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Farmer Perceptions of Conservation Agriculture in Maize - Legume Systems for Small-Holder Farmers in Sub Saharan Africa - A Beneficiary Perspective in Zambia

Kafula Chisanga[1], Nswana Kafwamfwa[2], Petan Hamazakaza[3], Mulundu Mwila[4], Joy Sinyangwe[5], Olipa Lungu[6]

[1,2]Department of Zambia Agriculture Research Institute, Mochipapa Research Station, Choma, Zambia
[3]Department of Zambia Agriculture Research Institute, Kabwe Research Station, Kabwe, Zambia
[4]Department of Zambia Agriculture Research Institute, Msekera Research Station, Chipata, Zambia
[5]Department of Agriculture, Ministry of Agriculture, Lusaka, Zambia
[6]Department of Soil Science, University of Zambia, Lusaka, Zambia

Abstract *— A survey was undertaken in three districts of Zambia namely; Monze, Mpongwe and Chipata which are hosting the Agriculture Productivity Programme for Southern Africa (APPSA) Sub-project titled "Developing Conservation Agriculture (CA) in Maize-Legume Systems for Smallholder Farmers in Zambia, Malawi and Mozambique". The overall objective of this study was to get farmer perceptions of CA practices in the study districts for key information and research gaps that will contribute towards the development of CA based research agenda. The study employed both qualitative and quantitative methods to collect data from the respondents. Data generated was subjected to analysis using Statistical Package for Social Sciences (SPSS). Results revealed that the major hindrances to the application of CA practices lay in biophysical, technological, land, institutional and agro-climatic constraints. Generally, farmers reported weeds as a major biophysical constraint to the implementation of CA technologies with Monze standing at 81.6% of the respondents followed by Mpongwe 58.1% and Chipata 52.1% respectively. This study recommends strengthening social networks of the community in order for them to have access to CA technologies information. Enhancing institutional linkages between Research, Extension and Meteorology departments is critical for dissemination of weather information which would aid in decision-making as to when farm operations would be carried out for improved agriculture productivity and production in the APPSA Project areas of Monze, Mpongwe and Chipata districts.*

Keywords — Conservation agriculture, practice, small-holder farmers, technology, Zambia

I. INTRODUCTION

Studies have shown that the use of Conservation Agriculture (CA) in sub-Saharan Africa (SSA) is limited generally. However, its use in Zambia is relatively considerable where an estimated 40,000 ha are cultivated using CA practices. This represents a greater amount than in any other SSA country (Friedrich *et al.*, 2012). The number of farmers who practice CA is not clear as different scientists have provided different figures depending on how CA is defined. Neubert *et al.* (2011) for instance reported that in 2007 around 120,000 Zambian farmers used some form of CA, (approximately 10 percent of smallholder farmers), while the Conservation Farming Unit puts the estimate around 170,000. The practice of CA has been reportedly highest in the southern, semi-arid parts of the country (with annual rainfall between 650 and 1,000 mm) due to the greater suitability of CA techniques there. Farmers in these areas are known to undertake mixed crop and livestock farming systems and grow mainly maize and cotton (Baudron *et al.*, 2007). This relatively widespread adoption is a product of agricultural crisis (Rockström, 2007; Haggblade and Tembo, 2003) and sustained promotion, mostly including subsidized inputs (Umar *et al.*, 2011; FAO, 2011b).

Economic difficulties led to the defunding of Government financed agricultural subsidies and extension programs in the 1990s, which had previously underpinned maize production in Zambia. Between 1991 and 2003 there was no explicit agricultural policy held by the National Government. At the same time, Zambian farmers were struggling with soils depleted from years of monocropping, a serious drought, an outbreak of

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livestock disease and high fuel prices (Haggblade and Tembo, 2003). In response, the Zambia National Farmers Union (ZNFU) began promoting CA to small-holder farmers in 1995 through a newly formed Conservation Farming Unit (CFU). Commercial farmers had used CA previously to reduce fuel expenditure, but discovered yield and soil conservation benefits also. These practices were adapted for small-holder operations and promoted with demonstration plots (Haggblade and Tembo, 2003).

