cooperation of the farmers was excellent. Often the questions produced long and revealing stories of circumstances on the farm and clearly of interest to the farmer. In total 55 interviews with small farmers were completed. Given the clear patterns emerging from the farmers sampled, it was considered that the sample provided sufficient numbers and reliability for the purposes of the case study.

At the conclusion of each interview, the interviewer would rate it on a 3-point scale: 1=very good with no problems; 2=good with few problems; 3= questions and potential problems in the data. The average rating given was 1.51 with a standard deviation of 0.57. Extreme values on interviews rated 2 or 3 should be treated with caution or excluded in calculation of means and standard deviations. Overall the survey procedure seemed to work quite well and elicit the appropriate farmer response. The complete data set for the small farmer survey, in an Excel spreadsheet is included as Appendix B. The following discussion will draw attention to some of the findings and discuss the implications for future program action.

Most of the farmers sampled (76%) were self-described landowners and 24% were borrowing land (at no cost) for annual cropping. In the sample, the average family size was 14.09 and the standard deviation was 12.13. The largest reported family size was 70 and the least was 3. Male and female literacy (French) was 18% for men and 15% for women. The husband and wife on average had similar levels of education (1 year). The average respondent had 37.5 years of experience in agriculture. Only 29% were currently financing operation or expansion costs of their farms; all with private bank loans at reported interest rates of 10%/yr. The farmers were all independent producers but 31% were affiliated with a local farmer cooperative/association for purposes of sale of product. Using equipment as a proxy to classify farmers demonstrates that farmers were using traditional methods. Most farmers (91%) had a cow for animal power, 95% owned a plow, 85% owned a small donkey cart with capacity of 400 kg and only 16% owned a planter/seeder.

Current Agricultural Practices of Farmers

The average area of total farm production was 8.73 ha with a standard deviation of 6.36 ha. Millet is the principle crop of the region, followed by peanut, sorghum, cowpea, 'fonio' rice, bambara nut ('vouandzou'), and corn (Figure 2). The average area of millet production was 5.96 ha with SD of 4.56 ha. The maximum total production area in the sample was 30 ha and the minimum was 2 ha; for millet the maximum was 20 ha and the minimum 0.5 ha. Three landscape types reported by farmers were flat (65%), slopes of less than 10% (49.1%), and lowlands subject to ponding (50.9%).

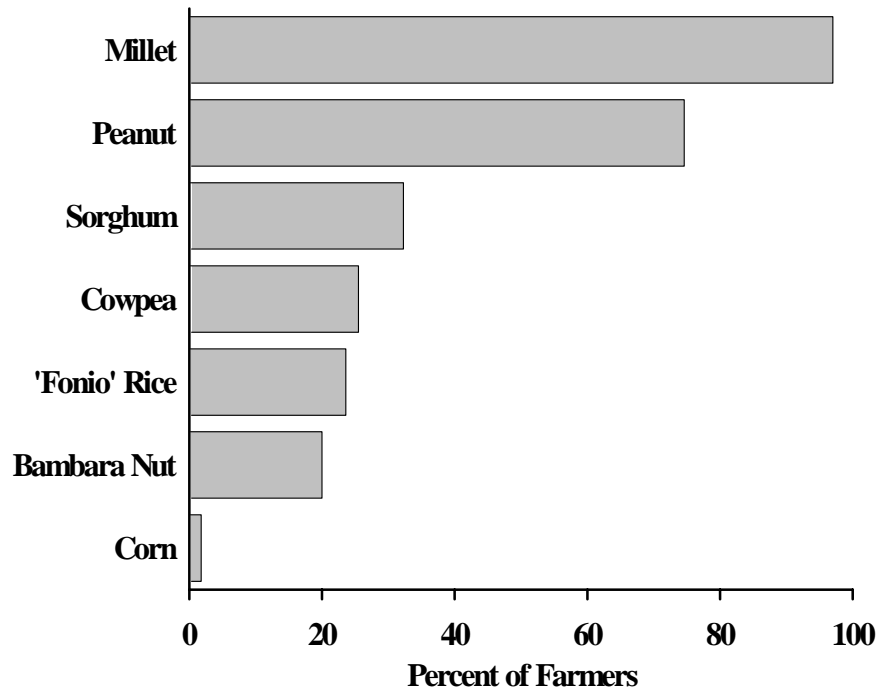


Figure 2. Principle crops grown in the Segou region of Mali.

