

BURKINA FASO

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OAU/STRC/SAFGRAD
SEMI-ARID FOOD GRAINS RESEARCH

Highlights of OAU/STRC/SAFGRAD
Support to the National Farming Systems Research Programme of
BURKINA FASO

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INERA/SAFGRAD FSR Program
Kamboinsé -- BURKINA FASO

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ACRONYMS

- DUA/STRC : Organization of African Unity/Scientific and Technical Research Commission.
- SAFGRAD : Semi-Arid Food Grains Research and Development.
- INERA : Institut National d'Etudes et de Recherche Agricole.
- ESFIMA : Eau, Sol, Fertilité, Irrigation et Machinisme Agricole (One of the programs of I.N.E.R.A.).
- IFDC : International Fertilizer Development Center.
- IFAD : International Fund for Agricultural Development.

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HIGHLIGHTS OF OUA/STRC/SAFGRAD SUPPORT TO THE
NATIONAL FARMING SYSTEMS RESEARCH PROGRAM OF
BURKINA FASO

INTRODUCTION

The OUA/STRC/SAFGRAD has been assisting the Institut of Agricultural Research (INERA) in launching a national farming systems research program on the central (Mossi) plateau of the country since 1985. The modalities of the assistance are through :

- Placement of senior SAFGRAD scientists to work jointly with national counterparts in the program ;
- Provision of funds to meet priority needs, such as equipment purchase, and some operational expenses ;
- Arranging formal and informal training program for national scientists.

Currently four SAFGRAD scientists make up part of the national farming systems research (NFSR) program : a soil scientist, an animal scientist, an agro-forester and a socio-economist. These scientists work full time with the national counterparts to develop, implement and evaluate the program activities. SAFGRAD organizes training programs (workshop, seminars and short term courses) for national scientists. This is one of the mechanisms of promoting continuity of the program by the national institute.

OBJECTIVES OF THE NFSR PROGRAM.

The major objectives of the program are :

- a) To study farming systems in the central plateau of Burkina Faso with multidisciplinary team of scientists so as to identify small farmers' problems, particularly the technical and socio-economic constraints to technology adoption.
- b) To promote a system of communication between farmers, researchers and developers so as to orient research and development programs to address problems faced by farmers.
- c) To develop, in collaboration with farmers, commodity researchers and extension agencies ; technologies that alleviate production constraints and fit farmers' resource base.
- d) To propose to policy-makers elements of agricultural development policies which would improve the productive capacity of the farming community.

EXPECTED OUTPUT OF THE NFSR PROGRAM.

The expected outputs of the program are :

- a) Increase in the general state of knowledge on the technical and socio-economic constraints of farming systems in the central plateau.
- b) Improvement in capacity of agricultural research and development programs to tackle farmers' technological needs.
- c) Generation of technologies that would help promote food security and fit farm conditions.

MAJOR TASKS ACCOMPLISHED.

As of date several activities have been accomplished and there is reason to believe the program will fulfill its objectives with time :

- Reconnaissance and subject matter surveys have been completed in which the production systems were characterized, constraints and technological needs identified.
- Three villages in the plateau representing the farm conditions on the area were chosen based on selected criteria, to serve as sites for long term research activities.
- Collaborative links between different research and development organizations in the country have been established in order to promote information and resource sharing to tackle farmers' technological needs.
- Several technologies have been evaluated under farm conditions.

2. AGRICULTURAL PRODUCTION ENVIRONMENT IN THE CENTRAL PLATEAU

The central plateau is the most densely populated part of the country. In some localities the density is nearly double the carrying capacity (40 inhabitants per square kilometer). As a result there is out migration of population from the plateau to the southern region of the country and to neighboring countries. The region has few permanent water courses. On the other hand it has relatively good road network linking to the capital, Ouagadougou, which is the major consumption center.

The mean annual rainfall ranges from 600 mm in the northern part of the plateau to 900 mm in the South, as contrasted to potential evapo-transpiration value of 1900 mm. Rainfall, distributed over a four month period, varies highly with time and location. Temperatures are high just before and right after the rainy season. Periods of drought stress are prevalent throughout the crop growing season, and especially so during plant establishment and grain formation stages. On the other hand, few intense

storms falling on soils with scanty vegetative cover contribute to serious soil erosion hazard and run-off water loss.

The soils of the area are predominately composed of sandy gravel topsoil of low fertility overlying more clayed subsoil. Their properties are characterized by:

- low water storage capacity due to low organic matter content (less than 1 %) and/or shallow depth ;
- poor soil structure
- high erodibility
- low ion retention and low buffering capacity
- low nutrient supplying capacity, especially phosphorus and nitrogen.

Some soil exhaustive practices (e.g. crop residues burning or removal from fields) further aggravate the degradation of the soil resource base.

