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AN EVALUATION OF THE AGRICULTURAL TECHNICAL PACKAGES FOR THE REPUBLIC OF NIGER

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MAIN REPORT

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U.S. Agency for International Development

by

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LIST OF ABBREVIATIONS AND ACRONYMS

CFDT	Compagnie Française pour le Développement des Fibres Textiles (France)
CIVT	composite intervariétal de Tarna (millet variety)
COTEAR	Comité Technique d'Arrondissement
COTEDEP	Comité Technique Départemental
CPT	Centre de Perfectionnement Technique (farmer training center)
DANIDA	Danish International Development Agency (Denmark)
FAO	Food and Agriculture Organization of the United Nations
FLUPP	Forestry and Land-Use Planning Project
KHP	haini kiré précoce (millet variety)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFDC	International Fertilizer Development Center (U.S.A.)
INRAN	Institut National de Recherches Agronomiques du Niger
IPDR	Institut Pratique de Développement Rural, Kolo
IRAT	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (France)
IRSH	Institut de Recherche en Sciences Humaines
MDR	Ministère du Développement Rural
NDD	Niamey Department Development Project (in French: PPN - Projet Productivité Niamey)
ORSTOM	Office de la Recherche Scientifique et Technique Outre Mer (France)
UCA	unité de culture attelée (set of animal traction equipment)
UNCC	Union National de Crédit et de Coopération
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture

PREFACE

This report was prepared in response to terms of reference calling for an assessment of agricultural technical packages in Niger under a contract between the United States Agency For International Development (USAID) mission in Niger and Ithaca International Limited of Ithaca, New York. The terms of reference are found in Annex E.

A joint team of American consultants from Ithaca International Limited and Nigerien counterparts worked together in Niger from August 5 to 18, 1983. Documents having already been examined and preliminary contacts made by the American members, the joint team proceeded directly to field interviews with farmers in the Niamey Department. Most of these interviews were with farmers trained at farmer training centers (CPTs) of the Niamey Department Development Project (NDD), funded by USAID. Many additional discussions, however, were conducted with farmers in the same villages who had never participated in the CPT training courses. A preliminary set of conclusions and recommendations was drawn up in Niamey by the joint team, with the assistance of Mary Abrams and Trevor Sweetman of the NDD staff. This report was subsequently drafted by the Ithaca International Limited consultants, with the active participation of Seydou Yacouba.

The members of the joint team were:

Ithaca International Limited

John H. Eriksen, agricultural economist/team leader

Dan R. Aronson, social anthropologist

Steven A. Clarke, agronomist

Charles Steedman, economist

Republic of Niger

Assadek Algabit, agricultural planner/Ministry of Planning

Michel Keita, sociologist/Social Science Research Institute (IRSH)

Mamadou Ouattara, soil scientist/National Agronomic Research Institute of Niger (INRAN)

Seydou Yacouba, financial analyst/Ministry of Rural Development

Members of the team wish to express their gratitude to the large number of individuals, many of whose names are found in the list of contacts in Annex F, who devoted time and effort to assist the joint team in its task. We are particularly grateful to the Director General of the Niamey Department Development Project, his Niamey staff, the Directors of the CPT centers we visited, and to the former CPT trainees and their neighbors who readily consented to long interviews, often while they were working in their fields.

Ithaca, New York December 1983

INTRODUCTION

The joint team concentrated its investigations on conditions in Niamey Department, where USAID is directly involved in bringing technical packages to farmers. This occurs through the medium of the Niamey Department Development Project (NDD). The project is similar in concept to others financed by different donors in the Departments east of Niamey. They are all known as "Productivity Projects" because they attempt to increase the productivity of local agriculture through farmer training and wider use of technical packages. The validity of these packages is the question on which we have focused and the point at which our investigations began.

We did not undertake an evaluation of the NDD project, that having recently been done (122)[1]. We did, however, look closely at project activities and we interviewed about 15 percent of the farmers who have graduated from the project's training centers. The interviews, coupled with an examination of many recent reports on Nigerien agriculture and discussions with interested officials, have made clear that distinctions can readily be made between Niamey Department and the Departments of Dosso, Tahoua, Maradi and Zinder. At the same time there are a number of issues of current debate that affect all Departments. The body of this report will discuss these issues in more detail.

First, the differences. For several reasons, the observations and conclusions of this report should not necessarily be considered as valid in other parts of the country. The main reason is the dominant presence and closeness of Nigeria to the area on both sides of the national highway from Dosso in the west to Zinder in the east. The sheer economic size of Nigeria, both as a supplier of agricultural inputs and food grains and as a market for Nigerien output, makes this neighboring state a vital factor in any calculation. Fertilizers and cereals now move into Niger from Nigeria in considerable quantities. The attractiveness of these goods is a function of the subsidies currently paid by the Federal Government of Nigeria and of the Naira/CFA franc

[1]Reference is to the bibliography, Annex G.

exchange rate. How long the current set of factors, which encourage movements of food and fertilizer across the border, will endure is an open question. Continued permissiveness by the government of Nigeria will have one set of consequences for Nigerien agriculture. Shutting down border traffic in these goods will have quite another. It is true, of course, that these effects will ultimately be felt in Niamey Department as well as in Zinder and Maradi, but distance and other factors tend to mitigate and delay the impacts in the former.

Zinder and Maradi also differ from Niamey in that local markets are generally bigger, more varied, and more active. This is in part a consequence of the proximity of the biggest regional market of all, northern Nigeria. Furthermore, the kinds of farming systems and the land tenure arrangements found in Dosso, Maradi or Zinder differ from those in Niamey Department both for ecological and for cultural reasons. This is not necessarily just a distinction between Djerma in the west and Hausa in the east, though that is an important element.

Despite these differences, we found that there were a number of issues that concern agricultural activities on a national scale. In no particular order, these issues can be described as follows:

1. Package Concept

   Is it worthwhile to promote a complex technical package in Niger, where both the inputs themselves and timely advice on using them may be unavailable to the great majority of farmers? Under such conditions, can the most effective techniques be packaged in simplified form for wide utilization?

2. Seasonal Credit

   In 1980 the Nigerien government abolished seasonal credit. Farmers are no longer able to obtain seed and fertilizer on credit to be repaid after the harvest. Should it be reinstated?

3. Input Subsidies

Animal traction equipment, seed and fertilizer continue to be subsidized by the government. Do the benefits outweigh the costs? If not, should the subsidies be selectively reduced and gradually eliminated?

4. Improved Seed

There is much debate within Niger about whether the so-called improved varieties are actually superior to traditional local varieties. If they are, what kinds of gains have been made or can be expected by farmers? If they are not, what is the rationale for continuing to support a seed multiplication scheme?

5. Pure vs. mixed stands

The technical packages for millet and cowpeas recommend that they be grown in pure stands and in rotation rather than intercropped. The Nigerien farmer prefers to intercrop. Are there real agronomic and economic advantages to be derived from intercropping?

6. Adaptive Research

In theory, the National Agronomic Research Institute of Niger (INRAN) is responsible for adaptive crop research in each Department. In practice it does not have sufficient personnel and resources for the job. The Productivity Projects try to fill the gap. Under what conditions could adaptive research be formally decentralized to the projects with INRAN retaining general supervision?

7. Productivity Project Concept

Observers have generally concluded that despite massive injections of donor funding the Productivity Projects have failed to increase per hectare yields on any grand scale though they may have increased aggregate output. Is there a better way to use outside financing to help reach national goals in agriculture?

8. Farmer Training Model

The Productivity Projects rely on the farmer training centers as their primary method of improving agricultural practices. The disadvantages of this approach include removing farm families from their village setting for up to nine months, the relatively insignificant number of farmers trained in this fashion, and the cost per trained farmer. Is there a more effective way to do the job?

9. Land Fertility

For a number of years observers have been concerned about a long-term trend toward depletion of land fertility and soil exhaustion. This is seen to be caused by greater population pressure on the land, shorter fallow periods, and failure to restore nutrients taken from the soil in cropping. Is this trend as much cause for concern as some observers believe?

10. Intensification vs. Extensification

It is believed that higher crop production in recent years has come mainly from the extension of crop cultivation to poorer quality land in lower rainfall areas, rather than higher per hectare yields. In an apparent situation of growing land scarcity, the Government of Niger has opted to promote intensified agriculture. However, current policies and the promotion of the technical packages appear to encourage continued extensification. Is land scarcity a real problem? Is a policy choice between intensive and extensive agriculture necessary?

11. Land Use Planning

If agricultural crop land is becoming more scarce and its limits are in sight, what are the uses of land -- including irrigation and double cropping -- that will make best use of the resource?

No one should expect definitive answers to these questions from this report since most will be debated in Niger for years to come. Our investigation of the technical packages and of their use in Niamey Department in particular have suggested answers in some cases or an approach that may find these answers in others.

A discussion of the issues will be found in Chapters II, III and IV. A summary of the entire report, conclusions and recommendations are presented in Chapter I.

At this point we think it worthwhile to make some general observations. They provide a context in which the issues can be discussed. They also give an indication of some common elements that run through our conclusions and recommendations.

Most important, perhaps, is the observation that Niger's agriculture is based overwhelmingly on dryland crop cultivation, coupled with extensive livestock production, and is likely to remain so. The potential for irrigated cropping is geographically rather restricted and is relatively small. If successfully tapped -- an extremely complex, difficult and costly undertaking -- this potential could certainly contribute in an important but still marginal way to the rural economy of Niger. However, any significant transformation of Nigerien agriculture will have to be in dryland farming. Here too there are caveats. The natural resource base of the country is very poor. Small, unpredictable amounts of rainfall occur along a gradient which declines rapidly from the southern border northward to the desert (see Figure 1). Niger is definitely not the Indian subcontinent nor is it even southern Mali or Chad, where the potential for dryland agriculture is much higher.

It is not out of the question that new varieties of millet, sorghum, cowpeas and peanuts can be developed that would be a great improvement over current varieties. They may be available for use in Niger in the next 10 to 20 years but probably not sooner. If soil fertility has been maintained or even improved and if adequate structures are in place, such a breakthrough could be significant. Even so, and this is the major point, because of Niger's fragile resource base, the total impact is likely to be limited. The better farms, which now get excellent yields in Nigerien terms of one ton or slightly more of millet per hectare, could double them. Average yields on farms

would, however, still remain at lower levels. It would be unrealistic to expect, and unwise to plan on, more substantial yield gains than this in the foreseeable future.

A second general observation flows from the first. Given this general order of potential in the next two or three decades, the overall goal of Nigerien agriculture must continue to be sustained, reliable production at the lowest possible levels of cost and risk. Sustained, reliable production means finding ways to harvest and retain an adequate foodgrain crop, even in years of low or uneven rainfall. Lowest possible cost essentially means reducing labor inputs per unit of output while maintaining production on a stable and minimal land base. This will permit regeneration of soil fertility and increase yields both per hectare and per labor unit in the long run.

A final observation underlines the importance of finding an answer soon to an issue raised above. There is a clear need for land-use planning in Niger. Questions now being posed by many observers cannot be answered until there exists an adequate data base for detailed analyses and decision-making on land allocation and management issues. The growing competition between crops, forestry and livestock for land, the potential for irrigated agriculture, the interactions that come under the headings of agroforestry and mixed farming; these matters cannot be adequately examined given the land-use data currently available. USAID's Forestry and Land-Use Planning Project (FLUPP) is working on a system for gathering this informatio . We consider this task to be very important for Niger's future.

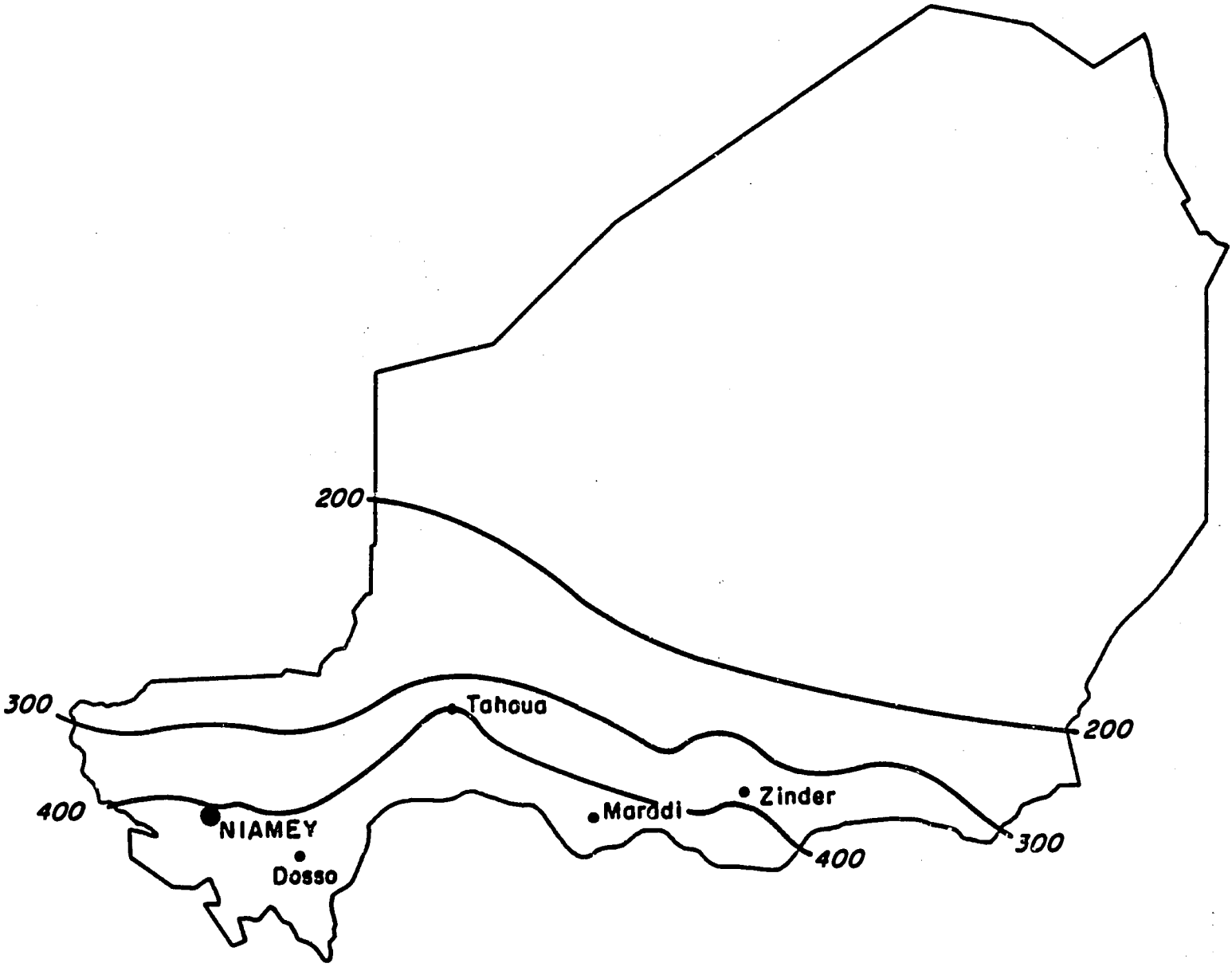

FIGURE I. AVERAGE ANNUAL RAINFALL ISOHYETS FOR THE REPUBLIC OF NIGER

SOURCE: Atlas du Niger, les atlas jeune afrique, Editions Jeune Afrique (1980) Paris

CHAPTER I

CHAPTER I

A. INTRODUCTION

This chapter provides the reader with a summary of the report. The summary and conclusions section follows the chapter sequence, beginning with the agronomic appraisal and ending with the contributions of the Nigerien members of the team. The final section of the chapter sets forth the team's recommendations.

B. SUMMARY AND CONCLUSIONS

1. In the period since the Republic of Niger gained independence, agricultural innovations proposed for the country have largely been based on the results of agricultural station trials or extrapolations from trials in other countries. Relatively little research was conducted under actual farm conditions. Nor did the research that was conducted seem to take farmers' real needs into consideration. The resulting agronomic recommendations were assembled as "technical packages" and have been promoted for several years through the Agricultural Service and various "Productivity Projects".

2. The packages for the most important crops -- millet, sorghum, cowpeas and peanuts -- had certain characteristics. They:

a. tended to assume that crops should be grown in pure stands rather than in association with other crops,

b. did not take into account the significant heterogeneity in Nigerien farming conditions,

c. were aimed at maximizing crop yields per hectare rather than maximizing labor productivity or minimizing risk for the farmer or stabilizing yields over time,

d. were presented as firm recommendations from which little deviation was expected and for which no modifications were envisaged in the course of the crop cycle,

e. assumed that those who used the recommendations would be full-time farmers with considerable access to land, labor and capital, and

f. assumed that users would be willing and able to market a large percentage of their crop each year.

3. The technical packages have remained relatively unchanged since they were formulated several years ago despite the fact that field personnel and others have called portions of them into question with increasing frequency (see 122, pp. 96-7 and 148, annex F, pp. 34-6.) The packages, with their lack of differentiation and their insistence on such practices as pure stands and the use of row tracers, continue to be taught to new agricultural field agents at the Rural Development Training Institute (IPDR) at Kolo and to farmers themselves at the farmer training centers (CPTs).

4. Our agronomic, financial and economic appraisals of the main packages have led us to a set of conclusions suggesting both modifications to the packages themselves and a different approach to the Nigerien farmer, on whom success of the program for food self-sufficiency depends. The conclusions of the agronomic appraisal are set forth in paragraph 5 below; those of the financial and economic appraisal are in paragraph 6. Conclusions regarding constraints to the spread of viable technical packages are found in paragraph 7.

5. <u>Agronomic Appraisal</u>

a. The use of one single package per crop for all of Niger, or even for all of Niamey Department, is not viable. Many of the recommended practices are highly location-specific, e.g. fertilizer rates, plant density, variety selection, types of animals for cultivation. They should be modified or refined as a function of such variables as rainfall, soil type, farm size and labor availability.

b. The packages should be divisible. The all-or-nothing approach is neither necessary nor effective. As field personnel are increasingly realizing and as farmers are

demonstrating, farmers need to be able to choose components without having to take the whole package. The entire package is in fact highly complex, expensive to implement, and risky for the farmer. Smaller, simpler combinations, designed to take advantage of the positive interactions of components, seem to be more suitable.

c. A range of choices or options should be built into most components of the packages. Those who promote the recommendations should seek to impart the reasons and scientific principles behind them. This will provide farmers with a base of knowledge on which to make adjustments to suit their own situations.

d. The packages do not contain, nor do the training institutions teach, "fall-back" strategies for farmers. For example, a farmer whose stand of millet is poor despite repeated replantings in a year of below-average rainfall needs to know whether he should make a second urea application or not. If it should be applied, what rate should he use? There is far too little emphasis on solving such practical problems as they occur.

e. Even if the packages are fully applied and rainfall is generally good, success is not assured. The crop may disappoint because of lack of rain in the locality, physical or chemical problems in the soil or damage from birds, insects or disease.

f. The packages do, however, contain components that can increase yields. As examples of this, the CPT fields and some trainee fields seen in August 1983 had more uniform and vigorous stands and were showing much higher yield potential than neighboring fields. The range of yields obtained in the demonstration villages of IPDR Kolo illustrates both the problems that can arise and the potential that exists when conditions are good. Using the recommended package with CIVT variety millet,

demonstration farmers in nine villages obtained from 570 to 1,600 kg per hectare in 1982. Thirteen fields of cowpeas ranged in yield from 274 to 1,460 kg per hectare.

g. Given access to the necessary inputs, primarily seed and fertilizer, to seasonal credit that can be repaid in kind, and to good prices, farmers in Niger have responded with enthusiasm to components of the packages. Contract growers working with the Seed Multiplication Center at Hamdallaye have demonstrated this. The area under contract production has increased dramatically from 143 to 1,875 hectares in the past three years. In an area that received less than 400 mm of rainfall in 1982, contract growers obtained yields averaging about 650 kg per hectare, almost 100 kg more than the average yield obtained at the Center. This was accomplished <u>without animal traction</u>, without imposing the entire package and with only a three-day training session.

h. Nigerien farmers are natural experimenters and know best what is relevant to their own circumstances. They are a unique and valuable resource that has hardly been tapped. They should be integrated more into the research and development process.

i. A major characteristic of crop production in Niger is the great heterogeneity which exists within and between fields. The variability within a field is often enormous, highly productive alternating with highly unproductive areas. One hill of millet may have green, vigorously growing plants while an adjacent hill has pale, stunted or few plants. Until more is known about what happens in the micro-environment of the hill, potential yield improvements are limited. The complex and little understood problem of stand establishment deserves high priority for research.

j. Little effort has been devoted to developing and adapting animal traction implements for Nigerien conditions. Donkey traction seems to have been ignored in favor of oxen traction, but financial and economic analysis (see pp. 19-22) reveals the advantages of the former under certain conditions.

k. Conclusions with regard to SPECIFIC COMPONENTS of the packages:

(1) Crop Regime. The packages recommend cropping in pure stands primarily because until recently no research had been done on intercrop systems. However, the traditional intercropping of millet and cowpeas in Niger is compatible with the rest of the technical package, including interrow cultivation by oxen or donkeys.

(2) Land Preparation. Because of the fragility and erosivity of Niger's soils, extreme care should be taken in deciding what material to remove in preparing land for crop production. It is doubtful that clearing fields of all surface debris is necessary or wise. There are striking cases of substantial wind erosion in northern sections of Niamey Department.

(3) Soil Preparation. Light, superficial pre-plant tillage by scarification can be beneficial. It increases moisture penetration and incorporates phosphate fertilizers and organic matter into the soil. In some sandy soils and at certain times, however, scarification can increase risk of erosion.

(4) Varietal Selection. There is no single millet variety that is superior under all conditions. Improved local varieties will not provide substantial changes in performance but will show yield stability and reliability characteristics. The new cereal varieties have been higher yielding on

research stations but data on off-station tests are very limited. Early-maturing cereal varieties may be prone to bird damage.

(5) Seed Selection. Use of the term "selected seed" hides the fact that there are two important factors in the preparation of good seed: genetic purity and physical purity. Poor seed quality may be one of the elements causing the problem of stand establishment.

(6) Seed Treatment. This recommendation is very simple and inexpensive to implement. It is the only one whose use is already widespread.

(7) Planting Date. Experience confirms that planting millet immediately after the first significant rain is a sound practice. Late planting of traditional millet varieties generally produces lower yields. Early planting of early-maturing varieties, on the other hand, may lead to serious pest problems. Sequential plantings or using varieties of different maturities may be the best strategy for minimizing risk.

(8) Seeding Rate and Plant Spacing. Over a rather wide range of plant density, millet can produce maximum yields. The recommended density of 10,000 hills per hectare for millet can in fact be varied considerably depending on variety and site.

(9) Row Tracer. This recommendation is time-consuming and the least cost effective of all the recommended practices. There are less onerous ways for the farmer to ensure that he will be able to cultivate between the rows with oxen in one, if not two, directions.

(10) Thinning. Strict adherence to a given number of hills or of plants per hill is unnecessary. If thinning millet to three plants per hill is a guideline, it is viable agronomically. If it is

considered a hard-and-fast rule, it is not viable. Rapid, selective thinning in conjunction with weeding is preferable. To reduce the need for thinning to a minimum would be an important labor-saving achievement.

(11) Weeding/Cultivation. The importance of timely and frequent weeding is recognized by farmer and agronomist alike. Early weeding, as recommended in the millet package, seems sound agronomically. The recommended times for weeding would better be taken as flexible guidelines rather than as rigid rules. Advice on time of weeding might be related more usefully to what is happening in the environment.

(12) Replanting. This seems to be a viable practice and it is widespread in Niger. Reseeding at the time of first cultivation is a sound practice.

(13) Crop Fertilization. There is now considerable evidence to show not only that Niger's soils are generally deficient in nitrogen and phosphorus but also that crops grown on them are quite responsive to organic and inorganic applications of these elements. Local as well as new crop varieties are responsive to increased soil fertility. The mechanics of fertilizer application are important. Fertilizer nitrogen left unincorporated on the surface tends to volatilize. A side dressing of urea, placed a short distance from plants or rows and immediately incorporated, is preferable. The immobility of phosphorus in soils may produce a delayed effect and explain the apparent lack of response on some former trainees' fields. Research to clarify the effects of fertilizers used under actual farm conditions and of various methods of fertilizer application on Nigerien soils should be

given priority. Inorganic fertilizers can play a major role in increasing crop yields substantially in Niger, but much depends on the use of proper techniques.

6. Financial and Economic Appraisal

CROP ENTERPRISE BUDGETS have been developed for four crops -- millet, sorghum, cowpeas and peanuts -- to test the financial and economic viability of the current technical packages in Niamey Department. For each crop separate budgets were calculated for three different farm sizes. For each farm size a budget was developed according to whether the farmer (a) uses traditional technology or (b) adopts only a part of the package or (c) uses the full package with ox traction or (d) uses the full package with donkey traction. The three farm types multiplied by the four levels of package adoption resulted in 12 budgets. The number was doubled by calculating a set for farms in the portion of Niamey Department that on average receives less than 400 mm of rainfall and a set for farms receiving more than 400 mm. The 24 resulting budgets became 48 when one set was calculated using financial prices -- i.e. actual prices faced by farmers in 1983 -- and a second set was developed using economic prices -- i.e. prices adjusted to remove subsidies and to reflect real costs of production or importation. The results may be summarized for each crop as follows.

a. Millet. This crop is the centerpiece of all agricultural production in Niger and even more so in Niamey Department, where it accounts for almost 80 percent of gross weight of agricultural produce. We believe that most farm families have a primary objective to produce enough millet to satisfy the family's annual needs. They devote land and labor to other crops only to the extent that it will not hinder them from producing enough millet. In modern agricultural terms, current millet production techniques are highly inefficient and

therefore tie up large quantities of land and labor. Operator and labor management returns per hectare are negative for millet production under all conditions.

(1) "Traditional" millet production in Niamey Department, using no part of the technical package, is financially less rewarding to the farmer than hiring himself out as a day laborer. His effective wage rate growing millet is approximately 410 CFA francs per day, compared to the 1,000 CFA francs he would earn in the south and 750 CFA francs in the north as a day laborer. However, the uncertainties of the local labor and grain markets make opting out of millet production altogether a risky proposition.

(2) "Partial adoption" of the millet package -- all components but animal traction -- is financially more rewarding for the farmer, though riskier since he must sell a larger portion of his crop to recoup expenses. If the package is used properly and the season reasonably good, the farmer in the south of Niamey Department will be able to retain over 300 kg more millet per hectare after covering expenses than will his traditional neighbor. In the north the farmer gains about 100 kg per hectare.

(3) Applying <u>economic rather than financial</u> prices, one finds that effective wage rates per man day <u>drop below</u> those for traditional production. If economic prices were in effect, the farmer using the partial package would incur even larger losses of potential income from outside jobs than his traditional neighbor while also running higher risk. In the north a farmer would have to sell about 90 percent of his crop to recover costs.

(4) Under financial price assumptions, farmers adopting the <u>full package</u> make considerable gains. Effective wage rates rise to about 900 CFA francs per

man-day in the south and to over 600 CFA francs in the north with donkey traction. Overall, results for donkey traction are slightly better than for oxen. Interestingly, the amount of millet to be retained after expenses is higher than for the partial package in the south but is lower in the north. There is also a scale effect that benefits the larger farms.

(5) With economic prices, however, almost all farms using the full package have results that are worse than those from the traditional system. The sole exception is millet production using donkey traction in the south.

b. Sorghum. This is a relatively minor crop in Niamey Department, occupying only about one-tenth of the land devoted to millet. It is usually planted on better land in higher rainfall areas. Given sorghum's more demanding nature, it does not compete with millet on most of the land planted to the latter. It should properly be considered as a complementary crop to millet rather than as competing with it for resources.

(1) Grown traditionally, sorghum is more profitable than millet. The effective wage rate is 16 to 22 percent higher, and higher yields enable the farmer to retain more of the crop. Slightly more labor is required for sorghum, however, and this renders operator labor and management returns per hectare even more negative than for millet.

(2) For adopters of the partial sorghum package, the crop is more profitable than millet when financial prices are used. If the farmer were obliged to pay economic prices, however, sorghum would be less profitable using the partial package than it would be using traditional methods.

(3) The farmer adopting the full package and facing financial prices would make substantial gains compared either to millet or to sorghum production using less than the full package. Operator labor and management returns per hectare are positive for the first time. The benefit/cost ratios are also greater than one for the first time. Donkey power is slightly more profitable than oxen.

(4) Even under economic prices, full package adoption for sorghum in the south is superior to either partial adoption or the traditional methods. In the north the full package is inferior to the two alternatives except that returns from donkey traction are marginally better than those for the partial package. The full package for sorghum is superior to that for millet in every way when economic prices are used.

c. Cowpeas. Peanuts and cowpeas are the Nigerien farmer's principal cash crops. Both also produce forages high in protein which serve as an important dry season livestock feed. The value of the forage is often overlooked in crop analyses.

(1) Grown traditionally, cowpeas are usually intercropped with millet. Our budgets calculated the contribution of this crop to the millet/cowpea association. All indicators are highly favorable in both north and south. The farmer can make considerably more income from cowpea production than from the same effort as a day laborer. Effective wage rates per man day are approximately six times higher for cowpeas than for millet.

(2) The adoption of the partial cowpea package is attractive when evaluated at financial prices, though somewhat less so for some indicators than when grown with traditional methods. This is

largely because cowpeas would be grown in sole stands in the former case. Under economic prices, the profitabilities of the partial package drop significantly but remain positive.

(3) The preferred method of cowpea production is adoption of the full package. This conclusion holds at both financial and economic prices. Benefit/cost ratios range from 2.2 to 3.0 for the former and from 1.7 to 2.4 for the latter.

d. Peanuts. Once the principal cash crop, peanuts must now be classified as a minor crop both in Niamey Department and in the country as a whole. Less than one percent of the cultivated land is planted to peanuts. The clear preference that Nigerien farmers show for cowpeas over peanuts is somewhat inexplicable in light of our calculations, unless it is because cowpeas produce more forage per hectare.

(1) Unlike cowpeas, peanuts are grown in sole stands when farmers use traditional methods. The indicators show that peanuts are much superior to millet or sorghum in profitability to the farmer. Benefit/cost ratios are significantly greater than one for all cases.

(2) With partial adoption of the peanut package, profitabilities are essentially the same as they are for cowpeas under similar circumstances.

(3) The results for the full package also approximate those for cowpeas at financial and economic prices.

e. Maize. Although no budgets were developed for maize, the team's field observations lead to the following conclusions about the crop.

(1) Requiring higher rainfall, better soils and heavy manuring, maize would compete only with sorghum.

(2) Maize may do well under irrigated conditions but is not adapted for extensive use under dryland conditions in Niger because its root system makes it more subject to moisture stress than millet or sorghum.

(3) It appears that Nigeria can easily supply the potential market for maize as a foodgrain in Niger.

The crop enterprise budgets discussed above reveal that, under the assumptions used by the team, millet and sorghum often have costs that exceed their benefits. Conversely, cowpeas and peanuts contribute to farm revenues in excess of their enterprise costs. What is the picture from the perspective of the farm as a whole? We developed WHOLE FARM BUDGETS for this purpose. These budgets were calculated for three farm types, for the northern and southern portions of Niamey Department and for either oxen or donkey traction, a total of 12 budgets. The results may be summarized as follows.

With <u>financial prices</u>:

a. From their net receipts, all 12 farm operations can meet the basic objectives of (1) amortizing equipment and draft animals, (2) paying the opportunity costs of family labor, (3) making annual payments for equipment and draft animal loans, and (4) providing an adequate return on the farm's equity capital.

b. Overall profitability increases considerably as one moves from the smaller Type I to the larger Type III farm.

c. Farms using donkeys have higher returns than those using oxen.

d. However, only 7 of the 12 farm operations evaluated in financial terms could meet all their objectives <u>without</u> off-farm rental of the farm's donkey or ox cart.

With economic prices:

a. Only in the case of Farm Type III in the north using a donkey does a farm come close to satisfying its objectives without renting its cart.

b. In four cases (Type I and II farms with oxen in both north and south) objectives cannot be met even with cart rental receipts.

7. Constraints

a. At the farm level. From the farmer's viewpoint there are three key questions that he must consider when assessing the technical packages. These are: (1) to farm or not to farm? (2) food crops or cash crops? and (3) sure things or risks? Under the first the farmer has to consider how the returns to be expected this year from his own farm measure up against anticipated wages as a laborer on other farms, in the city or in neighboring countries. As our financial analysis has shown, the latter is in many cases more attractive. In considering whether to devote land and labor to food or cash crops, the farmer correctly gives top priority to growing as much of the family's basic food supply as possible on his own farm. This means that unproven technical packages cannot be used for experiments on the central family fields. Finally, the farmer's aversion to risk means that he uses strategies and methods that not only do not put his food crop at risk but also help insure that some parts of a field or one of the crops on it will succeed even if the rest fails. Further, he knows that relying on commodity markets for food or labor can entail huge risks if he fails to produce any trade goods.

b. Niamey Department farmers. Since the farmer training center (CPT) is a preferred mechanism for transferring technical packages to farmers in Niger, the team interviewed some 30 former CPT trainees in the

Niamey Department. The interviews revealed a common set of problems faced by the former trainees as they try to use the techniques they have learned.

(1) Trainees tend to be young married men with small families who have some fields of their own but also work on family fields or who are independent and without large holdings.

(2) Once back in his village the trainee often finds himself and his family in difficult straits for a number of reasons. He has only the grain he brought back from the CPT to feed the family; often it will not last until the next harvest. He may not have received all of the equipment he was taught to use. One of his oxen may be too feeble to work when the rains come or may even have died. He cannot obtain fertilizer for credit and has to use any cash reserves for food. Nor can he obtain selected seed on credit. In many cases the recommended seed is not available; this has been true for cowpea seed in Niamey Department. When the rains approach the trainee knows he cannot apply the techniques he was taught, and his choices narrow. He may abandon agriculture for the time being or apply part of the package on part of his land.

(3) The former trainees we interviewed revealed that the technical packages were seldom being applied on more than one hectare out of three or four. Most used the packages, as one might expect, on an unmanured bush field hundreds of meters from their house. They are engaged in on-farm experimentation rather than in demonstration, as the Productivity Projects would have it. These farmers are con vinced of the advantages of inorganic fertilizer when there is adequate rainfall. For many it is the single most important input they wish to use.

They are disappointed and even angry that they cannot get it because there is no seasonal credit. Those who buy fertilizer with cash usually use less than the recommended dose.

