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Gendered Impacts of Conservation Agriculture and Paradox of Herbicide Use among Smallholder Farmers

Keywords: gender, agricultural labour use, innovation adoption, herbicides, food security, Zambia

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ABSTRACT: Conservation Agriculture (CA) is increasingly taking a central stage in agricultural policies and rural development among developing countries like Zambia. The challenge of gender gaps in agriculture has persisted despite efforts of gender mainstreaming. This paper assesses gender based impacts of conservation agriculture (CA) basins among smallholder farmers under the Conservation Agriculture Programme (CAP) in Zambia. Qualitative and quantitative approaches were used to collect data. Quantitative data was analysed mainly by descriptive statistics and qualitative data by thematic and content analysis. Results indicated that women and children experienced reduction in labour with respect to clearing of fields before tillage and during weeding where herbicides were used correctly. Improvement in household food security was also reported. Digging of CA basins was labour intensive and the *chaka* hoe was heavy for women. Labour requirement for women and children was more than for men during hand weeding. Herbicides have increased labour requirements for men because they are predominantly involved in spraying. Women needed to reduce their labour during weeding but feared that the use of herbicides would increase food insecurity during hunger peak period. This was because the use of herbicides is inconsistent with the practice of mixed cropping and selection of valuable wild vegetables that were important for food security. Results suggest that usage of herbicide such as atrazine could have health concerns that may affect women more than men. Use of herbicides raises questions as to what extent CA is environmentally sustainable. Interventions in CA need to be both gender sensitive and minimise tradeoffs between health concerns, socio-economic benefits and environmental sustainability.

INTRODUCTION

Men and women participate differently in agriculture and development interventions affect them differently. This is because of gender differences, the socially acquired notions of masculinity and femininity by which women and men are identified (Momsen, 2010:2). Gender relations, socially constructed forms of relations between men and women, tend to frame ownership of assets and access to resources between men and women in most developing countries. Gender based roles, activities, rights and responsibilities in particular societies, are not static but in constant flux with variations from place to place, over time and among households and individuals (Quisumbing & Pandolfelli, 2010).

Because of gender dimensions, men and women tend to have differentiated pathways out of poverty (FAO, IFAD, & ILO, 2010). Gender based inequalities constrain women's agricultural production and limit their contribution to poverty and food insecurity reduction (Ransom & Bain, 2011). The agricultural sector is increasingly becoming complex with major changes in farming systems towards conservation agricultural[4] (CA) (Derpsch, Friedrich, Kassam, & Hongwen, 2010) and shifts from subsistence orientation to market orientated farming (Mehra & Rojas, 2008) with emerging national and multinational agribusiness marketing value added products for local, national, regional and global markets (Bunch & Mehra, 2008; World Bank, 2011). The roles of women

[4] Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. http://www.fao.org/ag/ca/1a.html Last accessed 26.04.2012

and men in agriculture are also changing. Some feminists have observed that women are increasingly (though still very few) being involved in agricultural business that contributes to the broader national agricultural economy and global commercial agriculture (Bunch & Mehra, 2008; Momsen, 2010).

FAO argues that if women farmers were given the same access to resources and opportunities as men, yields on their farms would increase by 20-30% (FAO et al., 2010). This increased output could improve food security by a 12-17% reduction in hungry people (FAO, 2011b:5). Agriculture in many developing countries is under performing due to women farmers' poor access to resources and opportunities that would facilitate the productive use of their time among other reasons (FAO, 2011b). Udry (1996), observed that agricultural output from women in Burkina Faso was 20% lower than that of men because men used more inputs. Gladwin (2002) argues that there can be a 20% increase in production in crops such as maize if governments and development projects could adopt policies to reach African women farmers with productive inputs and opportunities. Momsen (2010) observed that increased access to education and agricultural inputs by female farmers relative to men increased their yields by 20% in Kenya. Most of the factors leading to women's poor access to resources and opportunities are gender based (FAO, 2011b). Such arguments have led to an increase in promoting gender equality, equity and empowerment through gender mainstreaming by the United Nations (UN Women, 2011); international development agencies (FAO, 2011b; IFAD, 2011), the donor community (Maal, 2011); political regional bodies[5] (Maal, 2011) and national governments (GRZ, 2011). It is not surprising that development policy makers are becoming increasingly aware of the crucial contributions of women farmers to agricultural production, food and nutrition security and economic development (World Bank, 2011).

Gender mainstreaming a core part of the contemporary Gender and Development (GAD) school of thought tries to address limitations of previous approaches, Women in Development (WID) and Women and Development (WAD) in improving women's status. These limitations of WID and WAD include insufficient focus on the following: reproductive roles; social relations and differences between and within classes; relationship between patriarchies; differing modes of production on the one hand and women's subordination and oppression on the other (Cornwall, 2003; Parpart, 1993; Rathgeber, 1990). Gender mainstreaming continues to be the main means to reduce gender gaps. According to the UN system (UN, 1997:28), gender mainstreaming is defined as follows:

> *"Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women*

[5] An example of such is Common Market for Eastern and Southern Africa (COMESA)

and men benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality."

The 2012 World Development Report indicates that gender mainstreaming has led to development policy makers becoming more aware of the crucial contributions of women farmers to agricultural production, food and nutrition security and economic development than before (World Bank, 2011). Moser & Moser (2005) in a study on international development institutions showed that all institutions identified gender mainstreaming in their development policies and projects. However, some critics have argued that gender mainstreaming has led to a reduced focus on women and even discarding projects and programs in some cases that were well intended to benefit women (Ransom & Bain, 2011). Others have pointed out that the use of gender mainstreaming as part of conditionality for funding development projects has led to paying more attention to securing funding than translating policies and gender mainstreaming into action in development projects (Wendoh & Wallace, 2005). Policy makers and implementing agencies of development interventions have shown more willingness to implement gender mainstreaming at a rhetorical and procedural level than at the practical and grass roots level where gender relations could have far-reaching implications on the impacts of development interventions (Ransom & Bain, 2011). Moser & Moser (2005) observe that the debate on gender mainstreaming revolves also around whether gender mainstreaming is a means or an end in itself.

