Journal of Exclusion Studies
Vol. 3 No. 2, August 2013, 77-83
DOI: 10.5958/j.2231-4555.3.2.010

Research Article

Impact of Conservation Farming Technologies on Poverty Reduction in Zambia

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ABSTRACT

This study aims to investigate the impact of conservation farming technologies on yield per hectare, cost per hectare and profit per hectare and ultimately on poverty. This study was carried out in the ecological region II a, which covers the central belt of Zambia. A total of 220 households were selected randomly who were using both conservation farming technologies in a part and the conventional farming technologies in other part of their land. The data were collected during March/April 2011. The study used SPSS 16 to analyse the data. Multiple regression models were used to know the impact of different independent variables on output per hectare in conservation and conventional Farming. The study revealed that the productivity per hectare in conservation farming was 58.53% higher than in conventional farming. The profit per hectare in conservation farming was 161.5% higher than in conventional farming. Hence, the study suggests for popularising the conservation farming technologies to increase productivity, profit and to reduce poverty in Zambia. The study also suggests for establishment of bank branches, co-operative credit societies/self-help groups and micro-finance institutions to provide financial facilities to enable the farmers to adopt conservation farming technologies.

Keywords: Conservation Farming Technologies, Conventional Farming Technologies, Output per hectare, Cost per hectare, Profit per hectare and poverty reduction.

INTRODUCTION

Agriculture is one of the priority sectors in achieving sustainable economic growth and reducing poverty in Zambia. Eighty percent of rural population depends on agriculture-related activities for their livelihood. The growth of this sector is important for the attainment of the long-term vision for Zambia, which is to become 'a prosperous middle income nation by 2030.' The vision for the sector is 'an efficient, competitive, sustainable and export led agriculture sector that assures food security and increased income by 2030.' Its goal is 'to increase and diversify agriculture production and productivity so as to raise the share of its contribution to 20% of GDP' (Sixth National Development Plan (SNDP) 2011). The objectives of SNDP include the promotion of participation of farming communities in adapting new agricultural technologies, such as conservation farming, through enhanced extension services to promote soil management for sustainable agricultural production and growth.

Efforts continue to be made by Government and stakeholders in order to reduce poverty in Zambia through the promotion of increased and sustainable agricultural production, productivity and competitiveness. It is

envisaged that these efforts will result in food security, income generation and creation of employment opportunities. The agriculture sector is capable of recording surpluses in production but due to factors affecting crop production, such as droughts, floods and poor agricultural practices, the Millennium Development Goal of reducing by half the proportion of people living in extreme poverty and suffering from hunger by 2015 will be difficult to meet (Republic of Zambia 2009).

The key performance indicators for the agriculture sector in Zambia show that the growth rate in the agriculture sector increased from 2.8% in 2007 to 7.1% in 2009 and the contribution of agriculture to GDP increased from 12.9% to 16.7%, respectively. The number of food insecure districts was reduced from 45 in 2005 to 39 in 2008 (MFNP, 2009). In Zambia, 250,000 farmers have adopted conservation farming agriculture, which is aimed at enhancing crop productivity. Conservation agriculture contributes to climate change mitigation and combating land degradation. This will help to improve the soil fertility thereby increasing agricultural production and productivity (Chanda 2012).

The following table shows the sector budget and financing during SNDP period.

CONSERVATION FARMING TECHNOLOGIES

Conservation farming involves the following five technologies:

1. Retention of crop residues in field, with no burning of residues. Residues improve rain infiltration and protect the top soil from erosion. Whereas, in conventional farming the residues are burnt.
2. Restricting land tillage and nutrient application to 10–15% of surface area where crops are sown. Whereas, conventional farming involves movement of the entire surface soil on a field.
3. Completion of land preparation during the dry season. Whereas in conventional farming ploughing is done after 18 days of first planting rains, which results in 25% loss of yield.
4. Establishment of a precise and permanent grid of planting stations, furrows or contoured ridges within which successive crops are planted each year and purchased organic nutrients can be accurately applied.
5. Rotations with nitrogen-fixing legumes.

'The principal aim of this approach is to restore and maintain soil fertility in the 15% of surface area and associated root zone occupied by the planted crop. The intervening area (85% of inter-rows) can remain relatively infertile as this area is mainly occupied by competitive weeds' (Conservation Farming Unit 2001).

REVIEW OF LITERATURE

According to Young (1988) for sustainable land use, it is required that it should meet the needs of farmers and second it should achieve conservation of the whole range of natural resources, including climate, water, soils, forests and pastures.