The promotion of CA to smallholders was endorsed as an official priority by the Zambian Government in late 1999 and was included in the 2004 'National Agriculture Policy' (Neubert *et al.,* 2011). A number of non-governmental organizations, international organizations (e.g. FAO, World Bank, SIDA, Norad and the EU) and government departments have since assisted the ZNFU/CFU in their promotional efforts (Umar *et al.*, 2011; FAO, 2011b). The CA techniques promoted in Zambia are known collectively as 'Conservation Farming' (CF). These are (1): reduced tillage to no more than 15 percent of the field area without soil inversion, (2) precise digging of permanent planting basins (to maintain soil moisture) or ripping of soil with a 'Magoye ripper' (the latter used where draft animals are available), (3) keeping of crop residues (no burning), (4) rotation of cereals with legumes and (5) dry season land preparation. This suite of techniques have been promoted through the subsidized offering of input packages (seed, fertilizer and lime) conditional on adoption. Not all small-holder farmers practice the entire suite of CF techniques: in 2003 approximately one quarter of farmers applied all five, while three quarters applied only a selection (Baudron, *et al.* 2007). A separate set of CF guidelines exists for mechanized commercial farmers.

Against this background, the Zambia Agriculture Research Institute (ZARI) at Mochipapa Research Station in partnership with the Department of Agriculture under the Ministry of Agriculture and Department of Soil Science at the University of Zambia, with support from the Agriculture Productivity Programme for Southern Africa (APPSA) undertook a survey to get the views of farmers regarding their experiences with CA practices in three provinces of Zambia where the practice has seen considerable adoption that included Southern, Copperbelt and Eastern provinces. The present paper discusses the farmers' perceptions of CA in the three districts of Zambia i.e Monze, Mpongwe and Chipata that are hosts to the APPSA Sub project titled *"Developing Conservation Agriculture in Maize-Legume Systems for Small-holder Farmers in Zambia, Malawi and Mozambique".* It is envisaged that the generated information in this work will provide insights on the existing situation regarding CA in these areas for policy decision-making.

II. JUSTIFICATION FOR THE STUDY

CA is one of sustainable intensification that is increasingly promoted by various international research centres, international non-governmental organizations (NGOs), faith based organizations and governments of southern Africa among others to overcome the problem of soil degradation, drought, low and unstable crop yields and high production costs. CA is defined by three principles which must be applied simultaneously (i) minimum soil disturbance (ii) permanent soil cover with previous year's crop residues and (iii) diversification of crop species in sequence and/or in association (FAO, 2013). CA takes away the unsustainable components of conventional agriculture such as tilling the soil, removing organic material and monoculture and includes all other principles of sound crop management. While efforts have endeavoured to implement all the three principles of CA, often one or two of these principles have been applied by smallholder farmers. Spreading of crop residues as soil surface mulch has been a major challenge in Zambia (Umar *et al*., 2011). Consequently, partial application of the principles of CA do not lead to the desired modification of various agro-ecological functions such as soil health benefits, increased crop productivity and sustainability. Maize accounts for more than 60% in Zambia. Food security in resource-poor households is critically linked to the productivity and sustainability of maize-based cropping system. However, productivity of maize in southern Africa is hampered by declining soil fertility and low and variable rainfall.

Farmers in agro-ecological regions II and III of Zambia predominantly intercrop maize with beans and maize with cowpeas while rotating maize with groundnuts. Maize/cowpea intercropping is more predominant in region I, the southern part of Zambia, which is host to the Regional Centre of Excellence for cowpea research at Mochipapa Regional Research station. There is also a growing trend in southern and eastern Zambia to rotate cowpea with maize. This has been observed after the project by Alliance for Green Revolution in Africa (AGRA) that promoted cowpea as a food legume at household level in drought prone areas of Zambia. In this paper we have attempted to discuss the farmers' perception regarding their experiences with CA practices in three pockets of Zambia namely Southern, Copperbelt and Eastern provinces.

III. OBJECTIVES

This study was conducted with a view to answer the following four-fold objectives; (i) to understand the status of CA at small-holder farm level in Chipata, Monze and Mpongwe districts; (ii) to establish the common CA based practices among farmers; (iii) to aid towards the identification of key constraints to the application of CA

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practices and; (iv) to identify key information & research gaps that will contribute towards the development of the CA-based research agenda

IV. METHODOLOGY

4.1 Research Sites

Three districts were chosen in Zambia for the study that included Monze, Mpongwe and Chipata. The host districts were selected on the basis of their agro-ecological and farming systems settings which are more representative of their respective provinces. The districts are predominantly maize growing coupled with high practice of CA. Monze is located in region II and receives medium to low rainfall (600-800mm) and farmers in the region are engaged in ox-drawn-maize systems. On the other hand, Mpongwe is located in region III with occasional high rainfall (>1000mm) with farmers mostly using a hand hoe/ox-drawn-maize based farming systems. Chipata in eastern Zambia receives medium rainfall (800-1000mm). Farmers in the area also use a hand hoe/ox-drawn plough-maize based systems