Despite major achievements in formulating gender sensitive policies, gender gaps in development practice are still a major challenge for most developing countries (World Bank, 2011) and very few studies have assessed the effects of implementing of gender mainstreaming (Moser & Moser, 2005). Some scholars such as Quisumbing & Pandolfelli (2010) have conducted extensive reviews of innovations used to address various needs of poor women farmers both in South Asia and Sub-Saharan Africa. However, much of the literature does not address the question of gender differentiated impacts of Conservation Agriculture (CA) among smallholder farmers. There is insufficient evidence as to whether CA does or will reduce some constraints (such as labour) faced by women farmers relative to men. Studies addressing gendered impacts of CA could provide relevant information for policy makers and CA project implementers. It is against this background that this study addresses the question: What are the impacts of CA among men and women smallholder farmers in Zambia? The study focused on the following three specific research questions:

1. What are the differential effects of crop residue retention in CA basins on labour among men and women farmers?
2. What are the differential effects of minimum tillage[6], digging of CA planting basins on labour among men and women farmers?
3. What is the effect of type of crops chosen for crop rotation in CA basins on men and women?

[6] Tillage refers to all what a farmer does to prepare the land for planting (CFU, 2009). Tillage mainly involves preparation of the soil by mechanical disturbance using various implements such as tractors, ox-drawn plough, rippers and hand hoe. With minimum tillage soil disturbance is reduced since there is no overall digging or ploughing.

The following section provides a background on CA and the Conservation Agriculture Programme (CAP) in Zambia. The third section focuses on the study areas and methods followed by the results and discussion section ending with the conclusion section.

1.1 Background of CA and CAP in Zambia

CA has widely been defined as an agricultural practice with three interrelated core principles: minimum soil disturbance, permanent soil cover and diversified crop rotation[7] (B Govaerts et al., 2009; Hobbs, Sayre, & Gupta, 2008).

CA agronomic practices are essential for soil and water conservation, building and maintaining healthier soils, sustainable optimal production and maintenance of a rich agro-biodiversity (Dumanski, Peiretti, Benetis, McGarry, & Pieri, 2006; Twomlow & Hove, 2006). It is claimed that CA provides farmers with a means for optimising their yields and profits while maintaining a balance between agricultural, economic and environmental benefits on a sustainable basis (CFU, 2006; FAO, 2006). However, constraints such as increased labour demand due to increase in weeds (Baudron, Tittonell, Corbeels, Letourmy, & Giller, 2011; Giller, Witter, Corbeels, & Tittonell, 2009); increase of labour during tillage in case of CA basins (Haggblade & Tembo, 2003b; Progress Hanzwida Nyanga, 2011); increased pests and diseases (Bram Govaerts et al., 2007); lack of compatibility of certain practices with existing beliefs and values (Pannell et al., 2006); challenge of crop residue retention especially in Africa (Marongwe et al., 2011) and water logging (Haggblade & Tembo, 2003a; Progress Hanzwida Nyanga, 2011) in the case of basins have also been reported. Despite these constraints, Conservation Agriculture (CA) is increasingly taking a central stage in agricultural policies and rural development among developing countries like Zambia. International development agencies such as the Food and Agriculture Organisation of the United Nations (FAO), the European Union (EU) and the United States Agency for International Development (USAID) and the Norwegian Ministry of Foreign Affairs are involved in the support of CA in Zambia. This is because of the potential benefits of CA already indicated above.

Haggblade and Tembo (2003) trace the development and diffusion of CA in Zambia from the late 1980s and early 1990s. Since its establishment in 1995, the Conservation Farming Unit (CFU) of the Zambia National Farmers' Union, has championed the training of both institutions and individual farmers in CA in the country (FAO, 2011a). Most CA developments in Africa are donor supported (Giller et al., 2009) in an effort to address livelihood needs. Baudron et.al (2011) point out that CA is increasingly receiving attention in sub-Saharan Africa as a means to increase food security and minimise environmental degradation. In a series of donor supported projects, the Conservation Agriculture Programme (CAP) is the most recent in Zambia. CAP was implemented by CFU (a non-government institution) from 2007 to 2011 funded by the Norwegian Ministry of Foreign Affairs through the Royal Norwegian Embassy in Zambia (CFU, 2006). The goals of CAP are to increase food security and profitability of agriculture

[7] Crop rotation is the practice of growing a series of different types of crops in the same area in sequential seasons for the purposes of replenishing nitrogen in the soil, improving soil structure and controlling of weeds, pests and diseases.

while encouraging environmental regeneration through increased adoption of conservation agriculture (CA) among a targeted 120,000 small-scale farmers (CFU, 2006).

There are two main variants of CA in Zambia. The first and most common is a hand hoe based CA that involves digging of CA planting basins (CA basins) using a *chaka* hoe. Farmers who adopt CA basins are advised to dig permanent planting basins spaced at 0.7 meters along the rows and 0.9 meters between rows resulting into a grid of 15,850 CA basins per hectare (CFU, 2009). Crop residues and other vegetative matter are retained in the area between basins. Recommended dimensions of a basin are 0.2 meters in depth, 0.3 meters in length and the same width as that of the blade of the *chaka* hoe. CFU recommends a basin depth of 0.2 meters because it is deep enough to go beyond the soil hard pans (CFU, 2009). For improved accuracy and precision in the layout of grids of basins, CFU advises farmers to use a teren rope, with markers of knots or small metallic plates spaced at 0.7 meters. Farmers tie one end of the teren rope to a peg at one end of the field and the other end of the rope to another peg at the other end of the field. A *chaka* hoe has an elongated thick strong blade and a long handle as compared to a traditional hand hoe. These features of the *chaka* hoe account for its heaviness relative to a traditional hoe. On the contrary, hand hoe based conventional agriculture involves tillage of the whole field using a traditional hand hoe or making of ridges resulting into maximum soil disturbance.

The second variant of CA is the animal draft power based CA that depends on the usage of a *magoye* ripper instead of a conventional mould board plough. Instead of complete soil inversion as is the case in conventional agriculture with ploughing, farmers make at least 0.15-0.20 meters deep ripped furrows at 0.9 meters spacing in CA while retaining the crop residues and other vegetative matter between ripped lines (CFU, 2009). In both variants of CA, the principle of minimum tillage restricts soil disturbance to precise areas where the crop is to be sown resulting in minimum soil disturbance of around 10% of the area (FAO, 2011a). This study considers CA basins only because it is the most widely adopted form of CA in Zambia and most farmers have experience with it (Haggblade & Tembo, 2003b; Progress H Nyanga, Johnsen, & Aune, 2011).

