

# BOOK OF PROCEEDINGS



*VII International Scientific Agriculture Symposium  
Jahorina, October 06-09, 2016*



**AGRO** 2016  
*sym*

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“Agrosym 2016”**

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## Impressum

VII International Scientific Agriculture Symposium „Agrosym 2016“

### Book of Proceedings

#### Published by

University of East Sarajevo, Faculty of Agriculture, Republic of Srpska, Bosnia  
University of Belgrade, Faculty of Agriculture, Serbia  
Mediterranean Agronomic Institute of Bari (CIHEAM - IAMB) Italy  
International Society of Environment and Rural Development, Japan  
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CIP - Katalogizacija u publikaciji  
Narodna i univerzitetska biblioteka  
Republike Srpske, Banja Luka

631(082)(0.034.2)

INTERNATIONAL Scientific Agricultural Symposium "Agrosym  
2016" (7; Jahorina)

Book of Proceedings [Elektronski izvor] / VII International  
Scientific Agriculture Symposium "Agrosym 2016", Jahorina,  
October 06 - 09, 2016 ; [editor in chief Dušan Kovačević]. - East  
Sarajevo = Istočno Sarajevo : Faculty of Agriculture = Poljoprivredni  
fakultet, 2016. - 1 elektronski optički disk (CD-ROM) : tekst, slika ;  
12 cm

CD ROM čitač. - Nasl. sa nasl. ekrana. - Registar.

ISBN 978-99976-632-7-6

COBISS.RS-ID 6216984



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## COMPARATIVE ANALYSIS OF AGRICULTURAL PRODUCTION SYSTEMS PERFORMANCES: CASE OF MILLET AND SORGHUM IN MALI.

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### Abstract

This study was carried out to compare the performances of agricultural production systems based on millet and sorghum in Sahelian and sudano-Sahelian areas of Mali in 2014. The two systems compared were production techniques of micro-dosing fertilizer and traditional cropping called conventional cropping system of millet and sorghum. One hundred and eight farmers (108) were selected and interviewed in the two areas. The techniques of micro-dosing used were manual and mechanical fertilizers distribution. The tools used for analysis were descriptive statistics (frequency, average, standard deviation) and analytical method (ANOVA). The software's used were EXCEL, SPSS 20 and STAGRAPHICS. The results of this survey show significant differences of mean at the plots levels. The production system based on fertilizer micro-dosing techniques is more efficient than traditional system of millet and sorghum through high yielding, lowering costs of fertilizers, diminution of farming operation work times and, high net profit at the plot level. The percent of yield obtained with manual technique is 41% and 52% with mechanical distribution (placement) for millet and respectively for sorghum 45% and 56%. The calculated cost ratio values (CRV>1) show that micro-dosing techniques are profitable for millet and sorghum production.

**Keywords:** *performance, production systems, millet and sorghum, Sahelian and sudano-Sahelian areas, Mali.*

### Introduction

Agriculture in Mali occupies 70% of population workforce and provides 42% of gross income and 75 to 80% of annual exports constituted by agricultural and livestock products (MA/PNIP-SA, 2010). Millet and sorghum crops occupy an important position in the country food security system, supported since 2009 by the government as part of the Rice Initiative in the frame of inputs subsidies (USAID/MSU, 2011). With a total production of cereal estimated at 6,674,427 tons in 2013-2014, millet occupied the second rank with 1,802,095 tons followed by sorghum 1,201,397 tons (MA-CPS-SDR, 2015). These cereals are most consumed and used as basic food of rural populations (whole grain or processed into flour for porridge, couscous, bread and alcoholic beverages).

Although constant advances research on millet and sorghum, achieving substantial efficiency gains in unstable environment become a challenge. Their production and yields during the past 20 years (between 1990/91 and 2008/09) have slightly increased compared to rice and maize. The productions grew for millet to 68% and 42% for sorghum, compared to 224% for maize and 228% for rice (USAID/MSU, 2011). Their yields are strongly linked to the rainfall, but also locust attacks and the lack of agricultural equipment (Traoré *et al.*, 2002). From these identified factors, climate variability is quoted in the generality of cases as the main constraint of cropping systems in Mali (MAEP/CPS, 2004).

To solve these constraints, several technologies have been developed by Agricultural Research in collaboration with international research institutions such as ICRISAT. Improved



varieties and appropriate crop management technologies are part of the released technologies on-farm for their adoption by farmers.