4.2 Research Process

The study was conducted in three stages in a chronological way in order to respond to the stated research objectives. Firstly the research team held key informant interviews in the respective study districts with public and private key decision-makers from Government departments and NGOs to get their views regarding CA practices in those particular areas. Secondly, focus group discussions were held with farmers with a view to get insights on their experiences with CA technologies and lastly a quantitative data collection exercise was undertaken from the community in order to get data from variables of interest which were to form basis for data analysis

4.3 Sampling Strategy

The study employed a systematic farmer sampling strategy by village, based on Agricultural Camp Register. A sample of 100 farmers in each district were selected in 4 Agricultural Camps/district with 25 farmers/ Agricultural Camp being interviewed on a structured questionnaire of which 30% were women to carter for gender empowerment as enshrined in the Gender Policy by the Government of the republic of Zambia

4.4 Data Analysis Strategy

All the data from qualitative interviews for this study was sorted out using triangulation method while that from structured questionnaires was subjected to the Statistical Package for Social Sciences (SPSS). MS Excel was used for graphical representations and special computations.

V. RESULTS AND DISCUSSION

Table.1: Sampled Household Types

District	N	Percent sampled households by type				
		Male headed	Female headed with another adult male decision-maker	Male headed with another adult female decision-maker	Female headed	Male headed without any adult female decision-maker
Chipata	98	70.4%	1.0%	17.3%	9.2%	2.0%
Monze	98	92.9%	1.0%	1.0%	5.1%	0.0%
Mpongwe	99	75.8%	2.0%	0.0%	16.2%	6.1%
Total	**295**	**79.7%**	**1.4%**	**6.1%**	**10.2%**	**2.7%**

Table.2: Sampled Household Demographic Composition by district

District	Household size	# <5 years	5<15years enrolled in school	5<15years not enrolled in school	15 ≤ 65 years	≥ 66years	Child-Adult Economic Dependence ratio
Chipata	7	2	2	1	3	0.18	1.03
Monze	9	2	3	4	4	0.09	0.97
Mpongwe	8	1	2	1	4	0.15	0.71
Total	**8**	**2**	**2**	**1**	**4**	**0.14**	**0.92**

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5.1 Status of CA at smallholder farm level in Chipata, Monze & Mpongwe districts