CFU provides extension support to selected farmers in the study areas in order to increase the adoption of minimum tillage, crop rotation including legumes and crop residue retention. In addition to these core CA principles, CFU has also encouraged farmers to practice early land preparation and planting, precise input application, early and continuous weeding and planting of *Faideherbia albida* (locally known as *Musangu* tree) for soil fertility improvement (CFU, 2009). Ploughing was the most dominant tillage system used accounting for 60% of cultivated areas and used by 66% of households in 2009/10 season (Progress Hanzwida Nyanga, 2011). This is mainly because of the long tradition of use of the conventional mould board plough in Zambia. It was further shown that CA basins were the second most (60% of households) common and ripping was the least (22%) during 2009/10 farming season (Progress Hanzwida Nyanga, 2011). The low adoption of ripping could be due to limited availability of the equipment and other constraints of CA indicated earlier. Common crops grown in the study areas are maize, sweet potatoes, cassava, mixed beans, cowpeas, cotton, sorghum, millet, sweet stalks, pumpkins, water melons and various types of cucumbers.

Crop production is dependent on rain and smallholder farmers are often not involved in irrigation (Siegel & Jeffrey, 2005). The main livestock kept in the study areas are cattle, goats, pigs and poultry. Both men and women can and do own cattle though the responsibility over cattle is mainly within the domain of men.

2.0 STUDY AREAS AND SAMPLING

The study areas consisted of 12 districts namely, Choma, Kalomo, Mazabuka, Monze, Sinazeze, Chibombo, Chongwe, Kapiri Mposhi, Mumbwa, Chipata, Katete and Petauke. These are organised into four regions: Southern, Central, Western and Eastern for operational purposes of CAP. The districts Choma, Kalomo, Mazabuka and Sinazeze consititute the Southern region; Chibombo and Chongwe constitute Central region; Western region has Mumbwa district while the Eastern region consists of Chipata, Katete and Petauke districts. These study areas were chosen because CAP has been operating in these areas only (Fig 1).

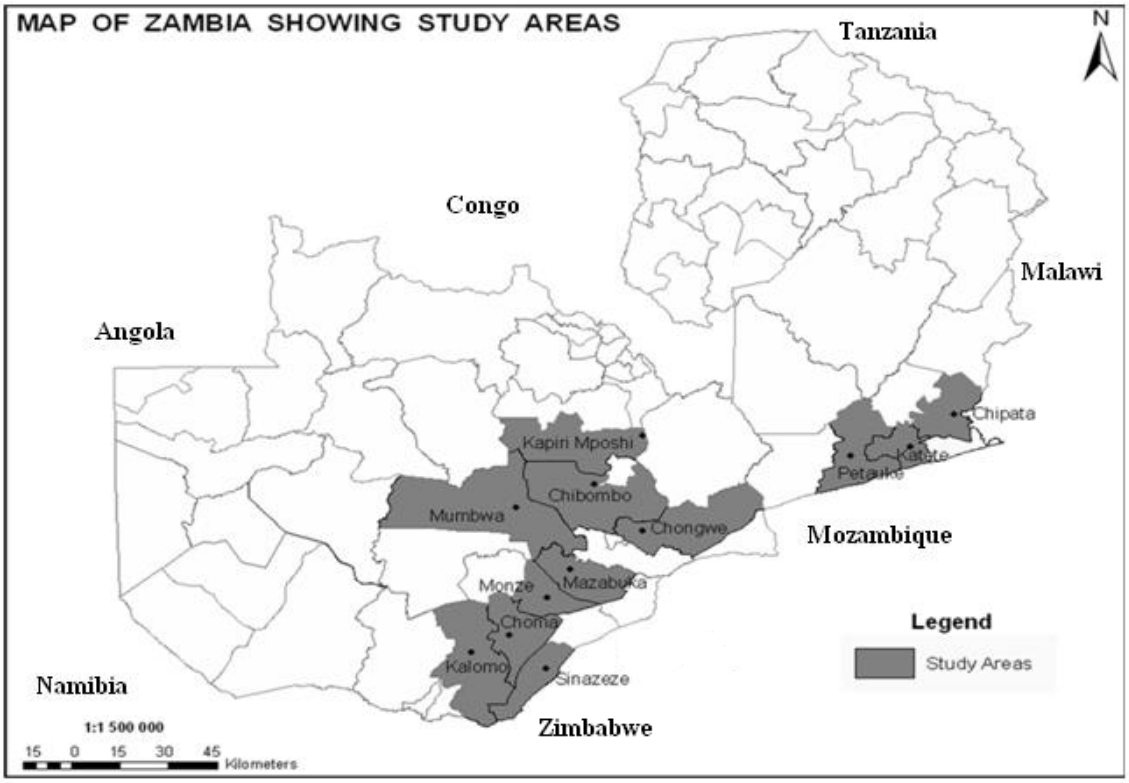

Figure 1: Map of Zambia showing study areas

Purposive sampling was used in the selection of key informants and focus group discussants in order to have participants who are known to have opinions and experiences on the topics for discussions. For the questionnaire survey, 640 households were randomly chosen from the updated CAP registers in 2007 for the monitoring and evaluation purposes for CAP. CAP had targeted a total of 120,000 smallholder farmers in the study areas. The same households as those chosen in 2007 were interviewed for three consecutive farming seasons for this

study. The sample size reduced to 535 in 2008, 486 in 2009 and 440 in 2010 due to deaths, migration, some respondents declining to be interviewed and others simply being absent at the time of the survey. The data was collected between June and October each year. This period was chosen because most parts of the study areas are easily accessible by road at that time.

2.1 Data collection and analysis

Mixed methods research is an approach to inquiry that combines or associates quantitative and qualitative strategies (Creswell, 2009:4) so that the overall strength of a study is greater than either quantitative or qualitative research. Each of the traditional research approaches, quantitative and qualitative, has strengths and weakness (see Bryman, 2008) but the mixed methods approach offers an opportunity to draw from the strengths and minimise the weaknesses of both in a single study (Johnson & Onwuegbuzie, 2004). It is for these reasons that a mixed method approach was used in this study.

