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ECONOMIC ANALYSIS OF TIED RIDGES AND FERTILIZATION IN FARMER-MANAGED SORGHUM TRIALS IN BURKINA FASO

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ABSTRACT

Farmer-managed field trials with sorghum were conducted to determine the economic potential of farmer-adoption of fertilization and construction of tied ridges to reduce rainfall surface runoff. Treatments were: A) flat cultivation and no fertilizer applied. B) construction of tied ridges and no fertilizer, C) flat cultivation with 100 kg/ha of 14-23-15 and 50 kg/ha urea, D) tied ridges plus fertilizer as in treatment C.

Although tied ridges alone or fertilizer alone resulted in grain yields significantly greater than that of treatment A, these technologies in combination resulted in the largest yield. Returns for labor were above the opportunity cost of labor. On the basis of B:C ratios and percentage of farmers who would have lost cash, the combination of tied ridges and fertilizer or tied ridges alone are more attractive than fertilizer alone. B:C ratios with fertilizer, labor costs and interest costs included were generally higher than 3.0 for the tied ridge-fertilizer combination.

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Introduction

In the Central (Mossi) Plateau of Burkina Faso, the population is increasing at a rate of 2.5 percent per year. Partially as a result of the increased man-land ratio, an increasing number of people migrate out of the Plateau leaving a net population growth rate of 1.7 percent. The increased man-land ratio has also caused a change in the traditional farming systems in that there is a shortening of the fallow rotation period to meet the demand for increased food production, (Lang, et al.). Long periods of fallow are required to restore the soil which is very low in organic matter and fertility. The shortening of the fallow period in combination with the present farm management practice of the removal or burning of all plant material is very exhaustive on the soil. The problem is compounded because the soil structure and low levels of organic matter preclude adequate water infiltration and rainfall (long-term rainfall averages for Burkina are 350 mm in the north to 1000 mm in the south) can not be fully utilized.

The end result is that as more pressure is put on the land for food production, soil deterioration will increase resulting in lower yields and lower food production and increased out-migration. Part of the solution to overcome these problems lies in changing the present farming system of the Central Plateau (FSU, 1983).

This paper summarizes some of the research undertaken by Purdue University's Farming Systems Unit (FSU) in the testing of certain water conservation and fertilizer technologies on farmer-managed trials.

Materials and Methods

The trials were designed to permit economic analysis required to evaluate the potential for farmer adoption of the technologies. The experiment was conducted on the main sorghum fields of up to 25 randomly chosen farmers in each of four villages throughout the central plateau of Burkina. Each of four treatments was randomly assigned to a parcel of the farmer's sorghum field. Plot size ranged from 0.05 to 0.12 ha, depending upon the size of the farmer's field. Farmers were replications. Treatments were: A) traditional management practices including flat cultivation, tied ridges not constructed, and no fertilizer applied, B) tied ridges[2] constructed one month after seeding, no fertilizer applied, C) flat cultivation, 100 kg/ha of cotton fertilizer, 14-23-15, applied in a band 10-15 cm from the rows of sorghum two weeks after seeding plus 50 kg/ha urea applied in pockets 10-15 cm from the seed pockets at one month after seeding, and D) tied ridges constructed as in treatment No. 2 plus fertilizer and urea applied as in treatment No. 3. Locally grown

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varieties of sorghum were utilized.

The farmers managed and carried out the experiment with advisory inputs as needed from FSU field staff stationed in each village. Labour inputs by the farmers were recorded each week by FSU staff on a farmer-recall basis. Prior to harvest all parcels were evaluated for proper construction of tied ridges, proper application of fertilizer and general condition of the sorghum. The farmers harvested all parcels FSU staff weighed the harvest from all parcels

Results and Discussion

As outlined in the introduction, the problems of soil deterioration on the Central Plateau can only be resolved by changing the present farming systems. In 1984, FSU conducted a set of farmer-managed trials based on the themes of increasing soil fertility and water conservation. Soil fertility was increased by using moderate levels of chemical fertilizer; levels at which the largely subsistance farmers could obtain the cash for purchase of the fertilizer. Water was conserved by the construction of tied ridges.

Results of a set of farmer-managed sorghum trials at four villages using manual, donkey and ox traction are presented in Table 1. Statiscally significant yield increases over traditional yields (treatment A) were recorded for treatments B, C, and D at all locations. Statistically significant yield differences were recorded between treatments B and C for the Dissankuy and Diapangou locations indicating that the application of fertilizer alone resulted in greater yield increases than did the construction of tied ridges alone. All locations recorded statistically significant yield increases for treatment D over treatments B and C. The economic analysis indicates that at all locations, the net revenue (above fertilizer cost) to the combination of tied ridging and fertilization (treatement D) were higher than either of treatments B or C. The return/hr of additional labor required for all treatments using new technologies is substantially above the 40 CFA/hr opportunity cost of labor. The percentage of farmers at each location who would have lost cash from fertilizer purchases is also given in Table 1 for treatments C and D. At all locations, when fertilizer was used alone (treatment C), some farmers lost cash. However, when fertilizer and tied ridges were combined (treatment D), only three farmers, one at Nedogo and two at Bangassé, all with manual traction, lost cash. An evaluation of the mangement ability of the FSU farmer-cooperators indicated that the farmer in Nedogo and one of the farmers in Bangassé were very poor managers with respect to quality and timeliness of field operations. Given the lower than average amount and poor distribution of rainfall at Bangasse for the 1984 growing season, it is surprising that more farmers did not lose cash.