(4) At the farm level the basic constraints lie outside the farmer's control. First, the institutional apparatus that could routinely deliver and service the new technology is still in its infancy. Second, the former trainees find that the packages are too integrated for them in their situations, as we have mentioned above (see paragraph 5(b).) But they cannot disaggregate the packages themselves and have been taught no alternative strategies. In many cases follow-up by extension agents has been non-existent or ineffective. Third, they lack working capital. Under these circumstances they may not be expected to risk unfulfillment of immediate needs for higher crop yields at some later date.

(5) When villages have chosen their CPT candidates with care and actively seek advice from the former-trainees, there may be some demonstration effect. However, in Djerma Niger there is a reluctance to take too much obvious uninvited interest in a neighbor's affairs. Combined with the fact that many former trainees do not yet have much to show, this raises the question of the effectiveness of the farmer training center model.

c. <u>Constraints at the Departmental and National levels</u>. There is an evident dearth of Agriculture Service personnel in Niamey Department. The problem is complicated by the presence of other government agencies in the field, such as UNCC, operating under different mandates. There are technical committees designed to coordinate the various strands of government action at

different levels, but skimpy operating budgets, lack of vehicles and few agents of any kind in the villages all conspire to make the system ineffective. The question that is being asked increasingly is whether the "agro-bureaucracy" is siphoning off resources that would better be applied at the farm and village levels. The lack of self-managed, viable village organizations prevents such a transfer from taking place. The vacuum may never be filled until villagers are taught to keep the books and manage their own cooperative as a village enterprise. Literacy in local languages will be required to make this happen.

In fact, there is already a high level of agreement on many of these issues between Nigerien technicians and foreign analysts. This agreement at the technical level needs to be acted upon by the Government of Niger with the active counsel of donor organizations so that a new approach to rural development can be fashioned.

8. Nigerien Team Member Reports

a. Sociological Summary. Interviews with former CPT trainees and with other villagers led to the conclusions discussed in paragraph 7(b) above. The farmers interviewed faced numerous difficulties on return to their villages. They were frustrated by the need to raise cash to feed their families on the one hand while being unable to obtain the recommended inputs for credit on the other.

b. Constraints. In addition to the constraints imposed by a capricious climate and the poor soils found in part of Niamey Department, there are administrative and technical constraints to consider. The integrated teams of field agents are not in fact operational. The technical

skills of the agents also leave something to be desired. They should be better able to advise farmers and explain techniques to them. At the same time, the concept of autoencadrement (trained villagers teaching their neighbors) is not yet a reality. The technical packages themselves need to be made more flexible and should be adapted to different zones, as discussed in paragraph 5(a)-(d) above. By the same token, more flexibility should be introduced into the CPT training programs. Trainees would profit from learning how to keep records on their farming operations so as to develop an idea of the returns to their labor, land and capital. Short-term training sessions would also be worthwhile. Once back on their farms, trainees are constrained, as indicated above, by the need to pay cash for inputs during the soudure period when food is scarce. They are also frustrated by delays in the delivery of inputs such as selected seed.

c. Soils of Niamey Department. In general the soils used for dryland agriculture in Niamey Department can be characterized as sandy, poor in organic matter, having low cation exchange capability, moderately to heavily acidic, poor in potassium and phosphorus, and weak in water-retention capacity. The degredation and erosivity of these soils under continuous cropping will soon constitute a major problem. To improve soil structure and overall quality the incorporation of more organic matter is required. Fertilizer trials have demonstrated a strong response on the part of millet to nitrogen and phosphorus. Agronomic research also indicates that lower plant densities are to be recommended for the drier northern zone and higher densities for the south. Details will be found in Annex D. Despite the relatively poor quality of the Department's soils, the combined

fertilizer and agronomic components of the technical packages seem to allow for significant increases in millet yields on these soils.

C. RECOMMENDATIONS

We wish to restate and emphasize here an observation made in the Introduction to the report. Niger's agriculture is overwhelmingly dryland agriculture and is likely to remain so. For this reason the team focussed its efforts on the dryland crops, particularly millet, the most important of all. We believe it would be a mistake to think that heavy capital investment in irrigation projects would solve Niger's agricultural problems. On the contrary, experience in Mali at the Office du Niger and in Senegal on the Senegal River delta has shown that ambitious irrigation schemes tend to provide very little return for substantial investment. In the Gambia and Senegal River Basins in recent years irrigated areas have been falling into disuse at about the same rate as new areas are irrigated.

Nor would it be prudent to encourage migration from Niger's rural areas to the sites of future irrigation complexes. The expectations thus raised may be sorely disappointed, and dryland agriculture would suffer as a consequence.

We believe that for the foreseeable future primary attention should be given to dryland agriculture in order to make those marginal gains in production, incomes and nutritional status that are possible. The gains are not spectacular but they are attainable and reasonable. Incentives should be created to increase the production and marketing of dryland crops. They should not be instituted to lure people away from these crops toward some chimerical future in irrigation. Accordingly, the recommendations that follow assume that the appropriate concern of the Government of Niger and donor organizations is on how to obtain maximum returns from interventions in the dryland sector.

The recommendations are addressed to three recipients: the Government of Niger and its research institutions, the Niamey Department Development Project, and USAID Niger.

FOR THE GOVERNMENT OF NIGER AND ITS RESEARCH INSTITUTIONS

1. Technical Packages.
   a. The technical packages should be made more flexible so that different combinations can be recommended for different zones. As a start, Niamey Department should be divided into northern and southern zones with distinct packages for each.
   b. More emphasis should be placed initially on the components of the packages that have proven their value and do not demand large investments from the farmer. These components would include the use of better seed (improved varieties with genetic and physical purity maintained), fungicide treatment, planting and weeding at appropriate times, and the use of organic and mineral fertilizers.
   c. INRAN, the Ministry of Rural Development and the NDD project should collaborate on determining the precise details of the simpler zonal packages so that the packages can be taught to trainees at the CPTs and be extended by field agents.
   d. In conducting research on the simpler zonal packages, INRAN and the NDD project should develop basic fall-back strategies to compensate either for a farmer's failure to perform an agricultural operation in timely fashion or for deviations in the rainfall pattern.

2. INRAN's Research Program. INRAN should:
   a. Focus fertilizer research on the mechanics of application (e.g. timing, method, placement, formulation) so as to maximize nutrient uptake by plants while taking into account labor costs, cultural practices and other important variables in the farming system. See Chapter II, section B.13.

b. Study specific on-farm soil-related problems as referred by MDR or Productivity Projects, using the Soil Testing Laboratory. This is likely to increase package adoption, improve extension agents' capabilities and credibility with farmers, provide valuable feedback to research scientists, and orient future soils research.

c. Conduct research on intercropping to determine its compatibility with the technical packages and its profitability.

d. In collaboration with the seed multiplication project, determine procedures for maintaining physical quality and generic purity of seed, both traditional and new varieties of millet, sorghum and cowpeas. Purity should be sought at the farm level as well as at the seed multiplication centers. Issues to be addressed include:

   (1) the effect of seedlots of different quality on crop performance;

   (2) procedures for purifying and maintaining purity of traditional varieties;

   (3) storage practices, especially for cowpea seed;

   (4) procedures for removal of chibras in millet;

   (5) pre- versus post-harvest selection of seed. See Chapter II, section B.5.

e. Study the complex of factors involved in stand establishment and test ways of improving crop stands.

f. Research alternatives to use of the row tracer. The objective is to attain uniform stands of optimal plant density that require minimal thinning and replanting.

g. Initiate a research program on the concepts and management practices associated with agro-forestry.

h. Seek alternatives to the use of animal-drawn implements in such tillage operations as scarification and weeding.

i. Focus animal traction research on donkey as well as on ox traction, developing as a matter of priority sturdier and better adapted donkey-drawn implements.

j. Experiment with various control measures, including pesticides, to develop ways to reduce field losses caused by insects and other pests.

k. Refine fertilizer recommendations by crop and by zone so that the recommended dosage is the most efficient one in the farmer's circumstances.

3. Farming Systems Research. The following questions deserve examination:

a. How to increase the productivity of farm labor either by stabilizing yields while reducing man-days or by increasing yields while stabilizing man-days.

b. The advantages and disadvantages of spreading out maturity dates for a millet crop compared to having all millet plants in a field mature at the same time.

c. The financial and economic profitability of alternatives to mechanical weeding such as a herbicide treatment at the start of the crop season.

d. The amount of grain that can be saved under actual farm conditions by avoiding losses due to birds, chibras, striga, downy mildew, earhead caterpillars and other pests.

FOR THE NIAMEY DEPARTMENT DEVELOPMENT PROJECT

1. The CPT Training Program. The NDD project should consider making significant modifications to the present

CPT training program. As simpler, more flexible zonal packages are introduced in Niamey Department, the training program should be modified:

a. To include short training sessions for groups of farmers to introduce them to simple techniques such as composting, or the mechanics of fertilizer application, or seed selection and treatment. Short programs could be scheduled during the dry season to avoid conflicts with the crop calendar. If at a given session all trainees came from the same village, the CPT technical staff would improve its knowledge of farming conditions in that village and the trainees would be able to reinforce each other in the village.

b. To establish mobile training teams to take training to the villages and provide refresher courses for former trainees. If conducted during the crop season, these short sessions would give CPT staff the chance to see how former trainees were faring on their own fields.

c. To create demonstration fields in villages close to the CPT to permit skeptical villagers to see the same good results that have convinced trainees at the CPT itself.

d. To introduce training in soil conservation and soil improvement techniques with an emphasis on the use of agro-forestry precepts such as the advantages of Gao trees and windbreaks.

e. To teach simple record keeping at the farm level. Literacy in local languages should be taught at the CPT to allow farmers to keep track of inputs and outputs using familiar terms and units of measurement. See Belloncle (16) for ways to implement practical, relevant literacy programs.

2. Seasonal Credit. If there is to be no national program providing seasonal credit for the 1984-85 crop year, the NDD project should consider establishing one for its former trainees, at least on a trial basis. This would allow them to obtain the seed and fertilizer they have been taught to use. The former trainees, now at a disadvantage compared to seed multiplication contract farmers, would thus be on equal footing. Repayment of the credit should be permitted in kind at harvest time. This would provide the CPTs with an additional source of grain to be allocated to the graduating class.

3. Applied Research. Reinforcement of NDD's applied research program is needed to permit adequate project participation in the proposed modification of technical packages. Additional staff will be required to increase the number of on-farm trials and for farming systems research. The project's capacity for applied research should be strengthened by choosing an individual with a graduate degree in agronomy to replace the staff agronomist on her departure.

4. Farming Systems Research. A farming systems research unit should be established. It might consist of two agronomists, a sociologist and an economist. The mandate of the unit should be:
   a. To give the NDD project a better understanding of the differences in farm-level opportunities and constraints between northern and southern zones of the Department; and
   b. To help the project mesh its research, training, and monitoring/evaluation activities so as to improve the productivity and output of the Niamey Department farmer.

5. Monitoring/Evaluation. This unit should be reinforced so that farm level surveys are conducted during the 1984-85 crop year. It requires strengthening in middle-level staff and in secretarial services.

6. Input Supply. The project should assume greater responsibility for ensuring an adequate and timely supply of agricultural inputs to the farmer. It is not clear how this can be accomplished, but the project should give high priority to this matter and work with other agencies such as the Centrale d'Approvisionnement to improve the distribution of seed and fertilizer.

FOR USAID NIGER

1. FEED Project. The Farm Equipment Enterprise Development Project should emphasize design and testing of animal traction equipment rather than production of current models. Considerable work remains to be done on the adaption of implements to local soils and conditions. Models that are enjoying success under somewhat similar circumstances in nieghboring countries, such as the houe Manga in Upper Volta, have never been adequately tested in Niger. Models from further afield, Asia perhaps, could be imported and tested. As indicated above under the INRAN recommendations, there is a particular need for work on the donkey traction implements since the houe asine is clearly inadequate for the task. USAID could make a valuable contribution in this matter through the FEED project or even apart from it.

2. Seed Multiplication. Continued support of the seed multiplication component of the Agricultural Production Support Project (APS) is strongly warranted, even if the cost of a unit of "certified" seed is considered to be very high. The reasons are:

a. Though it is not the primary purpose, the seed multiplication program provides one model for disseminating improved practices and increasing crop yields.

b. The seed multiplication centers are a valuable source of information and of input supply to local farmers. The farmers in turn are a source of information to agricultural research and extension personnel on the use of new practices.

c. The centers are an investment for the future. If plant breeders achieve a break-through in developing high-yielding varieties and even hybrids, it will be essential to have such a structure in place to maintain purity.

CHAPTER II

AN AGRONOMIC APPRAISAL OF THE AGRICULTURAL TECHNICAL PACKAGES IN NIGER

A. INTRODUCTION

The agricultural technical packages for the six major crops in Niger are defined and described in Annex A. These crops are millet, sorghum, cowpeas, peanuts (i.e. groundnuts), maize and cotton. There is some debate within Niger on the specific elements of each of these packages. For one thing, the two principal sources we have used (i.e. INRAN's Fiches Techniques (71) and the series of Agriculture Speciale (125 to 133) authored by Santens of IPDR/Kolo) are not totally consistent. Where conflicts or differences in recommendations occur between these sources, we have adopted the INRAN text as definitive. A second source of discrepancy arises from the fact that extension and project personnel in some cases have interpreted various elements differently from what seems to have been originally intended, and with field experimentation, the packages have been modified by the Productivity Projects. Hence, defining the packages has not been the simple and straightforward task we expected. Nevertheless, we have attempted to arrive at a reasonable concensus on each package, while realizing that certain components, as we have defined them, may still be subject to debate.

According to the most recent agricultural statistics available in Niger (41), the six crops mentioned above accounted for more than 98 percent of the total area cropped in 1980 (i.e. 5,240,393 hectares). The actual physical area producing these crops was only 3,552,330 hectares, or 68 percent of the total cropped area, because of the widespread practice of intercropping. Millet is far and away the predominant crop in Niger. It is estimated that millet is grown on over three million hectares and, therefore, covers over 85 percent of the total physical area cropped. It is the crop par excellence for sandy soils and low sporadic rainfall. Millet is central to Nigerien life for farm family consumption and as a cash crop.

The other major cereal grown in Niger is sorghum. It occupies only one fourth the area that millet does nationwide and less than one tenth in the Niamey Department. It is less drought tolerant than millet and is mainly grown on soils with a finer texture (e.g. depressions, valleys, lowlands), more organic matter (e.g. manured fields near compounds), and in higher rainfall areas. Although there are dune sorghums for lighter, sandier soils, generally sorghum and millet utilize different land types and may be viewed as complementary, rather than competitive, crops in land allocation decisions.

Maize remains a minor cereal for Niger. Although production rose steadily during the 1977-1980 period, the total area under maize cultivation is still only about 15,000 hectares. It is primarily a crop grown on small, heavily-manured fields in the higher rainfall areas. Most of the production is for direct farm family consumption as roasting ears.

Cowpea production has doubled in the past few years, with a considerable portion of the cowpeas being exported to the countries south of Niger. The area in cowpeas is now more than a million hectares, most of which is grown as an intercrop with millet. Average cowpea yields are relatively low because of low plant populations and competition in intercropping situations, and because of insect problems during the growing season, which are especially serious in pure cowpea stands, as well as after harvest. Use of cowpea hay as a dry season forage for livestock has been very important for a long time, and financial returns from forage sales often exceed those from cowpea sales per se.

The area in peanut cultivation is less than half of what it was ten years ago. Less than 200,000 hectares were planted in 1980, most of which were in the Departments of Zinder and Maradi. Peanuts are an insignificant field crop in the Niamey Department, with most production coming from small plots grown by women for farm family consumption and limited local sales as nuts. Part of the production, however, is processed in Niger and

consumed as vegetable oil for cooking. Niger's peanut oil extraction plants, however, are either closed or run at less than optimal efficiency.

Cotton is the only industrial crop currently grown and processed in Niger. The area under cotton cultivation has steadily declined for a decade and in 1980 was only about 4,000 hectares. Most of this is grown under irrigation at Adder Doutchi in Tahoua Department, although some is still planted under dryland or flood-recession conditions elsewhere in the country. No cotton is currently produced in the Niamey Department and, to our knowledge, no plans exist for starting production in this area.

It should be noted that determination of the best crop for a given situation cannot be simply a question of economics. The six major crops in Niger are not, for the most part, competitive for the same land. They should not be viewed by decision makers as interchangeable and hence competitive, since they are not all adapted to the same soils, moisture regimes, and other growing conditions.

The agronomic analysis which follows takes into account the tremendous differences in areas planted to these crops. Because of the overwhelming importance of millet to Niger and because most of the current debate over the viability of technical packages centers on millet, the primary emphasis of the following analysis is on this crop. The thirteen elements of the agricultural technical package for millet are examined point-by-point, with comments related to other crops added as appropriate.

B. THE TECHNICAL PACKAGES

1. Crop Regimes

All the packages specify that crop rotations be followed and that all crops be grown in pure stands, without intercropping. Suggested rotations are as follows:

a. Millet to be rotated every two or three years with cowpeas or peanuts;

b. Sorghum not to be grown on the same field two years in succession, but rotated with cowpeas, peanuts or cotton;

c. Maize, which is often cropped continuously on the same field, to be rotated with sorghum;

d. Cowpeas and peanuts to be the first crop planted after a fallow, preceeding millet or sorghum;

e. Cotton to be rotated with maize or sorghum.

These suggested crop rotations appear sound, especially if they effectively prevent build-up of certain diseases and insects in fields and take advantage of the differential uses of plant nutrients by, and the nitrogen-fixing capabilities of, the two legume crops. The major limiting factor for the proposed crop rotations is the practical necessity of growing millet on a large percentage of the cropped area to meet farm family consumption needs. Increased per hectare yields of this basic foodgrain, coupled with development of creative intercropping systems, may help bridge the current large gap between INRAN's research recommendations and actual farm practices.

The primary reason for recommending that each crop be grown in pure stands as a sole crop is simply that, until very recently, no research had been conducted in Niger on intercropping systems. Virtually all varietal, fertilization, plant density and other agronomic trials have been conducted -- and resultant recommendations promoted -- under the assumption of pure stands of these crops.

At present, preliminary research on intercropping of millet and cowpeas is being undertaken by INRAN and ICRISAT, as well as by the Applied Research Section of the Niamey Department Development Project (NDD). Millet has been grown traditionally in Niger, as in most of the Sahel, with cowpeas as an intercrop. The general practice we observed in western Niger was that of planting cowpeas late (i.e. 4-6 weeks after millet) and at relatively low densities (i.e. 1:10 to 1:4 density with millet). Millet is always treated as the primary crop in this association, receiving very little competition from the cowpeas, and none in

the early, critical growth stages. Hence, there are negligible reductions in millet yields. Cowpeas are much more affected by intercrop competition, however, since the millet is already well established in the field. Cowpeas are able nevertheless to spread out and take advantage of any openings or gaps in the millet stand and, therefore, produce at least some crop.

Research indicates that insect damage to cowpeas may be less when grown as an intercrop than in pure stands. If true, this would be an important additional benefit of intercropping. In any case, the major use of cowpeas in Niamey Department and elsewhere seems to be as a dry season forage, with actual cowpea production being of distinctly lesser importance.

Our opinion is that the intercropping of millet and cowpeas as traditionally practiced by Nigerien farmers is compatible -- or can be easily made so -- with the essential technical package recommendations, including interrow cultivation with animal traction equipment. For instance, the usual time for planting cowpeas occurs after the first two, and perhaps three, weedings as prescribed in the millet package are completed. This implies that the planting of cowpeas should not normally interfere with those operations. Furthermore, our field observations were that many former trainees did not actually use animal traction for later weedings in any case, resorting rather to hand hoeing to avoid damage caused by their animals in trampling or grazing the millet plants.

The usual dates for cowpea plantings also occur after all fertilizer applications, except in the case of the second urea application where a split application is used. If millet stands are uniform, vigorous and dense, then the recommended millet density in any intercropping system may have to be adjusted, but this adjustment can be accomplished with negligible yield losses (see comments below on seeding rate and plant density). Given time and experience, farmers themselves would no doubt make some modifications in the spatial arrangement of these intercrops to accommodate the new system, if they found it viable on other grounds.

2. Land Preparation

All the packages state: "If cultivation by hand hoe is anticipated, the land should be cleared of surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and all tree stumps must be removed." In addition, the sorghum package states that, if cotton was the previous crop, all cotton stubble and residues should be burned, preferably shortly after the cotton is harvested.

Given the fragility and erosivity of Niger's soils and the incidence of sand/wind blasting to crop seedlings, one should be extremely careful in deciding what material to remove in preparing land for crop production. It is doubtful that clearing fields of all surface debris is either necessary or wise. The recommendation should probably be phrased differently and state that only what is absolutely necessary should be removed. A tree should not be cut down or removed without a highly compelling reason. The same is probably true of tree stumps. Their removal is certainly not necessary if hand hoe cultivation is used, and can be avoided in many cases where animal-drawn implements are to be used. The inconvenience of having to circumvent a tree or stump may often be greatly outweighed by its role in reducing soil erosion, improving soil fertility and structure, and increasing crop stands.

The team observed several striking cases, particularly in the Sadoré and Ouallam areas, of substantial wind erosion on farmland which had been rendered practically treeless by cultivation. The beneficial effects of Acacia albida (Gao) trees are well-documented and have been thoroughly reviewed elsewhere (see Felker, 53). Other tree species, even those which do not fix atmospheric nitrogen and which do not shed their leaves at the end of the dry season, may assist crop development by bringing plant nutrients to the soil surface, moderating high soil temperatures, reducing evapotranspiration rates of the crop, and minimizing soil erosion by wind and water.

Results of windbreak experiments in the Majjia Valley (19) are impressive, and deserve field experimentation and possible adoption in other areas. An agroforestry section exists administratively within INRAN but is not yet operational. High priority should be given to initiating a solid research program in this area.

3. Soil Preparation

The package recommendations state that soil preparation for millet and peanuts, as well as for the other crops grown on sandy soils, should consist of scarification before the onset of rains. Scarfication (scarifiage in French) means superficial tillage prior to planting, which may be performed either with hoes or with an animal-drawn field cultivator. In the latter case, the field cultivator should cross the field in two directions at right angles to each other. For maize, sorghum, and cowpeas planted on heavier soils, plowing and harrowing at the end of the previous rainy season, or at the end of the dry season if physically possible, are recommended. For cotton, scarification is recommended before the first rains, followed by plowing and harrowing after them.

Light, superficial preplant tillage by scarification can be beneficial for two reasons:

a. it increases moisture penetration during the rains; and
b. it incorporates phosphate fertilizers and organic matter into the root zone prior to planting.

Preparing a suitable seedbed is not a valid reason for scarification in most cases in Niger because, in both traditional hoe and animal traction cultivation systems, seeds are planted by digging shallow holes with a hoe and then covering them with soil. Seedbed preparation would be more important if mechanical seeders were in widespread use.

Many of the sandy soils in Niger contain silt and clay fractions sufficient to cause crusting and sealing of the soil surface. Scarification, as well as periodic cultivation during the growing season, can help alleviate these problems. Scarification has little effect on soil structure or other physical

properties. Overworking sandy soils which do not have crusting and sealing problems or working them at inappropriate times can increase risks of erosion. The unstable dune soils observed in the Ouallam area are likely to fit into this category.

Incorporation of fertilizers and organic matter with a field cultivator will be at best superficial, but it is better than leaving these materials on the soil surface. Organic matter contains varying levels of the major elements nitrogen, phosphorus, and potassium. The fertilizer recommendation calls for phosphatic fertilizers to be applied prior to planting and nitrogenous fertilizers to be applied at specified times after planting. No applications of fertilizers containing potassium are recommended.

Both phosphorus and potassium are quite immobile in soils. The deeper they can be placed, therefore, and the closer they are to the crop's root zone, the greater and more immediate the benefits they will provide. They cannot be lost, like nitrogen, due to volatilization. However, if left on the surface they can be lost through simple physical movement caused by wind and/or water in the same way that soil particles are moved in the erosion process. Nitrogen, on the other hand, can be lost through both volatilization and leaching. This is why nitrogenous fertilizers should not be left exposed on the soil surface and why the ideal source of applied nitrogen under Niger's growing conditions would seem to be a slow-release form, possibly as coated or super granules.

It would be useful to know (a) whether there are differences in effects on yield between scarification by hoe and scarification by field cultivator and (b) whether phosphates can be just as effectively incorporated at planting time or at the time of first cultivation (recommended eight days after planting). Answers to these questions will help determine what, if any, preplant tillage is necessary on the very sandy soils.

4. Varietal Selection

A list of recommended varieties is given for each crop as part of the package. There are honest differences of opinion among and between farmers, extension agents, and researchers in Niger as to whether local varieties or "improved" varieties are superior. The recommended varieties of cowpeas, peanuts and cotton have been introduced from other countries, or bred and developed from introduced materials. Most of the recommended varieties of millet, sorghum, and maize are "improved" versions of, and have been selected from, local varieties or land races. As a result, one would not expect substantial changes in yield performance, negatively or positively. With their strong Nigerien backgrounds, these varieties should insure yield stability and reliability comparable to the local varieties from which they were derived. This currently is, and ought to be, a very important breeding objective.

The new cereal varieties -- the word "new" being perhaps more appropriate than "improved" -- have been generally higher yielding in research station tests. However, there have been few effective off-station tests comparing local varieties with new varieties. INRAN's multilocational testing program has conducted some off-station trials but the resulting data are limited and of variable quality. The latest INRAN annual report indicates that 15 such trials for millet were planned for the entire country in 1980, with only six completed with usable results. Of these six, only one was located in Niamey Department, near Say. In this particular trial, the local variety was significantly higher yielding at 1071 kg/ha than all of the new varieties tested. Yields of the new varieties ranged from 376 to 627 kg/ha. Rainfall was about 530 millimeters at this site in 1980.

Local millet varieties, collected by INRAN in the Niamey Department in 1979 and grown in small, unreplicated plots at Tarna in 1980, ranged in yield from 160 to 3,000 kilograms per hectare. This demonstrates not only the variability in local germplasm but also the yield potential of certain of these genotypes.

We conclude, therefore, that no single millet variety can be judged superior to all others under the full range of conditions facing farmers, even in relatively small geographic areas. The tremendous environmental variations from location to location and from year to year make it unreasonable to expect one variety to be well-adapted to -- and the "best" performer in -- all possible conditions. The wisest course for Nigerien farmers may, in fact, be to plant several different varieties to minimize risk, just as they do now, and not to plant an entire farm to one single variety. Farmers might also benefit from programs aimed simply at purifying the best local variety or varieties in each area. This may be especially true in the case of millet where local varieties appear to be quite heterogeneous in terms of maturity, percentage of chibras plants, and even yield potential.

It is already recognized by many field agents and farmers that early-maturing cereal varieties, with more uniform heading characteristics, are more prone to extensive bird damage and that this damage can easily negate any yield advantage new varieties might otherwise have. This damage will of course vary from one area to another, but it must be seriously considered by plant breeders and extension personnel in varietal evaluations. Several former CPT trainees complained about these bird problems; the Director of the Seed Multiplication Center at Hamdallaye estimated yield losses from birds in early-planted CIVT millet of approximately 25 percent of the total crop in most years.

5. Seed Selection

The recommendation is that farmers use certified seed of the varieties they have chosen to plant. If certified seed is not available, it is recommended that the seed used be examined and sorted to remove unsound grains and any foreign matter.

The team is not aware of any research conducted in Niger which actually compared the performance of seedlots selected according to this recommendation with seedlots prepared in other presumably less desirable manners. However, the principle is sound and the practice is not costly.

The goal of this practice is to plant genetically-pure seed of the desired variety which contains only whole, sound, vigorous grains and is free of chaff, insect parts, weed and other crop seeds. Planting seeds which are small, shriveled, broken, or cracked generally results in lower germination, reduced vigor, higher percentages of abnormal plants, and more plant susceptibility to diseases. Poor quality seed or seedlots can exist with any crop. Due to the extensive damage often caused by insects in storage, however, cowpeas require especially careful attention in this regard.

Use of the term "selected seed" - semences selectionnées in French -- hides the fact that there are two important factors involved in the preparation of good seed: genetic purity and physical purity. The seed multiplication scheme in Niger takes both factors into account in providing certified seed both pure for a specific known variety and superior in physical quality. This means that planting seed of good physical quality, even of the local varieties used by farmers, may be of benefit. Hence, this selection process should not be limited solely to the new or improved seed varieties but extended to include purification of local varieties as well.

Some simple experiments could be conducted at the level of the CPTs, if not on research stations, to test these concepts. Present seed quality may very well relate to the larger problem of poor stand establishment, which seems so crucial in determining the yield potential of a given field. It has been shown elsewhere that crops grown from good quality seed can outyield those grown from poor quality seed of the same variety, and that sometimes the yield differences among seedlots of the same variety are greater than the yield differences among different varieties.

The package also advises farmers, in the case of millet, to obtain their seed from selected heads, presumably after millet has been harvested. It might well be better to select those heads before harvest while the crop is still in the field. In this way, seed selection is based on the entire plant phenotype,

not on a single head, and on the plant's isolation from possible sources of foreign pollen contamination. The latter point is particularly important if neighboring fields contain varieties different from the one being selected. Of course, if the use of certified seed is profitable and farmers in the future procure their seed exclusively from seed farms, there would be no need for this part of the seed recommendation.

6. Seed Treatment

The recommendation in all the packages is that seed be treated with a fungicide/insecticide mixture, such as Thioral, prior to planting. A series of field experiments have been conducted by INRAN at Tarna over a number of years comparing various seed treatments. These experimental results have to date been variable and are not judged to be statistically conclusive. Frequently, there have been no significant differences between plots of treated and untreated seed.

Seed treatment, however, is a very simple and inexpensive practice. As with the use of certified seed, seed treatment is attractive because it requires little extra labor for the farmer and involves minimal risk on his part. It takes only a small gain in yield to make seed treatment cost effective. In fact, such treatments could produce no benefits in four years, yet be so helpful in the fifth year that they would be considered highly profitable overall. Of all the recommendations, it is the only one whose use is already widespread among farmers. It is no longer considered "new" and was frequently overlooked by the former CPT trainees we interviewed when they were asked what techniques they learned at the CPTs. It is a theme that has already become widely accepted and will spread by itself. Further dissemination of the practice requires little, if any, government intervention. Provision of inputs for this practice can be officially turned over to the private sector, which is already handling them to a large extent in any case.

7. Planting Dates

For all of the crops discussed here, except cotton, the recommended planting dates are immediately after a good soaking rain. This is variously described as a 10-15 millimeter rainfall or a rain which wets the soil to a depth of 15 to 20 centimeters. Farmers are advised to wait until the first good rain after June 10 for cowpeas and until late June or early July in the case of valley sorghums. Dune sorghums are to be planted in dry soil anytime after May 15th. The planting dates for cotton are more complex and are considered the key to successful production of this crop. The optimal cotton planting dates vary depending on whether the crop is grown under dryland, irrigated, or post-flood conditions but generally they all occur between mid-June and early July.

For millet at least, farmers' experiences, as well as numerous research trials, confirm that plantings immediately following the first soaking rain are a sound strategy. Later plantings of traditional Nigerien millet varieties -- which are photoperiod sensitive -- generally result in lower crop yields because of the shorter growing season and failure to benefit from nutrient flushes occurring at the first rains -- i.e. the conversion of nutrients from organic to mineral form which is available to plants. Early plantings of early-maturing varieties, however, may encounter serious insect and bird damage. On the other hand with early planting, moisture may be more favorable during the grain-filling period. Therefore, it is always difficult to predict which of these factors will be the most important at any given location in any given year, and sequential plantings and/or planting varieties with different maturity dates may be the farmer's best strategy for minimizing overall risk in millet production.

For the other crops, timing of plantings so that the crop's overall development fits the pattern of available moisture is crucial. The aim is to maximize dependable moisture during the pod and grain-filling period, while minimizing risks from disease and staining after physiological maturity. Planting in dry soil

seems to us risky although it has been successful in certain cases and is apparently used by farmers in some areas. There is perhaps more chance of success in the south than in the north because of a more consistent, less erratic rainfall pattern. Losses of planted seed to pests, to heavy winds (i.e. seed blown away or deeply buried in the soil), and to premature germination (i.e. light rain sufficient to initiate germination but insufficient to sustain seedling development) are always a potential problem with dry planting. Additionally, there is greater likelihood of having to replant, which wastes labor time and other resources. Decisions on planting depth when planting dry are critical but not easy to make.

8. Seeding Rate and Plant Spacing

The recommended density for millet is 10,000 hills per hectare (i.e. hills spaced one meter apart both in the row and between rows). No research clearly demonstrates that this is the optimal hill density under all Nigerien conditions. In fact, previous research in Niger has shown no significant yield differences from as few as 6,000 to as many as 12,000 hills per hectare. Recent on-farm tests in the Niamey Department further demonstrate the relative unimportance of density variation in total yield variation (86).

These data are not unexpected since density trials for most crops show that maximum yield is obtained over a range of plant populations. At lower populations, millet compensates by producing more fertile tillers and thus more heads per plant, more seeds per head, and/or higher seed weights. The optimal range may, and often does, vary according to variety and environment. Hence, a short variety such as 3/4 HK has a higher range than the tall, local cultivars and the optimal range for any given variety will likely vary somewhat from year to year and certainly from Ouallam to Say.

Given the existence of an optimal range for each variety and location, seeding rates chosen should be directed at assuring (a) final stand counts within that range, (b) spatial arrangements of

hills that allow growers to carry out efficiently other management practices such as weeding, cultivating, fertilizing, and harvesting.

Final stand count is what is really important. If the seeding rate is on the lower end of the range and a final stand count falls below the optimum level because of natural field losses, then yield reduction can occur. Replanting can usually compensate only partially for these occurrences, whereas timely thinning can correct overplanting without yield loss.

Choosing a seeding rate at the lower end of the optimal population range will reduce the time required to plant and to thin because of fewer hills per hectare as well as time required to harvest, assuming fewer but larger heads per hectare. The amount of seed used will also be less, which is of some importance if costly certified seed is planted. If localized as opposed to broadcast applications of fertilizer are made, then a lower number of hills will also decrease the amount of time involved in fertilizing the crop. Time devoted to weeding may not be greatly affected, although low plant populations, coupled with wide spacings, may very well increase the time required because of the larger area to be weeded between hills and reduced competition for weeds from the millet crop. Lower plant populations may also help a crop combat moisture stress. For instance, in lower rainfall areas more moisture is available to each plant if there are fewer plants to compete. This is why a lower plant density might be more appropriate in the north than in the south. Recent research in fact suggests that a density of 6,000-8,000 hills per hectare is more suitable in the drier areas (see the Ouattara report in Annex D).

In short, the recommended density may be as viable as any other as long as it is remembered that there is nothing sacred about 10,000 hills per hectare. Rather, it should be recognized that a wide range of densities can produce maximum yields, that the density for any variety is site specific, and that the density per se should fit well with the specific crop and soil

management practices used. Although millet has been discussed here in detail, the same principles are valid for the other crops.