When asked about what changes they planned for the coming 5 years, 90.9% of farmers planned to improve soil fertility using various strategies involving manure, chemical fertilizer and compost. Some 14.5% mentioned plans to improve equipment. Other changes planned included rotation (5.4%), improved varieties (5.4%), seed treatment (1.8%), management or diversification (7.2%) and early planting (1.8%). Farmers perceived numerous constraints (Figure 3). The most important were soil fertility (36%), lack of equipment (25%), lack of rainfall (20%), and land pressure (12%). Other constraints identified by lesser numbers of farmers were lack of capital (5.4%), fertilizer, seeds and labor (3.6% each). When farmers were asked about what indicators they use to judge the soil nutrient status of their fields, farmers referred to factors of yield (76.4%), vigor (14.6%), and plant growth (40.0%) (Figure 4). Striga was also mentioned as an indicator of nutritional deficiencies by 5.5%, wilting by 3.6%, pests by 3.6% and diseases by 1.8%.

All farmers use animal manure as their principal source of nutrient inputs. The average rate of application is 12,736 kg/ha (31.84 donkey carts of 400 kg/cart), but the standard deviation is also large (8,436 kg/ha). Since farmers only apply manure to selected fields each year, the average application rate cannot be used to estimate total amounts applied across a farmer's land holdings. Frequency of manure applications to individual fields and criteria used to select fields to receive available manure need to be explored in subsequent interviews. The farmers transport the manure to the field where it is left in piles during the period of March and April. At the beginning of the rainy season (May and June) some spread the manure by broadcasting (52.7%) and others localize the manure around plant hills (45.4%).

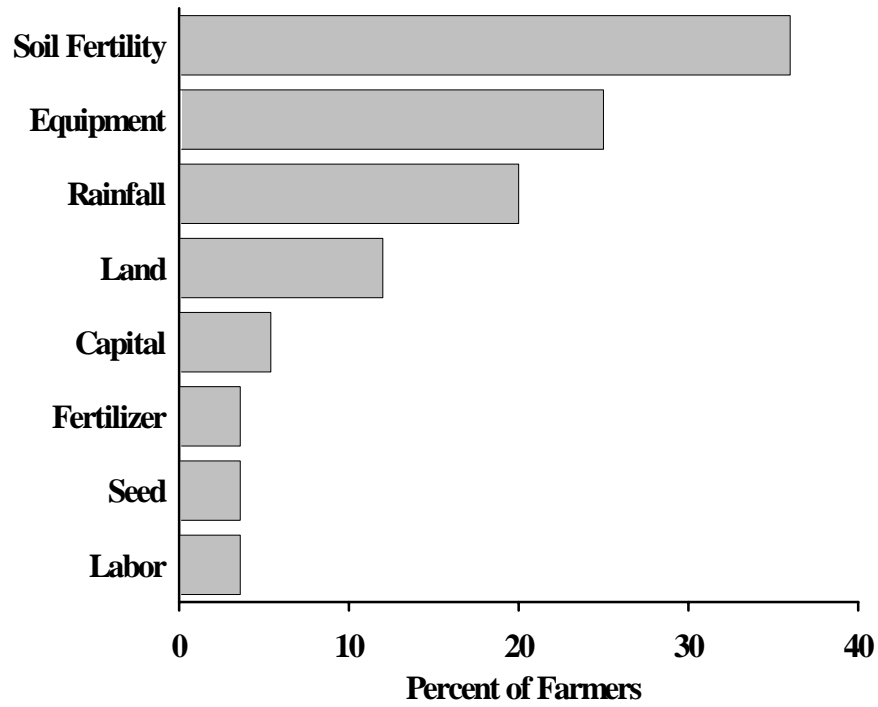


Figure 3. Farmer perceptions of production constraints in the Segou region of Mali.