If farmers were to hire labor for tied ridging at 40 CFA/hr and pay cash along with paying cash for fertilizer (not shown in Table 1) the same three farmers would have lost cash in treatment D. All other farmers would have covered their cash costs as before. With respect to doing tied ridges alone as in treatment B, two farmers in Bangassé, three farmers in Diapangou-manual traction and one farmer in Diapangou-donkey traction would have lost cash.

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Benefit cost ratios (B:C) by location and by treatment for 1) the cash cost of fertilizer only and 2) the cash cost of fertilizer plus the additional labor cost of undertaking new technologies are presented in Table 2. When considering the cash outlay of fertilizer only, attractive B:C ratios are obtained for treatment D. Favorable but less attractive B:C ratios are obtained when only fertilizer is added as in treatment C. When fertilizer and labor costs are included in the B:C ratio, very attractive B:C ratios are obtained for treatment B. The B:C ratios for treatment C are all greater than 1 but less than 3. Favorable B:C ratios are obtained for treatment D with only two of the 7 sites exhibiting figures lower than 3.

Summary and Conclusions

The purpose of the foregoing set of trials was to explore the use of new technologies that could be used by farmers on the Central Plateau. The analysis considered the agronomic and economic aspects of using moderate amounts of fertilizer to increase soil fertility and the construction of tied ridges to increase water retention.

The agronomic results indicated that significant yield increases can be obtained by using moderate amounts of fertilizer and/or tied ridges. The results indicate that yield levels are highest when both fertilizer and tied ridges are utilized indicating that soil fertility and water become constraints in turn.

The economic results indicate that in all scenarios, the return/hr. for labor is above the opportunity cost of labor. On the basis of the B:C ratios and percentage of farmers who would have lost cash, a fertilizer-tied ridging combination or a tied ridging scenario alone are more economically attractive than using fertilizer alone. The fertilizer-tied ridging combination results in the largest net returns. The B:C ratios with respect to cash outlays of fertilizer in the fertilizer-tied ridging combination are high and give indications that the returns may be high enough to cover the farmers' risk. The B:C ratios remain high even when all labor costs are included.

On the basis of the results of the agronomic and partial budgeting economic analysis, further on-farm testing is warranted. The results also set the stage for further analysis within a whole-farm modeling approach. Although the results suggest that the technologies, tied ridges and fertilizer, are both agronomically and economically favorable, other constraints may exist that prevent their adoption by farmers. When farmers are asked why they do not use the new technologies, the common answers are shortage of labor, credit and fertilizer availability. Preliminary linear programming results show that there is a labor shortage at critical periods within the agricultural growing season and that the available family labor limits the amount of tied ridging that can be done (Roth, et al). The problems of credit for fertilizer and availability of fertilizer are also well documented with recommendations for improving the situation (Topsoba).

Based on knowledge and results from trials in 1984 and both formal and informal feedback from farmers, FSU will conduct trials in 1985 that include construction of tied ridges mechanically. The mechanical tied ridger is attached to a houe-manga or a buture and results in construction of tied ridges during the weeding operation with animal traction.

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The use of the mechanical tied ridger will hopefully reduce labor requirements in peak labor demand periods and result in increased tied ridging constuction.

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1. Agricultural Economist and Agronomist, FSU/SAFGRAD, Ouagadougou, Burkina Faso.

2. FSU, funded by the U.S. Agency for International Development (USAID), is a component of the Semi-Arid Food Grains Research And Development (SAFGRAD) project. The SAFGRAD program of which FSU is a part provides a coordinating role for agricultural research in 25 African countries. Within the SAFGRAD program in Burkina, the flow of research information progresses from the component researchers (IITA, ICRISAT) to FSU to the accelerated crop production officers (ACPO's) to the host country extension system. The role of the ACPO's involves demonstrating and refining technologies obtained from component researchers and FSU which have been proven to be effective under on-farm conditions.

FSU's primary objective is to identify new technologies that are agronomically and economically acceptable to and adaptable by farmers. FSU agronomic experiments center on four main technology evaluation areas; 1) water conservation experiments to capture water and reduce rainfall runoff (tied-ridging), 2) soil fertility (manure and moderate amounts of chemical fertilizers), 3) cereal-legume crop associations, and 4) testing of new varieties.