Questionnaires, focus group discussions, key informant interviews, informal interviews, direct observation, and review of literature were used to collect data.

For detailed discussions in 2009 and 2010, four focus group discussions (FGDs) for women and four FGDs for men were conducted and 30 key informants were interviewed each year. It was necessary to hold separate group discussions so that the views of each group could be expressed without the influence of the other group. An additional 12 combined FGDs were also conducted during the same period. The experience turned out that there was more information from combined FGDs. Women expressed their views quite well and sometimes challenged the opinions of men. Aspects of gender were gradually introduced in FGDs along the years starting with experiences in relation to CA in terms of labour demand and influence of gender on the choice of crops used in CA rotation. Detailed discussions on gender roles and gendered labour implications of CA basins, perceptions of farmers on herbicides, and some effect of CA on household food security were done towards the end. This approach was important to allow the research team to gain updated knowledge on cultural aspects, gain trust of the respondents, identify with farmers in terms of norms, language, interest in agriculture and gender, and identify the major themes to be followed up in detailed discussions. The approach helped to reduce a major study limitation of biased information against women due to their lack of openness to discuss gender related issues to outsiders, especially men. The approach was also useful in deciding the most appropriate and feasible form of focus group discussions (separate groups or combined) to be conducted in the last two years of the study.

Qualitative analysis of information from focus group discussions, key informant interviews and informal interviews was a continuous process starting during data collection on identified major themes and ending with an in-depth description of the results. In other words exploratory thematic analysis (Johnson & Onwuegbuzie, 2004) and content analysis (Bryman, 2008) were used for this study. Direct quotations of key expressions were also used but the names and places of respondents were not disclosed due to ethical reasons.

In the questionnaire survey, respondents were, for instance, asked to state the number of days they used on hand tillage and hand weeding, average number of

working hours per day, average number of adults (usually above 15 years of age) and the area of fields involved. This was needed for calculating the person days per hectare. Descriptive statistics were used to analyse quantitative data and results were presented either as percentages or counts. Pearson Chi-Square (χ^2) test was used to determine any association between gender of the head of household and crops used in rotation. Student t-test was used to test any significant difference in means of area under cultivation and labour time use.

A 5% significance level was used to determine if the results were statistically significant or not.

A concurrent design was used in combining qualitative and quantitative methods for the purposes of triangulation and complementarities. Nweing (2011) defines a concurrent design in mixed methods as the use of quantitative and qualitative approaches in parallel either for the purposes of triangulation or complementarity to address different aspects (research questions) of the overall research objective. The results from quantitative and qualitative approaches were combined at presentation stage, as suggested by Holland and Campbell (2005), and Carvalho and White (1997) in order to provide a comprehensive analysis.

3.0 RESULTS AND DISCUSSION

In relation to the CA principles of minimum tillage and crop residue retention, this study identified two phases of land preparation, that is, pre-tillage phase practices and tillage phase practices presented and discussed in the next two sections. Separation of land preparation in two phases helped to identify different tasks carried out by women and men, and gendered impacts of adopting CA basins on labour time use. The third and subsequent sections present results and discussion on gendered aspects of CA basins on weeding; use of herbicides; women's paradox with the use of herbicides; potential increase in herbicide use; possible long term negative effects of herbicides and effects of crop rotation in CA.

3.1 Gendered effects of pre-tillage practices and crop residue retention in CA basins

In line with the practice of minimum tillage and crop residue retention in CA basins, the first phase of land preparation, pre-tillage, involved cutting and retention of vegetative debris and crop residues while the same are gathered and disposed or burnt in the case of conventional agriculture. In the pre tillage practices, results indicated that women using CA basins were involved in cutting herbaceous and small woody vegetation as much as in hand hoe based conventional agriculture (Table 1).

However, CA basins reduced labour time for women and children with respect to the process of gathering that included raking and heaping of vegetative and crop residues. This is because crop residue retention under CA eliminates the need to gather, rack and heap vegetative and crop residues (Table 1). Women and children predominantly do these tasks under hand hoe based conventional agriculture.

These findings seem to be at odds with past studies on gender roles in agriculture generalising that field clearing is a task under the male domain in

Africa (Momsen, 2010; Quisumbing, 1996). These results could reflect the constant changing nature of gender roles over time (Quisumbing & Pandolfelli, 2010) and the effect of separating land preparation into operational components, the pre-tillage and tillage components in analysis. Respondents often argued that men often did most of the land clearing in new fields or fields that had been in fallow for a long time. This was because such fields often involved the use of an axe that farmers perceived as a tool in men's domain since its use requires much physical strength in cutting down trees. In such instances, women and children would be involved in pulling branches to the edges of the field and raking and heaping of the vegetative debris. Respondents' explanations of gender roles in the clearing of new fields seem to be consistent with literature suggesting that men were most involved in land clearing (Quisumbing, 1996).

Table 1: Comparison of gender based labour use in conventional to conservation hand hoe pre-tillage phase of land preparation

Process	Specific tasks	Hand hoe based agricultural systems		Gender roles and labour implications for CA adopters	
		Conventional agriculture	Conservation agriculture	Men	Women and children
Cutting	Cutting herbaceous and woody vegetation	Task is done	Task is done	Very low involvement	Extremely involved
	Labour time use	less time used	less time used	No change	No change
Gathering	Raking entire field, hipping vegetative debris and crop residues	Task is done	Task not done	Very low involvement	Extremely involved
	Labour time use	more time used	Time saving	Not male domain	More time is saved
Disposal	Burning of vegetative debris and crop residues	Task is done	Task not done	Extremely involved	Very low involvement
	Labour time use	less time used	Time saving	Less time is saved	Not female domain

Regarding the process of disposal, burning the vegetative debris and crop residues, men were predominantly involved in this task compared to women and children (Table 1). Despite the task involving less physical strength, respondents (especially men) explained that men were responsible for handling bush fires because the task was risky for women and children to handle. However, respondents reported that the task demanded less time and energy than the cutting and gathering processes in which women and children are predominantly involved. Discussants indicated that men usually carried some match sticks to burn crop residues and vegetative debris gathered and heaped by women and children. Women pointed out that the task of burning only took a few hours as compared to several hours and sometimes days spent by women and children in clearing and heaping the crop residues and vegetative debris depending on the size of the field and amount of the herbaceous re-growth and

woody vegetation. These results show a gendered performative[8] aspect of labour that identifies men with spectacular, less time demanding tasks with huge immediate visible effects and often associated with prestige.