The technique of fertilizer micro dosing which involves applying a small amount of mineral fertilizer (complex cereal, DAP) in bunches crop planting is cited as a method that has the potential to increase cereal yields under dry farming conditions (Aune et al 2008; Hayashi et al 2008).

In Mali, the technique is practiced on millet and sorghum crops in the Sahelian and Sudano-Sahelian rainfall zones between 400-600 mm and 600-800 mm. It is realized manually or mechanically with the use of the hopper called mechanical placement technique (Coulibaly and al. 2012). This study evaluates the performance of these techniques compared to traditional system production in the Sahelian and Sudano-Sahelian of Mali.

## Materials and methods

### *Zone and samples*

The study was conducted in the Sahelian and Sudano-Sahelian regions with a sample of 108 farms in three regions (Koulikoro, Segou and Mopti) of which 36 farms by region (Figure 1).

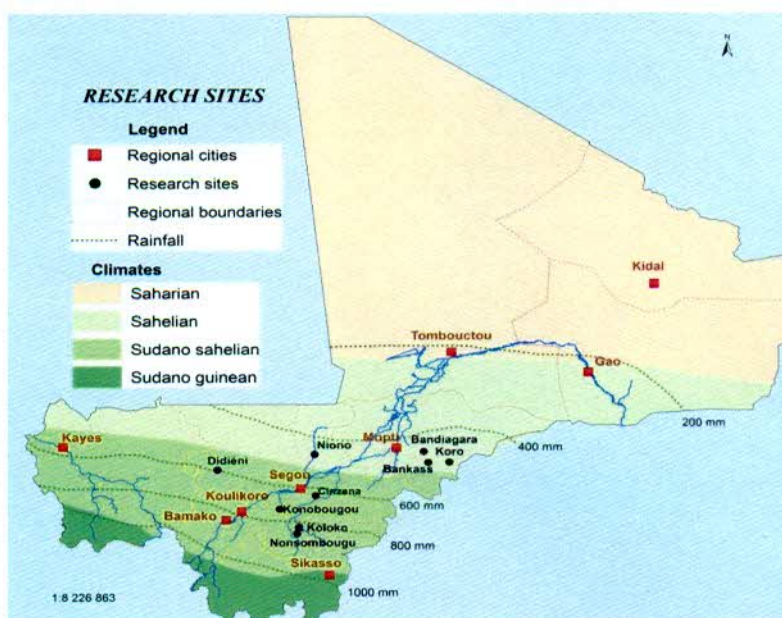


Figure 1: Map of regions and research sites in Mali.

Source: LABOSEP, IER-Mali, 2014.

### *Data collection and analysis*

Data's were collected using semi-structured interviews (SSI) with farm heads. A previously established questionnaire was used as interview guide. The main data's collected are farm characteristics and production systems of which total and cultivated area farms, cultivated areas of millet and sorghum crops, quantities and costs of biochemical inputs used (seeds, fertilizers, insecticides and other, the labors (family and outside family) and agricultural equipments utilizations and their amortization. The descriptive statistics (average, frequency) and analytical methods (ANOVA analysis) were used for data's analysis with the software's SPSS and STAGRAPHICS.



## Results and discussion

### *Socioeconomic characteristics and adoption technics by the farms*

Surveys in research sites identified two (2) cultivation systems of millet and sorghum practiced by farmers. These are culture system with micro dosing techniques of fertilizer, and traditional culture or conventional culture system of millet and sorghum, called the farmer practice. The system with the micro dosing fertilizer is represented by two techniques: the manual and mechanical techniques. The mechanical called mechanical placement involves the simultaneous application of seed and fertilizer in the planting hole with hopper utilization. In all research sites, the adoption rate of these techniques is 69 % for mechanical against 31% for farmer practice.

### *Comparative performance of millet and sorghum production systems*

Performance can be defined by search for high income, for the technical and economic profitability, employment and farms sustainability (Levallois, 2010). The concept of performance in objective or operational purpose is established by two other concepts, namely the effectiveness and efficiency. Efficient farm achieves the fixed goals and efficient farm maximizes the results with minimum resources and resources are managed with lower cost. The farm is successful, if it simultaneously efficient and effective, in other words it achieves its objectives while minimizing the use of its resources.

In this study, the performance of production systems is determined by the profitability and economic technique of identified systems on millet and sorghum crops. This profitability is assessed at agricultural plots of millet and sorghum. This is to compare the production system with fertilizer micro-dosing techniques and the traditional cultivation system of millet and sorghum.