9. Use of the Row Tracer

Although row tracers (rayonneur in French) are only mentioned specifically in the case of millet, they have been constructed and advocated for some of the other crops as well. We were amazed at how faithfully many of the former CPT trainees were following this recommendation. This is probably the most unnecessarily time-consuming and least cost-effective of all the recommended practices. If an iron tracer is used or the teeth are too short, it is also very hard work. As a recent INRAN report on farming systems (83) noted: "unanimously, all the farmers brought out the difficulty of using the row tracer and then the time and labor required for it." Other observers have stated (106): "The case of the row tracer is a typical example of the inconsistency in Nigerien agriculture today of not taking into account the value of labor in monetary terms".

Although the row tracer has no real impact on yields per se, it is designed to assure that the recommended density is achieved and that rows are aligned in such a way as to permit mechanical cultivation in both directions. There are undoubtedly less onerous ways of achieving both objectives. In fact, ex-trainees are already experimenting with various alternatives to this recommendation. For example, one farmer reduced the labor time involved in half by tracing in one direction only and then having his family plant as a group side by side in the direction perpendicular to the lines. The lines gave them the location for planting the hills and, by remaining more or less equidistant from each other as they proceeded across the field, they were able to make the rows sufficiently parallel to each other to permit interrow cultivation with oxen in both directions.

Another farmer traced in one direction only and then planted along these lines. In this way, even though he was unable to cultivate mechanically in both directions, he did cultivate in

one direction with his oxen and equipment and then finished weeding manually with the long-handled cultivating hoe. There were still other instances where farmers had abandoned the use of row tracers entirely but still planted carefully enough to allow them to cultivate with their animals. The rows planted, though not perfectly straight, were roughly parallel and usually at a wider row spacing than currently recommended.

If a large area is involved -- and if it takes at least two man-days per hectare to trace rows, as is assumed in our crop enterprise budgets (see Annex B) -- then this practice begins to run counter to the aims of recommendation #7 on planting dates. It also runs counter to the objective of achieving the greatest possible efficiency with available farm family labor, given alternative rural employment opportunities. It should be noted that there is a large amount of duplication in cultivating in both directions because the first pass may cover 75 to 85 percent of the area to be cultivated. The remaining area can perhaps be weeded more efficiently with hoes.

Given the importance of timely planting, the fact that hill densities and plant populations do not have to be strictly controlled, and that suitable alternatives are already in use, the use of row tracers could be dropped from the list of recommended practices. It might perhaps be retained as a demonstration to farmers of <u>one</u> of the means of reaching the real objectives, namely, adequate plant populations and a plant spacing or arrangement which allows mechanical cultivation.

10. <u>Thinning</u>

Thinning is recommended at two or three weeks after emergence in the packages for the three cereal crops, but not for cowpeas or groundnuts. The remarks made under recommendation #8 above with regard to seeding rates and plant spacings are appropriate here. Because of the ability of most crops to compensate over a range of plant populations to achieve optimum yields, we maintain that strict adherence to a given number of hills or plants is unnecessary and untenable from an agronomic point of

view. In the case of millet, leaving 20 plants or only one plant per hill will obviously not give the optimal yields but it is likely that leaving 3, 4 or 5 plants per hill will not change yields significantly. If thinning to 3 plants per hill is simply meant to be a guideline, it might be a practice suggested to farmers. If this recommendation is meant as a hard-and-fast rule, taught by extension personnel and followed by farmers with no flexibility, it is not viable. Thinning to a specified number of plants per hill with no exceptions can be an unnecessarily time-consuming operation (e.g. six man-days per hectare according to Enger (150) versus three days under "traditional" management).

Thinning is not a novel operation for Nigerien farmers. Most thin their millet crop to a limited extent already. Generally this is done rapidly and selectively. Rarely, according to farmers interviewed, are plants thinned to as few as three plants per hill. Thinning, furthermore, is often coupled with another operation, such as weeding, to reduce total farm family labor expenditures.

There is a certain amount of self-thinning which occurs as well -- a natural response of plants like millet to intraspecific competition. The real question is: What is the minimum amount of thinning necessary to prevent yield loss due to overpopulation or, conversely, to reduce the labor time and cost involved in achieving any additional yield?

The practice of overplanting -- a strategy for combatting the complex and numerous problems associated with stand establishment in a difficult environment -- necessitates the practice of thinning. The more confident farmers are of obtaining satisfactory stands with less seed, the less deliberate overplanting will be needed. High-quality seed, seed treatments, timely planting with good soil moisture and improved fertility are all part of the package and should help in this regard. Eliminating the necessity of thinning, or at least reducing it to a minimum, could be an important labor-saving achievement.

If thinning is necessary at all, then the other parts of this recommendation -- time of thinning (i.e. two to three weeks after emergence) and the kind of plants to remove -- seem logical.

11. Weeding/Cultivation

The importance of timely weed control is recognized by everyone in Niger. Since soil nutrients and moisture are often in short supply, it is especially critical to reduce competition from weeds for these scarce resources -- all the more so if expensive inputs such as chemical fertilizers have been used. In general, weeds can be most effectively controlled when they are in the young seedling stage. However, many of the annual weeds observed in Nigerien millet fields appear to have the capacity to re-root after being hoed out, if they were sufficiently developed and if there was sufficient moisture.

The timing of the first two weedings for millet in the technical package is quite different from that practiced by farmers. Millet fields are usually weeded twice; first at about a month and again at about two months after planting, depending of course on the rainy season and the extent of the weed problem. The part of the recommendation which calls for much earlier weeding (i.e. the first, one week after planting and the second, three weeks after planting) seems sound agronomically. Recent on-farm tests in the Niamey Department indicated that any delay from planting to first weeding reduced yields by an average of 9 kilograms of millet per day of delay (86).

This recommendation may also entail a larger number of weeding operations. McIntire (86) found that the use of an improved variety (CIVT) and/or fertilizers did not change total labor needed for weeding, and concluded that the "principal labor effects of using any of the three parts of the improved package -- CIVT, fertilizers or improved intercropping -- was the addition of extra tasks (especially spreading fertilizers and planting the intercrop), not the intensification of existing tasks such as weeding". If additional weedings are in fact required,

significant additional labor and cost are involved. According to data available in Niger, additional manual weedings of millet after the first two require an average of about 10 man-days per hectare. This compares to the 30 man-days per hectare in the south and 20 in the north required for the initial cultivation and the 20 and 10 man-days per hectare, respectively,for the second one.

The major benefit from animal traction is in fact the savings in labor time as a result of cultivating fields more quickly; the amount of time saved depends on the number of workers needed to handle the animals during cultivation. For the purposes of his analysis, Enger (150) used the figure of 4 man-days per hectare for weeding with oxen, compared to 12 man-days for manual weeding. It is not clear, however, whether Enger assumed one man working alone with the oxen. In all cases we observed there were at least two people -- and often three --working with the oxen at one time. This can change the labor times involved considerably. We did notice that several former trainees were making effective use of their young sons to help with oxen cultivation. These children were too young to handle the task of weeding with hoes, but were old enough to work as a team with their father and lead the oxen through the rows of millet. In the economic analyses of this report, it is assumed that two persons work with the animal or animals during cultivation and that, in the case of millet production in southern Niger, labor time involved in the first cultivation is reduced from 30 man-days per hectare with hand hoes to 8 man-days with oxen.

Mechanical weeding may or may not produce an increase in yield; apparently this has not been adequately tested (Enger, 150, p. 5). If the use of animal-drawn equipment results in more timely weeding, a yield increase is possible, assuming the quality of weed control with mechanical cultivation is comparable to that from hoe weeding. The recommended weeding times are stated in terms of a <u>fixed</u> number of days either from planting or from a previous cultivation. These should only be considered as a guideline for it is highly unlikely that any measureable

differences in yields would result from weeding on the seventh or the ninth day, as opposed to the eighth day after planting or the last cultivation as now recommended. As with some of the other recommendations, they should not be taken too literally -- and yet often it seems they are. Moreover, advice on time of weeding might be more useful if tied to observations of what is happening in the field environment. For example, farmers could be advised that best weed control might be obtained when the soil surface is dry and no rains are expected for several days, rather than being told to commence cultivations at specified intervals regardless of actual field conditions.

12. Replanting

The packages of all six crops recommend replanting in the hills where plants have not emerged. Replanting should occur at the time of first cultivation which varies from one to two weeks with the specific crop. This would seem to be a viable practice, especially if there are a large number of missing hills or if there are specific field areas with poor stands. Replanting, however, is already a widespread practice in Niger. The recommendation that reseeding take place at the time of first cultivation (i.e. at 8 days), which means shortly after general crop emergence, is sound. Early replanting is important for the same reasons as early planting (see remarks above under recommendation #7). The crop budgets contained in this report assume that 30-40 percent additional seed will be used each year by the average farmer for the purpose of replanting.

13. Crop Fertilization

The fertilizer recommendations for the six crop packages are summarized in the table below.

Fertilizers are recommended in all cases except sorghum grown on dune soils. In addition, large applications of organic matter, ranging from 6 to 10 tons per hectare, are recommended for all crops except peanuts and cotton.

As a set of guidelines, these recommendations appear viable, based as they are primarily on experiment station tests at several locations over a number of years. As with other parts of these packages, they suffer from a sameness that fails to reflect the heterogeneity of Niger's physical environment. At least the recommendations for millet and sorghum have been slightly modified, taking into account crop rotation and soil type, respectively. The discussion below again focuses on millet because of its overwhelming importance. Most of the principal issues, however, are directly applicable to the other crops.

Table 1: Recommended Fertilizer Rates
(in kilograms of nutrients per hectare)

Crop	N	P_2O_5	K_2O	Other
Millet (monoculture)	45[a]	22.5	None	None
Millet (in rotation with legume)	22.5	15[b]	None	None
Sorghum (valley soils)	45[a]	None	None	None
Sorghum (dune soils)	(Fertilizers are not recommended)			
Cowpeas	Small amount	22.5	None	None
	as a starter	22.5	None	None
Peanuts	None	15	None	None
Maize	90[a]	70	None	None
Cotton	50[a]	46	24	16 Sulfur 4 Boron

[a] Split application

[b] Applied on preceding legume crop

Practically all fertilizer experiments conducted to date in Niger have shown a strong response in millet to both nitrogen and phosphorus, no appreciable response to potassium, and a variable response to sulfur. IRAT's trials showed a highly significant and linear response to nitrogen up to 125 kilograms of nitrogen applied per hectare. Use of phosphate fertilizers was shown to

double millet yields. Experiments conducted by INRAN since 1980 have confirmed these results: phosphorus response was linear, and maximum yield (200 to 300 percent of the unfertilized check) was obtained with a combination of 100-150 kilograms of N per hectare and 240 kilograms of P_2O_5 per hectare. These trials were, of course, conducted on experiment stations under controlled conditions and high levels of crop management.

During 1981 and 1982, a large number of fertilizer tests (281 for the whole of Niger, 65 in the Niamey Department) were carried out on millet fields at CPT's under the auspices of the FAO-DANIDA's Programme Engrais (113). Similar tests were run concurrently on cowpeas, peanuts, and sorghum. They constitute an excellent source of information on fertilizer response. The response to nitrogen was linear for the Niamey area, as well as the rest of Niger, with a highly significant correlation (r = 0.994, CV = 4.9%) between the application rates of nitrogen and millet yields, regardless of phosphate levels. The response to phosphorus was curvilinear with a highly significant correlation (r = 0.997, CV = 4.9%) between phosphate application rates and millet yields, regardless of nitrogen levels.

Trials conducted by IFDC in 1982 at Sadoré showed positive responses to both nitrogen and phosphorus, with the response of millet being much greater to phosphorus than to nitrogen (88% of maximum yield versus 25%). A slight response to sulfur was also noted.

The Applied Research Section of the NDD conducted fertilizer trials on millet at two locations for the first time in 1982. At Boula (454 mm of rainfall), a linear response to nitrogen was recorded up to 200 kgs of N per hectare, but there was no significant response to phosphorus up to 150 kgs of P_2O_5 per hectare. At Simiri (269 mm of rainfall), there was no significant response to either nitrogen or phosphorus, very possibly due to the low rainfall. Similar experiments were in progress in 1983. ICRISAT's on-farm tests at two locations in the Niamey Department

in 1982 showed that the effect of the fertilizer package was highly significant and by itself more than doubled yield, as compared with the unfertilized check (86).

In summary, considerable evidence has now been accumulated in Niger to demonstrate not only that Niger's soils are generally deficient in nitrogen and phosphorus, but also that crops grown on these soils are quite responsive to organic and inorganic applications of both these plant nutrients. It also seems clear that local varieties, and not simply the new varieties, are responsive to increased levels of soil fertility. Because on-farm testing has been quite limited to date and has given variable results, the key question remains: How much fertilizer should a farmer apply to a given field in a given location to obtain consistently an economic return that justifies the application costs?

It is important to remember that application of the recommended rates of fertilizer is absolutely no guarantee of an increase in yield or of an increase sufficient to offset the application costs. There are many factors which may prevent an economic return. These include, but are not limited to, moisture availability, soil type and mechanics of fertilizer application (i.e. amount of fertilizer actually applied, method and time of application, and fertilizer placement).

a. Moisture Availability

The amount and distribution of rainfall and evapo-transpiration rates combined with various soil factors (e.g. soil texture, organic matter, slope, depth, moisture penetration, and water retention capacity) affect the quantity and pattern of moisture which becomes available to plants. Charoy's research showed that the water requirement of a 114-day millet was 366 millimeters (21). Brown concluded that only low yields could be expected with an annual rainfall of 300 millimeters or less and that yields would be further reduced if nitrogen fertilizer had been added (21). Agronomists continue to debate whether moisture or nutrient level is the major limiting factor in the Sahel.

Both, of course, are vital; but the disparity in crop appearance and yield potential between bush and house fields, even in the northern zones, suggests that low yields are not entirely the result of low rainfall.

b. Soil Type

A general description of the agricultural soils in the Niamey Department is given by Ouattara in Annex D. Important differences in soil type exist, and these need to be considered for the refinement of fertilizer recommendations. It is easy to forget that, even for the upland sandy soils upon which most millet is grown, there is significant variability. Furthermore, cropping history, extent of erosion, and the amount of livestock manuring affect soils and their responsiveness to fertilizer applications.

c. Mechanics of Fertilizer Application

In a number of the cases we observed, the amount of fertilizer actually applied was somewhat less than the recommended rate because the farmer could not either obtain or afford the amount specified. The lesser amount was invariably applied to the same area as would have been fertilized with the recommended amount rather than to a proportionately smaller area. The amount of nutrients actually taken up by the developing crop is also substantially influenced by the method, timing and placement of fertilizer applications.

Almost all fertilizer nitrogen applied in Niger is in the form of urea. We observed that it is often placed directly on top of the plant hills and left unincorporated on the soil surface. Nitrogen losses by volatilization to the atmosphere must be considerable as a result of this practice. Nitrogen losses due to physical movement of fertilizer particles along the soil surface are probably important in some cases too, especially when heavy rains occur soon after application and cause sheet erosion and runoff. Another form of nitrogen loss is the crop injury ("fertilizer burn") which results when a high

concentration of fertilizer is placed in close proximity to plants. For these reasons, we believe a side dressing of urea should be applied a short distance away from plants or rows, immediately incorporated, and linked to cultivation operations -- both to increase the amount of nitrogen available to plants and to minimize labor time required. Nitrogen losses due to leaching through the soil profile are also believed to be considerable in Niger's soils. Preliminary experiments using labeled nitrogen at the ICRISAT center at Sadore showed that only about 30 percent of the fertilizer nitrogen applied and incorporated was absorbed by the millet crop. Localized (spot) versus band applications, especially for a widely-spaced crop like millet, are another important question to be resolved. The former may result in greater uptake of nitrogen but requires more labor. These are not insignificant details. Together they may very well determine the success or failure of fertilizer use.

Because of the cost of inorganic sources of nitrogen, serious consideration needs to be given to stimulating legume production in Niger. The potential nitrogen credit accruing when millet is preceeded by nitrogen-fixing leguminous crops has been shown to be 25-50 kgs of N per hectare under Niger's conditions. This is impressive and has significant financial implications for Niger in that a substantial portion of the nitrogen requirement for the cereals could be et at no cost.

Because phosphorus is essentially immobile in soils, moving little from point of application, surface applications or even those which are superficially incorporated after being broadcast may not provide much benefit to the current crop. Through the course of the growing season, as a result of the various weeding-cultivation operations, fertilizer phosphorus is probably gradually worked down into the soil profile and becomes more suitably placed for the succeeding crop. This may explain in part the lack of response to fertilizer applications observed in some former trainees' fields. A delayed or residual effect of this year's application may be evident on next year's crop. As

with nitrogen, application techniques for phosphorus will affect the crop's responsiveness and must be looked at very closely by those responsible for extension and training.

Research must give priority to clarifying these issues. Increased soil fertility is a prerequisite for substantial increases in crop yields in Niger. Inorganic fertilizers can play a major role but their profitability for farmers depends to a great extent on the use of proper techniques.

Those who study the economics of fertilizer use often make judgments about profitability based on the marginal yield/cost ratio (i.e. the value of the last increment of yield increase compared to the cost of the fertilizer used to produce that increased yield). It is generally postulated that if such ratios are greater than 2, they provide a sufficient economic incentive for farmers.

IFDC's analysis of various fertilizer experiments conducted on millet in Niger (68) found that the marginal yield/cost ratio for the optimal nitrogen application rate of 75 kilograms per hectare was about 3. This was based on a fertilizer cost/millet market price ratio of 2.23. The marginal yield/cost ratio of the recommended fertilizer rate of 23 kilograms of nitrogen per hectare was calculated to be nearly 4.5, meaning that there should be even greater economic incentive at this level than at the higher rate. Based on their millet fertilization tests and a cost/price ratio of 1.36, the Nigerien Fertilizer Program determined that a marginal yield/cost ratio of 2 occurred with nitrogen fertilizer rates of 35 kilograms per hectare and of 3 at about 25 kilograms per hectare, which approximates the recommended rate in the millet package.

We cannot emphasize strongly enough that caution must be exercised in using such theoretical ratios and values as "rules of thumb" in assessing the profitability of fertilizer use under the conditions prevalent in Niger. The response coefficients do indeed seem quite favorable but Niger's crops are grown in a high risk environment. A variety of yield-reducing factors (e.g. striga, chibras, insects, birds, and severe drought) as well as

ineffective fertilizer application practices may intervene to mask or negate the effects of fertilizers. Marginal yield/cost ratios much higher than 2 or 3 may be required in order to compensate for the frequent yield losses caused by these other factors.

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NO. 65

A FINANCIAL AND ECONOMIC APPRAISAL OF THE AGRICULTURAL TECHNICAL PACKAGES IN NIGER

A. INTRODUCTION

During the past two decades, agricultural development projects sponsored by the Government of Niger, in collaboration with external donor agencies, have been the principal mechanism for introducing and promoting "improved" agricultural techniques and "packages" of techniques to Nigerien farmers. These projects have focused their development activities on increasing unit productivities of land and, to a lesser degree, labor in cultivation of the major food grain crops -- millet, sorghum and maize -- and two leguminous crops -- cowpeas and peanuts -- within given geographic areas. Cotton, a sixth major but more specialized crop, has been promoted outside the typical productivity project mode in certain selected areas in cooperation with a French organization, the Compagnie Française pour le Développement des Fibres Textiles (CFDT), as part of a regional crop development effort in Francophone West and Central Africa.

The principal responsibility for researching and testing the potential of new agricultural innovations for crops in Niger, prior to their dissemination as recommended practices through the projects, resides with the National Agronomic Research Institute of Niger (INRAN). This organization has formulated and, for the first time, in 1983 published a series of recommended packages of agricultural techniques for each of the major field crops. The resulting crop packages are described in detail in Annex A and have been critiqued in Chapter II.

The objective of this section of the report is to continue the critique of the existing packages by subjecting them to examination on financial and economic grounds. This will be accomplished through the use of farm enterprise budgets and whole farm budgets. However, before starting upon this exercise, it is

useful to review briefly the characteristics of these packages and of the research process from which they orginated.

The predominant orientation in INRAN's previous research -- and in those research results inherited from IRAT -- was on ascertaining the technical efficacy of certain agricultural innovations in increasing crop yields and agricultural production. Technical efficacy in this context was judged by INRAN's soil scientists, agronomists, plant breeders, and other staff in accordance with their own individual disciplinary criteria. Virtually all crop-related research results were obtained either from INRAN's own on-station crop trials or extrapolated from experimental results at other stations in Francophone West Africa.

Proposed agricultural innovations in Niger were tested under controlled, experimental plot conditions on INRAN's stations and sub-stations. Little, if any, effective field-testing of these innovations was done in actual farming situations prior to the release of the innovations as recommended packages. Furthermore, crop trials tended to assume that crops should be grown in pure stands, rather than in crop associations -- e.g. millet intercropped with cowpeas -- which is the typical practice in the existing farming systems.

During this period (1960-1975), the agricultural research community in Niger seems to have devoted little research time to research projects directly reflective of farmers' needs. Research priorities more in tune with actual farm conditions might have surfaced more quickly had researchers been in direct daily contact with Nigerien farmers. For example, a better initial field examination and topology of the existing farming systems in the country almost certainly would have led to more research concern for the following items:

CHAPTER III

1. The need for more regional orientation in adaptive research efforts to take into account the significant heterogeneity in farming conditions;
2. The need for better intercropping and sequential cropping systems, modifying the existing cropping systems rather than completely displacing them with pure-stand systems;
3. The need to recognize that many farm families in Niger derive only a relatively small share of their annual incomes from cropping activities and that the objective of such families in farming their land may not be to maximize crop yields per hectare but to minimize the amount of family labor necessary to produce some target quantity and mix of foodstuffs while allocating the rest of their available time to other activities;
4. The need to recognize that many farmers in Niger may consider interannual stability in crop yields and/or the minimization of financial and other risks in the crop production process to be at least as important as maximizing crop yields per hectare;
5. The need to recognize that any package of crop recommendations can be, at very best, only a starting point for orienting the farmer's activities over the crop season. Research directed at formulating "fall-back" strategies for different field conditions encountered in different crop years and in different geographic locations is possibly even more important to the successful adoption of the package than the initial set of generalized recommendations.

The types of issues put forth above are illustrative of many which could be posed in juxtaposition to the issues which seem to have been the basis of concern when the original research was performed. Moreover, the assumptions implicit in the recommended packages tend to limit the potential adopter population. To be successful, any farmer-adopter of the full package recommendations should have the following characteristics:

1. He would have to be a full-time farmer with considerable prior access to land, labor and capital resources;
2. He would have to be willing and able to assume considerable financial risks in adopting the package;
3. He would have to be willing to market a large percentage of his agricultural produce each year and be confident of access to the necessary markets;
4. He would have to be willing and able to allocate his labor and probably that of his family exclusively to crop activities during the crop season.

The field observations made by the team in Niamey Department during July and August this year do not provide prima facie evidence that there is a large population of farmers who have all of these characteristics.

The existing package recommendations, dating from an earlier era when farming systems were less known, pose three levels of ascending analytical difficulty for an economist. The levels of analysis necessary to make some judgment about the packages are:

1. Analysis of the financial attractiveness of package adoption to the farm family in contrast to "traditional" cropping practices;
2. Analysis of the economic feasibility of package adoption for Nigerien society;
3. Analysis of the relevance of the packages to the Nigerien farming population in the context of the total range of rural activities.

The team decided that the use of crop enterprise budgets was appropriate in determining the financial and economic viability of the various technical packages. This format was particularly appealing because it forced us to think through and analyze each step in the crop production processes dictated or implied by the technical packages and to attempt to attach appropriate technical coefficients and costs to each step. Furthermore, the crop enterprise budget approach allows one to take into account interactions with other crop enterprises in the farm situation under

examination. This is particularly important when considering the benefits and costs of animal-traction techniques because, whereas most benefits can be attributed to the crop on a per hectare basis, most costs are fixed and are shared with other crop enterprises. In addition, these fixed costs for animal traction equipment and animals need to be pro-rated over the number of hectares in production on any given farm.

Crop enterprise budgets also allow consideration of a number of important variables in the production process which are often overlooked in more generalized benefit/cost analyses of the type done in project design and evaluation efforts. Among the variables which the team thought might be key elements in package analyses, after our field interviews were completed, were the following:

1. The location of the farm with respect to the prevailing rainfall isohyets in Niger;
2. The level of technology used in the crop production process;
3. The size of the farm with respect to the number of hectares cultivated and the size of the family labor force;
4. The impacts of different sets of financial and economic prices on package viabilities.

As a consequence of our team discussions, 192 crop enterprise budgets were prepared for analyzing the four major crops grown in Niamey Department and in Niger as a whole. For each crop -- millet, sorghum, cowpeas and peanuts -- 48 budgets were assembled based upon the data collected in our field interviews with farmers, visits with agricultural technicians and other interested persons, and our review of the literature as reflected in the bibliography, Annex G. Each set of enterprise budgets for an individual crop reflects the importance of the variables mentioned above in the following ways:

1. In any complete set of 48 budgets for a crop, 24 are calculated using financial prices (the actual prices faced by farmers in 1983 in Niamey Department in

growing and selling their crops) and 24 are calculated using economic prices (prices adjusted to remove government subsidies and in general terms, reflect the real costs of production, importation into Niger, and/or local factor prices).

2. Next, of the 24 budgets in each crop financial and economic sub-set, 12 are calculated under the assumption that crop production takes place in that portion of Niamey Department receiving 400 millimeters or more of rainfall during the crop growing season, and 12 are calculated for areas receiving less than 400 millimeters of rainfall.
3. Furthermore, for each sub-set of 12 budgets by rainfall zone, three are calculated under the assumption of "traditional" crop technology, i.e. the farmer does not adopt the package in question; three under the assumption of "partial" package adoption, i.e. the farmer adopts all recommendations of the crop package except those concerning animal traction equipment; three under the assumption of "full" package adoption using a donkey as the single draft animal; and, finally, three under the assumption of "full" package adoption using a pair of oxen.
4. Lastly, with each sub-set of three budgets by level of "package" adoption, each individual budget represents a set of assumptions about farm size and farm family labor availability which we have arbitarily labeled Farm Types I, II and III. These assumed farm types are meant to be representative of actual farm situations in Niamey Department and are explained in more detail in Annex B. See also Figure 2 below.

The result of this rather complicated exercise is a series of indicators. In preliminary fashion, these indicators allow one to estimate the relative financial and economic viability of each individual crop package on a per hectare basis: first, under different conditions for adoption of the same package;

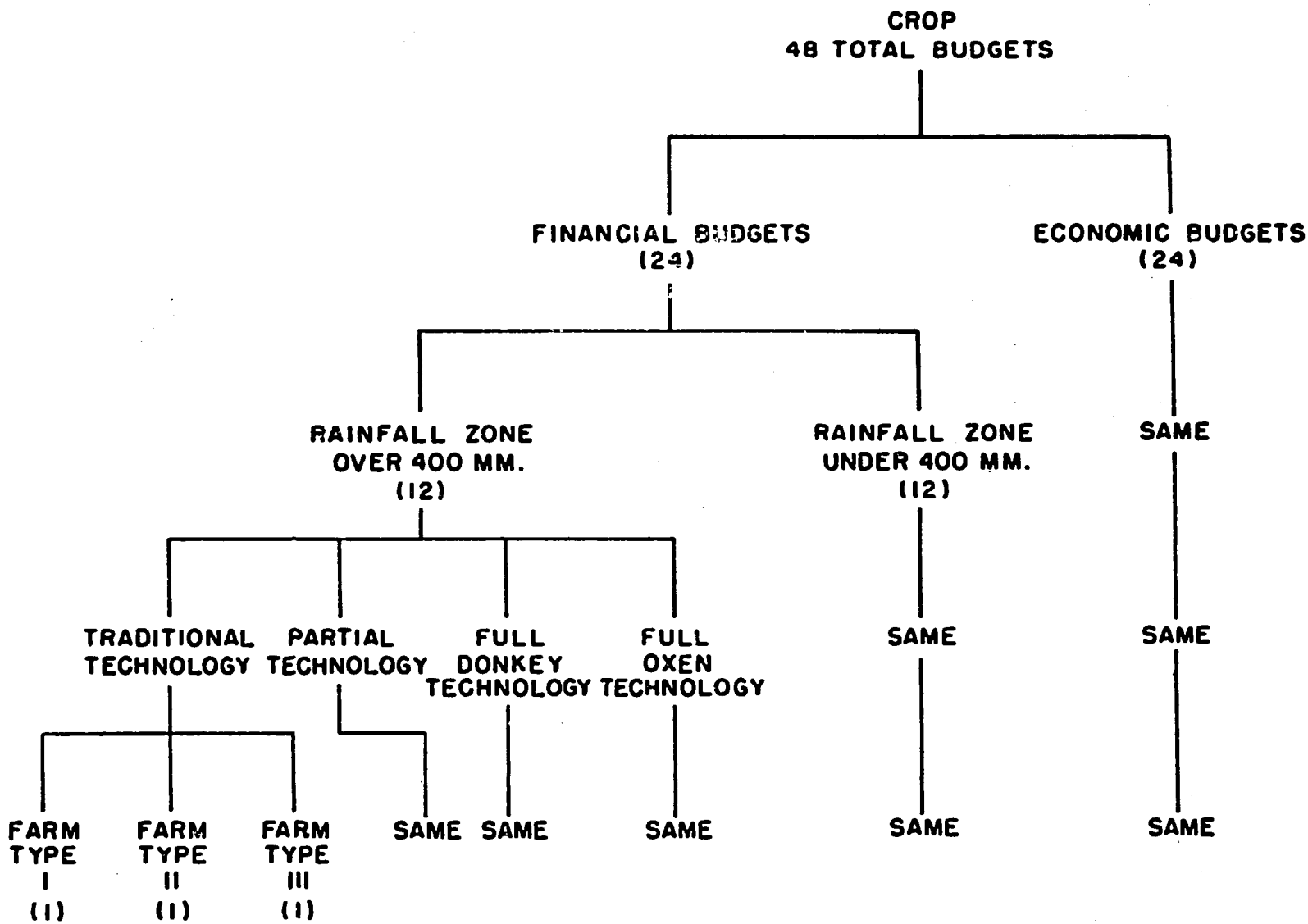

FIGURE 2. SCHEMA FOR CROP ENTERPRISE BUDGETS

and, second, for adoption of different crop packages under the same farm conditions. In short, then, the results following from the crop enterprise budgets map out a terrain which bounds most of the important conditions affecting package adoption as they were viewed by the team in Niger. The details of the results and assumptions for each crop enterprise budget are contained in Annex B in the following order: millet (enterprise budgets B-1 to B-48), sorghum (enterprise budgets B-49 to B-96), cowpeas (enterprise budgets B-97 to B-144) and peanuts (enterprise budgets B-145 to B-192).

It should be evident in the descriptions above that we have omitted two major field crops from full crop enterprise budgeting: maize and cotton. These two crops were handled differently because maize is currently a very minor crop in Niamey Department and cotton is not produced at all. Crop enterprise budgeting was attempted for maize basically as a possible replacement crop for sorghum on the better soils. However, it was found that there was insufficient information on virtually every critical maize coefficient to produce worthwhile budgets and the exercise was terminated. No budgeting was done for cotton for two reasons. First, the team saw no immediate prospects for cotton as a crop to compete significantly with millet, sorghum, cowpeas or peanuts in Niamey Department -- or elsewhere in Niger, outside the CFDT areas and/or selected irrigated perimeters. Second, the team was unable to collect any meaningful information on cotton cultivation from farmers in our survey area, and any producers who could have provided such field data were at some distance from Niamey Department.

B. CROP ENTERPRISE BUDGET RESULTS

In presenting the results of our crop budgeting exercise, we have used five indicators of financial and economic viability. They are the following:

1. Operator Labor and Management Return per Hectare;
2. Effective Wage Rate per Man-day;

3. Percentage of crop production required to reimburse annual cash production costs;
4. Number of kilograms of crop product, net of required sales, available to the farm family for on-farm consumption and other uses;
5. Benefit/cost ratio for 1983 crop production per hectare.

MILLET

As can be seen in Figures 3 and 4 below, millet, as a crop in pure stands and in association with cowpeas, completely dominates aggregate crop production in Niger. This crop is estimated to have been harvested from an averge of 60.3 percent of total harvested hectarage in Niger over the period 1977 to 1980. The percentage of harvested hectares is even higher in Niamey Department (74 percent) and, if one assumes that virtually all millet is grown in association with cowpeas, the total harvested hectarage devoted to this intercropping pattern is more than 85 percent of harvested hectares in the six major field crops.

If one looks at aggregate crop production, the same pattern is apparent. Millet production in gross tonnage accounts for 78.8 percent of all major crop production in Niamey Department and 62.2 percent in Niger as a whole. Millet and cowpeas account for 90.1 percent of aggregate crop production in Niamey Department and 77.3 percent for the country.