Through direct observation, most of the fields were open for communal grazing and some CA basin fields had crop residues cleared and heaped for burning although this was against CA principles. This shows that not everyone practicing minimum tillage using CA basins follows the core principle of crop residue retention. A number of farmers expressed knowledge of improvements in soil fertility and water holding capacity arising from decomposition of crop residues while a few explained that crop residues, if kept well, could suppress weeds. Some farmers believed that burning crop residues reduced the risk of the maize crop from being attacked by termites. Other farmers observed that the ash was a source of nutrients for crops. These results indicate that the extent to which the women and children reduced their labour time from pre-tillage practices under CA basins was dependent on the extent of correct application of the principle of crop residue retention.

3.2 Gendered effects of tillage phase of land preparation in CA basins

The second phase of land preparation involved tillage by digging basins in CA fields and hand hoe overall digging or ridging in conventional agriculture fields. For the principle of minimum soil disturbance, results showed that the adoption of CA basins increased labour for women and children more than it did for men (Table 2). The increase in labour requirement is firstly due to the high accuracy and precision demanded in CA basin digging that involves the use of teren ropes, a pair of 0.9 meters sticks and a pair of wooden pegs in addition to following recommended measurements for the size of basins. Secondly, CA basin digging is recommended to start during the dry season before the onset of the rainy season when the soils are relatively dry and hard. Thirdly, direct observation and respondents indicated that the way of using the *chaka* hoe in digging made it exhausting because it had to be swung from beyond the shoulders at a reasonable speed so that the weight of the hoe can break the soil easily. These results suggest that labour intensity is high as well when digging the CA basins. Women complained that the use of the *chaka* hoes was exhausting and reduced their performance in other household chores. The men and other key informants also agreed that the *chaka* hoe was heavier as compared to the traditional hand hoe. Surprisingly, though both women and men agreed that tasks that needed a lot of physical strength were under men's domain, these results suggest that the heaviness of the *chaka* hoe and its use is not sufficient to be under male domain. This could be because most men are not used to hand hoeing and the work of digging basins takes a lot of time. Digging CA basins is less spectacular and its visible areal effects take a long time as opposed to ripping or ploughing that are under the male domain that results in easily visible large areas of tilled land within a few hours.

Labour time use on digging basins was higher by 14.6% in 2007/8 season and 15.6% in 2008/9 seasons as compared to labour time use under conventional hand hoe tillage (Table 2). Other studies in Zambia among smallholder farmers have shown that digging of CA basins increased labour time use by 11.9% (59

[8] We are indebted to Dr. Randi Kaarhus,Noragric, for pointing out the concept of performative action

person days to 66 person days) in cotton fields and 40.0% (50 to 70 person days) increase in maize fields compared to conventional hand hoe agriculture (Haggblade & Tembo, 2003b). However, this study in 2009/10 season showed that labour time use was less by 9.3% in CA basins as compared to conventional hand hoe tillage. This could partly be because farmers gained experience in digging basins as observed by Haggblade & Tembo (2003b). Women also explained that some of them were using light traditional hoes instead of heavy *chaka* hoes while others were hiring men. This could explain the increased efficiency in 2009/10. These findings suggest that there are conditions under which men can use the *chaka* hoe depending on their motivation. Further studies in this respect are needed.

Table 2. Gender and labour use in conventional and conservation hand hoe tillage

	Conventional agriculture	Conservation agriculture basins
Hand hoe tillage systems	Full tillage by digging or ridging	Minimum tillage by digging
Implements used	Common light weight hand hoe	Heavy *Chaka hoe*, teren rope, two 0.9 meters sticks and a pair of pegs
Level of men involvement	Quite involved	Less involved
Level Women involvement	highly involved	Women extremely involved
Labour demand comparison	Less demanding and less intensive	More demanding, intensive and more technical
Person days per hectare 2007/8	68.5 (n=161)	78.5 (n=218)
Person days per hectare 2008/9	77.1 (n=70)	89.1 (n=253)
Person days per hectare 2009/10	77.5 (n=102)	70.3 (n=223)

Most of the increase in labour requirement experienced when digging CA basins was borne by women and children since they are the ones predominantly involved in digging. When probed why this was the case, the most common reason presented by women was that men were reluctant to carry out tasks that involved back breaking stress (pain in the lumbar curve). However, some women argued that it was right that men were less involved in the use of the hand hoe because they performed other tasks that required a lot of physical strength like ploughing and ripping with animal draft power. Similar sentiments were very common in men's focus group discussions and informal discussions. Most men agreed that as expressed by a respondent "*women are more experienced and strong at using hand hoes and can bear the back breaking stress when using these implements*."(Interview 11.10.2010)

In focus group discussions that involved both men and women it was common for men to take a leading role in explaining that the association of women with the use of hand hoes was part of the local cultural system. Women were quite strong in defending their high involvement in bearing much of the work load when the men tried to claim otherwise. Through such debates, it was clear that even in cases where a man and woman were working together in making CA basins, the role of the men was more of giving instructions about the correct basin dimensions and spacing than the actual digging. Women further explained that as soon as the men saw that work was proceeding well, they often left the rest of the family members to dig basins. More often than not, men claimed that they had other public responsibilities to attend to such as attending meetings

and funerals, and looking for inputs like seed and fertiliser through cooperatives, farmer associations and unions. Membership in farmer organisations is open for both women and men but men are dominant. Some women "scornfully" indicated that some men were using their public roles and involvement in search of inputs as excuses for engaging in social activities such as beer drinking.

Information from focus groups also revealed that some men were involved in helping women and working together during CA basin digging especially in the Eastern region than in other study areas. This could be due to the long traditional practice of hand hoe tillage in Eastern region. Women across the study areas also indicated that men in less resource endowed households had a higher tendency of helping their wives and women in basin digging than men from relatively more resource endowed households. These results suggests that although the use of hand hoe technologies is a women's domain, there are several differences among households and from place to place because of differences in factors such as cultural practice, personal disposition of men, as well as the resource status of the households.