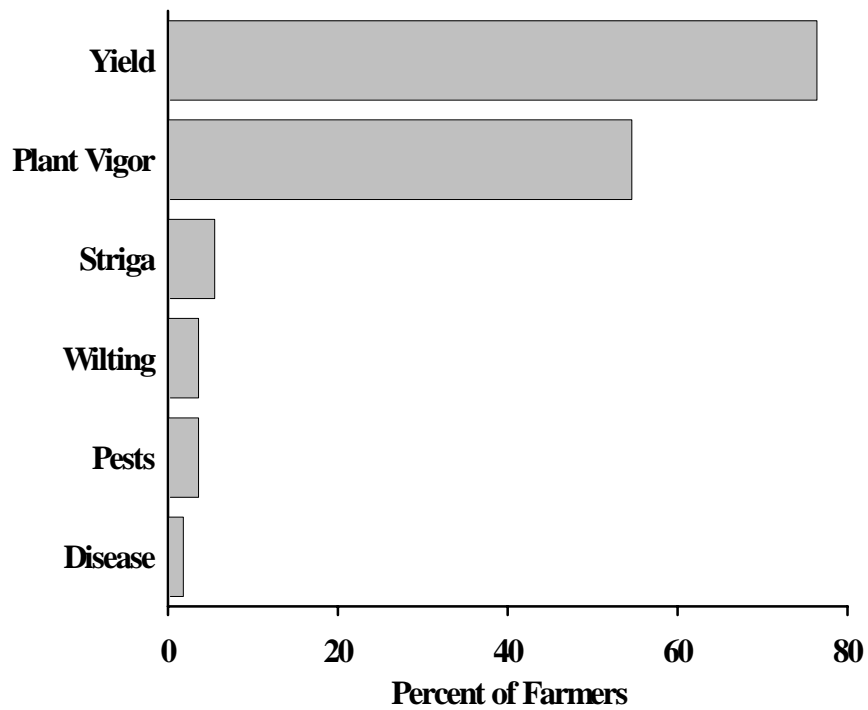


Figure 4. Indicators used by farmers in the Segou region to judge soil nutrient status of their fields.

Eleven of 55 farmers (22%) report use of cereal complex fertilizer 15-15-15 and 5 of 55 farmers (9.1%) report use of urea (46% N) for millet production. This is surprising because all economic analyses indicate unfavorable ratios of unit prices for millet per unit price of cereal complex fertilizer and/or urea. These results need to be reconfirmed and explained by follow-up interviews with the farmers. The maximum fertilizer application reported was 100 kg/ha and the average was 15 kg/ha with a SD of 33 kg/ha. All applications of manure and chemical fertilizers were made in the period of May to August. Localized placement of fertilizer was reported by 9.1% and broadcast methods of application were reported by 7.3%. Three farmers (5.4%) applied urea using a broadcast method and two used a localization method. One farmer (1.8%) applied TPR with localized placement. The maximum rate of application of both urea and TPR was 50 kg/ha. The farmer's access to purchased fertilizer, measured in distance, was 0 to 38 km with an average of 15.3 km and standard deviation of 13.6 km. The average price of cereal complex (15-15-15) to farmers was 10,062.50 FC/50-kg bag. The exchange rate, at the time of the survey, was 605 West-African francs (FC)/US\$.