As has been postulated by numerous observers of Nigerien agriculture, we believe most farm families in Niger develop their annual crop production strategies around the central objective of producing quantities of millet sufficient to satisfy projected annual family grain consumption needs. They modify their inputs into millet production as the crop season progresses and then optimize the utilization of their residual family resources -- i.e. land, labor, capital and managerial skills -- in the production of other dryland crops and/or other off-farm activities. We see that this cropping strategy is further extended to aggregate crop sales behavior where relatively low percentages of the annual millet crop actually enter commercial channels through

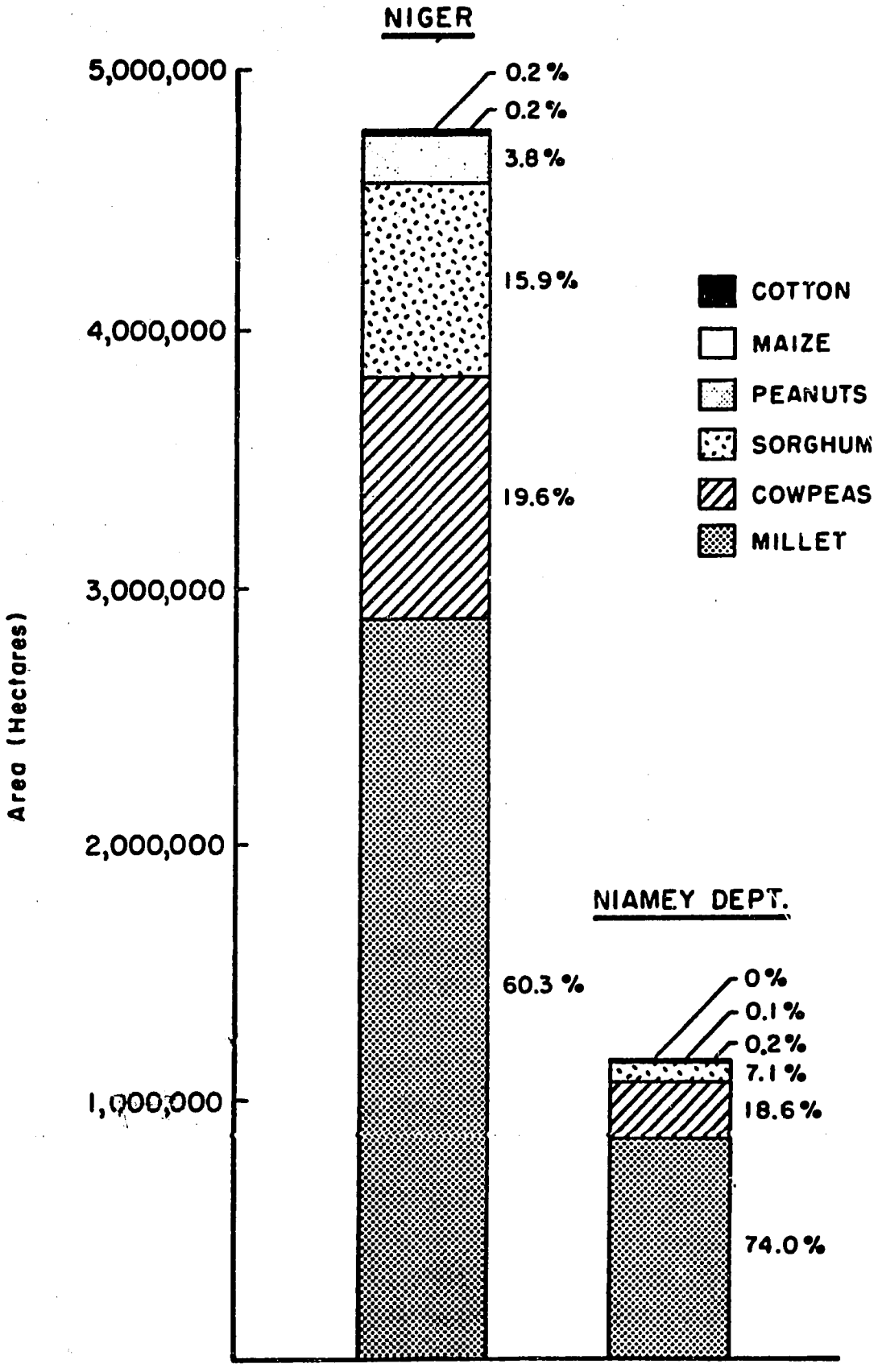

FIGURE 3. AVERAGE AREA HARVESTED BY MAJOR CROPS AS PERCENT OF TOTAL AREA HARVESTED IN MAJOR CROPS IN NIGER, 1977-80

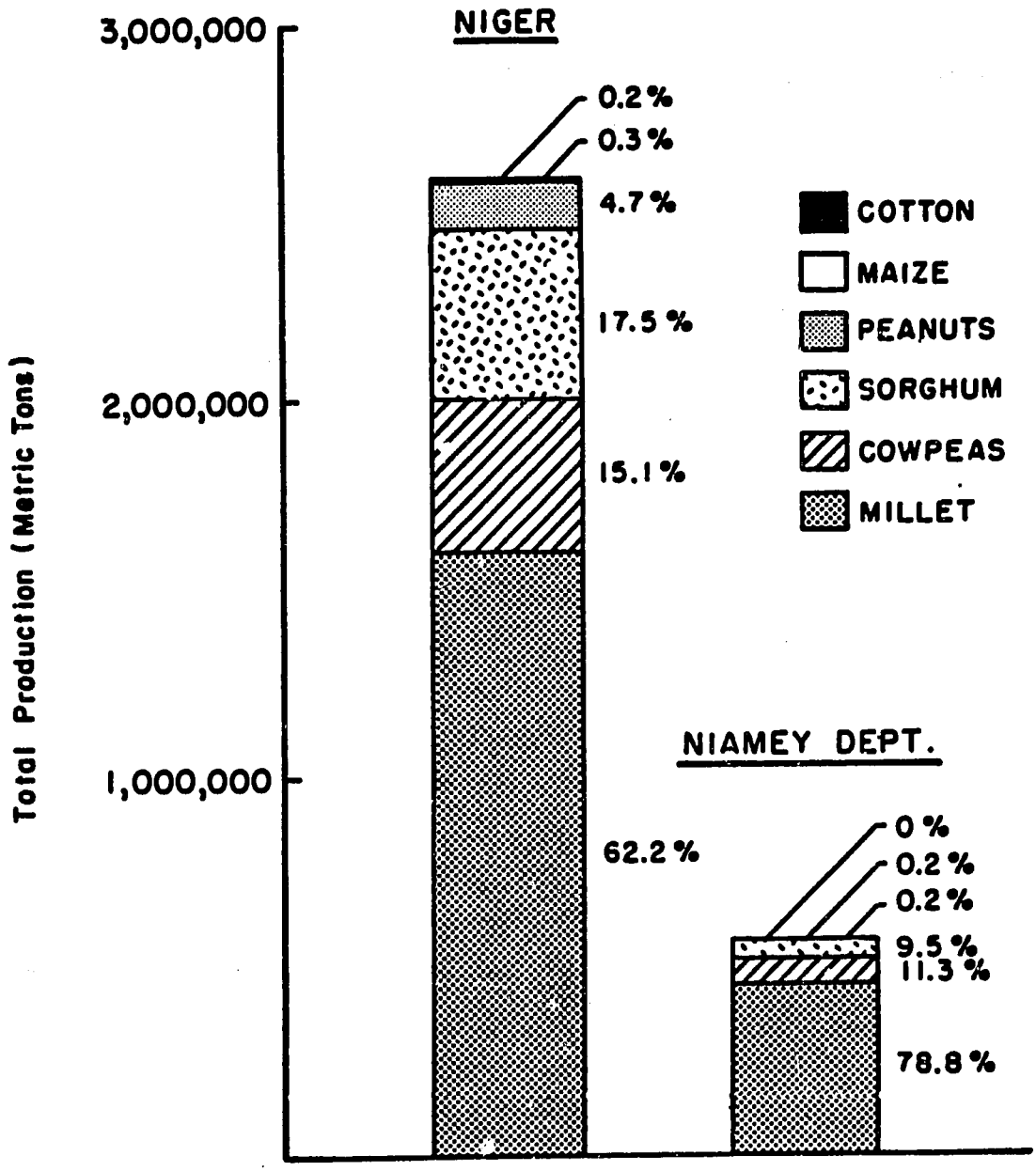

FIGURE 4. AVERAGE PRODUCTION OF MAJOR CROPS AS PERCENT OF TOTAL PRODUCTION OF MAJOR CROPS IN NIGER, 1977-80

direct farmer sales. Farm families seem to go to considerable pains to avoid unnecessary depletion of on-farm millet stocks. Farmers seem to grow and retain quantities of millet commensurate with their family's consumption needs and local obligations. In short, we believe that there are very few, if any, farm situations in Niger where millet is grown in significant quantities as a wholly commercial crop.

If this interpretation of farmer behavior is essentially correct, then development of improved agronomic practices for millet is absolutely critical for Nigerien agriculture. This need for improvement in the efficiency with which millet is produced per man-day of labor expended and per hectare of land used is vital not only in the sense of having sufficient millet for a rapidly growing population. It is also vital in the sense that success with this particular package is critically linked to the future prospects for all of the other major dryland crops.

In a very real way, the perceived need to produce sufficient millet in Niger can be seen as a major constraint on expansion of the other crops. Current millet production techniques are highly inefficient in modern agricultural terms and have the practical consequence of tying up large quantities of both labor and land in production processes which yield low returns. It would seem to us, however, that any real diversification in crop production away from millet and toward higher value crops can only be expected to take place on Nigerien farms as land and labor efficiencies in millet production improve on a sustainable basis. Only then will Nigerien farmers begin to feel sufficiently confident in their abilities to produce adequate quantities of their basic foodgrain and have the flexibility within their farming systems to grow large hectarages of higher value crops, even as wholly commercial ventures.

In this regard, the results of our millet enterprise budgeting exercise are somewhat mixed but encouraging in financial terms, particularly for the south of Niamey Department as can be seen in Table 1. Under the set of assumptions retained for our

TABLE 1: INDICATORS OF THE FINANCIAL VIABILITY OF MILLET PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-1	(47,575)[3]	405	10.0	387	.43
Type II, South, "Traditional"	B-2	(47,115)	411	8.6	393	.43
Type III, South, "Traditional"	B-3	(47,000)	413	8.1	395	.43
Type I, North, "Traditional"	B-13	(16,155)	399	16.2	218	.57
Type II, North, "Traditional"	B-14	(15,695)	409	13.8	224	.58
Type III, North, "Traditional"	B-15	(15,580)	411	13.1	226	.58
Type I, South, "Partial"	B-4	(38,885)	595	18.4	673	.64
Type II, South, "Partial"	B-5	(38,425)	600	17.6	680	.64
Type III, South, "Partial"	B-6	(38,310)	601	17.5	681	.64
Type I, North, "Partial"	B-16	(14,185)	492	32.8	311	.73
Type II, North, "Partial"	B-17	(13,725)	500	31.3	318	.74
Type III, North, "Partial"	B-18	(13,610)	503	31.1	319	.74
Type I, South, "Full, donkey"	B-7	(8,518)	871	20.9	719	.90
Type II, South, "Full, donkey"	B-8	(6,683)	899	19.1	735	.92
Type III, South, "Full, donkey"	B-9	(4,918)	925	18.0	746	.94
Type I, North, "Full, donkey"	B-19	(6,032)	603	36.0	330	.88
Type II, North, "Full, donkey"	B-20	(3,839)	656	33.3	344	.92
Type III, North, "Full, donkey"	B-21	(2,531)	691	32.0	351	.95
Type I, South, "Full, oxen"	B-10	(7,097)	873	30.8	629	.92
Type II, South, "Full, oxen"	B-11	(4,305)	923	28.5	650	.95
Type III, South, "Full, oxen"	B-12	(812)	986	25.1	681	.99
Type I, North, "Full, oxen"	B-22	(9,416)	496	50.2	257	.82
Type II, North, "Full, oxen"	B-23	(6,400)	577	45.9	279	.87
Type III, North, "Full, oxen"	B-24	(4,025)	641	42.1	299	.92

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
[3]Figure in brackets ( ) signifies it is a negative number.

Source: Annex B, Volume I of this report.

budgets, it appears evident that farmers in the south could make considerable gains by adopting the proposed millet package, with or without the animal traction component.

Results of "Traditional" Millet Budgets

In examining the "traditional" millet budgets in financial terms, one finds that the Effective Wage Rate[1] of labor expended in millet production is approximately 410 CFA francs. There is little variation in this figure between north and south, chiefly because higher yields in the south are offset by higher labor requirements needed to produce them. Farm size does not seem to be a significant variable affecting Effective Wage Rates in either area.

When one studies the results in terms of Operator Labor and Management Returns per hectare[1], however, in both north and south, the consequences of having to tie one's labor to millet production are evident. It is clearly costly in lost income from alternative employment to produce millet under "traditional" technology. Stated slightly differently, the results show that if a farmer in these circumstances had the alternative of hiring himself out as a day laborer at the prevailing wage, he might be well advised to do so in strictly financial terms, dropping out of millet production altogether.

Operator Labor and Management Returns are even more negative in the south. This is a reflection of the need for more labor per hectare to produce millet in the south -- the result of a more serious weeding problem over a longer growing season -- and

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[1]The Effective Wage Rate per man-day indicator is calculated in the enterprise budgets as [(total receipts per hectare) - (total expenses per hectare)] ÷ total man-days of labor expended per hectare. This indicator makes no a priori assumption about the opportunity cost of labor in the north and south of Niamey Department. Operator Labor and Management Return per hectare, on the other hand, is calculated as [(total receipts per hectare) - (total expenses per hectare)]. It includes as one of the expenses an opportunity cost per man-day of family labor expended. The assumed opportunity costs of such labor per man-day are 1,000 CFA francs in the south and 750 CFA francs in the north of Niamey Department.

the higher opportunity cost of that labor. Income losses from these factors are estimated to be approximately three times higher in the south.

There is already some evidence, particularly from southern Niamey Department, that many farmers are carefully weighing the option of dropping out of millet production for other employment. Some are choosing in favor of seasonal and longer-term migration in search of more lucrative situations. There are, of course, many reasons why this option out of farming is not exercised by more farmers. One is that local factor markets for unskilled, casual labor probably operate in a highly irregular fashion throughout the region. A second is that local grain markets function in a somewhat similar way. The first problem makes opting out of millet farming difficult unless the farmer is prepared to migrate for an extended period of time. The second means that the farmer choosing this course of action may not always be able to guarantee his family's supply of foodgrains from convenient local market purchases at reasonable prices, even if he has adequate cash available from alternative employment.

Other indicators show that, under the "traditional" millet system, the farmer must market only a small percentage of the crop to cover his cash production costs and he has no capital investment repayments to make to creditors. As a consequence, the farm family can retain 90 percent or more of the crop in the south and well over 80 percent in the north for family consumption and/or discretionary sales during the coming year.

As can be seen in Table 2, which presents the same indicators from budgets using economic rather than financial prices, the figures for the "traditional" millet system do not change. This occurs because this system, as defined in the budgets, uses virtually no purchased inputs and depends on no outside services and, therefore, incurs no penalties when production costs are re-evaluated in economic rather than financial terms.

TABLE 2: INDICATORS OF THE ECONOMIC VIABILITY OF MILLET PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-25	(47,575)[3]	405	10.0	387	.43
Type II, South, "Traditional"	B-26	(47,115)	411	8.6	393	.43
Type III, South, "Traditional"	B-27	(47,000)	413	8.1	395	.43
Type I, North, "Traditional"	B-37	(16,155)	399	16.2	218	.57
Type II, North, "Traditional"	B-38	(15,695)	409	13.8	224	.58
Type III, North, "Traditional"	B-39	(15,580)	411	13.1	226	.58
Type I, South, "Partial"	B-28	(61,361)	361	51.5	400	.53
Type II, South, "Partial"	B-29	(60,871)	366	50.7	407	.53
Type III, South, "Partial"	B-30	(59,701)	378	50.4	409	.54
Type I, North, "Partial"	B-40	(36,661)	83	91.8	38	.51
Type II, North, "Partial"	B-41	(36,171)	92	90.3	45	.52
Type III, North, "Partial"	B-42	(36,051)	95	89.8	47	.52
Type I, South, "Full, donkey"	B-31	(38,530)	416	55.2	407	.66
Type II, South, "Full, donkey"	B-32	(33,388)	494	51.9	437	.69
Type III, South, "Full, donkey"	B-33	(30,047)	545	49.9	455	.72
Type I, North, "Full, donkey"	B-43	(33,496)	(67)	94.2	30	.56
Type II, North, "Full, donkey"	B-44	(29,643)	27	89.9	52	.59
Type III, North, "Full, donkey"	B-45	(27,225)	86	87.4	65	.61
Type I, South, "Full, oxen"	B-34	(40,673)	274	66.6	304	.69
Type II, South, "Full, oxen"	B-35	(33,871)	395	62.8	338	.69
Type III, South, "Full, oxen"	B-36	(28,276)	495	58.2	380	.73
Type I, North, "Full, oxen"	B-46	(38,411)	(288)	100.0	0	.53
Type II, North, "Full, oxen"	B-47	(33,192)	(147)	100.0	0	.56
Type III, North, "Full, oxen"	B-48	(30,029)	(62)	100.0	0	.59

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
[3]Figure in brackets ( ) signifies it is a negative number.

Source: Annex B, Volume I of this report.

Results of "Partial" Millet Budgets

The "partial" millet system adopted in these enterprise budgets is defined as the farmer implementing all of the millet package recommendations except those connected with animal traction equipment. It is viewed as the likely intermediate adopter position on the millet package and was obviously quite attractive to many of the farmers interviewed by our team. Most of these men envisioned gradually working into a position of "full" package adoption by starting with this intermediate set of practices and using the profits from them to build up the capital for a downpayment and eventual purchase of animal traction equipment and a cart.

Under these circumstances, the farmer adopting the "partial" package immediately faces two new and possibly frightening prospects. First, he loses discretionary control of a larger percentage of his harvested millet since he must now reimburse the costs of the improved technology through market sales. Second, he runs the real risk of having to bear larger financial losses than his more "traditional" neighbors should the crop fail for lack of rainfall or any other reason. Adding further to this point, it should be remembered that, under present conditions, any such financial losses would have to be borne as out-of-pocket losses by the farm family since the farmer has no recourse to seasonal production credit from the government.

On the other hand, if the conditions set forth in the technical package are met and the season is reasonably typical, the farmer appears to be able to make considerable gains from his adoption of the new practices. The Effective Wage Rate per manday in all financial budgets improves by more than 20 percent, with larger gains in the south. Operator Labor and Management Returns per hectare, while still not comparable to returns from day labor, improve over the returns under the "traditional" system in comparable farm situations. Finally, while the farmer must now sell approximately twice the percentage of the harvest required under the "traditional" system and much larger amounts

of millet when measured in kilograms, projected yield increases, due principally to the applications of inorganic fertilizers, allow him to increase his millet stocks for family use by about 100 kilograms per hectare of millet grown in the north and by over 300 kilograms per hectare in the south.

Unfortunately, when the same budgets are evaluated using economic prices, the prospects for the viability of "partial" package adoption change rather dramatically, particularly in the north. The Effective Wage Rates per man-day drop below those obtained in the "traditional" system in both areas and, in the north, they drop below 100 CFA francs per man-day expended in millet production. Similarly, Operator Labor and Management Returns per hectare also increase in a negative direction. This means that the farmer adopting the "partial" package incurs even larger losses of potential income from outside jobs than his neighbor who uses the "traditional" system. Finally, the percentages of the crop needed to reimburse cash production costs jump in the south from 8 to 10 percent under the "traditional" system to about 50 percent. In the north, percentages increase from about 15 percent of the crop to about 90 percent of the crop. Even with the projected yield increases, the farmer in the south can retain only about the same amount of millet for family use as his neighbor using the "traditional" system. In the north, the farmer and his family work a greater number of days producing their millet and bear much greater financial risks than their "traditional" neighbors. They end up with a return of less than 50 kilograms of the crop per hectare for family use, after paying off their cash production costs.

Results of "Full" Millet Budgets

As will be recalled from earlier explanations, the "full" package budgets in our report are calculated in two different sets. One set is for the farmer who adopts the package using a donkey and its related equipment for tillage operations and the other set is for the farmer using a pair of oxen. The principal differences between the two sets of budgets are attributable to

the much higher costs of purchasing and maintaining a pair of oxen for farm work and the time differentials in performing field operations with oxen versus donkeys.

When reviewing the budget results, moreover, the reader should be alert to the fact that we have presented what we believe is essentially the most optimistic picture possible for animal traction use in Niger. This is so because:

1. We have not considered losses in work time and/or cash due to draft animal morbidity or mortality;
2. We have assumed for oxen that the farmer can and does fatten them for slaughter at the end of their productive lives and, thereby, recovers a substantial portion of their initial cost;
3. We have assumed that the farmer uses his oxen or donkey, with the appropriate cart, to generate additional income in 75 days of off-farm use and thus reduces considerably the pro-rated costs attributable to crop production on a per hectare basis; and,
4. We have assumed a 20 percent yield increase per hectare over "traditional" crop yields, across the board, to account for all the alleged but, as yet, unproven benefits of animal traction techniques over and above those attributable to "partial" package adoption of inorganic fertilizers, fungicides, and improved seeds.

It is quite evident, however, from our field interviews with farmers (see Annex C) that these optimistic assumptions about the uses of animal traction are seldom, if ever, fully met. Hence, actual on-farm results with animal traction techniques are almost certain to be worse than those projected in our budgets.

Under the assumptions in the budgets, if one evaluates millet production in financial terms, the indicators are encouraging, particularly in the south. In every farm situation, the farmer makes considerable gains from adoption of the package, with gains being slightly higher in most indicators with use of a donkey as opposed to a pair of oxen. The results obtained are substantially higher than those of the "traditional" system, on

the order of 75 to 100 percent for each indicator. The gains are also significant when juxtaposed with those from adoption of the "partial" package. Finally, unlike either large "traditional" farms or large farms of "partial" package adopters, large farms using the "full" package with either a donkey or oxen get the additional benefit of a scale effect. This comes about simply because "full" package adoption entails high fixed costs for animals and equipment and the ability to spread use of this equipment over a larger number of crop hectares reduces the prorated per hectare charges for any individual crop. The scale effects are estimated to be on the order of 6 to 12 percent when one moves from a Type I to Type III farm in the south and 14 to 29 percent in the north.

When the crop enterprise budgets are calculated with economic prices, however, the picture changes radically and negatively. Almost all farms using the "full" millet package have end-results that are worse than results from the "traditional" millet system. The sole exception is millet production using donkey equipment in the south. In these situations, the best that a farmer can hope for from millet production, after assuming all the risks inherent in "full" package adoption, is rough parity with his neighbors using the "traditional" system. In the worst case, using a pair of oxen in the north, the farmer, under the assumptions of our budgets, must sell 100 percent of his crop in the attempt to cover his annual cash production costs -- with no loan repayments included -- and he still finds he must use other family funds to meet the full per hectare costs for millet production.

SORGHUM

As can be seen in Figures 3 and 4, sorghum is a relatively minor crop in Niamey Department. It occupies only about one-tenth of the land devoted to millet and supplies about 12 percent of millet's average contribution to foodgrain stocks. Nationally, sorghum is planted on about 16 percent of the land devoted to the six major field crops and contributes on average one kilogram

TABLE 3: INDICATORS OF THE FINANCIAL VIABILITY OF SORGHUM PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-49	(55,725)[3]	474	7.5	601	.49
Type II, South, "Traditional"	B-50	(55,215)	479	6.5	608	.49
Type III, South, "Traditional"	B-51	(55,090)	480	6.3	609	.50
Type I, North, "Traditional"	B-61	(15,455)	492	12.3	351	.68
Type II, North, "Traditional"	B-62	(14,965)	501	10.5	358	.69
Type III, North, "Traditional"	B-63	(14,850)	503	10.3	359	.69
Type I, South, "Partial"	B-52	(48,695)	607	15.5	892	.64
Type II, South, "Partial"	B-53	(48,200)	611	14.8	899	.65
Type III, South, "Partial"	B-54	(48,085)	612	14.7	900	.65
Type I, North, "Partial"	B-64	(15,445)	532	27.0	440	.77
Type II, North, "Partial"	B-65	(14,835)	541	25.7	448	.77
Type III, North, "Partial"	B-66	(14,835)	541	25.7	448	.77
Type I, South, "Full, donkey"	B-55	17,940	1,299	17.4	971	1.22
Type II, South, "Full, donkey"	B-56	20,708	1,345	16.0	988	1.27
Type III, South, "Full, donkey"	B-57	22,290	1,372	15.2	997	1.29
Type I, North, "Full, donkey"	B-67	7,438	936	29.6	481	1.15
Type II, North, "Full, donkey"	B-68	10,044	1,001	27.2	497	1.21
Type III, North, "Full, donkey"	B-69	11,525	1,038	26.1	505	1.25
Type I, South, "Full, oxen"	B-58	18,344	1,367	26.1	869	1.23
Type II, South, "Full, oxen"	B-59	22,724	1,455	23.4	901	1.30
Type III, South, "Full, oxen"	B-60	26,665	1,533	20.9	930	1.37
Type I, North, "Full, oxen"	B-70	(149)	746	44.7	378	1.00
Type II, North, "Full, oxen"	B-71	4,324	870	40.3	408	1.08
Type III, North, "Full, oxen"	B-72	7,665	963	36.6	433	1.15

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
[3]Figure in brackets ( ) signifies it is a negative number.

Source: Annex B, Volume I of this report.

TABLE 4: INDICATORS OF THE ECONOMIC VIABILITY OF SORGHUM PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-73	(55,775)[3]	474	7.5	601	.49
Type II, South, "Traditional"	B-74	(55,215)	479	6.5	608	.49
Type III, South, "Traditional"	B-75	(55,090)	480	6.3	609	.50
Type I, North, "Traditional"	B-85	(15,455)	492	12.3	351	.68
Type II, North, "Traditional"	B-86	(14,965)	501	10.5	358	.69
Type III, North, "Traditional"	B-87	(14,850)	503	10.3	359	.69
Type I, South, "Partial"	B-76	(72,137)	418	42.6	606	.55
Type II, South, "Partial"	B-77	(71,627)	422	41.9	613	.55
Type III, South, "Partial"	B-78	(71,512)	423	41.8	614	.55
Type I, North, "Partial"	B-88	(38,887)	202	74.5	154	.56
Type II, North, "Partial"	B-89	(38,375)	209	73.3	161	.57
Type III, North, "Partial"	B-90	(38,262)	211	73.1	162	.57
Type I, South, "Full, donkey"	B-79	(13,363)	777	44.7	650	.88
Type II, South, "Full, donkey"	B-80	(7,803)	870	42.6	675	.93
Type III, South, "Full, donkey"	B-81	(4,709)	922	41.2	692	.95
Type I, North, "Full, donkey"	B-67	(24,118)	196	77.0	157	.70
Type II, North, "Full, donkey"	B-68	(18,767)	374	73.5	181	.75
Type III, North, "Full, donkey"	B-69	(15,736)	476	71.0	198	.78
Type I, South, "Full, oxen"	B-58	(18,982)	620	56.0	517	.84
Type II, South, "Full, oxen"	B-59	(9,674)	807	51.2	574	.91
Type III, South, "Full, oxen"	B-60	(2,026)	960	47.9	613	.98
Type I, North, "Full, oxen"	B-70	(39,817)	(356)	97.8	15	.59
Type II, North, "Full, oxen"	B-71	(29,676)	(74)	89.2	74	.66
Type III, North, "Full, oxen"	B-72	(23,093)	109	84.0	109	.71

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
[3]Figure in brackets ( ) signifies it is a negative number.

Source: Annex B, Volume I of this report.

of sorghum to 3.6 kilograms of millet in foodgrain stocks. Yields of sorghum per hectare are generally significantly higher than those for millet but it should be pointed out that sorghum is usually planted on better land -- i.e. soils in low-lying areas with more clay, loam and organic matter -- and in the higher rainfall areas. It is difficult, therefore, to determine whether sorghum is truly a more productive crop than millet over a broad spectrum of Nigerien growing conditions or whether it is simply more productive within a small range of more specialized environments.

In the absence of strong evidence to the contrary, we tend to believe that millet and sorghum should, in fact, be viewed as complementary crops in Niger, as opposed to a common view that they are resource competitive. We believe that the adaptive strategies of the farmers are such that sorghum, with its somewhat more demanding growth requirements, is planted under certain conditions as a secondary foodgrain. It is viewed, however, as a competing crop with millet over the full range of millet's growing conditions. In other words, whereas millet might compete with sorghum in plantings under better growing conditions in the south, sorghum cannot compete effectively with millet where growing conditions are poorer due to exhausted soils, lower rainfall or other negative factors.

Since Nigerien farmers face a wide range of crop conditions even within small geographical areas, a strategy of producing a range of crops with different growth characteristics on different land types and in different micro-climates makes good sense in terms of lowered risk and guaranteed, albeit low, levels of stable yields. It is not at all clear at present that an alternative strategy of encouraging farmers to grow crops in monocultures over large areas of their farms will be much more productive in the long run in Niger.

Results of "Traditional" Sorghum Budgets

The results of these budgets show that sorghum is significantly more profitable than millet under all indicators but

Operator Labor and Management Return. The Effective Wage Rate in sorghum production averages about 16 percent higher than that for millet in the south and 22 percent higher in the north. Moreover, due to higher yields per hectare, the farmer is required to sell a smaller percentage of his crop to meet his cash production costs and retains a much larger number of kilograms of grain in on-farm stocks.

Operator Labor and Management Returns per hectare are slightly more negative for sorghum than for millet under "traditional" production systems because of the slightly higher labor requirements per hectare for this crop -- i.e. for ridging and harvesting the larger crop. This is particularly true in the south where more labor is used and the opportunity cost of that labor is higher.

Results of "Partial" Sorghum Budgets

In financial terms, the pattern of higher profitability of sorghum vis-a-vis millet continues as one evaluates the budgets for "partial" package adoption. However, the magnitude of the differences between the crops appears to be less. The largest difference between the crops is in the amount of foodgrain stocks retained on-farm, net of necessary sales to cover cash production costs.

In economic terms, however, sorghum production is distinctly less attractive. If the farmer is obliged to pay economic prices for his inputs and receive them for his outputs, the profitability of sorghum under the "partial" system drops below that of sorghum under the "traditional" system for every indicator except kilograms of crop retained in the south. In the latter case, the farmer would be able to hold on to a marginally higher quantity of sorghum per hectare cultivated but this difference is not significant.

Results of "Full" Sorghum Budgets

When the farmer adopts the "full" package for sorghum, with either donkey or oxen power, he stands to make very substantial

gains by all our indicators and hence in net profitability per hectare, as compared with either the "traditional" or "partial" packages or with millet. Perhaps most significantly, the Operator Labor and Management Returns per hectare are positive for the first time, indicating that the farmer could clear returns in excess of those from off-farm day labor.

Other indicators are also encouraging. The benefit/cost ratios are greater than one for the first time. The profitability of sorghum production using a donkey for power is generally higher than package adoption with oxen, with the difference being due principally to the much lower cost of the donkey and donkey equipment.

When the budgets are evaluated using economic prices, we observe, again for the first time, that "full" package adoption, using either a donkey or oxen, in the south is superior to either the "partial" or the "traditional" systems. Only in the case of "full" package adoption with oxen in the north are returns such that the package is unattractive to the farmer. With "full" package adoption using a donkey in the north, returns are marginally better than those for "partial" package adoption but inferior to those to be had from sorghum production under the "traditional" system.

When sorghum returns for "full" package adoption are compared to those for millet, the former are superior for every indicator.

COWPEAS

The results of our budgets for cowpeas -- and for peanuts -- are quite different from those for the foodgrains. This is reflective of the fact that these leguminous crops are the principal cash crops in the Nigerien farmer's cropping strategy and, as such, present much better financial and economic prospects. Both crops produce two commodities in high demand in Niger and neighboring countries: the cowpeas or peanuts and their respective forages. These forages are high in protein and are an important dry season livestock feed resource. As such, they are

prized in local markets. Farmers often use such forages to fatten small ruminants and cattle on-farm for sale during holiday periods and at the end of the dry season. However, the value of these forages is usually overlooked in crop analyses despite the fact that their value often exceeds that of the cowpeas or peanuts themselves.

Results of "Traditional" Cowpea Budgets

Since, under "traditional" crop systems, cowpeas are usually grown in association with millet, the "traditional" budgets presented here calculate the contribution of this crop to the millet/cowpea association. This is particularly important when one allocates family labor times for the various field operations. In these budgets, cowpeas have been allocated only those marginal labor activities which are clearly specific to the crop, with all others being attributed to the millet, clearly the main crop for farmers.

Another factor which contributes to the pattern in the cowpea budgets and is open to further investigation, is the fact that current government statistics show no decline in cowpea yields as one moves from south to north. Such declines in yield are evident for all other crops over the same rainfall gradient and one sees no a priori reason why cowpeas should not be similarly affected. As a result of this statistical oddity, cowpea profitabilities turn out to be slightly higher in the north than in the south, which is the opposite of the normal pattern. Higher profitabilities result from getting essentially the same yield levels in the north and the south but having to devote less family labor to production of cowpeas in the former area.

As can be seen in Tables 5 and 6, all indicators are highly favorable for cowpeas both in north and south. The Operator Labor and Management Returns per hectare indicate that the farmer stands to make considerably more income for the same labor inputs in cowpea production as in off-farm day labor. Effective Wage Rates per man-day are approximately six times higher for cowpeas than for millet. Required crop sales are also relatively low,

TABLE 5: INDICATORS OF THE FINANCIAL VIABILITY OF COWPEA PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-97	33,350	2,573	30.6	125	2.25
Type II, South, "Traditional"	B-98	33,810	2,595	27.8	130	2.29
Type III, South, "Traditional"	B-99	33,925	2,600	27.2	131	2.30
Type I, North, "Traditional"	B-109	40,900	2,997	30.6	125	3.14
Type II, North, "Traditional"	B-110	41,360	3,023	27.8	130	3.22
Type III, North, "Traditional"	B-111	41,475	3,029	27.2	131	3.24
Type I, South, "Partial"	B-100	63,200	1,602	47.9	302	1.48
Type II, South, "Partial"	B-101	63,660	1,606	47.0	307	1.48
Type III, South, "Partial"	B-102	63,775	1,607	46.9	308	1.48
Type I, North, "Partial"	B-112	116,450	2,438	47.9	302	2.46
Type II, North, "Partial"	B-113	116,910	2,444	47.0	307	2.48
Type III, North, "Partial"	B-114	117,025	2,446	46.9	308	2.48
Type I, South, "Full, donkey"	B-103	129,164	2,769	44.1	389	2.19
Type II, South, "Full, donkey"	B-104	131,815	2,806	42.4	401	2.25
Type III, South, "Full, donkey"	B-105	133,095	2,823	41.4	408	2.27
Type I, North, "Full, donkey"	B-115	158,531	3,437	43.7	392	3.00
Type II, North, "Full, donkey"	B-116	160,784	3,475	42.1	403	3.09
Type III, North, "Full, donkey"	B-117	162,277	3,500	41.2	409	3.15
Type I, South, "Full, oxen"	B-106	130,266	3,068	54.7	315	2.21
Type II, South, "Full, oxen"	B-107	133,873	3,125	51.7	336	2.29
Type III, South, "Full, oxen"	B-108	137,064	3,176	49.0	355	2.36
Type I, North, "Full, oxen"	B-118	153,323	3,538	53.2	326	2.82
Type II, North, "Full, oxen"	B-119	156,950	3,604	50.3	346	2.95
Type III, North, "Full, oxen"	B-120	159,927	3,658	47.7	364	3.06

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.

Source: Annex B, Volume II of this report.