Some women and other key informants argued that dry season basin digging was important in spreading labour over a relatively long period. This makes it easier to plant early with the first heavy rains. Results from the 2009/10 agricultural season survey confirmed that on average, digging of CA basins started in the third week of August while conventional hand hoe tillage started in the last week of November. Associated with early land preparation and planting under CA basins, women cited increased food security due to the green harvest that comes during the peak hunger period as a positive experience. This was the most common advantage cited by women across the study areas. Women explained that while waiting for the crops in the main household conventional fields to ripen, they started eating the maize and legumes such as cowpeas harvested from CA fields since these mature quite early. Women claimed that this had reduced their burden of searching for food for children during the peak hunger period. Other studies on the same sample have shown that the hunger period has steadily and significantly ($p<0.0001$) reduced from an average of 4.4 months in 2006/7 agricultural season to 3.2 months in 2009/10 agricultural season (Progress H Nyanga, Johnsen, & Aune, 2011). Men likewise acknowledged the positive contribution of CA basins to household food security. These results show that there are benefits that women are experiencing despite increased labour under CA basins. However, there is a need for further research to determine the extent of CA basins' contribution to household food security.

3.3 Gender and hand hoe weeding in CA basins

Minimum tillage and crop residue retention resulted in labour requirement implications during weeding. This is because farmers do not invert about 90% of the soil during tillage and cattle often graze on the crop residues. The few remaining crop residues are not sufficient to suppress the weeds effectively. Results indicated that labour time use on hand hoe weeding in CA basins was higher by 14.0% in 2007/8, 11.6% in 2008/9 and 27.7% in 2009/10 seasons as compared to labour time use under conventional hand hoe weeding (Table 3). Haggblade and Tembo (2003b) reported increases of 16.2% (68 person days/ha to 79 person days/ha) in cotton fields and 39.7% (58 to 81 person days/ha) in maize fields in labour time use during hand hoe weeding of CA basins compared

to conventional agriculture. These results show that the labour time use during weeding under CA basins is generally higher than under conventional tillage due to lack of complete land inversion during tillage.

Discussants indicated that the increased labour in hand hoe weeding under CA basins was dominantly borne by women and children. Women often complained of backache due to hand hoe weeding activity. Respondents gave the same reasons for the highest involvement of women and children in hand weeding as those in hand hoe tillage explained earlier.

Table 3: Gender and labour use in hand hoe weeding

	Conventional hand hoe agriculture	Conservation agriculture basins
Cycles of weeding	Few	More
Weed pressure	Less	More
Level of men involvement	Less	Less
Level of Women involvement	Most	Most
Labour demand comparison	Less	More
Person days per hectare 2007/8	77.5 (n=142)	88.3 (n=218)
Person days per hectare 2008/9	92.2 (n=60)	102.9 (n=247)
Person days per hectare 2009/10	64.0 (n=102)	81.7 (n=240)

Some men reported that they were helping in the hand weeding process through hiring labour. Clarification and qualifying statements from women often followed as one female farmer said "*Not all men do that* (hiring labour to assist women in weeding); *only a few men actually do that for their wives and families*" (Interview 03.09.10). However, a common view across the study areas was that men in relatively less resource endowed households were the ones who are more likely to help women in the actual weeding process than men with relatively more resources.

3.4 Gender and use of herbicides

Due to the challenge of increased labour requirement during weeding, herbicide use is increasingly becoming an option for overcoming the challenge in Zambia (Progress H Nyanga, Johnsen, Aune, & Kalinda, 2011). Results indicate that men and women have clear tasks regarding the use of herbicides. Women and children were involved in drawing water for diluting herbicides while men were exclusively involved in diluting herbicides and spraying. In cases where water points were distant, women revealed that men often assisted them to ferry the water with oxen after women and children had drawn the water. The most common reasons advanced for the gendered differences in the use of herbicides was that men had more physical strength than women to carry a 16-20 litre knapsack sprayer on their backs and the work did not take a lot of time nor cause much stress on the lumbar region of the back as it was mostly done in an upright position. Men also often had more experience in the use and spraying of chemicals based on their experience in spraying agro-chemicals on cotton and spraying of ectoparasiticides on livestock. Women further argued that it was not good for them to engage in risky activities like handling and spraying of herbicides. Women pointed out that if they were hurt or got sick in the process of

spraying the children and the rest of the family would suffer more than if the samething happened to the men. This reflected the several multiple and critical household responsibilities and activities that the women are involved compared to men.

Women also indicated that women and children from households that used herbicides correctly had more time to do other things than their counter parts in households that did not use herbicides. Haggblade & Tembo (2003b) reports that the use of herbicides could reduce labour time use from 50-70 person days per hectare to 10-20 person days per hectare. However, this reduction depends on the type of spraying equipment; the type of crop involved; weed pressure and correct usage of herbicide; and the level of experience of the farmer among others.

3.5 Paradoxical position of women regarding the use of herbicides

Farmers, especially women often asked if they could still practice mixed cropping along with the usage of herbicides. Among herbicides, being promoted along with CA and found with some CA farmers during this study are atrazine® (a selective herbicide) paraquat® (a non selective herbicide), cyanazine® (a selective herbicide), and glyphosate® (a non selective herbicide). The use of triazine herbicides especially atrazine and cyanazine presents a potential paradox more to women than men because of the critical role that women play in household food security such as being responsible for growing pulses and searching for vegetables. In as much as women complained about labour increase and intensity with CA basins, they argued that the use of herbicides was likely going to aggravate food insecurity problems by disrupting crop rotation and the traditional mixed cropping that were essential for household food security. Women explained that they often planted the main crop especially, maize together with other crops like okra, sweet-stalks, pumpkins, watermelons, *makwaambala* (**African** horned **cucumber),** *makowa* (cream-white-yellow cucumber) and green vegetables (usually planted on large termite hills or mounds *(Zyulu)* within the fields). The women reported that these crops contributed a lot to household food security. They further explained that some of the "weeds", such as *Bondwe* (*Amaranthus species),* are consumed as vegetables during the peak hunger period. *Amaranthus species* usually grows as a weed and the leaves are one of the most important and common vegetable in many African societies (National research council, 2006). Fox & Young (1982) also asserted that *Amaranthus* species were among the most widely wild edible plant eaten in Southern Africa. The use of herbicides which destroys valuable wild vegetables like Amaranthus is thus undesirable.