Other purchased inputs identified were fungicides, to treat seeds prior to planting, including aprom plus (63.6%), sijolam (16.3%) and furadan (1.9%). The only other input identified was phostoxin (7.3%) to protect storage of cowpea grain.

Most farmers intercrop millet with cowpea (76.4%) or peanut (5.5%). The remaining farmers use a single cropping system for millet. The indication by most farmers that cowpea was intercropped with millet contradicts the superior ranking of peanut over cowpea as a principle crop in the region (Figure 2). A closer inspection of survey responses (Appendix B) revealed that several farmers report intercropping cowpea with millet, but do not include cowpea among their three most important crops. Apparently, the millet-cowpea association is so prevalent in the region that farmers assume the inclusion of cowpea when referring to "millet" as a crop. Planting densities for crops ranged from 0.5 x 0.5 m to 1 x 1 m. The farmers of the Dougouba village were quite uniform in using a planting pattern of 0.8 x 0.8 m. Other villages were more variable in their planting patterns.

Most farmers would occasionally arrange for temporary labor (most often a barter arrangement). Men and women both were active in field work with millet but in separate plots. The scale of male plots was larger. On most farms, it was reported that no women were involved in field work, but on other farms women participated in the field work, especially during periods of high labor requirement.

Yields were reported to be unstable by most farmers (56.4%). Some farmers (27.3%) reported increasing yields while others reported yields either stable (7.3%) or declining (5.5%).

Household consumption of farm products ranged from 100% to 25% with an average of 89.2% and standard deviation of 20.2%. Most farmers do not sell millet, rather all the millet is consumed at the household level. Those farmers who do sell surplus millet (27.3%), do so weekly in the local market. Others (7.3%) wait until the beginning of the next cropping season to sell. Clearly, farmers meet their consumption needs first and only sell the surplus to generate the capital for the expenses associated with the next cropping cycle. The maximum share of millet sold is 75% with an average of 11.0% and standard deviation of 20.4%. Access to product markets was also measured in kilometers between the farm and point of sale. Many farmers sold

their product at the farm to intermediaries or village cooperatives. The average distance to point of product sale was 4.3 km with SD of 7.4 km. The average price of sale by farmers was 68.38 FC/kg with a SD of 12.09 FC/kg. Quality is a factor in product pricing, especially with regard to substandard product which receives a discounted price.

Decision Processes of Farmers

With regard to the issue of decision making, farmers were asked to describe how they diagnose problems with their crops and how they decide what corrective measures are necessary to alleviate the problem. These were difficult concepts to communicate in simple terms to farmers, and some of the unsupervised interviews produced some strange responses. Yet these are very important questions that go to the heart of what a decision support system is all about. Most farmers gave only general responses that they observed problems or behavior of their crop. Specific indicators identified were disease, striga, pest, mildew, or signs of nutrient deficiency. The survey provides some insights but more work in this area is needed.

Farmer responses, when asked about corrective actions, referred to application of manure (32.7%), fertilization (12.7%), weeding (10.9%), maintenance (9.1%), selective thinning (5.5%), and eradication of diseased plants (3.6%) (Figure 5). When asked about where they learned how to plant and manage their farming system, 12.7% said they were self-taught, 60.0% learned from local or village sources. The IER research station was mentioned by 18.2% and the extension agent by 12.7%. When asked specifically, who can help, in case of problems on the farm, 45.4% said they had no access to help, 18.1% turned to persons within the village or family for help; 18.1% turn to the village extension agent, and 5.5% to the IER research station. When asked what kinds of information they used for purposes of farm planning and management, farmers