TABLE 6: INDICATORS OF THE ECONOMIC VIABILITY OF COWPEA PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-121	33,350	2,573	30.6	125	2.25
Type II, South, "Traditional"	B-122	33,810	2,595	27.8	130	2.29
Type III, South, "Traditional"	B-123	33,925	2,600	27.2	131	2.30
Type I, North, "Traditional"	B-133	40,900	2,997	30.6	125	3.14
Type II, North, "Traditional"	B-134	41,360	3,023	27.8	130	3.22
Type III, North, "Traditional"	B-135	41,475	3,029	27.2	131	3.24
Type I, South, "Partial"	B-124	40,770	1,388	86.6	78	1.26
Type II, South, "Partial"	B-125	41,230	1,393	85.9	82	1.27
Type III, South, "Partial"	B-126	41,345	1,394	85.7	83	1.27
Type I, North, "Partial"	B-136	94,020	2,113	86.6	78	1.92
Type II, North, "Partial"	B-137	94,480	2,119	85.9	82	1.93
Type III, North, "Partial"	B-138	94,595	2,121	85.7	83	1.93
Type I, South, "Full, donkey"	B-127	100,167	2,372	80.2	138	1.73
Type II, South, "Full, donkey"	B-128	105,310	2,442	76.7	162	1.80
Type III, South, "Full, donkey"	B-129	108,310	2,484	75.3	172	1.84
Type I, North, "Full, donkey"	B-139	129,735	2,949	79.7	141	2.20
Type II, North, "Full, donkey"	B-140	134,289	3,026	76.9	161	2.30
Type III, North, "Full, donkey"	B-141	137,253	3,076	75.1	173	2.37
Type I, South, "Full, oxen"	B-130	97,638	2,550	93.0	49	1.70
Type II, South, "Full, oxen"	B-131	104,852	2,664	88.1	83	1.79
Type III, South, "Full, oxen"	B-132	110,152	2,748	83.8	113	1.86
Type I, North, "Full, oxen"	B-142	121,332	2,956	90.5	66	2.04
Type II, North, "Full, oxen"	B-143	128,191	3,081	86.4	95	2.17
Type III, North, "Full, oxen"	B-144	133,401	3,175	82.5	122	2.28

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
Source: Annex B, Volume II of this report.

giving the farm family considerable discretionary control over the crop. And, finally, the benefit/cost ratios are greater than 2 in almost every farm situation.

Results of "Partial" Cowpea Budgets

When evaluated at financial prices, the adoption of the "partial" package is attractive to the Nigerien farmer. Although profitabilities by some of our indicators are somewhat less than under the "traditional" crop system -- mainly as a result of the fact that cowpeas are now grown in sole stands -- they are still high enough to be encouraging when compared to other crops. The Effective Wage Rates are about four times those from millet production. Operator Labor and Management Returns are higher than those under the "traditional" cowpea system. Although the percentage of the crop sold to cover cash production expenses rises to almost 50 percent, the farmer still retains two-and-one-half times the quantity of cowpeas retained under the "traditional" system plus a much larger quantity of forage.

Under economic prices, the profitabilities of cowpeas under the "partial" package drop rather significantly but remain positive. While they are no longer superior to profitabilities under the "traditional" system, they would still be clearly attractive to any farmer seeking to adopt both the "partial" package for millet and the "partial" package for cowpeas in his farming system since the profitabilities in cowpea production would serve to offset the lower ones in millet production. Under such conditions, an effective strategy might be to put the minimum level of farm inputs into millet production, sufficient to meet the family's consumption target, and devote the remaining resources to cowpea production.

Results of "Full" Cowpea Budgets

Under our [illegible]getary assumptions, the preferred method of cowpea production is adoption of the "full" package, with either a donkey or oxen as draft animals. This conclusion holds at both financial and economic prices. At financial prices, there is a

TABLE 7: INDICATORS OF THE FINANCIAL VIABILITY OF PEANUT PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-145	71,200	1,691	16.3	603	1.6
Type II, South, "Traditional"	B-146	71,660	1,696	15.4	609	1.7
Type III, South, "Traditional"	B-147	71,775	1,697	15.1	611	1.7
Type I, North, "Traditional"	B-157	83,500	1,688	18.4	518	2.1
Type II, North, "Traditional"	B-158	83,960	1,693	17.5	524	2.1
Type III, North, "Traditional"	B-159	84,075	1,695	17.2	526	2.1
Type I, South, "Partial"	B-148	88,910	1,823	31.7	584	1.7
Type II, South, "Partial"	B-149	89,370	1,828	30.9	591	1.7
Type III, South, "Partial"	B-150	89,485	1,829	30.8	592	1.7
Type I, North, "Partial"	B-160	102,460	1,840	35.2	499	2.2
Type II, North, "Partial"	B-161	102,920	1,845	34.3	506	2.2
Type III, North, "Partial"	B-162	103,035	1,846	34.0	508	2.2
Type I, South, "Full, donkey"	B-151	141,663	2,840	35.0	650	2.3
Type II, South, "Full, donkey"	B-152	146,987	2,909	31.9	681	2.4
Type III, South, "Full, donkey"	B-153	148,757	2,932	30.9	691	2.5
Type I, North, "Full, donkey"	B-163	133,577	3,120	36.6	569	2.5
Type II, North, "Full, donkey"	B-164	136,127	3,161	34.9	584	2.5
Type III, North, "Full, donkey"	B-165	137,920	3,189	33.8	594	2.6
Type I, South, "Full, oxen"	B-154	140,222	3,093	49.0	510	2.3
Type II, South, "Full, oxen"	B-155	145,739	3,175	44.6	554	2.4
Type III, South, "Full, oxen"	B-156	150,115	3,241	40.8	592	2.5
Type I, North, "Full, oxen"	B-166	126,954	3,152	49.8	450	2.3
Type II, North, "Full, oxen"	B-167	131,516	3,229	46.0	484	2.4
Type III, North, "Full, oxen"	B-168	135,079	3,289	42.7	514	2.5

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.
Source: Annex B, Volume II of this report.

TABLE 8: INDICATORS OF THE ECONOMIC VIABILITY OF PEANUT PRODUCTION FROM THE ENTERPRISE BUDGETS

Farm Situation	Budget Number	OLMR[1]	EWR[2]	Percent of Crop Sold	Kilograms of Crop Held For Family Consumption	1983 Benefit/Cost Ratio for the Crop
Type I, South, "Traditional"	B-169	71,200	1,691	16.3	603	1.6
Type II, South, "Traditional"	B-170	71,660	1,696	15.4	609	1.7
Type III, South, "Traditional"	B-171	71,775	1,697	15.1	611	1.7
Type I, North, "Traditional"	B-181	83,500	1,688	18.4	518	2.1
Type II, North, "Traditional"	B-182	83,960	1,693	17.5	524	2.1
Type III, North, "Traditional"	B-183	84,075	1,695	17.2	526	2.1
Type I, South, "Partial"	B-172	68,236	1,632	66.2	289	1.5
Type II, South, "Partial"	B-173	68,696	1,636	65.4	296	1.5
Type III, South, "Partial"	B-174	68,811	1,637	65.3	297	1.5
Type I, North, "Partial"	B-184	81,786	1,620	73.5	204	1.7
Type II, North, "Partial"	B-185	82,246	1,625	72.6	211	1.8
Type III, North, "Partial"	B-186	82,361	1,626	72.5	212	1.8
Type I, South, "Full, donkey"	B-175	113,562	2,475	68.6	314	1.8
Type II, South, "Full, donkey"	B-176	121,794	2,582	64.1	359	1.9
Type III, South, "Full, donkey"	B-177	125,199	2,626	62.1	379	2.0
Type I, North, "Full, donkey"	B-187	104,724	2,662	75.0	224	1.9
Type II, North, "Full, donkey"	B-188	110,465	2,753	71.1	259	2.0
Type III, North, "Full, donkey"	B-189	114,127	2,812	68.8	280	2.0
Type I, South, "Full, oxen"	B-178	104,510	2,560	87.2	128	1.7
Type II, South, "Full, oxen"	B-179	115,747	2,728	79.6	204	1.9
Type III, South, "Full, oxen"	B-180	123,560	2,844	74.0	260	2.0
Type I, North, "Full, oxen"	B-190	92,589	2,569	91.3	78	1.7
Type II, North, "Full, oxen"	B-191	102,427	2,736	84.5	139	1.8
Type III, North, "Full, oxen"	B-192	109,045	2,848	79.3	186	1.9

Footnotes: [1]Operator Labor and Management Return Per Hectare in CFA Francs.
[2]Effective Wage Rate Per Man-day in CFA Francs.

Source: Annex B, Volume II of this report.

marginal benefit to be derived from using oxen, as opposed to a donkey, as the draft animals. At economic prices, use of a donkey would be preferred but the margin of difference is not very great. Finally, as a result of the uniformity of cowpea yields across the rainfall gradient mentioned above, profitabilities for this crop are slightly higher in the north, although we view this outcome with considerable skepticism.

PEANUTS

Peanuts were once the principal cash crop for farmers in Niger. Over the past decade, however, production of this crop has been declining rapidly. It can now be classified as a minor crop both in Niamey Department and in the country as a whole. In Niamey Department, less than one percent of the land cultivated is planted to peanuts, and peanuts contribute less than one percent of aggregate crop production, exclusive of forage. Our field observations indicate, moreover, that peanuts are cultivated primarily by women as a crop for family consumption and limited local sales. We saw no large fields of peanuts and spoke to no farmers who were growing this crop using the recommendations of the INRAN peanut technical package.

The preference that Nigerien farmers show for cowpeas over peanuts is somewhat inexplicable, based on our budget calculations, unless cowpeas are judged superior because of their higher production of forage per hectare cultivated.

Results of "Traditional" Peanut Budgets

The indicators for "traditional" peanut production are calculated on the assumption that peanuts are grown in sole stands. This was done because we found no evidence that any significant hectarage of Niamey Department was planted to an association of peanuts and a foodgrain crop. This is a pattern which is distinctly different from cowpeas, since virtually all cowpeas, not grown under strict package recommendations, are grown in association with millet. For this reason, the "traditional" peanut budgets are not directly comparable to the "traditional" budgets for cowpeas.

The indicators for peanuts under the "traditional" system show that this crop is much superior to either of the foodgrains in profitability to the farmer. All Operator Labor and Management Returns per hectare are positive at greater than 70,000 CFA francs. Effective Wage Rates per man-day are approximately four times those for millet. Relatively low percentages of the crop need to be sold to cover cash production expenses, leaving the farmer with considerable discretionary power over the final disposition of his crop. Finally, benefit/cost ratios are significantly greater than 1 for all cases evaluated under the "traditional" system.

Results of "Partial" Peanut Budgets

With "partial" package adoption, peanuts follow essentially the same pattern of profitabilities as cowpeas. The single significant difference is that peanuts are marginally more profitable than cowpeas in the south whereas cowpeas are clearly superior in the north. This difference, however, is linked to the government statistical reporting on cowpeas yields and, as stated previously, this is somewhat suspect.

Results of "Full" Peanut Budgets

"Full" package adoption results approximate those for cowpeas at financial and economic prices. Again, peanut cultivation is marginally more profitable -- with a donkey or an ox team -- in the south, whereas cowpeas are more profitable in the north. Economic profitabilities are lower than those calculated with financial prices, as would be expected, but even under these conditions peanuts would make a substantial contribution to overall farm income.

MAIZE

Maize was not the subject of a crop enterprise budgeting exercise in this report because insufficient information was found on either technical response coefficients or input/output prices to permit such work. However, our field observations --

and subsequent review of the existing literature -- have led us to the following conclusions about this crop:

1. The growing conditions required for successful maize production make it unlikely that this crop will ever be a major contributor to aggregate foodgrain production in Niger.
2. Where maize is grown in Niger -- i.e. in higher rainfall areas on the better soils with heavy manuring -- it is likely to be a competitor only with sorghum.
3. Although maize may do well under irrigated conditions, it is not adapted for extensive use under dryland conditions because its root system is less extensive than that of either millet or sorghum and the plant is, therefore, more subject to moisture stress than either of these crops.
4. There is not likely to be a market for maize as foodgrain in Niger in excess of that which could be easily supplied from northern Nigeria, given the apparent success of the maize development program in that country.
5. Such local market demand as exists for maize on the cob for direct consumption as roasting ears can be easily satisfied from present production as a house-field crop.
6. Production of maize stover for forage is probably not very important given the present on-farm supplies of millet and sorghum stalks and the contributions from cowpea and peanut forages.

COTTON

The future of cotton production in Niger seems to be in considerable doubt and is, in any case, closely linked to the promotional efforts of CFDT and the Government of Niger in specific locations. We see no reason to believe that this crop will attain widespread acceptance among Nigerien farmers in the near-term, particularly in Niamey Department where it is unknown at present.

C. WHOLE FARM BUDGETS

In the preceeding section, the financial and economic profitabilities of crop production were evaluated from the perspective of per hectare crop enterprise budgets, using several different indicators. This type of budgeting is valuable in determining which crops actually contribute to increasing net farm incomes and which crops subtract from these incomes by generating more expenses than they return in receipts.

Under the assumptions incorporated in our farm enterprise budgets, we have seen that millet and sorghum often use more resources and generate more expenses than they return in farm receipts, measured either in cash or in kind. This was particularly true when these enterprises were evaluated using economic prices. Conversely, cowpeas and peanuts contributed to farm revenues in excess of their enterprise costs.

Enterprise budgets can contribute to evaluation of a farm operation only from a partial perspective. Whole farm budgets, on the other hand, attempt to put these pieces together and to present an integrated picture of the farm operation in terms of gross receipts, gross expenses, and net receipts. In doing so, whole farm budgets give us some ideas about the ability of the farmer and his family to satisfy their production and consumption objectives from the net receipts of their farming and related activities.

Without prejudging or weighting these production and consumption objectives, we believe that any farm operation must generate sufficient net receipts to cover four types of expenses, over and above the variable costs of annual crop production, if it expects to remain a viable operation in the long term. These expenses are:

1. The capital recovery costs necessary to replace the farm's equipment and draft animals;
2. The opportunity costs of family labor;
3. The repayment of any required annual loan repayments on capital equipment and draft animals;

TABLE 9: RESULTS OF WHOLE FARM BUDGETS FOR FARM SITUATIONS IN SOUTHERN NIAMEY DEPARTMENT UNDER FINANCIAL PRICES

Receipt/Expense	Farm Type, Location and Type of Draft Animal Utilized					
	Type I, South, Donkey	Type II, South, Donkey	Type III, South, Donkey	Type I, South, Oxen	Type II, South, Oxen	Type III, South, Oxen
	(In CFA Francs)					
A. Gross Receipts:						
1. Millet Grain	145,350	254,363	399,713	145,350	254,363	399,713
2. Sorghum Grain	18,740	32,795	46,850	18,740	32,795	46,850
3. Cowpeas	48,720	125,280	48,720	69,600	125,280	
Sub-Total	(212,810)	(356,758)	(571,843)	(212,810)	(356,758)	(571,843)
1. Millet Stover	14,600	25,550	40,150	14,600	25,550	40,150
2. Sorghum Stover	1,880	3,290	4,700	1,880	3,290	4,700
3. Cowpea Hay	117,600	168,000	302,400	117,600	168,000	302,400
Sub-Total	(134,080)	(196,840)	(347,250)	(134,080)	(196,840)	(347,250)
1. Cart Rental	150,000	150,000	150,000	150,000	150,000	150,000
Sub-Total	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)
Total Gross Receipts	496,890	703,598	1,069,093	496,890	703,598	1,069,093
B. Gross Expenses:						
1. Cash Production Expense: Millet	18,932	32,386	50,083	19,012	32,519	51,101
2. Cash Production Expense: Sorghum	2,064	3,612	5,160	2,087	3,652	5,217
3. Cash Production Expense: Cowpeas	12,238	17,483	31,469	12,421	17,744	31,939
4. Interest Paid on Animal Traction Package	7,241	7,241	7,241	17,271	17,271	17,271
5. Draft Animal Maintenance Expense	9,125	9,125	9,125	73,000	73,000	73,000
6. Cost of Expendable Hand Tools	6,900	9,200	13,800	6,900	9,200	13,800
Total Gross Expenses	56,500	79,047	116,878	130,691	153,386	192,328
C. Net Receipts Available	440,390	624,542	952,215	366,199	550,212	876,765
D. Charges Against Net Receipts:						
1. Capital Recovery on Animal Traction Package	18,100	18,100	18,100	23,713	23,713	23,713
2. Opportunity Cost of Family Labor	270,000	400,000	599,000	241,000	352,000	503,000
3. Required Annual Loan Repayment	22,849	22,849	22,849	54,494	54,494	54,494
4. Interest Return on Equity Capital	14,554	14,554	14,554	23,997	23,977	23,997
E. Surplus or (Deficit) Funds	114,887	169,039	297,712	23,015	96,028	271,581

TABLE 10: RESULTS OF WHOLE FARM BUDGETS FOR FARM SITUATIONS IN NORTHERN NIAMEY DEPARTMENT UNDER FINANCIAL PRICES

Receipt/Expense	Farm Type, Location and Type of Draft Animal Utilized					
	Type I, North, Donkey	Type II, North, Donkey	Type III, North, Donkey	Type I, North, Oxen	Type II, North, Oxen	Type III, North, Oxen
	(In CFA Francs)					
A. Gross Receipts:						
1. Millet Grain	82,400	144,200	226,600	82,400	144,200	226,600
2. Sorghum Grain	10,845	18,979	27,112	10,845	18,979	27,112
3. Cowpeas	48,720	69,600	125,280	48,720	69,600	125,280
Sub-Total	141,965	232,779	378,992	141,965	232,779	378,992
1. Millet Stover	8,200	14,350	22,550	8,200	14,350	22,550
2. Sorghum Stover	1,100	1,925	2,750	1,100	1,925	2,750
3. Cowpea Hay	117,600	168,000	302,400	117,600	168,000	302,400
Sub-Total	126,900	184,275	327,700	126,900	184,275	327,700
1. Cart Rental	150,000	150,000	150,000	150,000	150,000	150,000
Sub-Total	150,000	150,000	150,000	150,000	150,000	150,000
Total Gross Receipts	418,865	567,054	856,692	418,865	567,054	856,692
B. Gross Expenses:						
1. Cash Production Expense: Millet	18,894	33,065	51,959	18,788	32,879	51,667
2. Cash Production Expense: Sorghum	2,068	3,619	5,170	2,112	3,696	5,280
3. Cash Production Expense: Cowpeas	12,377	17,681	31,826	12,421	17,744	31,939
4. Interest Paid on Animal Traction Package	7,241	7,241	7,241	17,271	17,271	17,271
5. Draft Animal Maintenance Expense	9,125	9,125	9,125	73,000	73,000	73,000
6. Cost of Expendable Hand Tools	6,900	9,200	13,800	6,900	9,200	13,800
Total Gross Expenses	56,605	79,931	119,121	130,492	153,790	192,957
C. Net Receipts Available	362,260	487,123	737,571	288,373	413,264	663,735
D. Charges Against Net Receipts:						
1. Capital Recovery on Animal Traction Package	18,100	18,100	18,100	23,713	23,713	23,713
2. Opportunity Cost of Family Labor	154,500	219,000	320,250	146,250	204,750	297,000
3. Required Annual Loan Repayment	22,849	22,849	22,849	54,494	54,494	54,494
4. Interest Return on Equity Capital	14,554	14,554	14,554	23,997	23,977	23,997
E. Surplus or (Deficit) Funds	152,257	212,620	361,818	39,939	106,310	264,531

4. The reimbursement to the farmer, as investor, of an adequate return on his equity capital.

The results of our whole farm budgets, as presented in Tables 9 through 12, attempt to answer, in preliminary fashion, the central question: "Can the farm family, using the 'full' agricultural technical packages promoted for millet, sorghum and cowpeas, satisfy all four of these production and consumption objectives from the net receipts of their farm operation?". As was the procedure in the farm enterprise budgets, we have tried to provide answers to this question for three representative farm operations (i.e. Farm Types I, II and III) in two general zones (i.e. the south and north of Niamey Department) using one of two types of draft power (i.e. a donkey or an ox team) and, finally, under two sets of input/output prices (i.e. financial and economic). Table 9 presents our results in terms of financial prices for the south of Niamey Department. Table 10 presents our results under financial prices for the north. Tables 11 and 12 repeat the process using economic prices.

As can be seen from our financial budgeting results, all farm operations evaluated can satisfy all four of the objectives from their net receipts. In all cases, there is clear evidence that farm size greatly affects net receipts, with overall profitability increasing as one moves from the Farm Type I situation to the Farm Type III situation. Furthermore, when one considers the type of draft power used, it is evident that farms using donkeys have higher returns, after satisfying all their production and consumption objectives, than do farms using a team of oxen. Finally, and perhaps most significantly, it is apparent that only seven out of the twelve farm situations evaluated in financial terms could meet all their objectives <u>without</u> the financial receipts attributed to off-farm rentals of the farm's donkey or ox cart. In the south, Farm Types II and III using a donkey and Farm Type III using oxen could meet this criterion, whereas, in the north, all farms using a donkey but only Farm Type III using oxen could do so. Stated alternatively, Farm Type I using a donkey in the south and Farm Types I and II using oxen in both

south and north could not meet all their objectives from on-farm crop production alone and would be forced to allocate their resources to off-farm cart rentals. The situation forcing cart rentals would be particularly critical in Farm Type I situations with oxen in both the south and the north of Niamey Department.

When one turns to evaluating these same farm situations under economic prices, cart rentals become the issue in determining feasibility of "full" package adoption. Only in the case of Farm Type III in the north using a donkey does a farm operation come close to satisfying all its objectives without the cart rental receipts.

In seven other cases, the farm family could meet its objectives only if sufficient cart rental receipts were obtained. And, finally, in the cases of Farm Types I and II using oxen in both south and north, the family objectives cannot be met in full <u>even with</u> the projected cart receipts. The implications in these latter cases are that these operations, after allocating net receipts to cover required loan repayments and capital recovery expenses, would either have to pay family labor at much less than its opportunity cost or would have to forego adequate interest returns on equity capital. In some cases, farm families would have to incur returns lower than the opportunity costs of both family labor and equity capital and, thereby, suffer greatly reduced incentives to remain in farming under "full" package conditions.

TABLE 11: RESULTS OF WHOLE FARM BUDGETS FOR FARM SITUATIONS IN SOUTHERN NIAMEY DEPARTMENT UNDER ECONOMIC PRICES

Receipt/Expense	Farm Type, Location and Type of Draft Animal Utilized: Type I, South, Donkey	Type II, South, Donkey	Type III, South, Donkey	Type I, South, Oxen	Type II, South, Oxen	Type III, South, Oxen
	(In CFA Francs)					
A. Gross Receipts:						
1. Millet Grain	136,350	238,613	374,963	136,350	238,613	374,963
2. Sorghum Grain	17,640	30,870	44,100	17,640	30,870	44,100
3. Cowpeas	48,720	69,600	125,280	48,720	69,600	125,280
Sub-Total	202,710	339,083	544,343	202,710	339,083	544,343
1. Millet Stover	14,600	25,550	40,150	14,600	25,550	40,150
2. Sorghum Stover	1,880	3,290	4,700	1,880	3,290	4,700
3. Cowpea Hay	117,600	168,000	302,400	117,600	168,000	302,400
Sub-Total	134,080	196,840	347,250	134,080	196,840	347,250
1. Cart Rental	150,000	150,000	150,000	150,000	150,000	150,000
Sub-Total	150,000	150,000	150,000	150,000	150,000	150,000
Total Gross Receipts	486,790	685,923	1,041,593	486,790	685,923	1,041,593
B. Gross Expenses:						
1. Cash Production Expense: Millet	61,502	107,629	169,131	62,164	108,787	170,951
2. Cash Production Expense: Sorghum	6,509	11,391	16,273	6,623	11,590	16,557
3. Cash Production Expense: Cowpeas	28,564	40,805	73,449	28,801	41,144	74,059
4. Interest Paid on Animal Traction Package	16,231	16,231	16,231	33,776	33,776	33,776
5. Draft Animal Maintenance Expense	9,125	9,125	9,125	73,000	73,000	73,000
6. Cost of Expendable Hand Tools	6,900	9,200	13,800	6,900	9,200	13,800
Total Gross Expenses	128,831	194,381	298,009	211,264	277,497	382,143
C. Net Receipts Available	357,959	491,542	743,584	275,526	408,426	659,450
D. Charges Against Net Receipts:						
1. Capital Recovery on Animal Traction Package	26,333	26,333	26,333	37,061	37,061	37,061
2. Opportunity Cost of Family Labor	270,000	400,000	599,000	241,000	352,000	503,000
3. Required Annual Loan Repayment	33,333	33,333	33,333	69,362	69,362	69,362
4. Interest Return on Equity Capital	19,167	19,167	19,167	30,519	30,519	30,519
E. Surplus or (Deficit) Funds	9,126	12,709	65,751	(102,416)	(80,516)	19,508

TABLE 12: RESULTS OF WHOLE FARM BUDGETS FOR FARM SITUATIONS IN NORTHERN NIAMEY DEPARTMENT UNDER ECONOMIC PRICES

Receipt/Expense	Farm Type, Location and Type of Draft Animal Utilized					
	Type I, North, Donkey	Type II, North, Donkey	Type III, North, Donkey	Type I, North, Oxen	Type II, North, Oxen	Type III, North, Oxen
	(In CFA Francs)					
A. Gross Receipts:						
1. Millet Grain	77,400	135,450	212,850	77,400	135,450	212,850
2. Sorghum Grain	10,245	17,929	25,613	10,245	17,929	25,613
3. Cowpeas	48,720	69,600	125,280	48,720	69,600	125,280
Sub-Total	136,365	222,979	363,743	136,365	222,979	363,743
1. Millet Stover	8,200	14,350	22,550	8,200	14,350	22,550
2. Sorghum Stover	1,100	1,925	2,750	1,100	1,925	2,750
3. Cowpea Hay	117,600	168,000	302,400	117,600	168,000	302,400
Sub-Total	126,900	184,275	327,700	126,900	184,275	327,700
1. Cart Rental	150,000	150,000	150,000	150,000	150,000	150,000
Sub-Total	150,000	150,000	150,000	150,000	150,000	150,000
Total Gross Receipts	413,265	557,254	841,443	413,265	557,254	841,443
B. Gross Expenses:						
1. Cash Production Expense: Millet	61,442	107,524	168,966	61,506	107,636	169,142
2. Cash Production Expense: Sorghum	6,518	11,407	16,296	6,698	11,721	16,745
3. Cash Production Expense: Cowpeas	28,538	40,768	73,382	28,801	41,144	74,059
4. Interest Paid on Animal Traction Package	16,231	16,231	16,231	33,776	33,776	33,776
5. Draft Animal Maintenance Expense	9,125	9,125	9,125	73,000	73,000	73,000
6. Cost of Expendable Hand Tools	6,900	9,200	13,800	6,900	9,200	13,800
Total Gross Expenses	128,754	194,255	297,800	210,681	276,477	380,522
C. Net Receipts Available	284,511	362,999	543,643	202,584	280,777	460,921
D. Charges Against Net Receipts:						
1. Capital Recovery on Animal Traction Package	26,333	26,333	26,333	37,061	37,061	37,061
2. Opportunity Cost of Family Labor	154,500	219,000	320,250	146,250	204,750	297,000
3. Required Annual Loan Repayment	33,333	33,333	33,333	69,362	69,362	69,362
4. Interest Return on Equity Capital	19,167	19,167	19,167	30,519	30,519	30,519
E. Surplus or (Deficit) Funds	51,178	65,166	144,560	(80,608)	(60,915)	26,979

CHAPTER IV

CONSTRAINTS TO THE ADOPTION OF VIABLE PACKAGES

A. CONSTRAINTS AT THE FARM LEVEL

> "The agricultural projects [in northern Nigeria] have brought about a dynamic technological environment wherein technology, as the engine of growth, is continuously being adapted by farmers who in turn evolve their own practices". Balcet and Candler (6)

Since high-yielding seed varieties (HYVs) first started making possible dramatic agricultural production increases in Third World countries, planners have hoped to spread this revolution by technology to every crop and every land. The Productivity Projects in the Republic of Niger have embodied the faith in new technology as the solution to the problems of the country's vulnerable food crop sector. Using packages recommended by the National Agronomic Research Institute of Niger (INRAN) and modified by various sources, these projects have been attempting to persuade farmers of the efficacy of the new agronomic practices.

Farmers themselves, however, do not often adopt new technologies as if they were a simple set of cafeteria items among which they can pick and choose. Even if the technology has been "proven" both agronomically and economically, it becomes available for adoption only in the enormously complicated environment of the farmers' own beliefs, perceptions, skills, strategies, and capacities. In the final analysis, it is the farmers who decide whether projects succeed or fail. This section of the report discusses the context within which Nigerien farmers are making those decisions.

Nigerien Farming Systems: Some General Principles

Nigerien farming systems have been reasonably well described elsewhere (50, 117, 118) and we need not recapitulate those materials here. Three central issues affect the assessment of technical packages from the farmers' viewpoint. These issues may be seen as a set of key questions that each farmer must answer for himself periodically, and that younger or poorer farmers especially have on their minds all the time.

1. To Farm or Not to Farm?

In the current West African context, it is important to realize that the decision to leave home and do urban work, agricultural day labor or petty commerce is open to nearly all males. Especially for the predominant Djerma of Niamey Department, who have a long history of migration to Niamey city and southward, farming is just one possibility for making a living. It is definitely not an idealized life style to which everyone aspires. Expected gains from farming on one's own account -- "with" or "without" new technical packages--are continuously measured against the wages one can anticipate in the labor markets of nearby rural areas, Niamey, Nigeria, or the Ivory Coast. Women, extended family heads, and much older males find it harder to leave but they too operate with perceptions of opportunities open to them through migration. Wages are obviously higher nearer the coast but costs for rent, food, and travel are higher as well. Alternatively, some off-farm cash-earning opportunities are also available near or at home. Farmers do stay home but even then they make crop husbandry decisions within a calculus of other uses for time as the season itself progresses. It is not always self-evident that it would be better not to farm today, or this year, but it is always appropriate for farmers to think about other options, and they do constantly.

2. Food Crops or "Cash" Crops?

The old distinction made in West Africa between food crops and cash crops is no longer valid. On the one hand, Niger's "traditional" cash crops, cotton and peanuts (which were not widely grown in Niamey Department in any case), have been virtually dropped from farmers' repertoires everywhere in the country. On the other hand, extensive private and competitive markets have grown up for foodstuffs that are deemed surplus by farmers at harvest or later in the season, so that food crops are always potential cash crops as well. Research across Africa has demonstrated that, given the vagaries of market supplies and

prices, farmers are correct to assign their top priority to assuring as much of their basic food supply as they can on their own farms. In Niger this means that extended families devote their collective fields, poorer families perhaps their only fields, and everyone their fundamental labor commitment, to the most reliable food crops. As with other new crops in the past, until new varieties of the basic crops can be conclusively shown to provide the fundamental food supply year after year, the new packages must be regarded as supplementary possibilities rather than substitutes or experiments for the central family fields. Until well-proven, new packages are likely to be used on "evening" or personal fields within the farmer's own distinction as between the fields on which one can (i.e. personal plots) or cannot (i.e. family fields) experiment. In the short term at least, farmers must therefore use the new packages not to intensify foodgrain production but as residual claimants of any extra labor, land, or cash resources to which they may have access.

3. Sure Things or Risks?

Nigerien farmers are risk averse not by some hypothetical conservatism in their culture but by the hard lessons of experience with risks in a harsh and fickle environment. Crop disease, pest damage, storage loss, volatile markets, and above all, sporadic rainfall present many risks which must be minimized while the farmer attempts to optimize his income, first with food crops in kind and second with cash. The farmers' strategies to minimize risk have many implications for new technologies. First, as noted above, food supplies must be guaranteed using proven methods and varieties--though in Niger there has always been plenty of room for experimentation on fields variously labelled as "Friday" or "evening" or "personal" plots. Second, intercropping, planting seeds of different varieties on different locations, and wide spacing between rows, plants and fields help ensure that at least some parts of a field, or one of the crops on it, will succeed even if the rest fail. Third, investing crop

profits in livestock diversifies total family risk even when reinvestment in the cropping enterprise might directly benefit crop production. Fourth, reliance on commodity markets for food, labor or credit can entail huge risks if one fails to produce any trade goods with which to pay or reimburse the suppliers of these goods and services. Finally, the farmer is a keen observer both of nature and of people, and discriminates by long experience between essential elements of his environment and false or secondary ideas and messages. New technical packages cannot be just a bill of goods but will be assessed within the wide range of concerns that each farmer has about the best resource allocations he or she can make.

B. NIAMEY DEPARTMENT FARMERS AND THE NEW TECHNICAL PACKAGES

The Nigerien agricultural Productivity Projects decided upon the residential farmer training center (CPT) as the mechanism for transferring new technology to the farmers. A nine-month training program now brings both the farmer and his wife to the CPT to learn the new techniques through actual practice, doing them over a full cropping cycle. In Niamey Department, nearly 200 farmers have been trained at these CPTs over the four years of their existence (i.e. 1979-1983). As they are the primary consumers of the new technology, understanding these trainees' social circumstances, their experiences in applying their training, and their subsequent reflections on it is obviously a crucial part of assessing where the strengths and weaknesses lie in the effort to promote the technical packages. The team sought out and directly interviewed some 30 former CPT trainees in a series of field visits around Niamey Department. The visits were brief and were usually made without advance notice, but the interviews were carried out following a consistent format and the frankness of the responses in widely-separated areas of the Department provides a basis for confidence that the data gathered are reliable. The discussion that follows focuses on the problems that trainees face in applying the set of recommended practices learned at the CPT.

1. The Trainees

The projects require that an individual farmer and his wife move to the CPT to spend the entire agricultural season -- indeed, a full nine months -- in learning the new agricultural methods. Candidacy for the training is theoretically open to all married men who control their own farms, but in practice it has not been easy to find appropriate candidates. Since going to the CPT involves a risk that one will bring "home" neither food nor cash at the end of the year, men with responsibility for a large number of dependents do not go. Nor do men who would leave no one at home to cultivate a basic food crop, nor men with skills that can easily be sold in the labor markets whenever farm work is slack. The candidates put forward by their village cooperatives thus tend to be young married men (i.e. 25 to 30 years old) with small families who control some of their own fields but also work on their family's fields, or who are independent of their extended family and without very large holdings of their own but can rely on their extended family for food aid if their CPT experience goes awry. In a goodly number of cases, the trainees either were the only volunteers from the village -- some only after a second call -- or were chosen when no candidates presented themselves.

2. The Return to the Village

The effectiveness of CPT training itself is not a subject in review here. Trainees earn a share of the total produce of the CPT, taking home with them a maximum of 500 kilograms of grain at the end of their course. That amount is barely enough to feed two adults and perhaps a child for the year by current national standards, and reinforces the need to have other family resources to fall back upon when one leaves the CPT. Indeed, from being independent producers on their own fields, ex-trainees are likely to regress to temporary dependency on their extended family or others for the first year after their return from CPT training.