Table 1: Sector Budget and Financing (K' Billion): Agriculture, Livestock and Fisheries

Programme	2011	2012	2013	2014	2015
Agricultural crop production and productivity improvement	612.0	667.4	734.8	909.6	911.8
Sustainable land and water development	22.0	26.0	32.0	39.0	52.0
Food and nutrition security	36.0	42.0	52.0	65.0	85.0
Livestock production and productivity improvement	176.0	225.0	262.0	356.0	436.0
Fisheries development	20.0	26.0	30.0	41.0	46.0
TOTAL	**866.0**	**986.0**	**1110.8**	**1410.6**	**1530.8**

Source: SNDP 2011-15 (2011): Sustained Economic growth and poverty reduction, Lusaka.

Food and Agriculture Organisation (1998) found that the farmers using conservation tillage reduced the production costs of Soybeans per hectare by US$ 67 in Argentina, by US$ 35 in USA and by US$ 27 in Brazil.

Elwell *et al*. (1999) reported that the output of maize increased by 50–100% compared to conventional tillage system.

The study by Zulu *et al*. (2000) revealed that large-scale marketing support coupled with extensive fertilizer and input support subsidies induced farmers to devote ever larger areas to maize production.

The studies by Arulussa (1997), Langmead (2001, 2002), Stevens *et al*. (2002) found more output on conservation farming plots; double those achieved under conventional farming.

Vowles (1989) revealed that the Zambia National Farmers Union (ZNFU) played a crucial role in the development and promotion of conservation farming technologies in Zambia. Initial interest began when several commercial farmers in ZNFU traveled to Australia and the USA in the early and mid 1980s to learn about low-tillage systems. Extensive work and application by Zimbabwean commercial farmers and research at their privately financed Agricultural Research Trust further stimulated local interest in low-till technologies.

Many impact studies of conservation farming have failed to apply control groups. Most studies focused on comparing within conservation farming systems: conservation farming with and without lime, with different dosages of fertilizer, with different crop rotations. Most of the studies compared with national average yields rather than comparing it with control groups of farmers and farming conditions (Hagglade and Tembo 2003).

The study by Langmead (2001) evaluated output differences before and after conservation farming adoption using a small sample of 19 farmers only.

The study by Haggblade and Tembo (2003) filled some gaps in the previous studies, which measured the differences in profitability by comparing the value of differential output to the differential input costs. This study investigated the impact of conservation farming in Zambia on crop output, input use, cost of production and farm income. Though the sampling strategy aimed to select a group of a representative conservation farming plots together with a carefully matched set of conventional plots as control, there prevails differences in quality of soil, rainfall, level of education of the head of household, etc., between conservation farming plots and conventional farming plots.

This study is different from the above studies, as it selected those farmers who were using conservation farming technologies on a part of their land and conventional farming technologies on other part of their land. So, the impact of using conservation farming technologies on output and income was more reliable, as there was no difference in soil type, rainfall, level of education of the head of household, etc., of the control group.

OBJECTIVES

The specific objectives of this study are:

1. To know the impact of different variables on yield per hectare in conservation and conventional farming.
2. To measure the cost of production in both types of farming technologies.
3. To find out the productivity and value of output per hectare in conservation and conventional farming technologies.
4. To investigate the profit per hectare in both types of farming technologies.
5. To ascertain the loan available through organised and un-organised financial institutions.

MATERIALS AND METHODS

Zambia has been divided into three major agro-ecological regions depending on the rainfall. Region I receives the lowest, most un-predictable and poorly distributed rainfall. With less than 800 mm per year, it offers farmers a short growing period of 80–120 days. Region II receives between 800 and 1000 mm rainfall and a longer growing season of 100–140 days. Region II is sub-divided in to sub-region IIa and sub-region II b. Region III receives more than 1000 mm and the largest growing season of 120–150 days.

This study was carried out in the ecological region IIa, which covers the Central belt of the country. A total of

125 farmers from Imansa Agriculture Extension Camp and 95 farmers from Luanshimba agricultural Extension Camp, thus a total of 220 farmers, were selected randomly, who were adopting both conservation and conventional farming technologies. The data were collected during March/April 2011 and the information regarding input-use and output was collected for the last crop by administering questionnaire. The Agricultural Extension Officers of the Ministry of Agriculture of the said Camps have cooperated in collecting the data, which shows the reliability of the data for the present study.