### *Technical performance*

Technical or agronomical performance of production systems in comparison is evaluated on millet and sorghum production and on the timework of farming operations.

### *Comparison of millet and sorghum production*

- *Millet plots*

The results on millet plot show higher average yields on plots with fertilizer micro-dosing techniques than those obtained with the traditional farmer practice or system plots (Table 1). Average yields are respectively 1551kg/ha for micro-dosing technique with mechanical placement, 1256 kg/ha for micro-dosing technique with manual system and 741kg/ha for farmer practice. Increases in yields observed with the fertilizer micro-dosing technology compared with farmer practice are respectively 41% for the manual technique and 52% for technical mechanical placement.

The ANOVA test on yields shows a statistically significant difference between the yields in comparison techniques, indicated by the value P-value of statistic F test (table 2). The differences in average yields observed between techniques are 295kg/ha between the technique of mechanical placement and technique of manual micro-dosing, 514kg/ha between technical manual micro-dosing and farmer practice, and 810 kg/ha between the technique of mechanical placement and farmer practice.



**Table 1:** Compared millet yields (kg.ha<sup>-1</sup>) using three technics, 2014.

Technics	Count	Average	Standard deviation	Coeff. of variation	Minimum	Maximum
Manual microdo-sing	32	1256	320,84	25,55%	800	2200
Mechanical micro-dosing	15	1551	446,94	28,81%	1125	3000
Farmer practice	24	741	211,84	28,57%	400	1067
Total	71	1144	443,91	38,80%	400	3000

**Table 2:** Yield Statistics for millet, 2014. Method: 95,0 percent LSD.

Statistics tests	Valeur	Probabilité (P Value)
ANOVA F – statistic	32,81	0,000
Test on averages yields		
Contrast	Signification	Différence
Placement – Manual	*	295
Manuel – farmer practice	*	514
Placement - farmer practice	*	810

\* significant at 5%.

### ***Sorghum plots***

The results on sorghum plot show higher average yields on plots with fertilizer micro-dosing techniques than those obtained with the traditional farmer practice or system plots (table 3 and 4). Increases in yields observed with the fertilizer micro-dosing technology compared with farmer practice are respectively 45% for the manual technique and 56% for technical mechanical placement.

Statistical tests on yields (Table 4) show a statistically significant difference between the techniques in comparison (P value of statistic F test). Average differences observed between techniques are significant. They are respectively 295 kg/ha between the technique of mechanical placement and technique of manual micro-dosing, 514 kg/ha between technical manual micro-dosing and farmer practice, and 810 kg/ ha between the technique of mechanical placement and farmer practice.

**Table 3:** Compared sorghum yields (kg.ha<sup>-1</sup>) using three technics, 2014

Technics	Count	Average	Standard deviation	Coeff. of variation	Minimum	Maximum
Manual micro-dosing	22	1242	255,38	20,563 %	800	2000
Mechanical micro-dosing	17	1569	457,34	29,154 %	1033	2500
Farmer practice	11	686	295,97	43,122 %	300	1233
Total	50	1231	469,40	38,137 %	300	2500



Table 4: Yield Statistics for millet, 2014. Method: 95,0 percent LSD.

Statistic tests	Valeur	Probabilité (P value)
ANOVA F – statistic	58,59	0,000
Test on averages yields		
Contrast	Signification	Différence
Mechanical – Manual	*	327
Mechanical – Farmers practice	*	556
Manual – Farmer practice	*	882

\* significant at 5%.

### Compared farming operations work times

The performance of techniques in comparison has been evaluated for farming work times operation's that are sowing and weeding times, evaluated in man day per hectare (Hoe.j/ha). The results show a reduction of work times achieved with the technique of mechanical micro-dosing (placement), compared to those of the farmer practice (Figure 2).