Ex-trainees also receive the right to purchase tools, the row spacer, animal traction equipment and, above all, the oxen to

go with it. The principle is, of course, that they will have everything they need to recreate the cropping system they learned at the CPT. In actuality, they often lack one or another critical item and are blocked from proceeding with full package implementation. One of the animals they receive may be too young or feeble from illness; a critical tool is not available; the row spacer arrives too late. Whatever the problem, the whole technical package is threatened by these human errors, and this deeply discourages farmers for whom the vagaries of rainfall on their own local varieties is threat enough already.

One of the missing "pieces" of the package, clearly the most debilitating for the ex-trainees, is the unavailability of fertilizers on other than cash terms. The ex-trainees normally have little or no extra funds to spare for fertilizers; it is difficult to borrow funds from family members who have not seen any proof that fertilizers and a new package are worth the scarce resources; and yet the ex-trainees are afraid to plant new seeds with new techniques <u>without</u> fertilizer, since they feel that the selected (so by definition exotic to their local area) seeds may do worse than local ones if the fertilizer is not employed.

In short, as the ex-trainee approaches the new agricultural season, it may simply be obvious to him that he cannot apply the techniques he has been taught. His strategic choices narrow: in some cases he abandons agriculture altogether, perhaps to reenter it once he accumulates the working capital to apply the package correctly; or he can try to apply those techniques he can still mount on an experimental plot of land, if he can afford the high risk he knows this presents; or he can farm using his pretraining "traditional" technology, as modified by those techniques in which he has most confidence. All the ex-trainees recall all the techniques they learned at the CPT with fair precision: far fewer can afford to carry them out.[1]

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[1]Most, however, have not been taught the technical names for the agricultural chemicals in their packages. "Red poison" (a fungicide), "black fertilizer", and "white fertilizer" are adequate names only as long each color marks a clearly different compound.

3. Applying the Lessons: What Happens in the Fields?

For the 1983 agricultural season, the ex-trainees we interviewed headed families that had between one and six agricultural workers, with half having two or three.[2] Half the ex-trainees for whom we have data have a total farm size of 3 to 4 hectares: either average area cultivated per trainee family worker is much lower than for villages in the Maradi area studied by Raynaut (117, pp. 9-10) or our questions yielded underestimates of actual farm sizes.

What is far more important is that the technical packages were seldom being applied, during the season just completed, on more than one hectare of each farm. Nowhere, except in the special case of a seed multiplication village working under contract and supplied with all necessary inputs, were ex-trainees risking even as much as half of their land with the new technical packages. Some farmers were applying the packages on a well-manured field near their village but most had used their packages on an unmanured bush field some hundreds of meters from their houses. This is not a surprising finding: it is highly rational for risky ventures to be undertaken where failure will be least costly, and using bush fields for experimentation is the standard practice of West African farmers.

What this practice means is that the farmers themselves are engaged in a necessary phase of on-farm experimentation. During this phase the new technology has no effect on intensification of land use (i.e. it goes into a field that would otherwise have been planted to other varieties or crops) or actually extends farm size (i.e. encourages farmers to try the new crop on an extra field). Only long-term follow-up of this critical farmer-originated experimental phase will determine how the new technology could move from the bush fields into the far more important communal family fields.

On these experimental fields, three quarters of the farmers interviewed are raising CIVT millet, the rest are raising HKP

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[2]The figures cited are tabulated from our interviews. See Annex C for further details.

millet, and only two are also raising improved cowpeas. The farmers also cultivate a number of other crops on their other fields, including local varieties of millet, cowpeas, sorghum, Bambara groundnuts, and various vegetables and condiments. None were growing cotton or peanuts. The small number of cowpea cultivators was due both to farmer discouragement after the 1982 drought, which killed their cowpea plantings, and torrential showers early in this crop season, which washed away the newly sprouted 1983 cowpea crop.

Improved practices learned at the CPT were applied to the selected varieties of millet. Eight of the farmers had at least some manure on their test fields. Three-quarters used the prescribed insecticide/fungicide to treat their improved seeds and some use it on local seed as well. The insecticide/fungicide is inexpensive and visibly efficacious. About half the farmers used the row tracer (rayonneur in French) to insure that they could plant at the recommended density of 10,000 hills of millet per hectare. Sixteen farmers then used oxen to do row cultivation but, in several cases, the use of oxen for cross-row cultivation was compromised because the animals trampled plants which were not separated in the correct meter-by-meter spacing.

Farmers recognize that inorganic fertilizers produce yield advantages, even for local seeds, and they all know the potential of the selected millet varieties if there is both adequate inorganic fertilizer and enough rain for the crop. It has, therefore, been a profound disappointment for the farmers not to have access to seasonal credit to enable them to purchase the full amounts of fertilizers that they have been taught to use. For many farmers, fertilizers are the single most important input they wish to use, and many of the interviewees expressed outright anger that they could not get them. Indeed, about half found enough money to buy some fertilizers, which they usually applied at lower than the recommended amounts per hectare.

Only one third of the interviewed farmers planted in pure stands. The temptation to use the available soil nutrients for

an intercrop is strong, and indeed the farmers may be correct that intercropping increases total yields -- and hence returns -- per field with little compromise to the millet crop. The major conflict with intercropping may not be the crop competition but the difficulty posed for cultivation with oxen, if the intercrop is planted in the "traditional" way. More research is needed on ways to make cultivation with animals more compatible with intercropping.

In summary, it is clear that ex-trainees are ready and willing to experiment with the new practices they have learned. Especially with millet, they are eager to apply the insecticide/fungicide, inorganic fertilizers and animal traction in the hopes of significantly raising their output.

4. What are the Constraints?

Farmers interviewed by this team were highly articulate regarding the limitations they face in applying their CPT lessons. We may aggregate them in general statements:

First, it needs to be said that the basic constraints lie outside the farmer's control. An institutional apparatus that could routinely deliver and service the new technology is still in its infancy. Farmers address this constraint by both a fatalism as to whether they will really benefit from their training and an opportunism that suggests that, for example, they take credit now and gamble that perhaps it will never have to be repaid. Farmers are frustrated by the failure to deliver tools, or the lack of follow-up advice, or being short-changed in getting smaller animals than they could buy in the open market, but they still expect that government has a role to play in this domain. One real question is whether the private sector could provide any of these services more effectively: the GON decision to demobilize the UNCC and allow cooperatives to hire their own agents will test this idea.

Second, the farmers have discovered that the new technology is a package that is too integrated for their real situations on the ground. As they explain it, if the row tracing is not done,

then the animal traction cannot be successful. If animal traction is not to be done, then pure stands are of no special benefit. If your soil is poor and you cannot get enough fertilizer, then you should not plant at the recommended density. If there is too little rain, the fertilizer will not do its job. Since the farmers learn these lessons by working through them in a single season, they have little in the way of alternative strategies to fall back on if factors beyond their control do not work in the way they did at the CPT. They have been given no formulas to adjust fertilizer applications to their budgets, no alternative to tracing rows even though they insist they cannot afford the time to use the row tracer if they are to plant quickly enough after the first rains, no non-traction recommendations for cultivation depth or timing, and no skills in realistic farm budgeting to make their own evaluations of the returns to their efforts. Nor has follow-up by extension agents been effective. The ex-trainees thus find themselves entirely on their own to do their "adaptive", "on-farm", and "farmers" trials of the lessons they have been taught. Auguries for the success of such free flights are not good. Farmers must be enabled to disaggregate the packages themselves to meet their own needs in a technically satisfactory manner.

Third, farm working capital is the biggest single farmer-level constraint. Repeatedly the team was told by ex-trainees that cash could not be plowed into the farm operation because whatever they had in hand <u>had</u> to be kept available to buy food for the family. Until this operating capital constraint is broken, we do not expect farmers to risk unfulfillment of their immediate needs for the riskier, middle-term payoff of higher yields with the expensive new technologies proposed in the packages.

5. <u>What Lessons are There for Other Farmers?</u>

In the Nigerien Productivity Projects, graduates of the farmer training centers are expected to be models for their peers

and to propagate the new technology at home in their village settings. When village cooperatives have been open and careful about choosing young farmers to attend the CPTs, and when villagers actively pursue the ex-trainees for advice and aid, some moderate demonstration effect may indeed be taking place. However, the constraints noted in the foregoing sections conspire against the farmer's co-villagers just as they do against him. The team ran into cases where an ex-trainee tried to apply his "new technology" in a field just outside his house so that fellow villagers could easily watch its progress. But in this case, in cases where fellow villagers asked for help in using or repairing animal traction equipment, and in a case where the village as a whole expected demonstrations regularly from their ex-trainee, technical factors or acts of nature had vitiated the attempts to spread the word. In any case, in Djerma Niger, there is a reluctance to take too much obvious uninvited interest in a neighbor's affairs, so farmers generally do not drop by to study the crop on anyone's field. When this cultural reluctance (comparable to our reluctance to peer too hard at someone's checkbook balance or to ask about his income) is combined with the farmer/demonstrator not having much to show in any case, the whole rationale of technology transfer to the many through intensive training of a few is lost. Thus some non-trainees encountered by the team simply discounted what the trainees might have learned and said that they would find their own ways to innovate.

CPT graduates are trying to replicate their training on their own fields against great odds. They have apparent confidence that, for their millet, fertilizers and animal traction hold the potential for giving strong boosts to production. Where they can distribute some of the costs of the animals in the traction package to the non-cultivation activities -- mainly by renting out their carts -- they believe that the new technology is worthwhile.

On the other hand, their emotions range from disappointment to anger as they contemplate the support they have received since

their CPT training. A heavy organization has been built to transfer new packages onto the farm through the CPTs. Farm-level support and follow-up should be the obvious bedrock of ongoing attempts at long-term growth, but they are currently the weakest links in whole chain.

C. CONSTRAINTS AT THE DEPARTMENTAL AND NATIONAL LEVELS

The picture that emerges from the preceding discussion is one of both CPT-trained farmers and their neighbors needing help and advice from the world beyond the village but not getting it. One reason for this is that agricultural extension agents are in very short supply in Niamey Department. Agricultural Service personnel assigned to the Department number only 33, including 10 CPT chiefs. They are rarely seen at the village level. One UNCC agent we encountered had heard of agricultural agents distributing seed in his district but had not met them, much less coordinated his activities with them. The Service itself at all levels is the first to deplore this situation.

The problem is more complex than one of a simple lack of agricultural field agents. There are also other agencies working the same territory with somewhat differing mandates, notably UNCC and the Service d'Animation. The UNCC agents concentrate on the cooperatives in their zone but get involved in promoting the technical packages because inputs are sold through the cooperatives.

There is also "the Project", as each Department's Productivity Project is usually called. The NDD project, for example, has added its own group of monitors (agents de suivi in French) who are assigned specifically to work with the former CPT trainees. The monitors are now expected to advise as well as monitor the activities of their charges. This is a definite improvement given the paucity of agents in the villages. However, the monitors are linked to the Agricultural Service and in fact depend on it for transportation. This is not an improvement since vehicles are often unavailable and the monitors, like the

one at Chiwil, tend to become immobilized as a result. At the Department level, in sum, the situation is a complex one consisting of interwoven, even conflicting strands from the various agencies and projects. This complexity contributes to the system's inefficiency.

The means for coordinating these strands, at least in theory, is a pair of technical committees, one at the arrondissement level and the other at Department level. The former is called the COTEAR, the latter COTEDEP. Farmer demand for agricultural inputs is supposed to pass up the chain to the national level via the committees, while the activities of the various field organizations are supposed to be coordinated on the way down. The monthly meeting of the COTEDEP is expected to bring together the coordinators of the integrated teams of field agents (from Agriculture, Animation and UNCC), one in each arrondisement. In most cases the coordinator is the Agriculture agent, but in Filingué, for example, it is the UNCC delegate. In theory, then, there is a structure to bring the agencies together to work in a coordinated, effective way. Why do the results as viewed from the farmer's perspective seem to be so meager?

Skimpy operating budgets, lack of vehicles and equipment, few agents assigned to work at the village level -- all of these reasons can be cited and all are valid. The problem is a deeper one nonetheless, and it is not unique to Niger. One of the more penetrating recent reports on agricultural development in Niger, the Rainfed Crops Report, points in the right direction. "The overall development structure," it maintains, "is in the end heavy and overburdened with bureaucratic obligations." (106, p. 174) Surprisingly, the Ministry of Planning has stated the problem in stark terms, warning that "the development of the agrobureaucracy is the most menacing danger to our strategy of food self-sufficiency..." (99, p. 6) Niger's rural development services, patterned on the same models as others in Francophone West Africa, resemble them in many respects. In more than one

country the services have become expensive bureaucratic structures that in perfectly legitimate fashion siphon off resources that should be destined for the village farmer.

The structures are imposed from the top down, an oft-noted fact. In Niger they rest, at the bottom, on cooperatives which, as the NDD evaluation report remarked, are far from dynamic and self-managed. The cooperatives exist, not because of farmer initiative but because of government planning efforts. (122, p. 34. See also 106, p. 205) As is the case in several neighboring countries, government (UNCC) agents keep the books of many cooperatives. Farmers very often do not know how much they owe on credit nor when payments are due. (122, pp. 31, 74) One observer of these phenomena in several West African countries, Guy Belloncle, has advocated teaching literacy in local languages by teaching co-op members how to keep their own accounts. This, Belloncle maintains, is what they most want and need. Once members rather than outsiders manage the cooperative, they will be able to gain control of marketing and credit operations. The local organization could thus become a viable structure, a village enterprise. (16, p. 13) Funding for development initiatives could be funneled directly to the local organization, given certain safeguards, rather than diverted, as is now the case, through the local government services. The agrobureaucracy in turn could become more of an advisor to the farmer and the cooperative, less of an intermediary. It could cover more ground, more effectively.

The constraints to wider diffusion of viable technical packages can thus be considered from two perspectives. On the one hand, as argued earlier in this chapter, there is the farmer's own sense of the constraints on him. When he looks around, he finds no agent to help him tailor the package to his particular conditions, he finds no seasonal credit, he finds that certain inputs are unavailable when he needs them, and he realizes the practical impossibility of replicating what he learned under the relatively controlled conditions of the CPT. On the other hand,

looked at from the national perspective, one senses that the real constraint is the system itself -- the rural development approach which operates ineffectively through a hodge-podge of understaffed organizations with overlapping jurisdictions and differing mandates. No wonder the farmer is confused and cautious. He has nowhere to turn for a resolution of his problems. His own cooperative cannot help much. The government agencies are distant and seldom at hand when he needs them. If he is lucky enough to have attended a CPT, he has found afterwards that he is still on his own. Under such conditions the conviction and dedication of many CPT graduates compels admiration.

There is, however, one group of farmers who generally do receive adequate support in the form of technical advice, seasonal credit, and the availability of the recommended inputs. These farmers, as is evident by now, are not the CPT graduates. They are the ones who participate in the seed multiplication program. Evidence from the seed multiplication center at Hamdallaye in Niamey Department indicates that farmer response to these incentives can be excellent. Detail on how the contract growers have performed is found in Chapter II. Suffice it to note here that this program demonstrates what can happen if the farmer receives the basic support that he needs.

Our team was not asked to look at the agricultural sector as a whole nor even to explore such issues as the delivery of agricultural inputs since this is being done by others. Yet from the perspective that the team developed examining the technical packages, we found ourselves, Nigeriens and Americans, agreeing on a number of broader points that transcend the packages. We noted that there already seems to be a high level of concurrence on specific agricultural and rural development issues between Nigerien technicians and foreign analysts.

The positions which seem to draw wide support are articulately stated in a number of sources. Rather than attempt to summarize them here, we refer the reader to the documents prepared for the Zinder Seminar on Rural Development Strategy in November 1982 (e.g.3, 38, 99) as well as to the Rainfed Crops

Report (106). The latter report's Propositions de Programme can be cited as solid recommendations that are undoubtedly receiving serious consideration. For example, the report calls for:

(1) A reorganization of UNCC to give it more training and advisory functions while relieving it of responsibilities for agricultural production and credit.

(2) Endowment of cooperatives with facilities for the storage of inputs and marketable crops.

(3) Removal of government subsidy on an agricultural input when the use of the input has been generally accepted.

(4) Re-establishment of seasonal credit accompanied by a gradual removal of subsidies on seed and fertilizer.

(5) Higher producer prices for peanuts and cotton.

(6) Higher prices for certified seed with allowance for exchanges in kind.

(7) Re-examination of the policy of announcing producer prices at the end of the crop season. (106, pp. 212-214)

On some of these as well as on other issues the debate continues. We mentioned some of the other unresolved questions in the Introduction to this report. The overall effectiveness of the Productivity Project approach is one major issue that is unlikely to be resolved soon. To the extent, however, that there is an emerging consensus on certain key points, agreement at the technical level needs to be acted upon by the Government of Niger with the active counsel of donor organizations so that a new approach to rural development can be fashioned. We hope that the conclusions and recommendations of this report will contribute to that process.

The reader will find the recommendations emanating from our assessment of the agricultural technical packages in Chapter I, section C.

ANNEX A

THE TECHNICAL PACKAGES

THE AGRICULTURAL TECHNICAL PACKAGE FOR MILLET[1]

1. Crop Regime

It is recommended that millet be planted in pure stands as a sole crop, rather than intercropped with cowpeas or another crop.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed.

3. Soil Preparation

Scarification (i.e. superficial pre-planting tillage with hand hoes or an animal-drawn field cultivator) is recommended at the end of the dry season. If the work is done with animal-drawn equipment, it is recommended that the field be worked in both directions.

4. Varietal Selection

It is recommended that a variety of millet be chosen on the basis of maturity (i.e. length of growth cycle), grain quality, grain yield, and moisture requirements in relation to the rainfall area in which it is to be planted.

The following millet varieties are recommended to farmers at present:

Haini Kiré Précoce (HKP) is an 80 to 85 day variety recommended for areas having 450 millimeters or less of annual rainfall.

Ankoutess is an 80 to 90 day variety well-adapted to lower rainfall areas of 350 to 400 millimeters.

3/4 Haini Kiré (3/4 HK) is a 90 day semi-dwarf variety recommended for areas having 450 to 650 millimeters of annual rainfall.

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1 Sources for this summary of the agricultural technical package for millet are INRAN, Fiches Techniques Vulgarisation: Actualisation des Resultats de Recherches, 2ème édition, Janvier 1983 and Santens, P., Agriculture Spéciale: Fascicule 1- Le Mil, IPDR/Kolo, Nouvelle édition, Octobre 1982. Where differences in package recommendations occur, the former text was taken as definitive.

P3 Kolo is a 90 day variety recommended for higher rainfall areas having more than 500 millimeters.

Composite Intervariétal de Tarna (CIVT) is a 95 to 100 day variety which is recommended for the same rainfall areas as P3 Kolo.

5. Seed Preparation

Seed should be selected from well-filled millet heads of good appearance and then cleaned to remove inert matter and weed seeds.

6. Seed Treatment

Seed is to be treated with a fungicide/insecticide mixture such as Thioral (i.e. Thiram and Heptachlore) at the rate of 2 grams per kilogram of seed.

7. Planting Date

Planting should occur immediately after the first rain of 10 to 15 millimeters.

8. Seeding Rate and Plant Spacing

Seed is to be sown 2 centimeters deep in hills[2], with 7 to 10 seeds per hill. Hills are to be spaced one meter apart both within and between rows in a check-row pattern such that hills are aligned in rows in both directions (across the field as well as in the direction of planting). This requires 4 to 5 kilograms of seed per hectare and results in a density of 10,000 hills per hectare. It is recommended that this density be increased to 0.8 meters by 0.8 meters (i.e. 15,625 hills per hectare) for the variety 3/4 HK because of its shorter height.

9. Use of the Row Tracer

If use of animal-drawn equipment for cultivation is anticipated, the farmer should utilize a row tracer (rayonneur in French) to locate hill placements within his field. This is to be accomplished by dragging the row tracer across the field in two operations at right angles to each other so as to obtain a check-row pattern for hill placements at the line intersections.

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2 The agronomic term "hill" (poquet in French) means planting a group of seeds at a relatively wide spacing as opposed to planting single seeds in a more or less continuous row (i.e. drilling). This term does not imply that a mound is actually formed on which sowing is carried out.

10. Thinning

Thinning to three millet plants per hill is recommended at about three weeks after seedling emergence. The most vigorous and widely-spaced plants within each hill should be left. The final plant population should therefore be approximately 30,000 plants per hectare for all millet varieties except 3/4 HK. For this variety, a plant population of 46,875 plants per hectare is best.

11. Weeding/Cultivation

The first cultivation should take place eight days after planting to give the millet seedlings a competitive advantage against weeds and to maximize moisture availability during early crop growth.

The second cultivation should take place fifteen days after the first cultivation.

Additional cultivations should be performed as needed during the crop season.

The check-row pattern of seeding as described above permits cultivation with animal-drawn equipment in both directions (i.e. at right angles) in the millet field.

12. Replanting Missing Millet Hills

It is recommended that reseeding of millet take place at the time of first cultivation in those hills with no seedling emergence.

13. Crop Fertilization

Apply organic matter (e.g. animal manures, compost, peanut hulls, household wastes) at the rate of six tons per hectare prior to scarification so that these materials are incorporated into the soil.

In millet monoculture, apply (a) 50 kilograms of triple superphosphate (i.e. 22.5 kilograms of P_2O_5) per hectare at the same time as the organic matter and prior to scarification and (b) 100 kilograms of urea (i.e. 45 kilograms of N) per hectare in a split application. The first urea application is to be made at the time of thinning, approximately three weeks after seedling emergence. The second is to be made during the period of stem elongation approximately three to four weeks after the first application.

In a legume-millet rotation (i.e. peanuts or cowpeas in pure stands followed by millet in pure stands), apply (a) 34 kilograms of triple superphosphate (i.e. 15 kilograms of P_2O_5) per hectare on the preceeding legume crop and (b) 50 kilograms of urea (i.e. 22.5 kilograms of N) per hectare on

the millet at the time of the second cultivation. This recommendation implies that a residual amount of phosphorous will be available to the millet from the previous year's application and that a nitrogen credit of 20 to 25 kilograms of N per hectare will accrue for millet as a result of nitrogen fixation by the groundnuts or cowpeas grown in the preceeding crop year.

THE AGRICULTURAL TECHNICAL PACKAGE FOR SORGHUM[1]

1. Crop Regime

It is recommended that sorghum be planted in pure stands as a sole crop, rather than intercropped with cowpeas or another crop. It is further advised that sorghum not be planted on fields where sorghum was planted the preceeding year. Sorghum plantings should follow cotton, cowpeas or groundnuts in the rotation.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed. If cotton was the previous crop, all cotton stubble and residues should be burned, preferably shortly after the cotton is harvested.

3. Soil Preparation

On fine-textured, heavy soils which can be tilled when they are dry, plowing before the onset of the rainy season is advised.

On fine-textured soils which cannot be tilled when they are dry, plowing at the end of the previous rainy season is recommended. The field should be harrowed after plowing in order to prepare a good seedbed.

On light-textured soils, scarification (i.e. superficial pre-planting tillage with hand hoes or animal-drawn field cultivator) is recommended at the end of the dry season.

4. Varietal Selection

It is recommended that a variety of sorghum be chosen on the basis of maturity (i.e. length of growth cycle), grain quality, grain yield, and its requirements in terms of rainfall and soil type.

The following sorghum varieties are recommended to farmers at the present time and under two groups:

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1 Sources for this summary of the agricultural technical package for sorghum are INRAN, Fiches Techniques Vulgarisation: Actualisation des Resultats de Recherches, 2ème édition, Janvier 1983 and Santens, P., Agriculture Spéciale: Fascicule 6- Le Sorgho, IPDR/Kolo, Nouvelle édition, Novembre 1982. Where differences in package recommendations occur, the former text was taken as definitive.

A. Valley sorghums for use on the finer-textured, heavier valley, lowland and depression soils

1/2 MSB is a 90 to 100 day variety of medium height (160 cms.), compact panicle and light yellow grain. It is recommended for areas with annual rainfall of 550 to 900 millimeters.

L30 is a 90 to 100 day variety of medium height (150-200 cms.), compact panicle and white grain (although it is often stained, especially if rains occur during ripening). It is recommended for areas with annual rainfall of 400 to 600 millimeters.

Jan Jare is a well-adapted, 90 to 100 day, red-seeded variety which has been grown for a long time in Niger.

B. Dune sorghums for use in the lighter, sandy soils

a4d4 8-2-3 is an 80 to 85 day, non-tillering variety of medium height, compact panicle and white grain (often with red staining). It is recommended for areas with annual rainfall of 300 to 500 millimeters.

Babadia Fara is a long-season, 120 to 140 day, local variety of medium height recommended for central and eastern Niger. It has a short compact panicle with cream-colored grain.

Bagoda is a long-season, 130 day, local variety recommended for western Niger. It has a semi-compact panicle with light reddish-brown grain. P2 Matankari, a white-seeded selection from within Bagoda, is apparently also recommended for this area.

5. Seed Treatment

Seed is to be treated with a fungicide/insecticide mixture such as Thioral (i.e. Thiram and Heptachlore) at the rate of 2 grams per kilogram of seed.

6. Planting Date

For dune sorghums, planting should occur immediately after the first good rain which provides moisture to a depth of about 15 centimeters. Alternatively, seed can be planted in dry soil anytime after May 15. For valley sorghums, planting should wait until the soil is quite wet, usually in late June or early July.

7. Seeding Rate

Seed is to be sown 2 to 3 centimeters deep in hills[2] 0.8 meters apart between the rows and 0.30 meters apart within the rows. This requires as much as 15 kilograms of seed per hectare and results in a density of 42,000 hills per hectare. This row spacing has been chosen because it is the same as that recommended for cotton and allows cultivation with animal traction.

8. Thinning

Thinning to three sorghum plants per hill is recommended 15 to 20 days after seedling emergence. This can be timed to coincide with the second weeding/cultivation. The most vigorous and widely-spaced plants within each hill should be left. The final plant population should therefore be approximately 126,000 plants per hectare.

9. Weeding/Cultivation

The first cultivation should take place about ten days after seedling emergence to give the sorghum seedlings a competitive advantage against weeds and to maximize moisture availability during early crop growth.

The second cultivation should take place fifteen days after the first cultivation.

Additional cultivations should be performed as needed during the crop season.

Use of animal-drawn equipment for weeding and cultivation is recommended.

10. Replanting Missing Sorghum Hills

It is recommended that reseeding of sorghum take place at the time of first cultivation in those hills with no seedling emergence.

11. Ridging

It is necessary to ridge sorghum grown in the valleys. This should be done when the plants are 50 to 60 centimeters tall and should be combined with a weeding/cultivation operation. Ridging is not recommended on dune soils.

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2 The agronomic term "hill" (poquet in French) means planting a group of seeds at a relatively wide spacing as opposed to planting single seeds in a more or less continuous row (i.e. drilling). This term does not imply that a mound is actually formed on which sowing is carried out.

12. Crop Fertilization

It is considered desirable to apply organic matter (e.g. animal manures, compost, peanut hulls, household wastes) at the rate of ten tons per hectare every five years prior to scarification so that these materials are incorporated into the soil.

For valley soils with adequate levels of phosphorous and potassium, apply 100 kilograms of urea (i.e. 45 kilograms of N) per hectare at the time of thinning and just before the second cultivation. It is suggested that the nitrogen be applied in a split application if possible, with one-half at thinning and one-half during the period of stem elongation. It is further suggested that the nitrogen rate be increased if the variety 1/2 MSB is used, and that 100 kilograms of triple superphosphate (i.e. 45 kilograms of P_2O_5) per hectare be incorporated prior to planting if the variety a4d4 8-2-3 is used.

For dune soils, no fertilizer recommendations are made.

THE AGRICULTURAL TECHNICAL PACKAGE FOR COWPEAS[1]

1. Crop Regime

The following recommendations have been made for cowpeas grown as a sole crop and not as an intercrop with cereals. A rotation with cowpeas grown after a fallow and before millet is highly recommended.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed.

3. Soil Preparation

Plowing and then harrowing are recommended for fine-textured (heavy) soils. Scarification with a field cultivator is recommended for light soils.

4. Varietal Selection

The choice of variety depends on several factors:

a. Cropping system (sole crop or intercrop);

b. Production goals (grain, forage or both);

c. Length of the rainy season and rainfall distribution during the growing season.

The following varieties are recommended:

TN 88-63 is a 70 day, photoperiod-insensitive, erect variety recommended for areas with an annual rainfall of 300 to 400 millimeters.

TN 36-64 is a 70 day, photoperiod-insensitive, semi-erect variety recommended for areas with an annual rainfall of 400 to 500 millimeters.

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1 Sources for this summary of the agricultural technical package for cowpeas are INRAN, Fiches Techniques Vulgarisation: Actualisation des Resultats de Recherches, 2ème édition, Janvier 1983 and Santens, P., Agriculture Spéciale: Fascicule 5 - Le Niébé, IPDR/Kolo, Nouvelle édition, Mars 1982. Where differences in package recommendations occur, the former text was taken as definitive.

TN 4-69 is a 90 day, photoperiod-insensitive, semi-erect variety recommended for areas with an annual rainfall of 400 to 500 millimeters.

TN 98-63 is a 90 to 150 day, photoperiod-sensitive (flowering commences in early October), spreading-type variety recommended for high rainfall areas.

5. Seed Preparation

The available seedstock should be examined carefully so that only large, whole, healthy-looking cowpea seeds with no insect damage are selected for planting purposes. Cracked and moldy seed should be removed as well as off-types and other varieties (based mainly on seed color).

6. Seeding Date

Time of planting is a function of the maturity of the variety selected and should be done so that flowering and pod formation occur during good moisture conditions (e.g. August) and that ripening occurs under relatively drier conditions. It is generally recommended that cowpeas be planted immediately following the first good rain (defined as one which wets the soil to a depth of 20 centimeters) after June 10th.

7. Seeding Rate and Plant Density

Seed is to be sown 3 to 4 centimeters deep in hills[2] aligned in rows. Hills should be spaced 0.30 meters apart within the rows and 2 to 3 seeds sown per hill. For erect and semi-erect varieties, the distance between rows should be 0.50 meters resulting in a density of 66,000 hills per hectare. For spreading-type varieties, the distance between rows should be 0.80 meters, resulting in a density of 41,600 hills per hectare. No thinning is recommended.

8. Weeding/Cultivation

The first cultivation should take place 10 to 15 days after planting. The second cultivation should take place 15 to 20 days after the first cultivation. Additional cultivations should be performed as needed during the crop season. Cultivation can be accomplished with animal traction between rows, followed by hoe weeding within rows. Striga (i.e. witchweed) should be pulled out and removed as soon as it appears.

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2 The agronomic term "hill" (pouquet in French) means planting a group of seeds at a relatively wide spacing as opposed to planting single seeds in a more or less continuous row (i.e. drilling). This term does not imply that a mound is actually formed on which sowing is carried out.

9. Replanting Missing Cowpea Hills

It is recommended that reseeding of cowpeas occur at the time of first cultivation in those hills with no seedling emergence.

10. Fertilization

Cowpeas grown as a sole crop in a rotation with other crops (e.g. millet, sorghum, etc.) should receive ten tons of organic matter every four years. An application of 50 kilograms of triple superphosphate (i.e. 22.5 kilograms of P_2O_5) or 100 kilograms of simple superphosphate (i.e. 20 kilograms of P_2O_5) per hectare is also recommended. Organic matter and phosphate fertilizers should be applied prior to plowing so that they are incorporated into the soil.

In addition, a small amount of nitrogen should be applied as a starter fertilizer soon after emergence. No recommendation is given for cowpeas grown as an intercrop with cereals because it is assumed that the cowpea crop will benefit from the organic and inorganic fertilizers applied for the cereal crop.

11. Crop Protection

Because several insect species collectively cause substantial grain yield losses and because varietal (genetic) resistance is currently inadequate, two or three insecticide treatments are recommended. The first should be made at the beginning of flowering, with subsequent applications every ten days. Both Decis (ULV) and Asthoate are insecticides recommended for use on cowpeas. Although various plant diseases occur, no chemical pesticide sprays are recommended.

12. Harvesting

Several separate harvesting operations will be required because of the long flowering period of currently available cowpea varieties. Harvested pods should be sun-dried for at least three days before threshing.

THE AGRICULTURAL TECHNICAL PACKAGE FOR PEANUTS (GROUNDNUTS)[1]

1. Crop Regime

The following recommendations have been made for peanuts grown as a sole crop and not as an intercrop with cereals. A rotation with peanuts grown after a fallow and before millet is recommended but it is realized that the more normal practice in Niger is for farmers to follow a rotation of millet-millet-peanuts-millet-millet and that fallowing is rarely practiced due to the need to produce millet for consumption.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed.

3. Soil Preparation

In Niger, peanuts are grown on dune soils, which are light, sandy and of low fertility. These soils do not need plowing but scarification with a field cultivator is recommended. Scarification should be performed in both directions in the field and should take place at the end of April or in early May to take maximum advantage of early rains.

4. Varietal Selection

The following varieties are recommended.

55-437 is an early, 90 day Spanish-type variety recommended for northern zones with rainfall between 300 and 500 millimeters.

57-422 is an intermediate, 110 day Virginia-type variety. It is recommended for zones having a rainy season of 90 to 120 days and receiving between 500 and 600 millimeters of rainfall.

47-16 is a late, 120 day Virginia-type variety recommended for zones having between 500 and 600 millimeters of rainfall.

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1 Sources for this summary of the agricultural technical package for peanuts are INRAN, Fiches Techniques Vulgarisation: Actualisation des Resultats de Recherches, 2ème édition, Janvier 1983 and Santens, P., Agriculture Spéciale: Fascicle 2 - L'Arachide, IPDR/Kolo, Fevrier 1983. Where differences in package recommendations occur, the former text was taken as definitive.

28-206 is a late, 120 day Virginia-type variety with low resistance to drought conditions. It can only be grown in zones with rainfall between 500 and 600 millimeters.

28-204 is an early, 90 day Spanish-type variety recommended for northern zones with rainfall between 300 and 500 millimeters.

48-37 is a late, 130 day Virginia-type variety recommended only for zones with greater than 700 millimeters of rainfall.

796 (ZENIT) is an early, newly-introduced variety which is thought to be superior to 55-437 and grows well under the same conditions of 300 to 500 millimeters of rainfall in the northern zones.

5. Seed Preparation

Peanuts should be hulled by hand and seed which is small, broken, moldy, or insect-damaged should be eliminated. If available, use of certified seed is recommended.

Seed should be treated with fungicide/insecticide mixture such as Thioral (i.e. Thiram and Heptachlore) at the rate of one 25 gram package per 12.5 kilograms of seed.

6. Planting Date

Sowing should take place as soon as possible after the first rain which moistens the soil to a depth of 20 centimeters.

7. Seeding Rate

Seeding by hand should be done to have spacings of 40 centimeters by 15 centimeters for early varieties (i.e. 55-437 and 28-204) so as to have a population of 166,000 plants per hectare. Spacings for the later varieties (i.e. 47-16, 57-422 and 28-206) should be 60 centimeters by 15 centimeters for a population of 110,000 plants per hectare.