Several specifications of the yield regression were applied to estimate the impact of various factors on yield per hectare with the most general specification given as follows.

$$\text{Yield}=\beta 0+\beta 1(\text{plot size})+\beta 2(\text{tillage method})+\beta 3(\text{fert 1})+\beta 4(\text{fert 2})+\beta 5(\text{hired labor})+\beta 6(\text{family `labor})+\beta 7(\text{edu})+\beta 8(\text{gender })+\beta 9(\text{seed})+e \quad (1)$$

Where **plot size** indicates the average size of the plot in hectares, **tillage method** is a dummy variable equal to 1 if other than plough used and equal to 0 if plough used, **fert 1** is the quantity of decomposed basal dressing applied in kilograms per hectare, **fert 2** is the urea top dressing applied in kilograms per hectare, **seed** is the quantity of seed applied in kilograms per hectare, **edu** is the level of education of the head of the household, which is a dummy variable equal to 0 if illiterate, 1 studied up to primary, 2 studied up to secondary, 3 studied up to first degree and 4 for other level and **gender** is the dummy variable for the sex of the head of the household equal to 1, if male and 0 otherwise. The last term ***e*** in the estimating equation is the error term assumed to be independently and identically distributed with mean 0 and constant variance.

This study used 'SPSS 16' Statistical Package to analyse the data. Multiple Linear Regression Model was used to know the impact of different independent variables on output per hectare. The independent variables were plot size, tillage methods, fertilizers, seed, hired labour, family labour, education and gender of the head of the family.

The Descriptive Statistical Method was used to know the cost and output per hectare in both the conservation and conventional farming methods to know the profit per hectare.

RESULTS AND DISCUSSION

Land Utilisation

The sample households were holding 1589.5 hectares of total land. Out of which, 490 hectares (30.8 percent) of land was cultivated. The average plot size cultivated by the sample households was 2.23 hectares. The land used for conservation farming and conventional farming was 173 hectares (35.3% of cultivated land) and 317 hectares (64.7% of cultivated land), respectively. The average plot size for conservation farming and conventional farming was 0.79 hectares and 1.44 hectares, respectively.

Impact on Yield per Hectare under Conservation Farming Technologies

The *R* value of the model is 72% and the adjusted R^2 value is 50%. It implies that the impact of the independent variables on yield per hectare in conservation farming is statistically significant.

The impact of plot size and seed on yield per hectare is highly significant.

If the head of the household is male and the level of education is higher, then the impact on yield per hectare was significant.

Model Summary

Model	R	R^2	Adjusted R^2	Std. error of the estimate
1	0.722[a]	0.521	0.503	2,418,092.392

[a]Predictors: (Constant), hired labour, education, tillage method, fert 2 Qty, sex, plot size, seed quant, fert 1 Qty.

ANOVA[a]

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	1.341E15	8	1.676E14	28.659	0.000[b]
	Residual	1.234E15	211	5.847E12		
	Total	**2.574E15**	**219**			

[a]Dependent Variable: output per ha.
[b]Predictors: (Constant), hired lab, education, tillage method, fert 2 Qty, sex, pscf, sdqtycf, fert1qty.
ANOVA, analysis of variance.

Impact on Yield per Hectare Under Conventional Farming Technologies

The *R* value of the model is 36% and the value of adjusted R^2 is 9% only. It implies that the impact of independent variables on yield per hectare was insignificant.

But the impact of decomposed basal dressing and urea top dressing on yield per hectare was significant.

The impact of sex and level of education of the household, seed, tillage method, hired labour on yield per hectare was insignificant.

Model Summary

Model	R	R^2	Adjusted R^2	Std. error of the estimate
1	0.365[a]	0.133	0.096	0.270

[a]Predictors: (Constant), education, fert 1 qty, tillage method, family labour, fert 2 qty, sex, sdqty, hired labour.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.352	9	.261	3.579	.000[b]
	Residual	15.334	210	.073		
	Total	**17.686**	**219**			

ANOVA, analysis of variance.
[a]Output per ha.
[b]Predictors: (Constant), education, fert 1 qty, tillage method, family labour, fert 2 qty, sex, cf, sdqty, hired labour.

Cost of Inputs Used in Conservation and Conventional Farming

The Table 2 shows the cost of inputs used in conservation and conventional farming.

Table 2 shows that the cost of input per hectare in conservation farming was less than conventional farming, i.e., K 730,632 and K 153,998, respectively. The reason was that for conservation farming the fertilizers and seed were provided at subsidised price under Farmers Input Support Programme (FISP). Since the fertilizer 1 (de-composed basal dressing) and fertilizer 2 (urea top dressing) were provided at two bags each under FISP at K 50,000 per bag, while the market price was K 220,000 per bag, the fertilizers cost per hectare in conservation farming was much lower than in conventional farming. The seed cost per hectare under both types of farming was the same because the conservation farmers were provided only one bag of 10 kg for K 80,000 under FISP, while the market price was k 160,000 per bag of 10 kg. Since this quantity was not sufficient they purchased seed from market at a higher price.

The reason for lower instrument cost in conservation farming was that the farmers borrowed or rented them, while in conventional farming they purchased.

It may be observed that the hired labour cost per hectare in conservation farming was almost double than in conventional farming because conservation farming needed more hired labour than conventional farming.