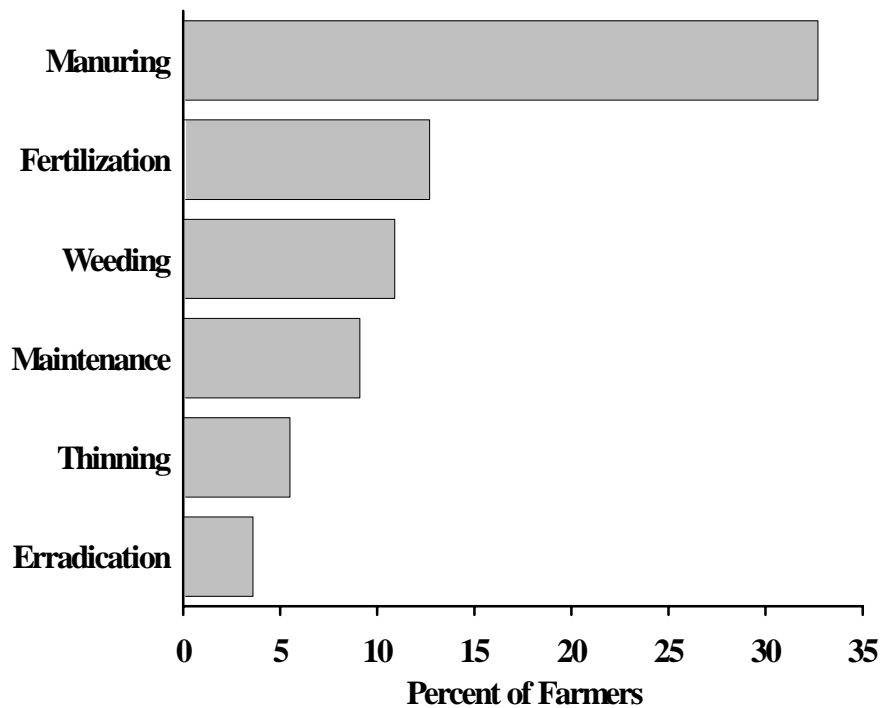


Figure 5. Corrective actions taken by farmers in the Segou region to improve crop production.

mentioned a variety of information content including erosion control (12.7%), nutrition and fertility (40.0%), yield (10.9%) and sources including village meetings (14.5%) and extension agents (1.8%). The dominant method for integrating diverse information types and decision making is the village meeting. Farmers meet and discuss their problems at length, sometimes with the assistance of a village extension agent. Analytical tools for integration of information are not used.

With regard to participation in decision making, it is significant that 62 % of farmers consult with their family. The farmer was not asked specifically if he consulted his spouse (that would have been regarded as an insensitive question by local standards) but one might surmise that the spouse is included as a family decision maker. From casual observation, one might conclude that women have little involvement in production of millet, but these data suggest an important and unrecognized role of women even though they do not participate in village meetings. Women have a dominant participation rate in the processing of millet. Participation rates in farm decision making are as follows: for village members (22%), fertilizer distributors (5%) and other technical specialists (38%).

In order to quantify the interaction and assistance giving between neighbors/farmers, two questions were asked, "how many neighbors do you help" and "how many neighbors help you". The range of responses on the first question was 0 to 25 and, on the second question, 0 to 30. The statistical averages on these measures are 2.8 and 5.1 respectively, but the standard deviations are relatively large because some interpreted the question to mean the assistance of neighbors given or received in the village meetings and reported the average number in attendance at those meetings. These data, then, only provide a rough approximation of the actual multiplier of technology transfer among farmers.

With regard to risk factors in making farming decisions, farmers most often identified uncertainties of rainfall as the biggest risk factor (58.2%). Rainfall effects timing of agricultural activities and yields. Other specific risks identified were from diseases (7.3%), birds (5.5%) and equipment failures (1.8%).

Perspectives Based on Interviews with Industry Representatives

Business decisions regarding fertilizer distribution are made centrally in Bamako. Local distribution outlets are run by a small staff of stock managers with no technical support. Most sales of fertilizer are made through farmer associations with financial credit arrangements made through the national development bank. Sales to individual buyers are made only on a cash basis. There appears to be a competitive market for both inputs (fertilizers) and products. Historical information was unavailable at the regional level about, annual sales volumes or prices. However, current information on prices and stocks of a major local distributor were obtained and serve to confirm farmer supplied information about minimum use of chemical fertilizer and prices (Table 1).