If a Super Eco seeder is used, the farmer should use the 24 hole disk with a row spacing of 50 centimeters for the early varieties and a row spacing of 60 centimeters for the later varieties. For the variety 57-422, a 20 hole disk should be used to obtain a spacing of 50 by 20 centimeters.

Seed should be planted at a depth of 3 to 7 centimeters and there should be only one seed per hill even though the traditional practice is to put 2 to 3 seeds per hill. This latter practice has not been found to result in superior stands and is wasteful of peanut seed.

8. Weeding/Cultivation

It is recommended that the first cultivation take place as soon as possible after the rows of plants are clearly visible. If cultivation is with animal-drawn equipment, one cultivation between the rows is recommended, with weeding between plants in the rows performed with hand hoes.

The second cultivation should take place fifteen days after the first one. A third cultivation, if necessary, should be done very carefully to avoid any cutting of the developing root system.

9. Replacement of Missing Plants

Replacement of missing plants is desirable and should take place at the time of first cultivation.

10. Ridging

After flowering, one or two ridgings of the peanut plants is useful on heavier soils to permit better root and pod development. Ridging is not usually practiced on light, sandy soils.

11. Crop Fertilization

It is recommended that an application of 75 kilograms of simple superphosphate or 34 kilograms of triple superphosphate (i.e. 15 kilograms of P_2O_5) per hectare be applied by broadcasting prior to scarification as a basal dressing for peanuts. Application of nitrogen fertilizers on peanuts in Niger is no longer recommended.

Peanuts should not be grown on fields which have been newly and heavily manured as this will promote excessive development of plant foliage at the expense of seeds.

THE AGRICULTURAL TECHNICAL PACKAGE FOR MAIZE[1]

1. Crop Regime

On dune soils and around houses, corn is grown in pure stands and usually succeeds itself without benefit of rotation. This practice, however, is only possible on heavily manured fields and even here it is recommended that corn be alternated with sorghum.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed.

3. Soil Preparation

On heavy soils, plowing is necessary and is to be followed three weeks later by harrowing to complete preparation of the seedbed.

On lighter soils and around houses, scarification is all that is necessary.

4. Varietal Selection

At the present time, only one variety is recommended in Niger.

P_3 Kolo is an improved local, yellow flint variety which matures in 100 days. It is recommended only for fertile soils in the Goulbi of Maradi and in the valley of the Niger River. It has good resistance to diseases (including smut), but has a high water requirement which limits its use to zones having over 500 millimeters of annual rainfall, preferably more than 600 millimeters.

5. Seed Preparation

It is recommended that the farmer use certified seed of P_3 Kolo.

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1 Sources for this summary of the agricultural technical package for corn are INRAN, Fiches Techniques Vulgarisation: Actualisation des Resultats de Recherches, 2ème édition, Janvier 1983 and Santens, P., Agriculture Speciale: Fascicule 6 - L'Maïs, IPDR/Kolo, Octobre 1982. Where differences in package recommendations occur, the former text was taken as definitive.

6. Seed Treatment

Seed is to be treated with a fungicide/insecticide mixture such as Thioral (i.e. Thiram and Heptachlore) at the rate of 2 grams per kilogram of seed.

7. Planting Date

Sowing is recommended at the start of the rainy season.

8. Seeding Rate and Plant Density

Recommended spacing of hills[2] for local maize varieties is 80 centimeters between rows and 40 centimeters within the row. Five seeds should be planted per hill.

If maize is to be grown for forage, the recommended spacing is 30 by 30 centimeters.

For the variety P_3 Kolo, INRAN recommends a spacing of 50 centimeters between rows and 25 centimeters between plants in the row. Two or three seeds should be sown in each hill at a depth of 2 to 3 centimeters in heavy soils and 5 to 6 centimeters in light soils.

9. Thinning

It is recommended that the crop be thinned to one plant per hill at the time of the second cultivation.

10. Weeding/Cultivation

The first cultivation should take place as soon as the rows of maize plants are clearly visible. The second cultivation should take place fifteen days after the first one.

11. Replanting Missing Maize Plants

Missing maize plants should be replaced at the first cultivation.

12. Ridging

Ridging during the maize plant's vegetative stage promotes new root development and permits better drainage of excess water away from the plant.

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2 The agronomic term "hill" (poquet in French) means planting a group of seeds at a relatively wide spacing as opposed to planting single seeds in a more or less continuous row (i.e. drilling). This term does not imply that a mound is actually formed on which sowing is carried out.

The first ridging should take place at the time of thinning and second cultivation. The second ridging should follow at the time when the maize plants are 50 to 60 centimeters tall.

13. Fertilization

It is recommended that fields used for maize be heavily manured and that this organic matter be incorporated into the soil by plowing it under before planting.

To obtain the conditions necessary for good maize production, it is recommended that 150 kilograms of triple superphosphate (i.e. 70 kilograms of P_2O_5) per hectare be broadcast and worked into the soil during plowing and harrowing. In addition, an application of 200 kilograms of urea is recommended in two doses. The first - 100 kilograms of urea (i.e. 45 kilograms of N) - is to be applied during soil preparation. The second dose is to be applied 15 days before tasseling. This dose is to be side-dressed in bands 10 centimeters from the plant rows.

For the more common practice of growing maize around houses, only organic matter is recommended for the fields.

THE AGRICULTURAL TECHNICAL PACKAGE FOR COTTON[1]

1. Crop Regime

There are three methods of growing cotton in Niger.

a. Cotton production under irrigation, which is limited to three areas in the country: Ma Birni Konni and Maradi. In 1982, cotton produ under irrigation totalled 1760 hectares.

b. Cotton production under rainfed conditions, which is estimated to have a maximum potential of 2,500 hectares and varies with annual rainfall totals. The potential is essentially limited to the area around Gaya and certain valleys with appropriate soils subject to seasonal flooding.

c. Cotton production in certain valleys, where the water table is close enough to the surface to permit production with cotton planting in late August.

In all cases, cotton is grown as a sole crop. Rotations with maize and/or sorghum are possible.

The principal limiting factor with cotton production is available moisture. Without exceptional circumstances and/or irrigation, cotton can only be grown in those dryland areas receiving more than 600 millimeters of annual rainfall.

2. Land Preparation

If cultivation by hand hoe is anticipated, the land should be cleared of all surface debris. If cultivation with animal-drawn equipment is anticipated, the land must be completely cleared of surface debris and, in addition, all tree stumps must be removed.

3. Soil Preparation

For valley soils and clay soil on the plateaus, it is recommended that the first step in soil preparation for cotton be a superficial scarification to break the soil crust and allow sufficient water penetration for plowing at the beginning of the rainy season.

The next recommended field operation is deep plowing to turn the soil and incorporate organic materials such as compost, animal manures, and waste material from the farm compound.

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1 Source for this summary of the agricultural technical package for cotton is Santens, P., Agriculture Spéciale: Fascicule 3 - Le Cotonnier, IPDR/Kolo, Nouvelle édition, Juin 1983.

Three or four days after deep plowing, it is recommended that the field surface be harrowed to break up soil clods and prepare a suitable seedbed for planting.

4. Varietal Selection

The variety currently used in Niger is HAR L 229-10/75 which is sown on 85% or more of all land used for cotton production. The alternative variety 444-2 is sown on the remaining land but is being phased out over time.

5. Seed Preparation

Cotton seed in Niger is treated by CFOT before it is distributed to farmers. Seed is currently treated with an insecticide/fungicide mixture called Gamoran.

6. Planting Date

Planting date is stated to be the most important factor in the success of cotton production in Niger. The principal criterion is the earliest possible planting date in order to allow maximum moisture availability for the cotton crop.

In the Gaya area, it is imperative that the planting date occur between the tenth and the thirtieth of June after plowing and ridging have occurred. The latest possible planting date for the crop is July 10, but this results in reduced yields.

In the irrigated areas, the planting period for optimal production is 15 to 30 June, with the latest possible date being July 10.

On heavy valley soils with temporary flooding, the planting period is 20 June to 30 July.

On fields where the crop is grown after flood recession (with residual moisture), cotton should be planted as early as possible before the end of August.

7. Seeding Rate

For most cotton production areas, the recommended plant spacing is 80 by 40 centimeters with 5 to 6 seeds per hill.[2]

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2 The agronomic term "hill" (poquet in French) means planting a group of seeds at a relatively wide spacing as opposed to planting single seeds in a more or less continuous row (i.e. drilling). This term does not imply that a mound is actually formed on which sowing is carried out.

For flood-recession fields, the recommended spacing is 70 by 30 centimenters due to the fact that the later planted cotton plants have less vegetative development over their growth period.

Recommended planting depth is 3 centimeters.

8. Thinning

Thinning should be performed between 15 days and 21 days after emergence when the plants have four true leaves. Plants should be thinned to the two most vigorous seedlings per hill. Thinning is generally combined with the second cultivation.

9. Ridging

Ridging in cotton fields is deemed essential under conditions of irrigation or in areas subject to seasonal flooding. In plateau areas, ridging is desirable for soil conservation purposes but not essential to crop development.

10. Weeding/Cultivation

The first cultivation should take place as early as possible after the cotton plants are clearly visible.

The second cultivation should be done 15 days after the first one, with succeeding cultivations conducted as dictated by local conditions.

In cotton fields which have been ridged, cultivation must be done by hand hoe. In fields without ridges, cultivation between the rows may be performed with animal-drawn equipment, with between plant cultivation by hand hoe.

11. Replanting Missing Cotton Plants

Cotton should be resown in all hills with no emerged plants within eight days of general crop emergence.

12. Mounding

Mounding of soil around the cotton plants at approximately 45 days after emergence is recommended.

13. Crop Fertilization

The CFDT fertilizer recommendation for cotton is an initial application of a cotton complex fertilizer (14-23-12 with 8 units of sulfur and 2 units of boron), broadcast prior to initial soil preparation at the rate of 200 kilograms per hectare.

This initial fertilizer application is to be followed at 50 to 60 days after emergence or at first flowering by a side-dressing of 50 kilograms of urea per hectare placed at a distance of 10 centimeters from each cotton plant.

14. Insecticide Treatments

It is recommended that cotton be sprayed at ten day intervals starting at the 45th day after emergence and continuing until the 105th day after emergence. The first two treatments are to be made with Preprothion at the rate of 3 liters per hectare. The remaining treatments are to be made with Decis at the same rate.

ANNEX B

THE FARM ENTERPRISE BUDGETS

THIS ANNEX IS BOUND IN TWO SEPARATE VOLUMES

ASSUMPTIONS AS TO TYPE OF FARM OPERATION FOR ENTERPRISE BUDGETS

The budget exercise which follows is one part of the analysis of the financial and economic results to be derived from farmer adoption of the agricultural technical packages currently being promoted by the Government of Niger with the assistance of external donor agencies. In order that consideration of different farm sizes be realistically introduced into this evaluation, three models of "representative" farms of different sizes were constructed. The sources of data used in constructing these farm models were the various issues of the Annual Reports of the Director of Agriculture in the Ministry of Rural Development and the Agricultural Census for Niger of 1980. The farm models used in the enterprise budgets are defined as follows:

A. Farm Type I

This farm consists of three hectares of arable cropland in production in 1983. The farm supports a family of five persons and has an active work force of two full-time man equivalents.

Under traditional farming technologies, this farm allocates the available cropland to 2.7 hectares of millet and cowpeas in association, 0.3 hectares of sorghum in pure stand, and 0.1 hectares to all other crops.

Under the cropping patterns of the agricultural technical package, the cropland allocation for this farm changes to 2.0 hectares of millet, 0.7 hectares of cowpeas, and 0.3 hectares of sorghum - all in pure stands, and 0.1 hectares to all other crops.

B. Farm Type II

This farm consists of five hectares of arable cropland in production in 1983. The farm supports a family of seven people and has an active work force of three full-time man-equivalents.

Under traditional farming technologies, this farm allocates the available cropland to 4.5 hectares of millet and cowpeas in association, 0.35 hectares of sorghum in pure stand, and 0.15 hectares to all other crops.

Under the cropping patterns of the agricultural technical package, the cropland allocation for this farm changes to 3.5 hectares of millet, 1.0 hectare of cowpeas, and 0.35 hectares of sorghum - all in pure stands, and 0.15 hectares to all other crops.

C. Farm Type III

This farm consists of eight hectares of arable cropland in production in 1983. The farm supports a family of nine people and has an active work force of four full-time man-equivalents.

Under traditional farming technology, this farm allocates the available cropland to 7.3 hectares of millet and cowpeas in association, 0.5 hectares of sorghum in pure stands, and 0.2 hectares for all other crops.

Under the cropping patterns of the agricultural technical package, the cropland allocation for this farm is 5.5 hectares of millet in pure stands, 1.8 hectares of cowpeas in pure stands, 0.5 hectares of sorghum in pure stands, and 0.2 hectares for all other crops.

ANNEX C

THE FIELD INTERVIEW RESULTS

The Field Interviews

Table 1. Summary of Field Interviews: Ex-trainees of Niamey Department CPT's

	1979	1980	1981	1982
Year of Training	4	1	4	10
	1-2	3-4	5-6	>6
Active Farm Workers in the Family (Number)	5	5	4	2
Total Farm Size (Hectares)	2	9	3	2
Area Cultivated new technical package (Hectares)	10	5	1	-

	Selected Seeds	Fungi-cide	Density	Animal Traction	Thinning	Chemical Fertilizer	Manure	Pure Stand
Training themes remembered	13	13	17	20	11	15	7	10
Themes applied to millet, 1983	14	14	10	16	13	10	8	7
Themes applied to cowpeas, 1983	2	2	1	2	-	2	2	2

	Seeds		Fertilizers			Fungicide
	CIVT	HKP	Super Simple	Super Triple	Urea	
Inputs used 1983	15	4	-	7	6	13
Inputs used 1982	1	-	-	-	1	1

	Cultivation	Transport	Rental	No Use
Use of Oxen	12	12	5	-

	Mixed Crops	Millet Pure Stand	Cowpea Pure Sand	Sorghum	Bambara Groundnuts	Peanuts	Others
Crops, 1983	12	17	6	10	3	-	4

	Lack of Money	Lack of Improved Seeds	Weak Animals	Sick Animals	No Constraints
Constraints Noted	19	6	9	2	2

Notes to Table 1

1. The data summarized here are not always complete for each individual. The interviewing team was more interested in exploring the use of technical packages than in pursuing all the questions in the interview guide prepared in advance. Thus some of the numbers in the foregoing table are not easily reconcilable with others, while total observations in each category are not necessarily reliable. We include the table here as a record of our work.

2. Total farm size and areas planted with new techniques are approximate: only a handful of ex-trainees could estimate their field sizes in metric measurements.

3. "Training themes remembered" reflects the concentration of farmers in reeling off a list of items taught to them. Many may have simply omitted themes thought to be of minor significance, or, like manuring, to be old, rather than new, practices.

4. In the list of themes, "density" and "thinning" refer to particular recommendations in the packages. "Density" for millet means 10,000 hills per hectare, using the row tracer for optimum spacing.

5. Source of data: interviews of 19 ex-trainees selected at random from lists of graduates of the CPT's at Guéladio, Simiri, Boula, and Chiwil.

Some Case Studies of Project Area Farmers

The thirty or so farmers - ex-trainees and others - whom the study team interviewed varied widely in experience, social position, capacities, problems and attitudes. Any distillation of the short conversations held with them is necessarily arbitrary. Brief summaries of several of these interviews are presented here in order to show both the diversity and similarity of themes that are to be encountered in the field. Through them all, whether of ex-trainees or not, run the common experiences of rural Niger: the vulnerability of the food supply and the need to try to secure it; the willingness to innovate; the perils of relying on external sources to continue to make ends meet. But they show great disparities as well:

I. Two non-trainees - rural life "without project" participation:

Y.K. is a non-trainee who is also head of his farming family of five people. He cultivates four or five hectares with local seeds and traditional techniques, mainly in millet/cowpea association.

He knows the ex-trainees in his village, and would be happy to follow their lead. The problem, he says, is financial. He would like to be able to get animal traction equipment because, with the time he thinks he could save in cultivation, he could either do a better job in other farm tasks or work off his own farm to earn some money. But with no risk capital in sight, he can hardly contemplate even taking the chance of going to the CPT for training.

D.F. is head of a family and a minor chief in his village. He did not do CPT training, since he must supervise the work on three family fields with a variety of crops being cultivated by himself, his wife, his two grown sons and their families.

On his fields he has been using both phosphatic and nitrogenous fertilizers for the past two years, but with local seeds. His yields increased, he estimates, by about 20 percent.

He knows the ex-trainees in his village, but has never visited their fields or talked to them about their experiences. Nor has he talked to any of the staff of the CPT or to other agricultural advisers. His innovations - the use of fertilizers and fungicide, the purchase of a cart for cash in Niamey, the introduction of sesame into some rotations - are all being made on the "private" markets of goods and ideas.

II. Ex-trainees

One just starting:

I.A. farms on his family fields, which support 20 people, but he has one field of his own as well that he works on in the early evenings and on Friday. The village chief suggested that he go for CPT training, which he did in 1982.

This year (1983) is his first applying the practices he learned there. Having seen the benefits of both animal traction and chemical fertilizers, he is using both on his personal fields, despite the fact that he has found it difficult to manage the traction because he works there by himself.

He is not sure how he will meet his credit repayment, since there has been little day work available in his region. If the harvest is very good, he will be able to sell part of his crop to meet his debt.

One trying to live up to project expectations that he be a model to his peers:

I.M. is optimistic about his chances to succeed. He has three brothers helping him in his fields, and they took over his share of the work while he went for CPT training. He has applied the recommended practices in only one field near his house; on the one hand, to use it as a demonstration field for his neighbors, and, on the other, because it was well-manured and he could not afford much chemical fertilizer. His money is only sufficient to feed his family. He scarified his field with his animal traction equipment, but he is not weeding with it because his animals are still too young, and besides, his rows are not very evenly spaced. He did not use the row tracer because it takes too long to get your seed into the ground after a rain if you are going to use it. He uses his animals and cart to carry manure to his field, and also rents it out for 250 to 500 FCFA a day for local hauling chores (building materials, manure, etc.). He is convinced he can triple his millet output on this field, but since the "proof of the pudding" is not yet available (at the time of interviewing), his five demonstrations to other farmers have convinced only one to take him seriously so far.

One with bad luck and not much place to turn:

H.N. is head of a small family, and has his unmarried younger brother working with him. His own farming had not been going well, so he volunteered for CPT training in 1981 in the hope that he would learn techniques which would enable him to get ahead. He was satisfied with the training he got, though he would also have liked to learn the use of the plough.

He has applied some of the recommendations to his millet fields. A major drawback to him has been that one of his animals became sick. H.N. fed it the hay that was the only result of his cowpea crop last year, but has also had to buy feed with receipts from renting out his cart for firewood transport. In 1982 he used traction in only one field, though he fertilized three. He could not do the row tracing because his wife, who would have helped him, was ill and his younger brother had migrated to earn some money. His results on the field he planted with the full package were good - perhaps one-third higher yields than on his others, although he has difficulty comparing field sizes.

He does not see his way out of his difficulties. There has been too little rain this year, and he has been sick himself. There was no fertilizer credit this year, so he purchased and applied an adequate dose of fertilizer only to the less well-manured field where he also used improved seed (feeling that the better manured field would produce without the new technology). A key part of his equipment has broken and there is no spare part.

In other villages, he knows, people get some money for renting their carts, but in his village there are already 25 carts and so people have access to cart transport from one kinsman or another without payment. With no money likely to come in from this source, he will have to defer a second payment due on his equipment loan at harvest this year. He will start to pay when he can, but right now does not know when this will be, or what may happen to him if he continues to default.

Two for whom the support system is not working:

K.A. was an enthusiastic volunteer for CPT training. Isolated from other male relatives, with several dependent women in his family and only one small boy to help him farm, he wanted to find a way to raise his crop yields. He observed a neighbor who had undergone CPT training, and had frequently passed by the CPT itself. At the CPT he learned all the techniques, but things started going wrong as soon as he restarted his own cultivation. First, one of his traction animals was too weak to work, and although he thought of teaming up with another ex-trainee in the same predicament, the two healthy animals were of such different sizes that they could not yoke them together properly. Second, he had no funds to buy the row tracer or fertilizer. So he did not plant the recommended millet seed (CIVT), because he was not convinced it would do well without the fertilizer. Nor did he get the full traction equipment - a number of parts just never arrived. Indeed, he has not even seen a copy of his loan obligations. As K.A. told the interviewers of his fears that his training may have been a waste of time, that the previous year's trainees got fertilizer, and that his hopes to be doing well this year had been rudely dashed, he was

banging the ground with a stick in angry punctuation of his points. Only his ability to rent out his cart and ox for 2500-5000 CFA per day helps assure that he may meet the debts that he incurred in this process.

P.H. is a village leader. Well-respected and a good farmer, he is president of his village cooperative. He was intrigued by the prospect of higher yields on his fields, and volunteered for CPT training. He learned and is applying virtually every one of the recommended agricultural practices to his millet and to a cowpea field (though the cowpeas got only that supertriple fertilizer that he had left over from the millet). Moreover, he learned to write his own language, and saw pictures of things (like a mechanical seeder) that he would like to see in action at future field days and retraining sessions that he hopes the CPT will hold for ex-trainees.

His fields are not doing very well. The millet field he planted with "traditional" techniques has been abandoned altogether. His "new technique" millet field is stunted and yellow except where Acacia albida trees stood. In fact, his "improved" field does not look very different from neighbors' fields nearby despite P.H.'s care and optimism.

Moreover, he feels "deceived" by the project - he did not get as much grain as he needed at the end of his training, so that he had to do manual labor for other families during the dry season to feed his family. He did not receive some parts of his traction equipment. The insurance policy promised for the draft animals did not materialize. And the CPT program for his wife was much less significant than they had been told it would be. Worst of all, he received a credit (that is, undertook a debt) of 120,000 FCFA to buy his oxen, but they only cost 80,000 or 90,000 FCFA. He was told that he would receive the rest in tools and spare parts, but he has not seen any of it. He is thinking of leading a delegation of ex-trainees to Niamey to register charges against the CPT official whom they think simply absconded with funds that they must now pay back.

One managing with a mature labor force:

D.Z. is an older farmer with three grown children, one of them married and still farming with the family. D.Z. was chosen to attend CPT training in 1979 by the chiefs of his village and canton.

He cultivates two fields and has another large field in fallow. On one, that is about 2.5 hectares in size, he has planted CIVT seed that derives from the seed he brought back from the CPT with him. He did not use the row tracer but aligned his rows carefully anyway. He did not use animal

traction to scarify his field so did not put in a basal dressing of fertilizer, but he did apply supertriple phosphate and urea at weeding.

His second field is planted in mixed crops, mostly local varieties (except for some CIVT) and without fertilizer, since he judged that the soil is richer. He did not plant selected cowpeas partly because he can only sell it since his wife does not like to cook it, but mainly because he could not get the seeds.

He declares that if he had not "lost" his oxen, he would have been able to apply all the themes and would be better off - but in fact it turns out that he sold his animals after not using them anyway in his first year out of the CPT. What financial constraints led him to do so are not clear. He knows the new technology well, is especially enthusiastic about the selected seeds and fertilizer, but with no seasonal credit available to carry his operations through the year, he has had a hard time anyway.

And finally, one for whom secure finances seem to be making a difference:

B.H. is the younger brother of an ex-trainee in a village that does contract seed multiplication for the nearby CPT. In all, five brothers together cultivate three large fields of CIVT millet in association with cowpeas. They use fungicide, row tracing, ox-traction, manure and chemical fertilizers, insecticide, and the various management practices. All the inputs including the fertilizer, are received on credit from the cooperative, and all their crop marketing is also done through the coop (though in 1982 there was barely sufficient grain to feed themselves), and no surplus to sell. As a result, the two unmarried brothers migrated to Nigeria this past dry season to find work.

Although only one of the brothers trained at the CPT, all of them understand the strengths and limitations of the themes he learned there. They are constantly on the lookout for new possibilities. They have tried the donkey traction equipment, but the machinery was poorly designed. They are looking for better cultivator blades, and would like to learn mechanical seeding. They are trying improved cowpea seeds from the CPT, and are varying their crop rotations and fertilizer treatments to see what works best.

But what gives them the capacity to do all this is the credit they receive and the guaranteed market they have. They get up to twice the yields they used to, and with the security of their input supplies and contract prices, they - like others in the village - have been able to meet all their debt repayments. The whole system of financing their operation is different from what goes on in non-contract villages. Its economic costs have not been calculated, but clearly the financial benefits for the farmers involved are attractive.

ANNEX D

INDIVIDUAL REPORTS BY TEAM MEMBERS

SITUATION DES EX-STAGIAIRES DES (CPT) DU DEPARTMENT DE NIAMEY, PROBLEMES ET PERSPECTIVES DANS LE CADRE DU PROJECT PRODUCTIVITE (PPN), OBSERVATIONS ET RECOMMANDATIONS

Aperçu Sociologique

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La Mission, plutôt une série de courtes visites sur le terrain a consisté en interviews et quelques observations (champs, matériel agricole) auprès des ex-stagiaires des CPT, dans le contexte même de leurs villages et exploitations familiales. Ainsi, ont été visités par notre sous-équipe, les ex-stagiaires des arrondissements de Say (Canton de Kounari, village de Ouro-Gueladio), Ouallam (Canton de Tondikiwindi, village de Tondibia), Filingué (Canton de Bonkoukou, village de Balley). Au total, 6 ex-stagiaires ont été interviewés sur la base du guide d'entretien élaboré à cet effet. Par ailleurs quelques villageois non-ex-stagiaires ont été entendus sur le thème de l'agriculture et son évolution, mais de manière très informelle. Du résultat de ces entretiens et des discussions entre les membres de la mission au complet, on peut retenir les éléments suivants:

I. - Identification des Ex-Stagiaires

La moyenne d'âge des ex-stagiaires rencontrés est de 28 ans, le plus jeune ayant 20 ans alors que les plus âgés se situent entre 32 ans et 34 ans.

Ces ex-stagiaires sont tous mariés, chefs de ménage; la taille des ménages est réduite alors même que leur forme est nucléaire = aucun des ménages n'est polygamique et le nombre des enfants varie de 1 à 2 sans jamais dépasser ce dernier chiffre.

Quatre des ex-stagiaires sont les chefs de leur exploitation et deux travaillent dans le cadre de la grande exploitation familiale en même temps qu'ils entretiennent un ou plusieurs champs personnels.

A l'évidence, les ex-stagiaires chefs d'exploitation sont limités en disponibilité de main d'oeuvre alors même que les non chefs d'exploitation s'ils constituent une force de travail d'appoint pour l'exploitation familiale connaissent la même situation sur leurs champs personnalisés.

Les superficies cultivées par les ex-stagiaires varient de 3 à 15 ha la moyenne étant de 4 ha. Les produits cultivés sont essentiellement les mils et sorgho de type local et/ou amélioré et haricot. Les cultures se font le plus souvent en pur.

Dans l'ensemble, la production de ces ex-stagiaires, largement auto-consommée, est chroniquement déficitaire. D'ou l'obligation pour la plupart d'entre eux, sans soutien paternel ni fraternel, de se louer comme ouvriers champêtres sinon de partir en exode: "la force, c'est la disponibilité en vivres; quand tu ne l'as pas, ton champ est comme celui d'un jeune, un dépendant familial. Tu le travailles un jour et un autre jour tu le laisses pour chercher de quoi manger. En fait, je n'ai pas assez de cette force, la disponibilité en vivres, pour me consacrer entièrement à la mise en valeur de mes champs. Pour

trouver à manger, je me loue comme ouvrier agricole à raison de 700 à 750F par jour en temps normal (ce qui veut dire moins en général). Je ne puis louer mon U.CA et en tirer profit, les gens te proposant le même tarif journalier (700/750F) alors qu'il faudrait compter 5000F/jour et même plus. Je n'utilise mon U.C.A que sur ma seule exploitation, aidé par mes deux jeunes frères." (B.H., ex-stagiaire chef d'exploitation - Village de Ouro Guéladio).

II. - La Condition des Ex-Stagiaires

Trois cas de figure se rencontrent au niveau du recrutement du futur stagiaire:

- La désignation par les autorités et/ou l'assemblée villageoise;
- Le choix du futur stagiaire par les mêmes instances parmi plusieurs candidats;
- En l'absence de plusieurs candidats, l'enregistrement automatique de la candidature exprimée.

Dans tous les cas, les futurs stagiaires répondent généralement aux critères de sélection pré-établis et communiqués au village par les agents des services techniques, de même que leur candidature bénéficie de l'assentiment du village. Ainsi, "l'encadreur UNCC a avisé le président de la coopérative, qui a réuni les villageois. Ils nous ont choisi HH et moi. Nous avons donné notre accord" (B.H. ex-stagiaire, Ouro Gueladio); ou encore "j'ai été désigné à défaut d'autres candidatures; je répondais toutefois aux critères de sélection; mon père avait des appréhensions de voir partir pour 9 mois, un de ses aides agricoles" (O.H. ex-stagiaire, Tondibia); et aussi, "au marché, par hasard, nous avons su qu'on recherchait des gens pour aller au stage; j'ai demandé à être inscrit....puis on est venu me chercher pour y aller" (A.A. ex-stagiaire, Balley).

Les ex-stagiares sont unanimes à déclarer leur profonde satisfaction quant aux conditions de leur stage et la formation reçue:

- "Je suis satisfait de ma formation en CPT et en connais les profits. Je ne vois pas de thèmes techniques a ajouter au contenu de la formation, sauf pour celui qui n'aurait pas bien compris les thèmes enseignés" (B.H. ex-stagiaire, Ouro Gueladio);

- "Je suis satisfait de cette formation, elle est profitable. Ce type d'agriculture est moins fatiguant que notre mode traditionnel de culture et puis il soulève bien les sols. En en plus tu as de l'engrais, alors c'est parfait!" (A.A. ex-stagiaire, Balley).

La satisfaction quant à la formation reçue, la bonne et très bonne rétention des thèmes enseignés caracterisent l'ensemble des ex-stagiaires. Parmi les thèmes appris, la place centrale revient aux thèmes techniques agricoles organisés autour de l'apprentissage de la culture attelée, la densité des semis, l'utilisation des engrais et fongicides.

Mais si ces thèmes sont en théorie connus et maîtrisés, leur application laisse à désirer. La dominante, dans la condition des ex-stagiaires est celle des difficultés au passage de la théorie à la pratique, des difficultés au retour et la réinstallation: "la première année après le CPT est difficile pour l'ex-stagiaire; c'est une année de déficit: quand tu reviens à la maison et que tu les trouves sans provisions ni vivres, la priorité est de chercher à les nourrir...tous les éléments du matériel ont leur utilité, mais la première année après le CPT, on ne peut se considérer dans une situation saine" (B.H. ex-stagiaire, Ouro Gueladio.)

Autre contrainte, l'entretien des boeufs de labour: "il n'y a pas d'herbes, d'où la difficulté de nourrir les boeufs; c'est pour éviter leur mort par inanition que nous ne les faisons pas travailler" (O.H., ex-stagiaire Tondibia). Aux difficultés rencontrées par la plupart des ex-stagiaires pour l'entretien des boeufs, au coût même de leur entretien vient s'ajouter l'incapacité financière généralisée d'acheter les engrais et autres fongicides: "je n'utilise pas d'engrais; quand tu n'as pas d'argent pour manger, tu ne peux pas acheter des engrais (A.A. ex-stagiaire, Balley)...

Enfin, l'utilisation de l'équipement pour la culture attelée est limitée si non impossible du fait de la faible disponibilité en main d'oeuvre au niveau des ménages des ex-stagiaires: "tu as le matériel mais tu manques d'aides familiaux; là, je tiens en m'entraidant avec Lala, ex-stagiaire qui réside au village de Bonkoukou" (A.W. ex-stagiaire, Balley).

De manière générale, il apparaît que les ex-stagiaires gèrent des exploitations économiquement fragiles et chroniquement déficitaires; l'entretien des boeufs de labour, l'acquisition des intrants sont d'autant plus problématiques que la main d'oeuvre est insuffisante et que les maigres moyens monétaires sont affectés en priorité à l'approvisionnement en vivres.

III. - Les Problèmes et Perspectives du Progrès de l'Agriculture dans le Cadre du Projet Productivité Niamey

Si la formation de jeunes agriculteurs par la formule des CPT et leur équipement en U.C.A. est une des pièces maitresses de l'action du PPN, il faut reconnaître l'ampleur des problèmes vécus par les ex-stagiaires de retour dans leur milieu d'origine. D'une part l'identification des thèmes techniques est

insatisfaisante et inadaptée, d'autre part le suivi et l'appui aux ex-stagiaires sont insuffisants sinon inexistants.

Devant cette situation contradictoire et illogique, nous recommandons vivement la révision de l'approche, les objectifs et procédures du PPN en vue de leur zonalisation et la plus grande adaptation aux réalités, contraintes et préoccupations locales. L'évolution et le suivi, l'appui aux ex-stagiaires devront être intégrés et renforcés.

RAPPORT DE MISSION DE L'ETUDE DES THEMES TECHNIQUES AGRICOLES PROGRAMME D'ÉVALUATION CONJOINTE USAID-NIGER

par Assadek Algabit

L'étude sur les thèmes techniques agricoles a pour objectifs:

- l'évaluation des thèmes techniques individuels qui sont vulgarisées par les projets afin d'en dégager la rentabilité financière et économique;
- d'analyser les contraintes actuelles à la dissémination des paquets de thèmes;
- d'indiquer clairement là où il existe actuellement des données insuffisantes pour cette analyse et de conseiller quant aux mesures nécessaires pour pallier à cette insuffisance;
- de faire des recommandations quant à ce qui est de l'orientation et/ou de la structure des projets et programmes actuels USAID/Niger.

Pour atteindre ces objectifs combien modestes eu égard à l'ampleur de la tâche mais aussi à la limitation géographique de l'étude (zone d'influence du Projet Productivité Niamey), l'équipe des consultants chargee de l'étude et les homologues nigériens se sont entendus sur un certain nombres de questions:

1) De la réunion du 02/08/83, il en ressorti qu'une analyse du système de collecte existant au sein du PPN doit être faite afin d'en dégager non seulement les lacunes mais aussi les possibilités d'amélioration de celui-ci. Ceci se trouve renforcé par la nécessité de l'usage des documents établis par les réunions des cadres du terrain à savoir les coordinateurs d'arrondissement du PPN.

2) La base de travail doit être un questionnaire aux ex-stagiaires des CPT du projet, questionnaire qui doit en définitive faire ressortir les blocages à l'utilisation effective des thèmes enseignés aux CPT ou les contraints socio-culturelles, économiques et techniques qui limitent la portée de ceux-ci.