Table 2: Cost of inputs in Conservation and Conventional Farming (In Kwacha)

	Cost of input per Ha			
	Conservation farming		Conventional farming	
Details of cost	**Total cost**	**Cost per Ha**	**Total cost**	**Cost per Ha**
Seed cost	37,584,400	217,251 (23.38)	65,100,000	205,363 (13.47)
Instrument cost	17,266,175	99,804 (10.75)	58,875,350	185,727 (12.20)
Fertilizer 1 Cost	33,289,000	192,422 (20.71)	183,500,270	578,865 (37.98)
Fertilizer 2 Cost	65,009,000	375,775 (40.44)	168,310,000	530,946 (34.84)
Hired Labor Cost	7,590,506	43,876 (4.72)	7,322,000	23,098 (1.51)
Total Cost	**16,0739,081**	**929,128 (100)**	**483,107,620**	**1,523,998 (100)**

Note: (1) Figures in the parentheses are the percentages. (2) 1 USD=5000 Kwacha.
Source: Primary data.

Productivity and Value of Output per Hectare

The Table 3 shows the productivity and value of output per hectare.

Table 3: Productivity and Value of Output per Hectare in Conservation and Conventional Farming

Details	Conservation farming	Conventional farming
Output per hectare (bags)	65	41
Value of output per hectare (in Kwacha)	4,446,058	2,868,994

Source: Primary data

It may be observed that the productivity per hectare in conservation farming was 65 bags, whereas it was 41 bags in conventional farming. The productivity in conservation farming was 58.53% higher than in conventional farming.

The value of output per hectare was K 4,446,058 in conservation farming, whereas it was K 2,868,994 in conventional farming. The value of output in conservation farming was 54.97% higher than in conventional farming.

Profit per Hectare

The Table 4 shows profit per hectare (in Kwacha) in both types of farming.

Table 4: Profit per Hectare in Conservation and Conventional Farming

Sl.No	Type of Farming	Value of output	Value of input	Profit
1.	Conservation farming	4,446,058	929,128	3,516,930
2.	Conventional farming	2,868,994	1,523,998	1,344,996

Source: Primary data

It may be observed that the profit per hectare in conservation farming was K 3,516,930, whereas it was K 1,344,996 in conventional farming. The profit per hectare in conservation farming was 161.5% higher than in conventional farming.

Sources of Loan

The Table 5 shows the sources of loan from organised and un-organised sectors.

Table 5: Sources of Loan

Sl.No	Sources of loan	No. of households	Percentage (%)
1.	Organised sector		
	(a) Bank	01	0.45
	(b) Co-operatives	-	-
	Total (a+b)	**01**	**0.45**
2.	Un-organised sector		
	(c) Money lenders	02	0.90
	(d) Relatives/friends	99	45
	Total (c+d)	**101**	**45.90**
3.	No. of households not received loan	118	53.64
4.	**Grand total**	**220**	**100.00**

Source: Primary data

Out of 220 sample households, 99 (45%) households got loan from relatives/friends, 02 (0.90%) from money lenders and only 01 (0.45%) from bank and the remaining 118 (53.64%) households did not get any loan. The average loan amount was K 215,277 only.

CONCLUSIONS AND SUGGESTIONS

1. In conservation farming, the impact of plot size and seed on yield per hectare were highly significant. If the head of the household was male and his level of education was higher, the impact on yield per hectare was significant.

   Therefore, there is need for increase in plot size under conservation farming technologies and use of high-yielding varieties of seed. The average plot size under conservation farming was 0.79 hectares only. When the plot size increases full utilisation of inputs is possible. There is also need for increase in their level of education.
2. The sample households were holding 1589.5 hectares of land. Out of which, only 490 hectares of land was under cultivation–173 hectares (35.3%) under conservation farming and 317 hectares (64.7%) under conventional farming.

Therefore, there is need for bringing more land under conservation farming.

3. The productivity and the value of output in conservation farming was higher than in conventional farming. The profit per hectare in conservation farming was 161.5% higher than in conventional farming.

   Therefore, there is need to popularise the conservation farming techniques and to increase the incentives under FISP, as a policy to reduce poverty in Zambia.

4. Out of 220 sample households, 118 households (53.64%) do not have any source of loan. The main source of loan was relatives/friends only. The average loan amount was K 215,277 only.

   Hence, there is need for establishment of Bank branches in rural areas and to develop the banking habits among the rural communities. There is also need for establishment of credit co-operative societies/self-help groups. There is need for establishment of micro-finance institutions.

   The efforts for poverty reduction in Zambia should include popularisation of conservation farming technologies to increase productivity and profit, on the one hand, provision of loan facilities by banks, co-operative societies, self-help groups and micro-finance institutions.

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