The infrastructure and system of intermediaries for fertilizer distribution is targeted to irrigated rice production. At the current time there is little volume in sales to millet producers. There is an extended chain of distribution of fertilizers reaching all the way to the village farmer where small purchases can be made by kilogram or by 50-kg sack. In the Segou area approximately 10 intermediaries buy quantities of 5-10 t weekly from the central supplier (Comadis) and resell to 4 or 5 smaller distributors who move the fertilizer to weekly village

markets where sales are made in small unit volumes (by bag or by kg). Transportation costs are covered by buyers either directly or indirectly in the sales transaction.

Table 1. Annual fertilizer sales, formulations and price for the largest agricultural supply store in the region of Segou, Mali

| FERTILIZER | SALES | FORMULA | PRICE |
|-------------------|--------------|--|----------------|
| | ----t---- | %N-P ₂ O ₅ -K ₂ O | FC/50-kg bag |
| DAP | 1105 | 18-46-0 | 12,250 +/- 250 |
| Urea | 915 | 46%N | 10,500 +/- 250 |
| Cotton Complex | 10 | 14-22-12 | 11,500 +/- 500 |
| Cereal Complex | 0 | 15-15-15 | ? |
| Phosphate Rock | 0 | 28%P | 4 |

Source: Personal communication with regional Comadis manager (February, 1998)

There may be some industry resistance to sale of local Tilemsi phosphate rock, because it does not present the same profit opportunities as imported soluble P fertilizers. However, market forces should work to gradually expand the use of phosphate rock if the technical issues associated with its use can be verified in the field to the farmers' satisfaction.

Farmers have multiple options for commercialization of their surplus millet. The most common procedure is for farmers to sell through the village cooperative. The farmer receives credit for the amount of the sale. In this way the farmer has access to the credit markets of the national development bank. Farmers may also sell to intermediaries or directly to buyers in the local markets.

Linkage between the private sector and researchers or government extension activities has been minimal. Industry representatives are unaware of relevant research and respond that they have not used information from research or extension to support their activities. They have no decision support system (DSS) or information integration tools to assist with analysis and decision making. The local fertilizer distributors are stock managers with little technical knowledge to share with customers about their products (e.g., rates, method and timing of fertilizer applications). Also most of the millet processors are not specialists nor have they received special training.

Perspectives Based on Interviews with Government Representatives

The strategic plan (1995-2005) of the government for the central zone, including the Segou, Mopti and northern sections of Koulikoro and Kayes, is to:

- improve and secure traditional crops,
- increase production from an average of 735 kg/ha to 825 kg/ha, and
- increase the area of production from 900,000 ha to 949,000 ha (IER, 1995).

The government supports research, training, extension and technology transfer, and international cooperation in the sector. The national programs are coordinated by a inter-agency

committee composed of government professionals. The new government is currently in the process of making an agriculture sector policy review. Little information was available on the status of the policy review, what kinds of information were being used and what methods of analysis were supporting the policy-making processes.

Industrial Processing and Marketing

The traditional technology for processing millet is manual crushing/grinding, washing, roasting, and soaking. Milling machines and milling service providers are available in some communities, but typically not at the village level. The cereal flour is consumed as a paste, porridge, bread or related product. Processed millet products are commercialized in local markets and packaged in plastic or paper bags.

'Grand Moulin', based in Bamako, is the largest single miller of millet, but a medium scale miller (UCODAC) and many small scale millers (Verges - Maraichere) operate throughout the country. Value added processing and packaging are high priority activities for future development. USAID is supporting value-added development to expand and stabilize millet markets within the country. The plan is that processing industries will be owned by individuals or managed by cooperatives of small producers.