La mission a eu à se deplacer dans les arrondissements de Filingué (Chiwil), Kolo (Boula), Ouallam (CPT de Simiri) et Say (CPT de Gueladio). Elle a eu à rencontrer les ex-stagiaires présents des CPT de ces différentes localités. Des réponses au questionnaire placé, il en est ressorti l'existence de contraintes ou freins à l'utilisation effective des thèmes techniques appris au CPT de plusieurs ordres:

1) Contraintes agro-climatiques.

a. l'aléa climatique: cette contrainte est de loin la moins maîtrisable dans la mesure où l'on ne peut affirmer quelles sont les précipitations probables selon les régions.

b. la défense et la restauration des sols: à ce niveau il s'agit de remarquer que certaines zones du départment sont pratiquement pauvres d'un point de vue des cultures. Les projets ne comportant pas de manière explicite une composante de ce genre, cette contrainte se trouve renforcée et d'un impact non négligeable sur l'effet démonstratif attendu des champs des ex-stagiaires. L'enseignement du thème technique de l'assolement trouve sa juste place dans le programme des CPT mais comme celui-ci a été abandonné, l'on est obligé de se demander si l'on ne peut le reprogrammer.

2) Contraintes d'ordre administratif et technique.

a. l'encadrement: il faut signaler à ce niveau que non seulement le suivi des ex-stagiaires mais aussi la technicité des agents laissent à désirer. Surtout quand il faut à chaque moment "rectifier le tir" mais aussi expliquer et convaincre l'ex-stagiaire . Ce problème se trouve renforcé par le fait que les équipes intégrées préconisées par le PPN se trouvent de fait inopérationnelles. Composées par les cadres techniques locaux afin d'assurer un appui technique au projet, celles-ci se limitent ou stagnent dans l'élaboration des rapports d'évaluation de campagne. Les raisons de cet état de fait sont nombreuses et dépassent le cadre du projet.

b. l'autoencadrement paysan: ce problème est à lier au rapport de forces ex-stagiaire-villageois. Il faut en fait que celui-ci maîtrise les techniques enseignées, les pratiques pour que l'on pense à l'encadrement qu'il doit effecteur sur les autres villageois. Celui-ci doit aussi être suivi de facon permanente pour que l'autoencadrement soit une réalité.

c. le paquet technologique enseigné: du questionnaire lancé lors de cette étude, il en est ressorti que le paquet de thèmes techniques enseignés dans les CPT est considéré comme une sorte de chaîne ou un "tout indissociable" à appliquer littéralement ou aucunement.

Cela montre le manque de souplesse dans la formation et les enseignements communiqués et ce fait se trouve renforcé par la nécessité d'un usage quotidien des "fall-back strategies" c'est à dire une adaptation au moment et au lieu d'utilisation des thèmes techniques appris. Celà dénote un certain style stéréotype de formation au niveau des CPT. La variable socio-écologique n'est pas pris en compte dans la formation des stagiaires.

Il faut que la nécessité d'une modulation des thèmes techniques agricoles aux différentes zones agroécologiques soit une constante au niveau de la conception des CPT.

d. De la formation:
A ce niveau, des lacunes sont à relever et celles-ci se situent à deux niveaux:

- au niveau de la formation proprement dite celle-ci ne comporte aucun élément qui puisse permettre au stagiaire d'évaluer (physiquement ou monétairement) l'effort consenti et dépensé dans l'application des thèmes. Cela montre et justifie la réponse imprécisée des ex-stagiaires quand il leur est demandé d'essayer de quantifier les dépenses engagées sur une parcelle sur laquelle les thèmes techniques sont appliqués. Des techniques simples de gestion enseignées dans les CPT pourront pallier à cette carence.

- la nécessité d'une formation de court terme permettant ainsi de toucher un plus grand nombre de paysans. Cette formation s'intéressera a la maîtrise de thèmes techniques simples mais aussi à un recyclage systématique des ex-stagiaires.

3) Contraintes éco-financières.

L'une des contraintes jugée plus importante par les paysans enquêtés se trouve être les moyens financiers leur permettant l'acquisition des intrants nécessaires à l'application des thèmes techniques appris. Celle-ci se trouve être renforcée par le fait qu'il leur est nécessaire d'acheter des compléments alimentaires durant la période de soudure, période anté-campagne agricole. A la question de savoir qu'est-ce qu'ils préconisent pour une amélioration de leurs terres et une application des thèmes techniques agricoles appris aux CPT, tous ou presque tous ont fait remarquer:

a. Les retards dans les livraisons de certains intrants notamment les semences sélectionnées ce qui les amènent à utiliser ce dont ils disposent quand bien même qu'à ce niveau, l'usage et la rentabilité des semences sélectionnées sont compris.

b. Les revenus dont ils disposent ne leur permettant pas d'acheter les engrais chimiques, ils se demandent pourquoi est-ce que le projet ne met pas à leur disposition un système de crédit de campagne au niveau des engrais. Ils se demandent si l'on ne peut effecteur les paiements en nature à ce niveau. Cette réponse mérite à notre avis une réflexion mûre dans la mesure où il faut reconnaître qu'effectivement, la campagne agricole démarre généralement à une periode où les paysans sont le plus démunis.

En conclusion, force nous est de reconnaître que l'échantillon de l'étude à savoir le Projet Productivité Niamey ne peut forcer où porter à généralisation. Au sein même de la zone d'influence du Projet, une politique de modulation géographique du système de formation dans les CPT doit être entreprise tout en favorisant une politique de formation d'agents de suivi pouvant épauler réelement les paysans ex-stagiaires dans leur rôle de paysans démonstrateurs. Beaucoup reste à faire quant a l'amélioration du système de formation mais la question du budget de l'exploitation agricole à proprement parler devrait être étayée et des solutions adéquates doivent être apportées.

CANEVAS QUESTIONNAIRE

Ex-stagiaire

A. 1. Votre nom?

2. Quelle est la composition de votre famille?

3. Etes-vous chef d'exploitation ou dépendant?

4. Qui vous a recruté pour aller au CPT? Pourquoi?

B. 1. Au CPT quels TT avez-vous retenus? Pourquoi?

2. Au CPT quels TT avez-vous appris?

3. Etes-vous satisfait de votre formation au CPT?

4. Y a-t-il des choses que vous auriez souhaité apprendre?

C. 1. Combien de champs cultivez-vous cette année?

2. Avez-vous des champs en jachère? Combien?

3. Quelles sont les cultures cette année?

4. Sur quels champs utilisez-vous les TT enseignés? Quels TT? Pourquoi?

5. Sur quels champs utilisez-vous d'autres TT (non-enseignés)? Quels TT? Pourquoi?

D. 1. Quels sont vos problèmes?

2. A quelles contraintes devez-vous faire face?

3. Quels sont vos besoins?

Les Sols Agricoles du Département de Niamey
par Mamadou Ouattara

I-1. Rappel sur la géologie.

L'Est de tout le Département de Niamey est sur des formations du "continental terminal" aussi appelées grès du moyen Niger. Cette formation est constituée de grès argileux et sableux; l'entaillement, par des nombreux cours d'eau, donne un paysage de plateaux réparés par des nombreuses vallées aujourd'hui sèches et ensablées.

L'Ouest du Département est, lui, caractérisé par des bassins sédimentaires métamorphisés, séparés par d'énormes batholites de granite syntectonique. La série sédimentaire est constituée de schites sericiteux, de schites non métamorphiques et de grauwacks. On note également la présence de roches basiques et neutres qui sont des roches métamorphiques d'origine soit magmatique, soit sédimentaire. La série granitique, représentée par trois (3) massifs granitiques, présente une grande hétérogeneité au point de vue petrographique; les granites calco-alcalins à biotite ou biotite + amphibole semblent dominer.

I-2. Les sols.

I-2.1 Dans la moitié Est du Département, siège du continental terminal, dominent des sols ferrugineux peu lessivés, évolués sur formation sableux du moyen Niger. Ces sols correspondent, selon leur dégré d'évolution (lessivage en argile, pH) aux paleustalf, haplustult et même psamment de la classification USDA (soil taxonomy).

Ces sols ont pour substrat la formation sableuse du moyen Niger, recouvrant d'un manteau éolien variable les plateaux et vallées de la zone.

L'ensablement est uniforme et épais dans les zones situées à l'Ouest des grandes vallées et dans les dépressions; il est discontinu sur le versant Est des valées et sur le sommet des plateaux; l'épaisseur du manteau dépasse rarement 4 mètres et est souvent inférieure à 2 metres.

L'études pédologiques de reconnaissance effectuée par l'ORSTOM (1965) montre que le taux de sable fin est compris entre 45 et 65%; celui de sable grosier entre 45 et 22%. La teneur en argile est comprise entre 3 et 7% et croit en général avec la profondeur pour atteindre son maximum dans l'horizon B. La teneur en fer libre excede rarement 10% et varie selon la position topographique; dans l'ensemble, les profils sont lessivés en fer et en

argile; le fer tend à migrer plus profondement que l'argile. Le taux de matière organique, relativement faible, décroit régulièrement avec la profondeur. Le taux d'aggrégats stables est très faible et est fonction de la texture; les horizons de surface sont en général dégradés et très pauvres en aggrégats; l'étude ORSTOM trouve 7 à 4% d'aggrégats stables.

La capacité d'echange de ces sols est faible, en général inférieure à 2 meq/100 gr. Le calcium et le magnésium sont en général dominant; toutefois l'aluminium échangeable peut présenter jusqu'à 50% de la capacité d'échange. Le pH, acide dès la surface, décroit en profondeur pour atteindre des valeurs situées entre 4 et 5. La réserve hydrique se situe entre 40 à 60 mm/m.

Ces sols, de par leur texture, constituent les sols à mil par excellence; ils ont toutefois certains facteurs défavorables: leurs horizons de surface sont souvent dégradés et pauvres en éléments fins; ils sont pauvres en éléments minéraux nécessaires aux plantes; ils nécessitent une génération et une protection contre l'érosion éolienne et hydrique dans certains cas. Ceux de ces sols classés comme série de Tanchia (recouvrement des plateaux) sont relativement homogènes; ceux classés comme séries de la toposéquence des vallées sont hetérogènes; pour l'emplacement des cultures, il serait intéressant d'étudier leur régime hydrique selon la position topographique. Les CPT de Koné-Béri, Simiri et Gueladio sont installés sur ces types de sol.

II-2.2 On trouve également dans l'est du Département des sols développés sur des formations sableuses des grandes vallées sèches; ces sols sont classés dans la classification ORSTOM comme sols peu lessivés peu différenciés; ils correspondraient à certains psamment de la classification USDA. Ce sont principalement les sols du Dallol Bosso et d'un de ses affluents donnant la vallée de Fandou.

Dans le Dallol, 3 niveau de terrasses sont souvent distingués; les sols ferrugineux peu lessivés peu différenciés sont les sols des deux niveaux les plus hauts; ils ont en commun l'absence de structure bien développée; leurs horizons de surface sont également très remaniés. Ces sols possèdent en profondeur un horizon de sable blanc correspondant sans doute à l'ancien nappe; cet horizon est surmonté d'un horizon jaune, également sableux; dans les sols peu lessivés peu différenciés, l'accumulation de la matière organique est faible (0,3% en surface) et décroit rapidment avec la profondeur. Ces sols sont aussi caractérisés par une faible teneur en argile et limon; le taux de fer libre est compris entre 4

et 7%; l'horizon jaune est encore riche en fer libre; les sables décolorés sont par contre très pauvres en argile, limon (2%) et en fer libre (2%). Le pH varie de 5 à 6. La capacité d'échange est inferieur à 2 (1,5 à 0,8 meq/100 gr. dans les profils décrits). Cette capacité d'échange décroit avec le profondeur. Pour ce qui est des bases, le calcium et le magnésium dominent. Le potassium et le sodium sont à l'état de trace. Ces sols sont faiblement désaturés en surface, mais moyennement désaturés dans les horizons de profondeur.

Les sols ferrugineux peu lessivés peu différenciés du Dallol Bosso sont très cultivés malgré leur pauvreté chimique et leur faible réserve hydrique. La présence d'une nappe peu profonde favorise sans doute leur utilisation. L'amélioration de ces sols pourrait se faire par accroissement de leur teneur en matière organique (apport de fumier et/ou de compost), par correction des carences minérales et par des techniques culturales les protegeant de l'érosion et de la dégradation. Les CPT de Chiwil et de Boula sont situés sur ces types de sol.

Associés aux sols ferrugineux peu lessivés peu différenciés, on trouve au niveau le plus bas des vallées sèches, là où la nappe phréatique affleure par endroit - des sols hydromorphes à gley et des sols à alcali. Ce niveau est surtout le domaine de cultures maraichères et du manioc. Des salines artisanales existent également entre Birni N'Gaouré et Baleyara. Dans l'utilisation des sols hydromorphes à gley (aquent) du Dallol Bosso, on devra donc aussi faire attention aux risques d'alcalisation.

I-2.3 Dans les zones du socle granitique, des schistes et roches vertes (basiques), les sols sont en général peu profonds, regiques (gravillonnaires) érodés, souvent durcis, incultivables ou dedaignés par les paysans. Les cultures se concentrent dans les zones de recouvrement sableux et dans les vallées. C'est pourquoi nous nous sommes intéressés seulement aux sols formés sur ces recouvrements; ces sols sont classés comme ferrugineux peu lessivés, différenciés dans la classification ORSTOM ils correspondraient aux psammentic paleustalf de la classification USDA. Ce sont des sols sableux, homogènes, assez profonds; leurs propriétés sont assez voisines des sols ferrugineux peu lessivés décrits plus haut. Leur teneur en argile augmente avec la profondeur. Elle est de l'ordre de 2% en surface et peut atteindre 10% dans l'horizon B. Ils sont pauvres en matière organique (0,7%); leur capacité d'échange est également faible (2 à 4 meq/100 gr); ils sont moyennement désaturés avec un pH l'ordre de 6 en surface et 5 dans les horizons B et C. Ces sols ont une faible réserve

hydrique. Pour les recommandations quant à l'utilisation de ces sols, on pourrait se reporter aux sols ferrugineux peu lessivés évolués de la série de TANCHIA.

Toujours dans la zone Est du Département, on trouve également sous culture des sols ferrugineux peu lessivés peu différenciés et des sols brun-rouge peu différenciés sur sables pauvres en argile et limon d'origine éolienne (ergs recents). Ce sont des sols très sableux, pauvres en argile, avec fabile capacité d'échange; ils sont faiblement désaturés; ils ont une faible réserve hydrique.

I-2.4 En conclusion générale pour les sols utilisés pour les cultures pluviales, et principalement pour le mil, on peut retenir que ce sont des sols sableux, pauvres en matière organique; ces sols ont également une faible capacité d'échange cationique; ils sont moyennement désaturés; les cations dominants sont le calcium et le magnésium; l'aluminum échangeable peut occuper dans ces sols une bonne partie du complexe d'échange; il n'a pas été signalé toutefois de toxicité dûe à l'aluminum sur le mil; le pH est moyennement à fortement acide; ces sols sont pauvres en potassium; les essais agronomiques n'ont pourtant pas indiqué de réponse pour cet élément. Ces sols sont egalement carencés en phosphore. Leur réserve hydrique est faible. L'amélioration agronomique des sols ferrugineux, peu lessivés, sableux devrait porter donc sur l'accroissement de leur teneur en matière organique en vue d'améliorer leur structure, leur disponibilité en cations et leur réserve hydrique. Les carences en azote et phosphore peuvent être corrigées par apport d'engrais minéraux. La dégradation et l'érodibilité des ces sols, face à une exploitation de plus en plus continue (sans jachère), constitueront d'ici peu un problème majeur dans l'utilisation de ces sols. A noter afin que peu d'études ont été menées sur les oligo-éléments de ces sols.

II. Les Resultats Agronomiques

Les thèmes techniques actuellement vulgarisés découlent des résultats de recherches menées par l'IRAT et l'INRAN. Ces thèmes ont un caractère général car destinés à être appliqués à tous les sols et à toutes les conditions agroécologiques du Niger. Les recherches qui sont en train d'être menées à présent aideront sans doute à préciser ou modifier certaines recommandations et à les rendre plus spécifiques aux différentes conditions pédologiques et agro-climatiques des régions naturelles du Niger.

Dans ce qui suit, nous passerons en revue les seuls thèmes liés au sol ou à l'agronomie générale.

II-1. La Fertilisation: tous les essais de fertilisation menés ont montré une forte réponse du mil à l'azote et au phosphore sur sols ferrugineux.

Les essais IRAT ont montré une réponse à l'azote hautement significative, linéaire jusqu'à 125 kg de N/ha. Pour le phosphore, les essais en vase de végétation avaient montré une carence des sols ferrugineux de Kollo-ND'ounga en cet élément. Les essais réalisés en parcelle, toujours à Kollo, ont montré que la fumure phophatée pouvait doubler le rendement de mil en grain et fourrage. Les essais IRAT n'avaient pas permis de déceler de carence en potasse; pour le soufre, les essais en vase de végétation ont donné des résultats irréguliers d'une année à une autre et il est difficile de décider d'une carence en soufre.

Les essais menés par l'INRAN depuis 1980 ont également montré des réponses significatives du mil à l'azote et au phosphore sur plusieurs sols ferrugineux. Pour l'azote, la production maximale (200 à 300 % du temoin) est obtenue avec 100 à 150 kg de N/ha en présence de 240 kg de P_2O_5 par hectare. La réponse au phosphore est elle linéaire. Les essais INRAN n'ont pas permis d'obtenir une réponse à la potasse.

Les essais IFDC, pour l'année 1982, ont montré que le phosphore est sans doute l'élément le plus limitant pour le rendement dans la zone de Sadoré. La seule application du phosphore permet d'obtenir 88 % du rendement maximum alors que l'application l'azote permet d'obtenir 25 % du rendement maximum. Ces essais ont également permis de déduire un léger effet du soufre et une réponse négligeable à la potasse. Du point de vue économique, le chercheur IFDC a pu déduire que la non-utilisation des engrais ne permet que d'effectuer 14 % du revenu maximum net et que le prix des engrais n'est pas le facteur limitatif de la production agricole.

Des tests également menés par le programme engrais national sur les sites des CPT du Projet Productivité Niamey ont montré que les réponses du mil au phosphore et à l'azote étaient hautement significatives; ces tests ont confirmé les doses optima de 45 unités d'azote et 45 unités de phosphore à l'hectare. Les tests de potasse n'étaient pas significatifs.

Il ressort de l'examen de tous ces résultats que les sols agricoles du Département de Niamey sont nettement carencés en azote et phosphore. Il a été enregistré des accroissements de rendements de 50 % à 350 % du témoin par application de l'azote et du phosphore. Les doses optima pour chacun de ces deux éléments serait de 45 à 90 unités/hectare; les doses recommandées pour la vulgarisation sont donc bien dans les normes. Il conviendrait de tester

les réponses des cultures aux doses faibles d'engrais dans certaines régions du Département où la pluviométrie est déficitaire et où les doses préconisées ne peuvent être appliquées.

Il n'a pas été signalé de réponse du mil à la potasse; une carence en soufre est par contre possible. Les oligo-éléments ont été peu étudiés dans ces sols (un rapport IRAT signalait une carence en oligo-éléments, mais il ne précise ni les éléments concernés, ni la méthodologie utilisée pour cette détermination).

II-2. Le travail du sol: peu de données existent également sur ce thème technique; l'IRAT a toutefois mené des essais comparatifs entre le labour, le scarifiage et le non travail du sol (témoin). Le labour à 15 cm à l'aide d'un bati Arara équipé d'une charrue de 10 pouces donne le meilleur rendement (145 à 129 % du témoin) suivi du scarifiage à la houe Manga (110 à 120 % du témoin).

II-3. La densité de semi: les travaux de l'IRAT, comparant des densités de semi comprises entre 6000 et 12000 poquets par hectare ont abouti à des résultats préconisant, aussi bien pour la zone humide que la zone sèche, une densité de 10.000 poquets par hectare. Cependant certains résultats suggéraient qu'une densité de 6000 à 8000 poquets par hectare pouvait être appliquée pour la zone sèche alors qu'une densité de 10.000 à 12.000 poquets par hectare pouvait être appliquée pour la zone humide. Ces travaux avaient également montré une interaction densité fertilité du sol; sur les sols pauvres, les fortes densités ont un effet dépressif sur le rendement.

A partir de ces résultats, on pourrait suggérer, pour les zones Nord du Département, ou l'humidité est un facteur limitant, un allègement des densités sans autant diminuer le rendement.

II-4. Conclusion: la totalité des thèmes relatifs à la fertilisation et à l'agronomie générale semblent donner des accroissements de rendement significatifs lorsqu'ils sont appliqués pour le mil sur des sols ferrugineux sableux du Niger.

Une etudé de l'INRAN ayant porté sur 31 exploitations et 214 champs de paysans en 1980 et 1981 a resulté dans le classement suivant des thèmes techniques en fonction de l'importance de la perte sur le rendement lorsqu'ils ne sont pas appliqués:

1. fumier de parc

2. engrais (aux doses recommandés)

3. densité de semi

4. sarclage

La date de semi, la culture attelée, le précédent cultural semblaient avoir un moindre effet.

ANNEX E

TERMS OF REFERENCE

JOINT PROGRAM ASSESSMENT

TERMS OF REFERENCE

AN ASSESSMENT OF AGRICULTURAL TECHNICAL PACKAGES

I. INTRODUCTION

The Government of Niger's strategy of food self-sufficiency is based in large measure upon quantitative increases in production from rainfed cereal and legume crops to meet the consumption needs of a growing population. Even when one includes the efforts currently being made to develop more irrigated crops, given the limited availability and high development costs of such irrigated cropland, the dependency on rainfed agriculture is likely to continue through the balance of this century. Furthermore, the pressures on domestic food production have been heightened in recent years by the decline in revenues from Niger's principal exports - i.e. first livestock and then uranium - which had in the past been used to offset imports, including foodstuffs. Therefore, the national goal of food self-sufficiency is now and will remain closely linked with a goal of yearly increases in aggregate outputs from rainfed crops.

Sustained growth in aggregate food outputs from rainfed crops can take place through increases in the number of hectares devoted to these crops each year; through intensification of crop activities on presently cultivated areas; or through some combination of these two methods. Available information on land availability in Niger, however, seems to indicate that opportunities for large increases in food production by simple land extensive methods are becoming much more limited with population growth, the present spatial distribution of the rural population, and other factors. Expansion of crop cultivation in areas of better soil resources and higher rainfall can for the most part now take place only at the expense of the normal - and agronomically vital - practice of fallow rotations with their regenerative effects on soil fertility and structure. Continuous cropping on these areas, without intensification techniques such as increased use of inorganic fertilizers and incorporation of humus-producing materials in the soil, is doomed to be a self-defeating exercise in soil mining. On the other hand, extension of cropping onto less fertile soils in drier areas of the country increases the risks of crop failures; deprives the pastoral population of much needed grazing for its animals; and generally contributes to the further deterioration of the country's fragile resource base without adding significant quantities of food to aggregate stocks.

Given this situation, the Government of Niger, with external donor assistance, has opted to encourage Nigerian farmers to intensify their rainfed agricultural ativities. Under this

strategy, per hectare yields of the major cereal and legume crops - i.e. millet, sorghum, maize, cowpeas and peanuts - are to be raised principally through the promotion and application of "agricultural technical packages". These packages are composed of several technical elements - e.g. improved seed, better agronomic practices, inorganic and organic fertilizers, and animal traction equipment - which in combination are thought to have the potential for raising crop yields per hectare at acceptable economic rates of return. Several major "productivity projects" in Niger have been planned and are now being implemented based in large measure upon the promotion of such "agricultural technical packages" to farmers. In addition, several joint efforts are being mounted to support the "productivity projects" through provision of modern agricultural inputs, training of Nigerien technicians and extension workers, and research into ways of increasing agricultural productivity. In this regard, the Government of Niger and the Government of the United States, through the United States Agency for International Development (USAID), are collaborating in the Niamey Department Development Project (Phase II), the Niger Cereals Research Project, and the Niger Agricultural Production Support Project. In addition, several other related projects are in various stages of planning and development, including, for example, the Niger Agricultural Sector Grant Program and the Niger Farm Equipment Enterprises Development Project.

II. OBJECTIVES OF THE ASSESSMENT

Given the need for both the Government of Niger and USAID to reassess and evaluate their joint development efforts in order to assure optimal use of limited resources to desired ends, the objectives of this analytical assessment are to:

1. Evaluate the components of the "agricultural technical packages" as they are currently being promoted in the aforementioned projects for financial <u>and</u> economic viability;

2. Analyze the existing constraints to the further dissemination of those packages and/or package components found to be financially <u>and</u> economically viable;

3. Indicate clearly where insufficient information currently exists for adequate analyses of viability and advise on what additional steps should be taken to permit such analyses to proceed in the near-term future;

4. Propose recommendations for policy and/or structural adjustments in current Government of Niger/USAID project and program activities and/or new activities for further consideration in the context of the Joint Project Assessment policy dialogue.

With regard to the first objective, the analytical team should clearly distinguish at the outset and throughout the assessment the differences between analysis of financial viability for an "agricultural technical package" or component of that package and analysis of economic viability for the same package or component. The former is wholly concerned with the financial profitability of the package or component to the Nigerien farmer; whereas the latter is concerned with analysis of potential gains or losses to the entire Nigerien society from widespread adoption of a given package or package component.

This distinction is considered very important to the successful completion of this assessment because whereas:

1. Decisions on agricultural policy matters taken by the Government of Niger and USAID with regard to their collaborative agricultural efforts should be based primarily upon the economic costs and benefits to be derived from alternative courses of governmental action; decisions taken by Nigerien farmers in ultimately adopting or rejecting the packages or components are based on the actual prices they face in the marketplace which constitute for them the financial costs and benefits to them personally from such adoptions.

2. Results of financial and economic viability analyses may have very different outcomes and point the researchers in different directions. For example, it is possible that certain agricultural innovations could be very attractive to a farmer because the actual prices he faces in the marketplace are very different from the economic prices faced by the society as a whole. This would lead him to overutilize his available resources to produce outputs which have less economic value to the society than to him personally. The opposite case is also possible where outputs which have very high economic value to the society are not produced in sufficient quantities because the farmer faces market prices which give him little or no incentives to produce the product in question.

It is only in the case of perfectly competitive markets that the financial and economic viability analyses of an agricultural innovation would give exactly the same results. It is therefore extremely important that the analyses of the "agricultural technical packages" or their components proceed simultaneously at both the financial and economic levels in assessing the viability of innovations.

III. STEPS TO BE FOLLOWED IN IMPLEMENTING THE ASSESSMENT

The following steps are to be followed in implementing the assessment of the "agricultural technical packages" and their components:

1. Precise definition of the "agricultural technical packages" to be assessed;

2. Disaggregation of the "agricultural technical packages" into their components;

3. Establishment of technical input/output relationships for each component of each "agricultural technical package" under consideration;

4. Establishment of financial and economic prices for the inputs and outputs of each component of each package;

5. Use of farm enterprise budgeting techniques to determine the financial and economic viabilities of varying combinations of package components from the simplest innovation to the complete adoption of the package;

6. Analysis of the farmer's ability to pay for all inputs required for each component of the package over time using whole farm budgeting and cash flow analysis techniques;

7. Analyses of the net benefits to be derived from package adoption in comparison with alternative uses of the farmer's land, labor, capital and management skills, particularly in production of cash crops;

8. Analysis of the effective constraints to the widespread dissemination of financially and economically viable "agricultural technical packages" or their components;

9. Recommendations for further data collection and analyses in areas where insufficient information now exists to complete the present assessment;

10. Recommendations for policy and/or structural adjustments in present or planned Government of Niger/USAID joint project or program activities affecting the agricultural sector.

IV. COMPOSITION OF THE ASSESSMENT TEAM

The assessment team will be composed as follows:

1. American Contractor Personnel

   a. Agricultural Economist: This person will be primarily responsible for Steps 4 to 7 in close collaboration with the American Economist/Financial Analyst and the Nigerien Agricultural Economist. He will actively participate and contribute to all other Steps in the Assessment.

b. Economist/Financial Analyst: This person will be primarily responsible for Steps 8 to 10. He will actively participate and contribute to all other Steps in the Assessment and will share with the Agricultural Economist the responsibility for final analysis and production of the Assessment Report.

c. Tropical Agronomist: This person will share with the two economists above and the Nigerien soil scientist and agronomist responsibility for Steps 1 and 2 of the Assessment and will bear primary responsibility for Step 3. He will also contribute to Steps 8 to 10.

d. Rural Sociologist/Anthropologist: This person, in collaboration with the rest of the team and particularly with the Institutional Analyst and the Nigerien Rural Sociologist, will be responsible for contributions to Steps 8 to 10. Particular stress will be placed upon farm-level constraints to package dissemination by this person and his Nigerien counterpart.

e. Institutional Analyst: This person will contribute primarily to the analyses involved in Steps 8 to 10. He will contribute particularly to analysis of constraints to dissemination of the packages and components at levels higher than the farm.

All American Contractor personnel will be expected to have professional training in their respective fields to, at least, the Masters level and preferably to the Ph.D. level; to be competent in the French language to, at least, the FSI 3/3 level and preferably higher; and to have had prior resident professional experience in West Africa, preferably in one of the Sahelian countries and optimally in Niger itself.

2. Nigerien Personnel

a. Agricultural Economist

b. Agronomist

c. Soil Scientist

d. Rural Sociologist

e. Institutional Analyst/Evaluation Specialist

It is expected that the Nigerien personnel would be actively involved in agricultural development activities in Niger. It is probable that they will be recruited from the staffs of the Ministries of Planning and Rural Development and/or from affiliated institutions like INRAN, IRSH or others.

V. ANTICIPATED WORK PLAN

It is anticipated that the Assessment will be implemented in the period July to November 1983. The Assessment will be conducted in two phases as follows:

1. Field Operations and Preliminary Analysis Phase: July-September 1983

The multidisciplinary joint field phase of the Assessment will be concerned with collection and analysis of all available data and information from Government of Niger and USAID sources concerning the existing "agricultural technical packages". It is anticipated that this secondary source material will be supplemented and amplified by primary interviews between assessment team members and Nigerien farmers, government officials, foreign technical assistance personnel, and other relevant persons as appropriate.

2. Final Analysis and Report Writing Phase: September-November 1983

With the majority of the Assessment analyses having been completed in preliminary form in the first phase, a sub-group of the Assessment team will be assigned the tasks of finalizing all analyses, formulating final team recommendations, and editing and translating the final Assessment report during this second phase.

VI. REQUIRED REPORTS

The American Contractor will provide a written report on the status of the Assessment at the end of the first phase and such oral briefings as may be desired to both Government of Niger and USAID officials before commencing second phase operations.

Upon completion of the second phase of the Assessment, the American Contractor will present ten copies in English and ten copies in French of the final Assessment report to USAID/Niger for appropriate distribution.

ANNEX F

LIST OF PERSONS CONTACTED

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics)

Kanayo F. Nwanze, entomologiste
L.K. Fussel, agronome
K.J. Guthrie, plant pathologist
Anand Kumar, millet breeder/sélectionneur de mil
John McIntire, économiste

INRAN (National Agronomic Research Institute of Niger/Institut National de Recherches Agronomiques du Niger)

Toukoua Daouda, Division Etudes et Programmes
Issaka Magah, Chef du Département de Recherches Agricoles (DRA)
John Clark, sorghum breeder/sélectionneur de sorgho, DRA
Ly Samba, Chef du Départment de Recherche en Economie Rurale (DECOR)
Moussa Abba, DECOR
Scott Swinton, DECOR
Robert Chase, Département de Recherches Ecologiques (DRE)
Gandah Mohamadou, DRE
Issaka Mahamane, DRE
Botorou Ouendeba, millet breeder/sélectionneur de mil, Kolo

IPDR/Kolo (Institut Pratique de Développement Rural)

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Yahaya Issaka, Chef du Département Agronomie
Alain Blanchin, Département Agronomie
Boubacar Moumouni, Département Socio-Economie
Bucumi Joachim, Département Socio-Economie
Cao Quan, Département Socio-Economie
Josue Dione, Département Socio-Economie
Andre Ferchat, Département Agronomie

IRSH (Social Science Research Institute/Institut de Recherche en Sciences Humaines)

Sidikou A. Hamidou, Directeur

Ministère du Développement Rural

Salha Aladou, Secrétaire Général
Bawa Assoumane, Directeur des Etudes et de la Programmation
Ibrahim Oumarou, Directeur des Services de l'Agriculture
Katché Illo, Chef du Service des Statistiques Agricoles, Etudes et Documents
Hikmet Gursoy, Service des Statistiques Agricoles

Marc Randon, Service des Statistiques Agricoles
Ali Dankintafo, Directeur, Projet Intégré Elevage, Tahoua

Ministère du Plan

Lawaly Chaffani, Direction des Programmes et du Plan, Bureau d'Evaluation
Mamadou Amadou, Bureau d'Evaluation
Seydou Yayé, Service de la Planification Sectorielle
Louis Siegel, Bureau d'Evaluation

Niamey Department Development Project/Projet Productivité Niamey

Cdt. Saley Moussa, Directeur Général
Mary Abrams, Agronomie
Trevor Sweetman, Suivi-Evaluation
Wendy Wilson, Women in Development/Promotion Feminine

UNCC (Union National de Crédit et de Coopération)

M. Landes, Centrale d'Approvisionnement
Ian Pattinson, Centrale d'Approvisionnement

USAID

Irving Rosenthal, Mission Director
Jesse Snyder, Deputy Director
Steve Dawes, FLUPP Project
Harry Dorcus, Assistant Controller
Abbe Fessenden, Program Officer
John Heermans, FLUPP Project
Lance Jepson, Agricultural Development Officer
James Lowenthal, NDD Project Manager
John Mullenax, Agricultural Production Support Project
Thomas Olson, Agricultural Economist
Wilbur Thomas, Agricultural Development Officer
K. Toh, Program Economist
Boyd Whipple, Controller

Projet de Développement Rural/DOSSO

Francois Durand, Suivi-Evaluation
Moutari Mahamane, Suivi-Evaluation

Filingué

Magagi Abdou, Délégué UNCC
Maraye Maidawa, Chef du Service Agricole Adjoint
Harouna Djibratta, Délégué Adjoint UNCC

Gueladio

Ousmane Issa, UNCC

Koné Béri

Alio Dankarami, Chef du CPT

Service Départemental d'Agriculture/Niamey

Moutari Souley, Chef de Service

Hamdallaye

Sahiron N. Allah, Directeur, Centre de Multiplication de Semences

MM. les Chefs de CPT à Boula, Chewil, Gueladio, Simiri et Tondikiwindi

ANNEX G

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