VEGETATION : The vegetation is a savannah type with considerable number of tree and shrub species. These are maintained in the crop fields for food (fruits and leaves), timber and firewood, medical purpose, soil regeneration, fodder supply, and provision of shade. The principal species in the area comprise of : *Butyrospermum parkii* (Karite), *Parkia biglobosa* (Nere), *Combretum glutinosum*, *Combretum micranthum*, *Guiera senegalensis*, *Diospyros mespiliformis*, *Piliostigma reticulata* and *Acacia albida*.

CROPS : Major crops in the area are cereals (sorghum, millet, maize and rice), cowpeas, groundnuts, cotton, sesame, Bambara nuts, and some fruits and vegetables. Mixed cropping is the predominant practice in the area.

LIVESTOCK : Mixed farming is the prevalent practice of the farmers with regional variations in the emphasis given to the crop or livestock component. Livestock products account for nearly half of the agricultural export.

Livestock husbandry on the Mossi plateau is generally characterized by the sedentary husbandry of small ruminants on the farm and by cattle raising through collaboration of Mossi farmers and Fulani herdsmen, whereby the cattle belonging to the former are entrusted to the latter.

3. CHALLENGE TO AGRICULTURAL INTENSIFICATION

Self sufficiency in food production and conservation of the agricultural resource base are the major objectives that the farmers and the state as a whole attempt to achieve in the Mossi plateau. The unpredictable rainfall pattern has always made agricultural production risky. Traditional practice worked well in the area when land was abundant. Higher population pressure and increasing integration in the market economy has led to more parcellization of land, reduced fallow period and cultivation of marginal land. This has led to serious degradation of natural resources. Forest cover is decreasing, firewood is scarce and in general agricultural production is stagnant at a low level. There is a demand for increasing production per area and conserving natural resources through search for technologies appropriate to the farming systems of the area.

4. SOME CHARACTERISTICS OF THE FARMING SYSTEMS IN THE CENTRAL PLATEAU

4.1. Household food security.

A survey on access to food security of households conducted during 1982-85 revealed that self sufficiency in food grain production is achieved only in one year out of seven by the average household in the Sudano-Sahelian zone and about three years out of eight in the Sudanian zone. Food security is in general positively correlated with area cultivated per household resident as well as with area cultivated per active resident. Ownership and use of animal traction equipment positively influences the area cultivated per household resident and thereby food security achievement. The proportion of the total cultivated area located on lowland influences attainment of household food security in the Sudano-Sahelian zone but not necessarily in the Sudanian zone.

4.2. Crop management practices

The farmers manage their fields differently depending on production/consumption goals. Four types of fields can be identified based on this criteria.

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a) Hungry season and spice fields:

These are planted with short cycle staple crops, such as maize, early varieties of sorghum or millet and intercropped with sauce plants. The cereals are used as relief crops during the hungry period preceding the main harvest season. These fields often benefit from application of farm yard manure and domestic waste.

b) Minimum food security fields:

These are cereal fields which occupy a limited portion of the cultivated area (about one third) where the household attempts to maximize the chances of crop success through better management so as to guarantee a minimum food supply to the household within the year. Cultivation is relatively intensive in the fields. Sorghum and millet are planted with the former as dominant in the Sudanian zone and the latter in the Sudano-Sahelian zone.

c) Complementary food security fields:

These are cereal fields where cultivation is rather extensive with a relatively low management and chances of crop success is consequently lower than in the minimum food security fields. They are mostly planted with millet and designed to provide extra food supply.

d) Cash and social obligation fields:

Cash crops for sale or fulfilling social obligations, such as gifts and ceremonies, are grown in these fields. The crops are cotton, rice, tuber crops and legumes (ground nuts and Bambara nuts).

Additionally cereals from other fields, if there is surplus, are sold. Savings is mostly used to purchase livestock, which is the major component of the Mossi farmers' portfolio.

4.3. Animal Production;

Surveys conducted in 1986 in the village sites reveal the following characteristics.

About 95 percent of farmers raise livestock in the Mossi Plateau and over 90 percent at least poultry and small ruminants.

.../...

Fifty percent own large stock (bovines and/or asines) while 30 percent own bovines. The major roles assigned to livestock are drought power and manure production, and for sales to finance food grain purchases and agricultural inputs.

The number of small ruminants raised by the average household is about ten with equal proportion of bovines and caprines in the Sudano-Sahelian zone but with more caprines than bovines in the Sudanian zone. Households who own cattle possess between one to thirty six heads with average value of five per household.

Small ruminants, donkeys and draft oxen are usually raised on the farm. The cattle are entrusted to herders further away from the farms during the crop growing season and grazed on the fields after the crop harvest.

