EFFECT OF MULCHING PRACTICE ON GROSS MARGIN ANALYSIS OF SORGHUM AND MILLET PRODUCTION IN SEMI-ARID NORTH-EAST NIGERIA.

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ABSTRACT
An experiment was conducted at two sites to determine the economic benefit associated with rice bran-mulch under sorghum and millet production in Maiduguri, Semi-arid North-east Nigeria. The experiment was laid out in a split-plot design with test crops as the main-plot, and residue rates as the sub-plot treatments. The treatments were replicated four times. Crop cultural practices were carried out. At maturity, grain yield was determined. Cost – benefit analysis of the mulching practice was carried out using farm budgeting techniques. Findings from this study showed that application of 15 t/ha rice bran-mulch resulted in higher economic benefit (profitability) than 0 and 10 t/ha mulch treatments in both sorghum and millet enterprises.
Keywords: Mulching practice, sorghum, millet, gross margin and Semi-arid North-east Nigeria.

INTRODUCTION
Semi-arid North-east Nigeria is characterized by scanty and undependable rainfall. Evaporative losses are quite high during the year. Crop growth and yield are adversely affected, thereby reducing the income of the mostly subsistent farmers in the region as a result of poor yield. The use of crop residues as mulch to conserve soil moisture (Rao, *et al.*, 1998; Odofin, 2005a and b), have been observed to improve crop growth and yield in areas with low and erratic rainfall pattern. Rice bran faces less competition, especially, as livestock feed and therefore could effectively be used as mulching material. Sorghum (*Sorghum bicolor* (L.) Moench) and millet (*Pennisetum glaucum* (L) Br.) are major staples (Chiroma, *et al.,* 2003; Ojeniyi, *et al.*, 2009) in Semi-arid North-east Nigeria. They are mainly grown for their grains once a year under rain-fed condition.

In order to ensure sustainable crop production and food security, arable farming must be appreciated as a lucrative business that would raise the standard of living of the mostly subsistent farmers in the Semi-arid tropics. This underscores the need to consider the costs and returns of farm management practices carried out in a given agricultural enterprise to enhance profitability.

Farm Budgeting Techniques are tools that are used to estimate the profitability of agricultural enterprises and investment projects (Olukosi and Erhabor, 1988; Olukosi, *et al.*, 2006; Ojo, *et al.*, 2010). The techniques, also referred to as profitability or cost and return analysis tools, include gross margin, gross farm income, net farm income, total variable cost, total fixed cost, total farm expenses, total operating cost, gross ratio, operating ratio and return on capital invested.

Gross margin (GM) represents the difference between gross farm income (GFI) and total variable cost (TVC). Gross margin analysis is usually employed in the measurement of the profitability

of small scale, subsistence cropping enterprises, especially, in situations where fixed capital (land, buildings and farm machinery, e.g. tractor and attached implements) constitutes a negligible portion of the farming enterprise. Gross farm income (GFI) is the product of total quantity of harvested farm produce (in kg) and unit price of farm produce per kg. Total variable cost (TVC) represents the sum of the cost of variable farm inputs such as hired labour (e.g. costs associated with land preparation, seed sowing, mulch application, fertilizer application, weeding, harvesting and processing of farm produce), cost of rice bran, seed and fertilizer. Net farm income (NFI) is the difference between GM and total fixed cost (TFC). Total fixed cost (TFC) is the sum of cost of fixed capital inputs such as land, building, tractor and farm implements. Gross ratio (GR) which is defined as total farm expenses (TFE) divided by GFI, is a profitability ratio that measures the overall success of the farm. TFE represents the sum of TVC and TFC. The lower the ratio, the higher the return per naira invested. Operating ratio (OR) is given as total operating cost (TOC) divided by GFI. Total operating cost (TOC) is the sum of costs associated with variable farm inputs. OR is directly related to the farm variable input usage. The lower the OR, the higher the profitability of the farm enterprise. Return on capital invested (RCI) is defined as GM divided by TVC.

The objective of this current study was to determine the profitability of sorghum and millet production as influenced by the application of varying rates of rice bran-mulch.

MATERIALS AND METHODS

The research was carried out at two sites located within the University of Maiduguri. Site 1 is situated near Gate 2, on the Faculty of Agriculture Teaching and Research Farm (11^0 49′ N, 13^0 13′ E and 324 m above mean sea level), while Site 2 is situated in the Faculty of Agriculture orchard, opposite Centre for Arid Zone Studies complex (11^0 49′ N, 13^0 12′ E and 327 m above mean sea level).