Technology Transfer and Training

The government extension program provides for each extension agent to serve 6-8 local villages. The extension agent lives in a centrally located village and provides technical assistance. NGO's also assist with technology transfer and training. Still, the needs for training were frequently mentioned by local farmers. Few (36%) reported having had some type of training in production of millet, and 49 farmers out of 55 (89.1%) had specific requests for additional training in the form of courses or written information. The course topics most frequently requested were compost management (23.6%), crop management (12.7%), basic literacy (12.7%), draft animal management (5.45%) and nutrition (3.6%) (Figure 6).

Risks and Externalities

According to previous analysis (Kieft, et al.,1994), the ratio of unit price of product (millet)/unit price of inputs is not favorable for cereal complex (50/115) or urea (50/110) fertilizers. Only TPR with a unit price ratio of 50/38 produces positive economic returns. Also farmers are resistant to use TPR because the fine powder is difficult to apply and slow to release. Adding TPR to compost provides a potential alternative to farmers and should accelerate the release of P through microbial action with manure and through early dissolution. On-farm trials with TPR will begin this year and should provide data to test this hypothesis.

Given the rapidly expanding population and the market development of nontraditional uses for millet, there appears to be no risk of over production. Rather, the greater risk is of continued production shortfalls and food insecurity. In the short term, millet prices may rise. Over the intermediate term and longer term, the improved nutrient management practices and new production capacity should improve the food security, stabilize product prices, and nutrient balances of the farming ecology.

Conclusions

Food insecurity and environmental degradation are the stark reality in the Sahelian, Sudanan and sub-Sudan zones of West Africa. Population pressure is unrelenting. In this socio-economic context, millet farmers must become more efficient producers.

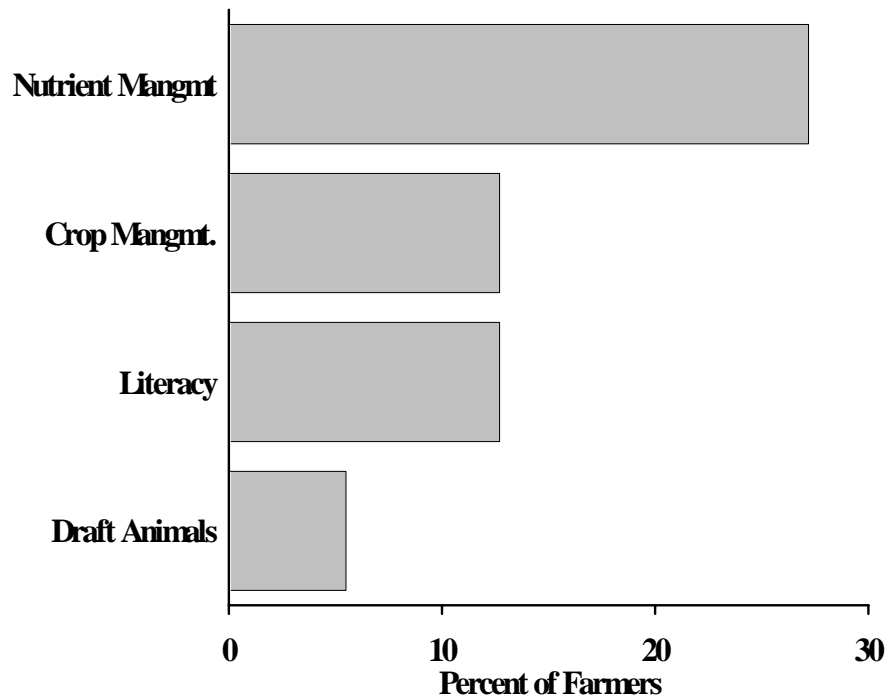


Figure 6. Most frequent types of training requested by farmers in the Segou region of Mali.