4.4. Energy source.

Firewood is the major source of energy in the Mossi Plateau. The demand for fuelwood is highest during the second half of the dry season, when it is collected for use during the rainy season, and low during the post harvest period when cereal stalks are used as substitutes or complement of wood. There is relatively more dead wood in the Sudano-Sahelian zone than in the Sudanian zone. Since use of green wood is restricted by law more firewood is used in the Sudano-Sahelian zone. Consumption per household resident is on the average 1.4 kg/day in the Sudano-Sahelian village and 0.7 kg/day in the Sudanian one. About 1 kg/day/household resident of cereal stalks is consumed in the Sudanian zone when cereal stalks is used alone.

.../...

4.5. Major constraints to agricultural production.

Surveys conducted in 1986, 87 confirmed the major constraints to food production and natural resource conservation in the area. These are listed under each production subsystems as follows:

a) For crop production:

- inadequate and unpredictable moisture supply
- low soil fertility and poor land quality
- labor bottlenecks during the crop season
- crop pests and diseases

b) For animal production:

- water shortage during the dry season
- inadequate feed availability particularly during the dry season
- livestock diseases.

c) For tree planting:

- insufficient moisture for seedling establishment
- shortage of seedlings
- livestock browsing
- termite attack
- lack of permanent land rights for women and some farmers

Other constraints of general nature are

- shortage of cash resources
- high input prices
- inadequate farm tools and implements
- poor extension service

.../...

4.6. Traditional mechanisms for coping with the constraints.

Farmers of the area have for long recognized the importance of the major constraint and have designed sets of adjustment mechanisms to minimize the adverse effects of such constraints. Diversification is the major risk minimizing strategy and explains most of the characteristics of the farming systems in the region. The major elements of the adjustment mechanisms are:

- differential field management system
- polyculture, mixed cropping and use of several varieties of a crop
- search for short cycle and drought tolerant varieties
- crop replacement strategies
- lowland development with intensified cultivation and construction of wells and/or water catchments;
- increasing use of traditional soil conservation techniques
- increasing use of animal traction
- increasing investment in livestock (small ruminants) and in small trade to spread risk;
- seasonal and long term out migration (e.g. to Ivory Coast).

5. RESEARCH IMPLICATIONS

Analysis of survey studies and observations of the farming systems lead to the following modalities of research activities :

- Changes in the relative importance of constraints between years and across farms imply that most major constraints should be tackled simultaneously by agricultural research and development to induce increase in agricultural productivity.
- Labor saving and risk reducing technologies are needed to promote stronger integration of crop, animal and agro-forestry subsystems. Particular emphasis should be put on :
 - . Soil and water management technologies ;
 - . Development of animal traction tools and implements ;

- . Animal feeding practices ;
- . Drought tolerant crop varieties.
- Lowland development programs are necessary complements in order to improve agricultural productivity in the Mossi plateau, particularly in the Sudano-Sahelian zone.
- Environmental heterogeneity, farmers' diversification strategies and farmers' crop selection criteria need to be considered in selecting varieties so as to have sensible impact on crop production in the area.

6. RESULTS OF TECHNOLOGY EVALUATION BY INERA/SAFGRAD FSR PROGRAM

The program addressed the following major constraints in its research activities :

- inadequate moisture and poor soil fertility
- environmental degradation
- labor bottlenecks
- inadequate feed resources.

6.1. Alleviation of crops moisture stress and soil nutrient deficiency

The technologies available to tackle the problem of inadequate moisture are : varietal selection for drought escape (early maturing) and field level soil-water management practices. Several varieties of sorghum (white and red), millet, maize, cowpeas and peanuts have been released for on-farm testing. For soil-water management the following technologies are available for testing :

- tied ridging
- mulching
- construction of stone hunds

The constraints of inadequate moisture and soil nutrient deficiency affect crop production jointly. Hence experiments were designed to note the interactive and individual effects of tied ridging (as a model of soil water management practice) and application of minimal doses of fertilizer (especially nitrogen and phosphorus sources).

a) Influence of tied ridging and minimal doses of fertilizer :

Tied ridging was constructed one month after planting and fertilizer at the rate of 100 kg/ha $N:P_{2O_5}:K_2O$ plus 50 kg/ha urea was applied for cereals. For legume grains phosphate fertilizer was applied at the rate of 100 kg/ha super phosphate (46 % P_{2O_5}) or 400 kg/ha of Burkina phosphate (26 % P_{2O_5}).

Cereals

There was marked increase in grain and straw yields over several locations under researcher managed trials. Yield increases of the order of 50 to 150 % were obtained with white sorghum, red sorghum, maize and millet with tied ridging plus fertilizer compared to those under traditional management (flat cultivation without fertilizer application). Under farmer management in 1985 the yield increment was less marked. This is attributed to the learning time required by farmers to implement the trials.