The experiment was laid out in a split-plot design with test crops as the main-plot, and residue rates as the sub-plot treatments. The treatments were replicated four times. Rice bran-mulch was uniformly applied following land preparation. Crop husbandry (planting, thinning, fertilizer application, weed control and harvesting) was carried out. At maturity, grain yield was determined. Farm Budgeting Techniques (Olukosi and Erhabor, 1988; Olukosi, *et al.*, 2006; Ojo, *et al.*, 2010) were used to estimate the costs and returns (profitability) of mulching practice under sorghum and millet enterprises.

RESULTS

Cost - Benefit Analysis

The estimated cost-benefit analysis for the three rates (0, 10 and 15 t/ha) of mulch application under sorghum and millet production at Sites 1 and 2 are presented in Tables 1 and 2, respectively. The results in Table 1 showed that at Site 1, under sorghum enterprise, total variable cost, total cost, gross income, gross margin, net farm income, operating ratio and gross ratio increased with increasing mulch application rate. At Site 1 also, under sorghum production, the return on naira invested increased with increasing mulch application rate. At Site 1, under millet enterprise, total variable cost, total cost, operating ratio and gross ratio increased with increasing mulch application rate. Ten t/ha mulch application rate produced the highest millet gross income, gross margin and net farm income, followed by 15 t/ha mulch rate, at Site 1. Zero mulch produced the lowest millet gross income, gross margin and net farm income, at site 1. Also, under millet production at Site 1, the return on naira invested increased with increasing mulch application rate.

The results in Table 2 showed that at Site 2, under sorghum enterprise, total variable cost, to-

Table 1: Estimated cost - benefit analysis for three rates of mulch application under sorghum and millet production at site 1 at Maiduguri, 2009

	Sorghum Enterprise						Millet Enterprise					
	Mulch application rate (t/ha)						Mulch application rate (t/ha)					
	0		10		15		0		10		15	
Cost items and revenue	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost
Variable cost												
Hired labour cost												
i. Land preparation (N500/128 m^2/man-day)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
ii. Seed sowing (N200/128 m^2/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
iii. Mulch application (N250/128 m^2/man-day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
iv. Fertilizer application (N200/128 m^2/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
v. Weeding (N500/128 m^2/man-day)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
Rice bran mulch cost (N250/50 kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seed cost (N50/333.3 g/128 m^2)	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32
Fertilizer cost (N500/4.17 kg/128 m^2)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
Harvesting and processing cost (N200/128 m^2/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
Total variable cost (TVC)	167,968.75	100.00	167,968.75	100.00	167,968.75	100.00	167,968.75	100.00	167,968.75	100.00	167,968.75	100.00
Fixed cost	0.00		0.00		0.00		0.00		0.00		0.00	
Total fixed cost (TFC)	0.00		0.00		0.00		0.00		0.00		0.00	
Total cost (TC)	167,968.75		167,968.75		167,968.75		167,968.75		167,968.75		167,968.75	
Returns												
Gross income (GI) (at N100/kg)	918,670.00		1,042,500.00		1,068,660.00		832,670.00		959,340.00		950,220.00	
Gross margin (GM)	750,701.25		874,531.25		900,691.25		664,701.25		791,371.25		782,251.25	
Net farm income (NFI)	750,701.25		874,531.25		900,691.25		664,701.25		791,371.25		782,251.25	
Return on naira invested (RNI)	4.47		5.21		5.36		3.96		4.71		4.65	
Operating ratio (OR)	0.183		0.161		0.157		0.201		0.175		0.177	
Gross ratio (GR)	0.183		0.161		0.157		0.201		0.175		0.177	

GM = GI – TVC; NFI = GM – TFC; RNI = GM/TVC; OR = TVC/GI; GR = TC/GI; TC = TVC + TFC

Table 2: Estimated cost - benefit analysis for three rates of mulch application under sorghum and millet production in use 2 at Maiduguri, 2009