Women wanted to have their labour during weeding reduced while meeting food security needs for their families without harming the environment. However, meeting such goals simultaneously in CA basins seemed to be impossible for most of them. Increased labour reduction through herbicide use implies an increased immediate risk of being food insecurity at least during the peak hunger period. This is because the use of herbicides is inconsistent with the practice of mixed cropping and selection of valuable wild vegetables. In such instances, most of the farmers opted not to use herbicides and women had to bear the cost of increased labour requirement. This further limits the area that a household can have under CA basins due to labour constraints.

3.6 Potential for increased herbicide use amidst farmers' scepticism

Increased labour requirement during weeding in CA basins had led to an increased emphasis on the use of herbicides to overcome the labour constraint in CAP. Results showed a steady increase in the adoption of herbicides from 1.1% households in 2006/7, 1.7% in 2007/8, 6.4% in 2008/9 to 8.2% in 2009/10 farming seasons. Reasons given by respondents for low usage of herbicides were lack of knowledge, financial constraints, ignorance of where to find herbicides, long distance to some agro-chemical dealers, negative effects on legume crop rotation, disruption of intercropping, and not being convinced about the effectiveness of herbicides. Some respondents feared that the soil would be sterilised while others feared bad experiences like other farmers who had their crops damaged. Other farmers cited lack of sprayers and safety equipment, complex instructions on herbicide labels not in local languages, not experiencing labour constraint and uncertainty about the effects of herbicides on health of people and livestock. It was very common for focus group discussants to cite incidences where herbicides had been wrongly used. These results show that most farmers have some rational scepticism about the use of herbicides. This shows the need for the CA development interventions and policies to be sensitive to both prevailing livelihood systems and gender roles.

However, there is a high likelihood for further increase in the use of herbicides in future because firstly, the number of development organisations, seed companies and agro-chemical companies that are trying to reach out to smallholder farmers through the use of herbicides is increasing. Secondly, institutional collaboration between agro-chemical suppliers and CFU the leading promoter of CA is likely to increase the campaign for herbicide use. CFU has already started linking CA farmers to suppliers of agro-chemicals and is increasing the focus on use of herbicides in trainings to farmers. Thirdly, international donors such as the Norwegian Ministry of Foreign Affairs, European Union (EU) and FAO are also playing an important role in enhancing the use of herbicides through the support of an electronic voucher system that allows farmers to access herbicides from some registered agro-dealers. These emerging concerted efforts in promotion of CA with herbicide use could lead to a huge increase in the use of herbicides and substantial reduction in labour requirements with increased environmental and health problems among small scale farmers especially, women and children.

3.7 Potential long term differential effect of Atrazine herbicide between women and men

The majority of the farmers, especially women, were concerned about the effect of herbicides on human health. They often asked questions such as *what is the effect of these chemicals (herbicides) on our health and children?* Men were mostly concerned about the effect of herbicides on the health of livestock while both women and men expressed concern of sterilizing the soil by herbicides. These results show that the perceptions of the potential effects of herbicides are gendered, with women more concerned about caring for the family while men were more concerned with livestock - symbols of wealth and status in society.

All herbicides have some negative effects on the environment but among the herbicides being promoted atrazine (also called maize weed killer), raises the most environmental and health concerns about the long term negative effects of

CA in Zambia. Atrazine is the most commonly detected pesticide contaminant of ground water, surface water, drinking water and precipitation in places where it has been used (Hayes et al., 2011). It is a persistent herbicide with a degradation half-life in soil ranging from 1.5 months to 5 years depending on the dosage, weather and soil characteristics (Bessac & Hoyau, 2011; Kettles, 1997). It is likely that both atrazine and in its combinations with other herbicides will be the most widely used herbicide in Zambia in the near future because of its low cost and high effectiveness for both pre- and post emergence control of annual and broad leaved weeds and grasses (Williams II., Boerboom., & Rabaey., 2010). Generally, the cost of a litre or kilogram of herbicide in Zambia ranges from 10 to 15 US Dollars as of 2009/10 agricultural season. Above all, the herbicide is a selective one for maize, the most widely grown and subsidised crop in Zambia.

Atrazine is an endocrine disruptor,—a chemical that disrupts normal hormonal activity of animals and humans (Colborn, Myers, & Dumanoski, 1996). The effects of herbicides such as atrazine may manifest entirely in different ways, with permanent consequences in the early developmental stages (embryonic, foetal and neonatal stages) (Ackerman, 2007). These effects suggest that women and children may experience more problems than men due to their differing reproductive roles and young age. Given that women among smallholder farmers are more associated with the usage of water than men, the chances of exposure to endocrine disruptor polluted water are higher for women than men. Some studies have shown that women whose wells had water contaminated with triazine herbicides were more likely to develop breast cancer (Kettles, 1997). Other studies suggest that atrazine caused "chemical castration" leading to low sperm level and quality among men in agricultural areas where the chemical has been used for some time (Swan et al., 2003). Pocar *et al*. (2003) also show that atrazine is associated with reduced birth weight, birth defects, menstrual problems, abortion, breast and prostate cancer. Effects of endocrine disruptors can also change the course of development and potential of offspring and often manifest at maturity or adulthood (Theo, Dianne, & Peterson, 1996). These results suggest that there could be health concerns that may affect Zambian farmers as well, just like elsewhere as reviewed in the literature. The use of atrazine is still very controversial in United States of America (USA) but it is banned in the European Union (EU) (Ackerman, 2007) and in countries like Norway (Lode, Eklo, Holen, Svensen, & Johnsen, 1995), the very sources of support for the CA programme that is promoting atrazine use in Zambia.

3.8 Gendered effect of crop rotation principle of CA

Crop rotation with diversified crops including legumes is one of the canons of CA. Results show that the three most common crops used in rotation are maize, (a cash crop and staple food), cotton (a cash crop) and groundnuts (a food and cash crop). A chi-square test showed significant association between gender of the head of household and the use of cotton, an absolute cash crop in rotation (Table 4). These results suggest that the type of crop chosen for rotation in CA is influenced by gender.