Legumes

There was marked increase in cowpea yields with tied ridging plus phosphate in the Sudanian zone. Similarly there was good response by peanuts and to a less extent by Bambara nuts. In contrast, in the Sudano-Sahelian zone legume grain yields were low and management effect was insignificant.

b) Crop varieties

A red sorghum variety, FRAMIDA, released by ICRISAT, demonstrated its superior performance in grain yield over local ones under improved management in the Sudanian zone. Under traditional practice the variety compared well with the local ones. Further, it has good consumer acceptability and its straw yield is comparable to the locals. The variety can be recommended to farmers' in the Sudanian zone with no risk of yield loss.

Two white sorghum varieties (IRAT 204, SPV 35) were seen to excell locals under improved management while being comparable to the locals under traditional practice in the Sudano-Sahelian zone. However, one of the varieties (IRAT 204) is of low consumer acceptability. SPV 35 on the other hand could be suitable for the area.

For the Sudanian zone two introduced varieties (ICSV 1002 and ICSV 16-5) were found to be promising with respect to grain and straw yield. Similarly, a local variety (KANFIAGUI) from the eastern region of the country demonstrated good response to management. Its prospects of wider adoption in the zone look good.

Local varieties of millet had comparable yields to introduced varieties. Better varieties of millet have as yet to be identified.

Maize varieties for the Sudanian zone that yield higher than local ones have not yet been found. Maize is a minor crop in the Sudano-Sahelian zone.

One cowpea variety (TVX 3236) released by IITA/SAFGRAD had marked yield advantage over locals both under traditional and improved management levels in the Sudanian zone, provided minimum insecticide is applied. Another variety (SUIVITA 2) performed well in the Sudano-Sahelian zone. The need for insecticide application for cowpea monocrop is emphasized.

- Introduced varieties that perform better than the ones currently grown by farmers were not found for peanuts.
- There is need for improvement work on Bambara nuts.

c) Forage legume contribution in alleviating moisture and soil fertility stress

Forage legumes such as Stylosanthes hamata, Macroptilium atropurpureum and Dolichos lablab stayed green and provided good soil cover for one month after the rainy season. There is potential to use these species in improving soil physical condition and thereby soil moisture storage.

Dolichos lablab, Vigna unguiculata (cowpeas), Stylosanthes hamata, Macroptilium atropurpureum and Phaseolus aureus managed to nodulate under the environmental conditions of the Sudanian zone. Cowpeas had the best nodulation. Regrowth biomass, organic matter and nitrogen yield of legumes after cutting for hay indicated that potential exists to gradually improve soil fertility through forage legume - cereal rotation practices.

d) Cereal/legume association

Some cereal/legume intercropping practices for the Sudanian zone have shown promising results for crop intensification.

In a red sorghum/cowpea trial a full yield (800 kg/ha) of red sorghum was obtained with additional, low grain yield (100 kg/ha) of cowpea without insecticide application. In a millet/cowpea intercropping a full grain yield (700 kg/ha) of millet and some grain yield (300 kg/ha) of cowpea was recorded.

There is possibility to increase contribution of intercropped cowpea for grain, and forage and possible N-fixation with minimum additional resource than used for cereal production in the sudanian zone. These prospects do not seem as feasible for the Sudano-Sahelian zone.

e) Effect of Burkina phosphate on millet

Trials over four years on the effect of Burkina phosphate on millet yield were not conclusive. Research work to increase activity of Burkina phosphate by acid treatment and/or incorporation with compost is in progress (IFDC, ESFII)

f) Manure effect on crop yields

Application of manure at the rate of 3 t/ha for two years on farmers's field did not show significant effect on millet. However, the beneficial effect on crop yields of farm yard manure and domestic waste applied near dwellings in the villages is very marked compared to the outlying fields where manure is not applied.

Long term experiments conducted on station (SARIA by ESFIMA) have demonstrated significant increase in crop yields with manure plus minimum fertilizer application compared to fertilizer application alone or control. Further manure application reduced the rate of soil acidification.

It is concluded that manure application over several years can improve soil productivity. The question of manure availability, transport and incorporation to soil need to be resolved through search of modalities to promote stronger integration of crop and livestock systems.

6.2. Environment restoration

Contour bunds traditionally constructed with stones in the Sudano-Sahelian zone have been noted to increase soil moisture storage and thereby crop yields in the proximity of bunds. Similary substantial accumulation of soil deposits adjacent to bunds have been noted even on the first year of installation. Recently earth dykes have been constructed to control erosion. There is need to work out design criteria of bunds, search for alternative materials of barrier construction, and reduce maintenance cost.

Andropogon gayanus (an indigenous grass) is often grown as a barrier between field boundaries for erosion control.

Several multipurpose trees and shrubs which in part serve to restore the soil resources have been identified. Among these are :

- Several indigenous species of *Acacia* (e.g. *A. albida*, *A. nilotica*, *A. polyacantha*).
- Introduced *Acacia* species (e.g. *Acacia holosericea*).