	Sorghum Enterprise						Millet Enterprise					
	Mulch application rate (t/ha)						Mulch application rate (t/ha)					
	0		10		15		0		10		15	
Cost items and revenue	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost	Cost (N/ha)	% of Total cost
Variable cost												
Hired labour cost												
i. Land preparation (N500/128 m²/man-day)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
ii. Seed sowing (N200/128 m²/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
iii. Mulch application (N250/128 m²/man-day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
iv. Fertilizer application (N200/128 m²/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
v. Weeding (N500/128 m²/man-day)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
Rice bran-mulch cost (N250/50 kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seed cost (N50/333.3 g/128 m²)	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32	3,906.25	2.32
Fertilizer cost (N500/4.17 kg/128 m²)	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26	39,062.50	23.26
Harvesting and processing cost (N200/128 m²/man-day)	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30	15,625.00	9.30
Total variable cost (TVC)	**167,968.75**	**100.00**	**167,968.75**	**100.00**	**167,968.75**	**100.00**	**167,968.75**	**100.00**	**167,968.75**	**100.00**	**167,968.75**	**100.00**
Fixed cost	0.00		0.00		0.00		0.00		0.00		0.00	
Total fixed cost (TFC)	0.00		0.00		0.00		0.00		0.00		0.00	
Total cost (TC)	**167,968.75**		**167,968.75**		**167,968.75**		**167,968.75**		**167,968.75**		**167,968.75**	
Returns												
Gross income (GI) (at N100/kg)	**1,849,240.00**		**2,556,840.00**		**2,434,490.00**		**1,443,778.00**		**1,308,220.00**		**1,512,660.00**	
Gross margin (GM)	**1,681,371.25**		**2,388,861.25**		**2,266,521.25**		**1,275,809.25**		**1,140,251.25**		**1,344,691.25**	
Net farm income (NFI)	**1,681,371.25**		**2,388,861.25**		**2,266,521.25**		**1,275,809.25**		**1,140,251.25**		**1,344,691.25**	
Return on rupee invested (RNI)	**10.01**		**14.22**		**13.49**		**7.60**		**6.79**		**8.01**	
Operating ratio (OR)	**0.091**		**0.066**		**0.069**		**0.116**		**0.128**		**0.111**	
Gross ratio (GR)	**0.091**		**0.066**		**0.069**		**0.116**		**0.128**		**0.111**	

GM = GI – TVC; NFI = GM – TFC; RNI = GM/TVC; OR = TVC/GI; GR = TC/GI; TC = TVC + TFC

tal cost, operating ratio and gross ratio increased with increasing mulch application rate. Ten t/ha mulch application rate produced the highest sorghum gross income, gross margin and net farm income, followed by 15 t/ha mulch rate, at Site 2. Zero mulch produced the lowest millet gross income, gross margin and net farm income, at Site 2. Under sorghum production at Site 2, the return on naira invested increased with increasing mulch application rate. At Site 2, under millet enterprise, total variable cost and total cost increased with increasing mulch application rate. Ten t/ha mulch application rate produced the lowest millet gross income, gross margin and net farm income, at Site 2. Fifteen t/ha mulch application rate produced the highest millet gross income, gross margin and net farm income, followed by 0 t/ha mulch rate, at Site 2. Ten t/ha mulch application rate had the highest operating ratio and gross ratio, but had the lowest return on naira invested under millet at site 2. Fifteen t/ha mulch rate had the lowest operating ratio and gross ratio, and consequently the highest return on naira invested under millet at Site 2.

DISCUSSION

Cost – Benefit Analysis

Results obtained from estimated cost-benefit analysis exhibited similar trends at both sites for all the residue rates for both sorghum and millet production. The total variable cost in both enterprises increased with the residue rates. An increase in gross income, gross margin and net farm income with increasing mulch rate in the sorghum enterprise at Site 1, the return on investment (naira) increased with decreasing mulch rate as indicated by the operating ratio and gross ratio. It is important to note that, the lower the gross and operating ratios, the higher the return per naira invested (Olukosi and Erhabor, 1988; Olukosi, *et al.*, 2006; Ojo, *et al.*, 2010). Under millet production at Site 1, and sorghum production at Site 2, gross income, gross margin and net farm income were highest under 10 t/ha mulch rate, followed by 15 t/ha mulch treatment, while 0 t/ha had the lowest gross income, gross margin and net farm income values. Also, at Sites 1 and 2, under millet and sorghum enterprises, operating and gross ratios increased with mulch rate, with a consequent decrease in return per naira invested following increase in mulch rate.

The implication of the results so obtained, is that, the profitability of sorghum production at Sites 1 and 2, and the profitability of millet enterprise at Site 1 increased with increasing mulch rate. Under millet production at Site 2, 15 t/ha mulch rate gave the highest gross income, gross margin and net farm income values, followed by 0 t/ha mulch treatment, while 10 t/ha had the lowest gross income, gross margin and net farm income values. Under millet production at Site 2, 15 t/ha mulch treatment had the lowest operating and gross ratio values, and consequently, resulted in the highest return on naira invested. Ten t/ha mulch had the highest operating and gross ratio values, and consequently, resulted in the lowest return on naira invested, compared with 0 and 15 t/ha mulch treatments, under millet enterprise at Site 2. Thus, the profitability of millet enterprise at Site 2 was highest under 15 t/ha mulch rate, followed by 0 t/ha mulch application rate, while profitability was lowest with the application of 10 t/ha mulch.

CONCLUSION

Based on the findings in this current study, application of 15 t/ha rice bran-mulch resulted in higher economic benefit than 0 and 10 t/ha treatments in both sorghum and millet enterprises. Therefore, 15 t/ha mulch application rate is suggested in the study area.

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