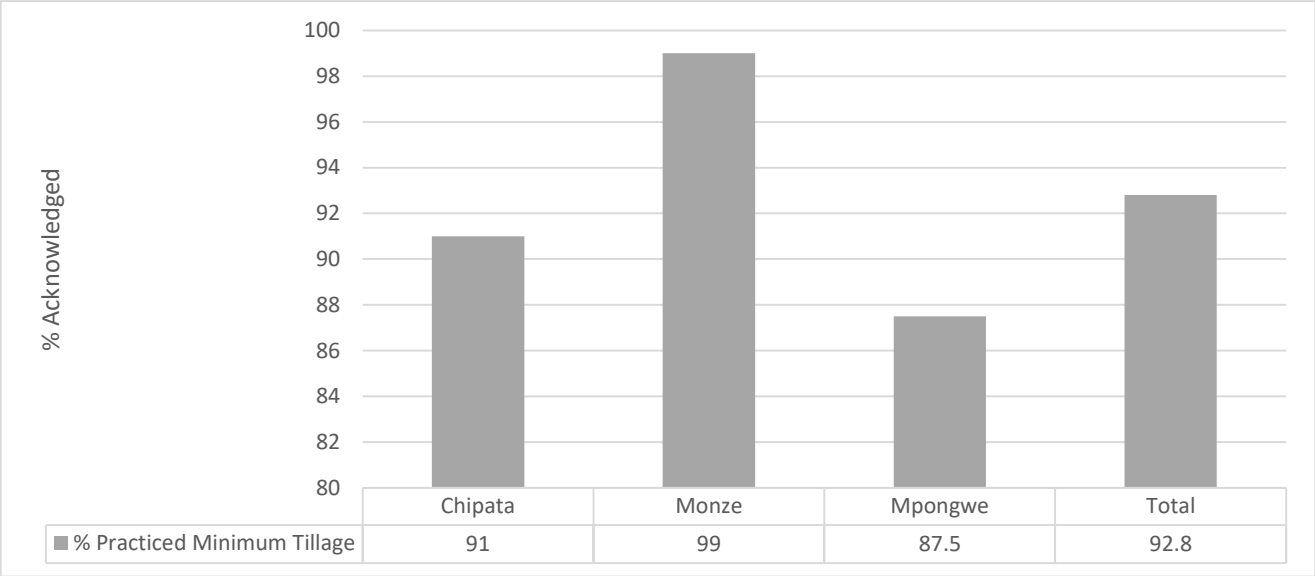

Fig.1: Farmers Practicing Minimum Tillage

5.2 Common CA based practices among farmers across the Study districts

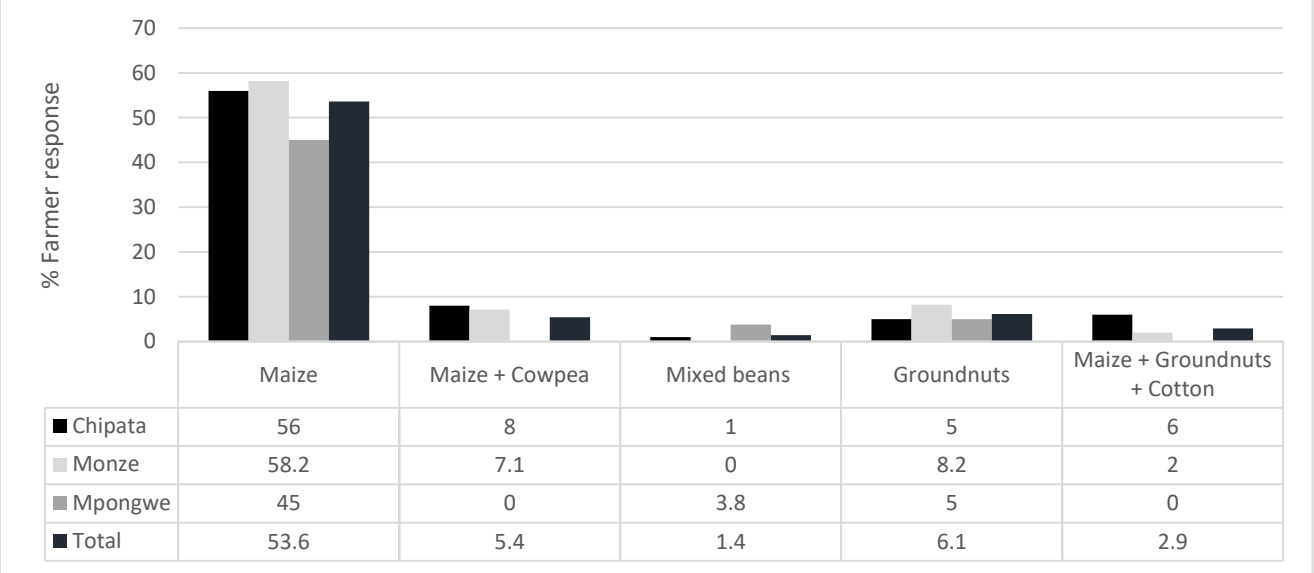

Fig.3: Major Crops and Area under Conservation Agriculture Technologies (CAT)

5.3 Key constraints to the application of CA practices

Table 3: Biophysical Constraints to CA Implementation

District	% Farmer response to CA constraints				
	Decreasing soil fertility	**Soil erosion**	**Soil type**	**Weeds**	**Insect pests & diseases**
Chipata	29.2	17.7	25	52.1	51.6
Monze	12.2	10.2	13.3	81.6	43.9
Mpongwe	17.7	24.2	16.1	58.1	50
Total	**19.9**	**16.4**	**18.4**	**64.8**	**48**

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Table.4: Technological Constraints to CA Implementation

District	Limited farm products	Lack of soil fertility leguminous green manures and food legumes	Lack of soil fertility tree seedlings	Lack of knowledge of agroforestry tree species
Chipata	22.9	24	28.1	20.8
Monze	25.5	11.2	8.2	10.2
Mpongwe	24.6	43.5	40.3	45.2
Total	**24.3**	**23.8**	**23.4**	**22.7**

Table.5: Land and Other Related Constraints

District	Limited access to land	Security of land tenure	Inadequate labor	Poor infrastructure development	Limited capital
Chipata	32.3	17.7	52.1	38.5	70.8
Monze	17.3	9.2	46.9	25.5	62.2
Mpongwe	24.2	25.8	27.4	29	27.4
Total	**24.6**	**16.4**	**44.1**	**31.2**	**57**

Table.6: Institutional and Agro-Climatic Constraints

District	Limited access to research & extension services	Poor institutional linkages in CA outreach/Promotion	Poor rainfall patterns
Chipata	10.4	28.1	47.9
Monze	11.2	35.7	71.4
Mpongwe	22.6	24.2	32.3
Total	**13.7**	**30.1**	**53.1**