Leucaena leucocephala (on lowland) and *Cajanus cajan* have established well in the area and survived the dry season in the Sudanian zone.

Reclamation of degradation land

- Land that is too degraded to support crop production can be used to grow trees and shrubs for fuelwood, timber and supplementary animal feed. This in turn will reduce the demand for crop residue removal from fields which in part contributes to soil degradation.
- *Stylosanthes hamata* and *Macroptilium atropurpureum* established well in the area.
- *Cassia siamea*, *Eucalyptus camaldulensis* and *Acacia lebbeck* were among the tree species that established on fairly degraded soils.

6.3. Alleviation of labor constraint

Labor shortage, especially during the rainy season, has been identified as major constraint for agricultural production in the Mossi plateau. Three types of technologies are being tested to alleviate this constraint.

- animal drawn seed drill
- use of mechanical ridge tyer and ditcher to make micro catchments
- use of tree species to protect gardens (live fence).

Seed drill

Use of seed drill could reduce time required for planting and paveth the way for row planting. Evaluation of the locally available animal drawn seed drill carried out in 1987 indicated need for improvement in design of equipment. A wider choice of light, versatile and easily operated equipments is needed.

Mechanical ridge tyer and ditcher

Tied ridging has heavy labor requirement. A mechanical ridge tyer has been developed by IITA/SAFGRAD. Similarly a mechanical ditcher for construction of small depressions to collect runoff has been manufactured.

Evaluation of the earlier version of mechanical ridge tyer indicated need for lighter and more versatile design. Modified version is currently being evaluated. Preliminary tests of the ditcher reveal that the equipment has potential of being accepted by farmers due to its lighter weight and ease of handling. Furthermore ditches were noted to be effective in increasing cereal yields.

Live fences

Substantial labor is required to collect and transport crop stalks and to construct fences annually for garden enclosures in the villages. Establishing permanent live fences can partially resolve the labor demand and reduce farmers' dependency on crop stalks. Among the suitable tree species found are: *Acacia nilotica*, *Acacia polyacantha*, *Bauhinia rufescens*, *Prosopis juliflora*, and *Parkinsonia aculeata*. The gain in labor saving using these species is currently under evaluation.

There is need for vigorous effort in design of labor saving small tools and implements suited to different prototype farmers in the area i.e. manual (majority), animal traction (some) and to some extent mechanical devices. The choice of technologies for increasing labor productivity is currently limited.

6.4. Feed Resources Improvement

Inadequate quantity and poor quality of feed is the major constraint to animal production in the area. The nutritive value of a feedstuff is essentially a function of the availability of energy and nitrogen. Cereal crop residues and natural pasture have abundant sources of energy as cellulose and hemicellulose, but could not be utilized effectively mainly due to the constraint of nitrogen availability. The improvement in the efficiency with which ruminant animals transform the above poor quality roughages into meat, milk and draught power will have important implication in the integration of animals into the strongly cereal crop oriented production system.

Farmers have not given due importance to the incorporation of forage crops into the production system. As a result there is a mismatching

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of supply of nutrients and the demand for the various physiological states of animals. However, possibilities that could increase the production of forage energy and nitrogen do exist : (a) conservation of natural pasture at the right stage of growth, (b) replacement of poor fallow pasture with cultivated forage legume or oversowing with a prennial legume to the botanical composition of the pasture in favour of legume, (c) intercropping cererals with forage or dual purpose legumes; and (d) production of brouses along contour bunds or alley cropped with cerals.

1) Conservation of natural pasture as hay under the prevailing farm conditions is technically possible. This could increase the quality of the basal diet which could be budgeted according to the demands for each physiological state of animals particularly during the long dry season.

A preliminary investigation showed that young Djallonke sheep were able to maintain their liveweight when fed natural pasture hay, predominantly P. pedicellatum, between January and end of April. This is a period with known severe deficit of nutrients to maintain body weight. The hay was made in late September.

2) The trials on forage or dual purpose legumes have clearly demonstrated the possibility of alleviating the constraints of N availability to improve the utilization of cereal crop residues and mature natural pasture. All the legumes tested had their N content well above the critical level of 11.2 g/kg DM at all stages of growth. The minimum recorded was 20.0 g/kg DM for Phaseolus aureus at 116 days of growth. Below 112 g/kg DM the voluntary intake of the animal normally declines. The production of forage or dual - purpose legumes could, therefore, be a reliable source of N for supplementation. The forage legumes in addition to correcting the deficiency in N could also contribute substantial amount of energy to the animal with a concentration of about 8.2 mj metabolizable energy/kg dry matter.