A test of difference in proportions also indicated that the percentage of male headed households engaged in crop rotation with cotton was significantly higher (p-value=<0.02) than the percentage of female headed households. This supports the views of key informants and focus group discussants that cotton was a crop

under the male domain. Other studies have also shown that cash crops are often under men's domain (Haggblade & Tembo, 2003b). Men are usually in control of the income from cotton. However, women in most focus group discussions explained that men often did not use the income from cotton for food security purposes. The men revealed that they use the income from cotton for buying assets like iron roofing sheets, agricultural implements and drugs and vaccines for livestock. However, in informal discussions with men it was clear that most men were in the habit of using the income from cotton on individual and personal items than for the benefit of the whole family.

Table 4: Association of crops in rotation to type of household headship

		Main crops used in rotation		
Seasons	Type of household	Maize	Cotton	Groundnuts
2007/8	Female headed (%) (n=64)	73.44	23.44	62.50
	Male headed (%) (n=471)	74.73	36.52	54.99
	Chi-Square	0.05	4.24*	1.29
2008/9	Female headed (%) (n=72)	59.72	16.67	55.56
	Male headed (%) (n=412)	69.66	27.91	55.34
	Chi-Square	2.79	4.01*	0.00
2009/10	Female headed (%) (n=72)	86.15	15.28	77.78
	Male headed (%) (n=366)	88.89	28.42	77.05
	Chi-Square	0.39	5.36*	0.89

*significant at 0.05 level

CA farmers are trained to practice crop rotation that includes at least 30% legumes (CFU, 2009). This is vital as a means of biological nitrogen fixation, food security purposes, reduction of soil erosion and suppression of weeds when legumes are used as cover crops. The most common legume used in crop rotation among smallholder farmers in Zambia is groundnut that is both a cash crop and a staple crop. Respondents classified groundnuts under women's domain. This is because of their wide range of usage in food dishes and its role as a source of proteins for children under five years of age. Women grow groundnuts mainly for household consumption and excess for sale. When men are involved in the growing of groundnuts like in the Eastern region, the prime purpose is selling rather than food security. A general perception of respondents was that women were more likely than men to spend their income from groundnuts on the family. These results support the argument for improving food security through reducing gender gaps in agriculture by increasing opportunities for women presented in other studies (Momsen, 2010). These findings indicate that implementing gender mainstreaming, going beyond policy and CA project proposals pronunciations to action, can reduce food insecurity as long as the focus on improving the status of women is not lost in the process.

Plausible explanations for the lack of significance in association between type of households and use of groundnuts and maize in rotation (Table 4) include, firstly, smallholder farmers growing both crops for the prime purpose of household consumption and excess for sale regardless of the type of household headship. Secondly, male household headship does not significantly reduce opportunities of women within the household of growing groundnuts. This implies that women in male headed households are quite successful in negotiating to have their

groundnuts grown despite a man being the *de facto* final decision maker. Men explained that when women are not supported (often given time) to work on their groundnut fields, it would result in "confusion" in many ways during the farming season. Most men observed that tasks such as mobilising household labour, supervision of children in carrying out specific agricultural tasks, planting and hand weeding would not be done well without full involvement and support from women.

The emphasis on involvement of legumes in rotation in CA along with project support with seeds, has led to a significant (p-value < 0.0001) increase in the number of households engaged in crop rotations involving groundnuts from 56% in the 2007/8 season to 77% in 2009/10 season. The average area under groundnuts increased significantly (p-value = 0.001) from 0.25 hectares in 2007/8 season to 0.39 hectares in 2009/10 season. On the contrary, despite the emphasis on use of cotton in crop rotation the households engaged in using cotton in rotation have significantly reduced (p-value=0.003) from 35% in 2007/8 season to 26% in 2009/10 season. The average area under cotton reduced from 0.43 hectares in 2007/8 to 0.37 hectares in 2009/10. This is mainly because of low prices of cotton over the farming seasons as commonly explained by men.

4.0 CONCLUSION AND IMPLICATIONS

This study has shown that development interventions such as CA in Zambia affect women and men smallholder farmers differently. It has documented gender identities associated with various agronomic practices associated with principles of CA basins and their differential effects on women and men. The principle of crop residue retention in CA basins resulted in women and children's reduction in labour time use during pre-tillage practices while the principle of minimum tillage in CA basins increased labour time use for women more than men during basin digging and hand hoe weeding. This is because of the socially acquired notions of femininity in the use of hand hoes, hand weeding, and doing tedious work. The correct use of herbicides had reduced women's labour during weeding while it increased labour time for men because of spraying that they have to do. Generally, work that demanded less stress in the lumbar region (lower back), less time and more physical strength, and whose results were almost immediate and very visible were often associated with men than women. Farmers are generally sceptical about the use of herbicides with women being in a paradox of wanting to reduce their labour by using herbicides without losing or disturbing their mixed cropping, rotation with legumes and valuable wild vegetables essential for household food security. Herbicide use is most likely increasing due to concerted efforts by donors, international development agencies and strong synergies between CFU and agro-chemical companies promoting CA with increased herbicide use. There are health concerns and long term effects of herbicide use especially atrazine that could affect women and children more than men. Though herbicides could be a necessary evil, a careful consideration of the type of herbicides to use is important. In line with the principle of crop rotation, this study has shown that the choice of crops in rotation is influenced by gender. Women dominated legume crops benefit the environment in terms of biological nitrogen fixation and contribute more directly to household food security more than male dominated cash crop like

cotton. Interventions in CA need to be both gender sensitive and minimise tradeoffs between health concerns, socio-economic benefits and environmental sustainability.

Policies and CA projects should take into account the linkages between existing livelihood systems and gender relations so as to minimise the risk of food insecurity. Hence, CA practices should be adapted to local conditions. There is still a need to develop hand hoe based labour saving technologies that are environmentally socially and economically acceptable for women. The development process of CA tillage equipment should be gender sensitive because the use of tillage equipment tends to be gendered in countries like Zambia. Practical strategies to improve women's opportunities in agriculture are essential for improving food security. This is because women's crops and corresponding incomes tend to contribute more to household food security than men's. In this regard, increasing marketing opportunities for women farmers should be encouraged. Technological "fixes" alone in CA projects will not result in desired attitude change of reducing gender gaps. Social approaches are also necessary to foster change in attitudes that could influence men to move into the domains of women while spending agricultural proceeds on the whole family. Gender mainstreaming in policies and CA projects must be translated into action without losing women in the process of implementation.

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