In terms of household type in this study, Monze had a higher percentage of households (HHs) headed by males (92.9%), followed by Mpongwe (75.8%) with Chipata recording a percentage of 70.4% (Table 1). The higher percentage of HHs headed by males has a bearing on the decision making and adoption of the CA technologies being promoted by various extension agents. Further, the study noted that the average family size was highest in Monze (9), with Mpongwe and Chipata recording 8 and 7 respectively (Table 2). Size of the family at HH level contributes to labour requirements for farm activities and ultimately contribute to enhanced production and productivity

Results obtained in the sampled HHs, also revealed that the percentage of farmers acknowledging practicing minimum tillage was highest in Monze (99%), compared to Chipata (91%) and Mpongwe (87.5%). (Fig. 1). Monze had the highest percentage of HHs involved in minimum tillage owing to a lot of Government and NGO programs on CA that have been extensively promoted in the district. Similar views are held for Mpongwe and Chipata but not to the scale of Monze.

The year the sampled HHs first learnt about CA technologies was acknowledged as being 2009 in Monze, 2011 in Chipata while 2013 was spoken of in Mpongwe

For common CA based practices among farmers across the study districts, the study found that crop rotation was highly practiced in Mpongwe with an average area of 3.8 ha, while Monze and Chipata recorded 3.1 and 1.0 ha respectively. As for minimum tillage practice, Monze had the highest average area under cultivation of 3.29ha while Mpongwe and Chipata had an average of 2.73ha and 1.1ha respectively. HHs in Monze own more cattle which they use for land preparation in terms of ripping for CA practices unlike in other districts in this study

Sampled HHs though practicing CA and not to the level they wished, indicated that the major hindrances to the application of CA practices lay in biophysical, technological, land, institutional and agro-climatic constraints. Generally, farmers reported weeds as a major biophysical constraint to the implementation of CA technologies with Monze standing at 81.6% of the respondents followed by Mpongwe 58.1% and Chipata 52.1% respectively (Table 3). This statistic corresponds to what farmers revealed in the focus group discussions that weeds in CA technologies are a challenge as most of the HHs do not have enough income to buy chemicals or simply lack enough knowledge on herbicide application including the correct type of nozzle to use in their fields.

Technological constraints to CA implementation was reported to be the highest for lack of knowledge of

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agroforestry tree species (45.2%), soil fertility leguminous green manures & food legumes (43.5%) and soil fertility tree legumes (40.3%) in Mpongwe (Table 4) as compared to other districts, 10.2%, 8.2% and 11.2% in Monze and 20.8%, 28.1% and 24% in Chipata. This could probably be attributed to poor extension services in the area.

Limited access to land for CA implementation in the study areas was more pronounced in Chipata and stood at 32.3% followed by Mpongwe (24.2%) and Monze (17.3%) respectively (Table 5). Most farmers in Chipata face this constraint probably due to the customary system being practiced in the area. Institutional and agro-climatic constraints in form of access to research and extension services were found to be higher in Mpongwe (22.6%) while Monze and Chipata reported 11.2% and 10.4% of respondents acknowledging the constraint (Table 6). Anecdotal evidence reveals that ZARI Mochipapa has been the first research station to carry out agriculture experiments in Mpongwe during the 2014/15 agriculture calendar.

As for agro-climatic constraints, poor rainfall was reportedly a major incentive to CA implementation in Monze standing at 71.4% while sampled respondents in Chipata and Monze were reportedly statistically at 47.9% and 32.3% in that order.

VI. CONCLUSIONS

This study has revealed a number of issues that require immediate attention at both farmer, institutional and policy levels in order to scale out CA practices for improved agriculture productivity and production in the APPSA Project areas of Monze, Mpongwe and Chipata districts. The following are the recommendations made to address some of the constraints at different levels:

(i) Farmer Level: Farmers need to engage themselves more in social groups e.g cooperatives, community clubs etc at community level to get information on CA practices

(ii) Institutional Level: In order to scale out the CA technologies, there is need for strong linkage between the researchers, extension agents and the Meteorological department in order for correct CA technologies to be disseminated to farmers. Making available weather information is also critical for decision making. This should be in simplified form. Probably engaging and training community weather agents on weather interpretation would help the communities to prepare themselves for CA practices to implement for a particular season

(iii) Policy Level: Policy makers should take keen interest in carrying out frequent monitoring visits to get feedback on the policies formulated on CA practices to see where changes can be made to suit the prevailing social-economic conditions in the country

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