3) Considering the pattern of change with stage of growth in DM yield and nutritive value (N and cell wall contents, digestibility and solubility of DM) and schedule of labour on the farm, forage legumes could be harvested for conservation at about 75 days of growth. This usually coincides with the period at which the labour requirement for cereal crops is at its low ebb.

4) The N component of the legumes were found to be rapidly degraded with a disappearance of not less than 80 % within 6 hours of incubation. This pattern of release of the legume N in the rumen does not appear to be fully synchronized with that of the slowly released energy component from the cereal crop residue. This might result in loss of N in the urine which cannot be justified under conditions of limited supply of N. Further investigations will be conducted to find means of improving the efficiency of utilization of such N sources.

5) In order to improve the quality of natural pasture on the fallow land S. hamata and M. atropurpureum were oversown. S. hamata appears to have the potential to regrow in increased density in subsequent rainy season after passing through the long dry season. This makes it suitable of mixture with grass to improve the natural pasture.

6) Some multipurpose shrubs and trees which could partly supplement forage needs have been established on fallow land. Among the promising ones are : *Bauhinia rufescens*, *Prosopis juliflora*, *Parkinsonia aculeata*, *Acacia trachycarpa* and *Combretum aculeata*.

7. TRAINING

- Technicians of the program have participated in FSR training sessions held by SAFGRAD.
- One technician has taken a specialized training course in computing at the national level.
- Some university students completed of their final year research work under the supervision of FSR researchers and with the assistance of the program.
- Researchers participated in workshop and regional meetings of SAFGRAD.

8. REPORTS

- Some 16 reports and university final year thesis have been completed under the program.

9. CONCLUSION

The national Farming Systems Research (NFSR), Kamboinsé team, of INERA covering the central plateau of the country has been launched through the support of OUA/STRC/SAFGRAD with IFAD financial assistance. SAFGRAD contributed scientists, equipment and operational fund.

The program was started in 1985 and has accomplished the following tasks.

- identified the major agricultural production constraints in the Mossi Plateau ;
- elaborated a farming systems research methodology ;
- established collaborative linkages with research and development partners;
- conducted on the job training of technicians and some university students;
- tested technologies which address the major constraints of farm conditions.

The major constraints addressed are : inadequate moisture and poor soil fertility, environmental degradation, shortage of labor during peak periods of demand, and inadequate animal feed resources.

a) Alleviation of moisture and soil nutrient stress

Tied ridging or micro-ditches to store moisture complemented with minimum doses of fertilizer, (nitrogen and phosphorus sources) can alleviate moisture and soil nutrient stress. Wider choice of soil-water management technologies such as mulching, use of deep rooting legumes to improve soil structure, organic matter application and utilization of soil ameliorating legume perennials is needed. Such work is currently on progress.

Red and white sorghum varieties that perform well in the area have been identified. Similarly local varieties of cereals which respond well to management are available. Cowpeas which yield well in the Sudanian zone have been released (e.g. TV x 3236, IITA/SAFGRAD). Improved varieties of peanuts and Bambara nuts have yet to be released.

Red sorghum/cowpea and millet/cowpea intercropping practices look feasible in the Sudanian zone. This would increase contribution of legume grains in food, feed and soil fertility amelioration at the farm level.

Manure application over several years can improve soil productivity. The question of manure availability and transport need to be resolved within the overall context of crop/livestock integration.

Improvement of local rock phosphate solubility is underway in research organizations. In the long run this could provide cheaper source of phosphorus.

b) Environmental restoration

Traditional soil erosion control measures (such as contour bunds) can effectively contribute to soil restoration.

Many grass species that can be used for bund stabilization and/or barrier construction are available. Similarly tree and shrub species which could in part serve as soil ameliorants have been identified.

Land that is too degraded to support crop production can be used to generate fuel wood, timber and animal feed thereby reducing demand for crop residue export from fields. Tree species that establish on the degraded soil have been identified.

c) Alleviation of labor constraint

This is an area which merits more vigorous activity in implement technology design for the different prototype farm conditions e. g. manual (majority), animal traction (some) and to a less extent mechanical devices. The choice of technologies addressing the labor constraint is particularly limited.

Preliminary evaluations have been carried out on :

- i) use of seed drill - improvement on design needed for dependable and easy functioning.
- ii) Mechanical ridge tyer - is designed to tie ridges mechanically.
Evaluation of lighter and simpler version of the original is in progress.
- iii) Mechanical ditcher - for making micro-ditches to collect runoff water. It has potential of adaptability by farmers.
- iv) Live fences - for garden protection. Tree species which can protect gardens effectively have been introduced on the farms. This would eliminate labor required to collect, transport and construct fences using crop stalks annually.

d) Improvement of animal feed resources

- Forage and dual purpose legumes of good nutritional quality for animals have been identified.
- Animal feed conservation techniques in the form of hay and silage using local resources have been introduced.
- Some multipurpose shrubs and trees which could partly supplement forage needs have been established.