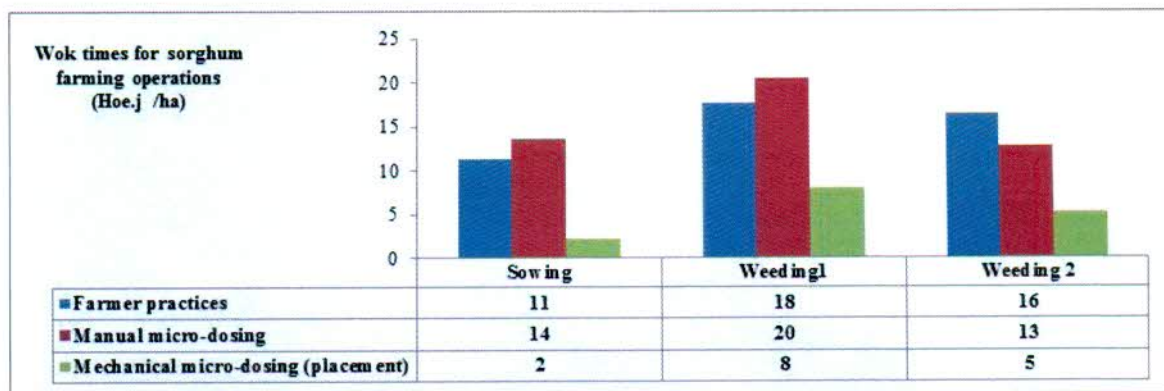


Figure 2: Wok times for sorghum farming operations (Hoe.j/ha)

### Compared economic performance of technics

The benefit costs analysis (Ferraton and Touzard, 2009) were used to determine the economic performance of different production systems in comparison for millet and sorghum crops. The calculated performance indicators are in table 5.

- **The Gross value (GV):** is the value of crop system, calculated from the production quantity by area unit multiplied by the product market price. The market price during harvesting time for millet is 150 FCFA by kg, and 125 FCFA by kg for sorghum.

- **Variable charges (VC):** are represented by the cost of intermediate consumption (IC) which consist of input costs used ( seeds, fertilizers , herbicides, pesticides and fungicides) and the labor costs (domestic and external) on millet and sorghum plots.

- **Gross margin (Gm):** is equal to the gross product (GP) minus variable charges (VC).

$$Gm = GP - VC$$

- **Net margin or benefit (Nm):** is the GVA minus the value of amortization (Am) (or fixed costs) of agricultural machineries used on parcels.



$$Nm = Gm - Am$$

Economic amortization is calculated by dividing the acquisition value of the equipment (excluding inflation) by the number of years during which it is really used before being replaced, either its useful life (Ferraton and Touzard, 2009).

- **Value Cost Ratio (VCR)** was used as an indicator to compare the profitability of the two production systems. It is defined as the ratio between the value of the additional production and additional costs. In this study, the value-cost ratio is calculated from the ratio of production value on all charges (variable and fixed).

On millet and sorghum, the estimated economic performance indicators show that the fertilizer micro-dosing techniques allow generating on millet and sorghum parcels higher profits or margins compared to the farmer practice (table). The calculated cost ratio values show that these techniques are profitable (CRV > 1). A CRV equal to 2 is generally accepted as critical threshold (Henk Kieft et al., 1994).

**Table 5:** Economic performance indicators on sorghum and millet using cropping systems technics (FCFA/ha).

Economic indicators (FCFA <sup>1</sup> /ha)	Millet			Sorghum		
	Farmer practice	Manual microdosing	Mechanical microdosing	Farmer practice	Manual microdosing	Mechanical microdosing
1. Gross Value	111 213	188 343	232 667	85 796	155 245	196 091
2. Variables charges (VC)	91 420	80 360	44 894	102 983	92 461	58 843
Inputs	14 436	15 369	7 632	22101	11999	7811
Labor	76 984	64 991	37 262	80 882	80 462	51 032
Amortization (fixed charges)	5 468	3 392	3 937	3 087	3 617	1 891
Total charges (CT)	96 888	83 752	48 831	106 070	96 078	60 734
3. Gross margin	19 793	107 983	187 773	-17 187	62 784	137 249
4. Net margin or benefit	14 325	104 592	183 837	-20 274	59 167	135 357
5. C RV (value cost ratio)	<b>1,1</b>	<b>2,2</b>	<b>4,8</b>	<b>0,8</b>	<b>1,6</b>	<b>3,2</b>

Source : data survey, 2014.

### Conclusion

Comparative analysis of millet and sorghum production systems in the Sahelian and Sudano Sahelian zones of Mali permitted to lay in evidence that the production system based on fertilizer micro-dosing techniques is more efficient than the traditional system cultivation of millet and sorghum. The technical and economic indicators assessed at crop parcels level show that these techniques can increase yields of millet and sorghum crops, reduce the work time of cultural operations and increase the profits of producers. The percent of yield obtained with manual technique is 41% and 52% with mechanical distribution (placement) for millet and respectively for sorghum 45% and 56%. The calculated cost ratio values (CRV > 1) show that micro-dosing techniques are profitable for millet and sorghum production.

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<sup>1</sup> 1€= 656 F CFA



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