The strategy to substantially increase production of millet and cowpea is taking shape based on previous research in nutrient management, crop varieties, and early planting. Complementary research on processing, packaging, nontraditional or reformulated products and marketing holds the promise of adding substantially to the social and economic value of the region.

Government, industry, and farmer organizations operate without analytical tools or ready access to technical information. Traditional mechanisms of technology transfer and training are costly and therefore cannot be extended broadly throughout the region. The World Bank's model for Training and Visits (T&V) mobilizes local resources, but it can be made more effective with better analytical tools and research products, such as field-tested, nutrient balance sheets.

Each component of the agriculture-based system is preoccupied with its own concerns. One benefit of the baseline study was to serve as a catalyst sharing information across groups about areas of common interest. Integration of technical databases and shared contact information about who is doing what will help to strengthen the current system and create a basis for sustained food security and environmental protection.

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10. What proportion of the family millet does the family: consume?_____ % sell_____ %

11. When (how often) do you sell the millet you produce?_____

12. Do you plant millet in pure stand or in association with another crop or ground cover?_____

Decision making relating to land use

13. How do you determine if there is a problem with your crop? _____

14. How do you decide what corrective action is required?
what actions _____
comments _____

15. Where did you learn the techniques of corrective action (and crop management)?

16. What are the principal risks associated with the production of millet?

17. Who can help you, in case you have a problem with your crop?

18. What kinds of information do you use when making decisions about management of your land (soil)? _____

19. Where do you get technical information about crop management?

20. Do you help any neighbors with problems or management of their crop? How many? _____

21. How many neighbors help you with problems concerning your crop? _____

22. What kind of information is most important (most necessary) for making decisions about management of your soils? _____

23. When making a decision, do you do so alone or do you consult with others?
the family (wife) Yes ___ No ___
the community Yes ___ No ___
the industry Yes ___ No ___
other specialists Yes ___ No ___

24. When making decisions, do you evaluate and integrate information of different types and different sources (no, yes, if yes, explain)? _____

Social, Economic and Cultural Conditions

25. Number of persons in the family? _____

26. Male literacy? French: yes _____ no _____
 Bambara: yes _____ no _____

Female literacy? French: yes _____ no _____
 Bambara: yes _____ no _____

27. Years of schooling completed:

Male _____ yrs.

Female _____ yrs.

28. How many years of experience do you have in agriculture? _____ yrs.

29. Do you receive operational loans (credits)? Yes ___ No ___
If yes, what source? _____ interest rate _____

30. Do you have sufficient family labor (or do you need to look for labor outside the family)?
Yes ___ No ___
If yes, how many men? _____ how many women? _____

31. Do you apply fertilizer and/or other input for production of millet?
Yes ___ No ___

32. How many kilometers from your farm must you travel to purchase fertilizer? _____ km

33. What is the average price, maximum price and minimum price for each type of fertilizer:

| Type of fertilizer | Average Price | Maximum Price | Minimum Price |
|--------------------|---------------|---------------|---------------|
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

34. How many kilometers from your farm must you travel to sell your millet? _____ km

35. What is the average 12-month price, maximum price and minimum price for sale of millet?

| Average Price | Maximum Price | Minimum Price |
|---------------|---------------|---------------|
| _____ | _____ | _____ |

36. Have you received any training in agricultural production?

Yes ____ No ____

37. What kind of training/course would you like to have (is most necessary) in order to improve your agricultural production?

38. Do you sell your product independently or do you market your product in association with others (industry or a cooperative)? Yes ____ No ____ If yes, explain _____

39. Observations: (rate quality of the interview: 1=very good; 2=ok; 3=poor or questionable)
If rating is 3, explain _____

Draw a layout of your farm: (indicate total area, production area of principal crops, fallows, and features of the landscape)

Appendic B
Results for Farmers Surveyed in the Segou Region, Mali

The complete dataset of the survey results are included in a separate Acrobat Reader file (*.pdf) named "Mali_SurvResult.pdf".