Forage and dual purpose legumes possess high potential as sources of nitrogen and could serve as the key link in the crop, animal and agro-forestry production systems.

ANNEXE

Table 1 - 4

$$\begin{array}{r} 3722 \overline{) 726} \\ 744 \\ \hline 3540 \\ 3348 \\ \hline 1920 \end{array}$$

Table 1 Mean cereal yield under two levels of management on the Mossi Plateau summary of 1985 and 1986 findings

Year and (rainfall)	Zone	Crop	Yield Component	Management level		Factor	Remarks
				Traditional	Improved (TR+F)		
1985 (608.6 mm)	Sudanian	White Sorghum	Grain (kg/ha)	400	1000	2.5x	- Researcher managed
			Straw (t/ha)	3	5	1.7x	- One variety
			Grain (kg/ha)	400	1500	3.8x	- Researcher managed
			Straw (t/ha)	2	3.4	3.4x	- Four varieties
1986 (663 mm)	Sudanian	White Sorghum	Grain (kg/ha)	860	1800	2.1x	- Researcher managed
							- Four varieties
		Red Sorghum	Grain (kg/ha)	2000	3600	1.8x	- Researcher managed
							- R.M. - Two varieties - Several locations
		Millet	Grain (kg/ha)	1000	1600	1.6x	- Researcher Manager
							- R.M. - Three varieties - Several locations
		Maize	Grain (kg/ha)	1500	2200	1.5x	- Researcher Manager
							- R.M. - Three varieties - Several locations

Table 1 (Contd)

1986 (468 mm)	Sudano- Sahelian	White	Grain (kg/ha)	389	979	2.5x	- Researcher managed
		Sorghum	Straw (t/ha)	2.1	3.8	1.8x	- Three varieties
							- Several locations
		<hr/>					
		Millet	Grain (kg/ha)	771	1266	1.6x	- Researcher managed
			Straw (t/ha)	1.5	2.8	1.9x	- Three varieties
							- Several locations
<hr/>							
1985 608,6 mm)	Sudanian Zone	Red	Grain (kg/ha)	1400	1600	1.14x	- Farmer managed
		Sorghum	Straw (t/ha)	3.2	3.8	1.18x	- Two varieties
							- Several locations

CONTROL traditional practice , no fertilizer, flat planting

TR tied ridging constraint constructed one month after planting

F 100 kg/ha NPK (14 : 23 : 15) one month after planting and
50 kg/ha urea six weeks after planting.

Researcher managed small agronomic plot trials on farmers' fields

Farmer managed field scale trials on farmers' fields, managed by farmers.

Table 2 Mean grain legume yields on the Mossi Plateau. Summary of 1986 findings.

Year (rainfall)	Zone	Crop	Yield Component	Management				Remarks
				TR+SP	TR+BP	BP	Control	
1986 (468 mm)	Sudano- Sahelian	Cowpea	Grain (kg/ha)	460	418	423	348	<ul style="list-style-type: none"> - Researcher managed - Two varieties - Several locations - Low yield, no difference
			Straw (t/ha)	0.8	0.8	0.8	0.6	
		Peanut	Grain (kg/ha)	324	304	271	295	
			Straw (t/ha)	1.9	1.7	1.8	1.7	
		Bambara nuts	Grain (kg/ha)	36	36	28	56	Failed
1986 (663 mm)	Sudanian zone	Cowpea	Grain (kg/ha)	822	762	602	391	<ul style="list-style-type: none"> - Researcher managed - Several locations - Significant increase
		Peanuts	Grain (kg/ha)	659	590	475	391	
		Bambara	Grain (kg/ha)	443	358	355	238	<ul style="list-style-type: none"> - Researcher managed - Several locations - Significant increase

BP - 400 kg/ha of Burkina phosphate at planting band

SP - 100 kg/ha of super phosphate at planting application

TR - tied ridging one month after planting

dry matter (DM)
 Table 3 Performance of legumes in DM yield at 75-80 days after planting, in biomass yield (shoot + root) of regrowth after conservation as hay, and in nodulation (Sudanian zone).

Species	Yield of hay (kg DM/ha)	Estimated yield of regrowth (g/ha) ¹				Nodulation ²	
		DM	DN	N	P	No of nodules per plant	Diameter of nodules (cm)
<u>D. lablab</u> 'CV. Highworth)	3560	5881	5130	115	4.7	8.3	0.51
<u>V. unguiculata</u> (CV. KN. 1)	3040	8786	7805	274	11.4	16.5	0.41
<u>P. aureus</u>	1800	4353	3825	82	3.8	4.5	0.32

1. The regrowth was incorporated into soil (fallow land).
2. V. unguiculata varieties performed better than other legumes in nodulation and characteristics of nodules (58-90 % nodules colonred red or pin in cross section).