3. The technique of modified tied ridges consists of creating a small depression between the crop rows either by hand tillage or animal traction. If done by hand tillage depressions (32 cm long x 24 cm wide x 16 cm deep) are made between rows and spaced 11/2 meters apart. If done by animal traction, the cultivator must be equipped with a middle sweep to create a furrow, then followed by hand tillage to make a 16 cm high ridge perpendicular to the furrow every meter.

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Table 1 Economic Analysis of Farmer Managed Sorghum Trials, 1984.

	Treatments 1/				S.E. of Difference Between 2 Treatment Means	Number of Farmers
	A	B	C	D		
Nedogo, Manual Traction						
Grain Yield, kg/ha	157	416	431	652	75.1	11
Gain in Yield Above Traditional, kg/ha	-	259	274	495		
Gain in Net Revenue, CFA 2/	-	23828	13275	33607		
Return/hr. of Additional Labor, CFA 3/	-	238	664	280		
% Farmers Who Would Have Lost Cash	-	0	27	9		
Nedogo, Donkey Traction						
Grain Yield, kg/ha	214	476	451	849	63.4	11
Gain in Yield Above Traditional, kg/ha	-	262	237	635		
Gain in Net Revenue, CFA	-	24104	9871	46487		
Return/hr. of Additional Labor, CFA	-	321	494	489		
% Farmers Who Would Have Lost Cash	-	0	36	0		
Bangasse, Manual Traction						
Grain Yield, kg/ha	293	456	616	944	145.0	12
Gain in Yield Above Traditional, kg/ha	-	163	323	651		
Gain in Net Revenue, CFA	-	14996	17783	47959		
Return/hr. of Additional Labor, CFA	-	150	889	400		
% Farmers Who Would Have Lost Cash	-	0	8	17		
Dissankuy, Ox Traction						
Grain Yield, kg/ha	447	588	681	855	35.1	25
Gain in Yield Above Traditional, kg/ha	-	141	234	408		
Gain in Net Revenue, CFA	-	12972	9595	25603		
Return/hr. of Additional Labor, CFA	-	173	480	270		
% Farmers Who Would Have Lost Cash	-	0	28	0		
Diapangou, Manual Traction						
Grain Yield, kg/ha	335	571	729	1006	48.4	19
Gain in Yield Above Traditional, kg/ha	-	236	394	671		
Gain in Net Revenue, CFA	-	21712	24315	49799		
Return/hr. of Additional Labor, CFA	-	217	1216	415		
% Farmers Who Would Have Lost Cash	-	0	26	0		
Diapangou, Donkey Traction						
Grain Yield, kg/ha	498	688	849	1133	45.6	19
Gain in Yield Above Traditional, kg/ha	-	190	351	635		
Gain in Net Revenue, CFA	-	17480	20359	46487		
Return/hr. of Additional Labor, CFA	-	233	1018	489		
% Farmers Who Would Have Lost Cash	-	0	21	0		
Diapangou, Ox Traction						
Grain Yield, kg/ha	466	704	839	1177	46.8	19
Gain in Yield Above Traditional, kg/ha	-	238	373	711		
Gain in Net Revenue, CFA	-	21896	22383	53479		
Return/hr. of Additional Labor, CFA	-	292	1119	563		
% Farmers Who Would Have Lost Cash	-	0	5	0		

1/ A = Traditional (flat cultivation and no fertilizer); B = Tied ridges constructed one month after seeding; C = 100 kg/ha 14-23-15 two weeks after seeding + 50 kg/ha urea one month after seeding; D = B + C.

2/ Net revenue = yield gain x grain price (92 CFA/kg) minus fertilizer cost; (78 CFA/kg for 14-23-15, and 66 CFA/kg for urea). Includes interest charge for six months at rate of 15%.

3/ Net revenue/additional labor of tied ridging and fertilizer application. Manual, Donkey, and Ox traction require 100, 75, and 75 hours of additional labor/ha for tied ridging respectively. Fertilizer application requires 20 additional hours/ha.

Table 2 Benefit Cost Ratios of Farmer Managed Sorghum Trials, 1984.

Location/ Traction	Fertilizer Cost Only 1/ Treatments 3/			Fertilizer and Labor Costs 2/ Treatments		
	B	C	D	B	C	D
Nedogo, manual	-	2.1	3.8	6.0	2.0	2.7
Nedogo, donkey	-	1.8	4.9	8.0	1.7	3.7
Bangasse, manual	-	2.5	5.0	3.7	2.3	3.6
Dissankuy, ox	-	1.8	3.1	4.3	1.7	2.4
Diapangou, manual	-	3.0	5.2	7.2	2.8	3.7
Diapangou, donkey	-	2.7	4.9	5.8	2.5	3.7
Diapangou, ox	-	2.9	5.5	7.3	2.7	4.2

1/ (yield gain x grain price) / fertilizer cost. Data taken from Table 1.
2/ (yield gain x grain price) / fertilizer and Labor costs. An opportunity cost for labor of 40 CFA/hr. is used. Other data taken from Table 1.
3/ Treatments are defined as in Table 1.