Table 4 ^(DM) Dry matter yield and the energy and nitrogen contents of natural pasture on fallow land.

	Pennisetum pedicellatum	Mixed grass species
Average DM		
Yield (kg/ha)	7295	6800
DM digestibility (%) (<u>in vitro</u>)	64	57
Estimated metabolisable energy (MS/kg DM)	7.6	6.8
Average N content (g/ha DM)	12.8	7.4

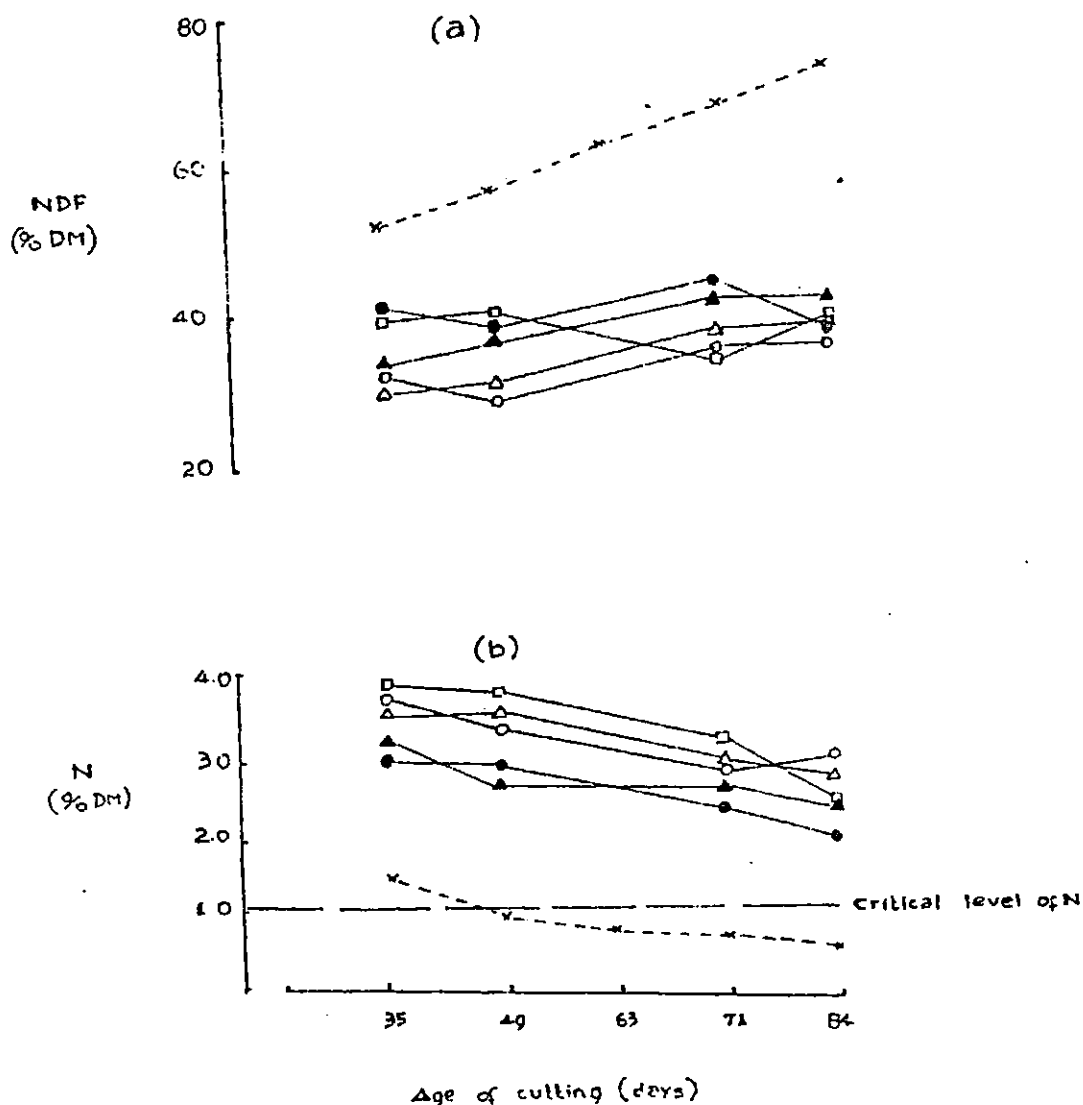


Fig. 1 : Patterns of change in nitrogen (N) and neutral detergent fibre (NDF) contents of forage legumes compared to fallow land natural pasture as growth advances : = D. lablab,
 ○ = V. unguiculata (CV. KN.1), = S. hamata
 = M. atropurpureum, = P. aureus, x = natural pasture

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Kibreab, Tadesse

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