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Gender and Legume Production in a Changing Climate Context: Experiences from Chipata, Eastern Zambia

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Abstract: This study explored legume production by female and men smallholder farmers in Chipata, in a changing climate context. The study objectives were to (i) find out how men and women smallholder legume farmers in Chipata understand climate variability, (ii) investigate how climate variability affects smallholder legume farmers and (iii) identify the different challenges faced by women and men legume farmers in Chipata. Interviews were conducted with 86 male and 86 female legume farmers selected using stratified random sampling. Purposive sampling was used to select nine key informants and focus group discussants. Qualitative data were analysed using content analysis, while quantitative data were analysed through statistical tests. About half the men and women perceived that climate change in Chipata manifested through a shorter rainy season, late start of rainy season, intra-seasonal droughts and heavy downpours. Some men (34.9%) and women (23.3%) reported that heavy downpours caused common bean (*Phaseolus vulgaris*) flowers to drop off. About 41% of the men farmers interviewed and 23.3% of the women reported witch weed (*Striga asiatica*) on their groundnuts (*Arachis hypogaea*) fields after periods of heavy rainfall. The men discussants complained that soya bean (*Glycine max*) fields became waterlogged after prolonged heavy rains, which delayed weeding. Women farmers had challenges accessing hybrid legume seed, inoculants and marketing legumes. Men's challenges were low market prices for soya beans. The study recommends agricultural interventions should focus on climate-smart legume seed multiplication and certification among legume farmers and promotion of local seed-sharing networks to enhance seed diversity.

Keywords: climate variability; vulnerability; smallholder farmers; soya beans; groundnuts



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1. Introduction

Smallholder agriculture is an important livelihood strategy in rural sub-Saharan Africa (SSA). However, smallholder farmers face a myriad of challenges, which include low productivity and returns, low agricultural diversification and food insecurity, which contribute to poverty [1,2]. Studies show that although agricultural related challenges are faced by both female and male smallholder farmers, women smallholder farmers experience them to a greater extent [3,4].

Challenges faced by women are aggravated by traditional norms and cultural barriers [5] such as gendered division of labour, which limits women's physical mobility and decision making at household and community levels [6,7]. Additionally, women often have limited access to agricultural inputs, latest agricultural technologies [8], including technologies for mitigating and adapting to the negative impacts of climate change [9,10], as well as climate forecast information [11]. These constraints contribute to the widening gender gap and lower agricultural productivity by women [4,12]. Because of climate change and/or increased climate variability, agricultural challenges faced by smallholder farmers, especially women smallholder farmers have worsened.

Women's gendered climatic vulnerability has been demonstrated during several extreme climate events since the beginning of the 21st century [5,13,14]. In Zimbabwe, a study conducted by [15] found that the 1994–1995 droughts adversely affected the body mass of women more than men. In South Africa, Ref. [11] showed that women spent more time and labour in agriculture than the men due to increased climate variability. This is because of reproductive roles such as childcare and cooking. During the 2011 drought in rural Kenya, men emigrated with livestock to look for water and pasture, while the women took charge of households, which heightened the vulnerability and decreased the safety and security of communities, particularly of women and girls [13].

Smallholder farmers' vulnerability to climate change and climate variability is affected in part by the types of crops they produce. Over the past 30 years, frequent rainfall anomalies have been observed in Zambia, with resulting decreases in productivity for crops such as maize and legumes [16]. Both male and female smallholder farmers are adversely affected when they produce crops or crop varieties that are intolerant to drought or to flooding such as maize (*Zea mays*), groundnut (*Arachis hypogaea*), soya beans (*Glycine max*) and common beans (*Phaseolus vulgaris*). The importance of legumes the world over cannot be overemphasized as they are a source of protein and income for many poor rural communities. In comparison to the dominant maize crop, legume grains prevent malnutrition commonly linked to cereal-based diets [17]. Protein deficiency affects infants, children, pregnant and lactating women in SSA more than elsewhere in the world, particularly because starchy foods are staples and most low-income families cannot afford animal protein [7]. Thus, legumes are an important source of protein, feed and fuel for millions of households in the region [18,19]. Alongside increasing the total food production needed to alleviate hunger [20,21], legumes can be marketed, and enable farmers to earn more income and improve their livelihoods [22,23]. Additionally, legumes may improve blood pressure, reduce cholesterol, lower heart disease risks, and promote weight loss in the long run [24].

In Zambia, both male and female smallholder farmers grow different types of legumes such as groundnuts, soya beans, cowpeas and common beans. Groundnuts are the second most widely grown smallholder crop in Zambia, with nearly fifty percent of households producing groundnuts in 2018 [25]. Groundnuts are also particularly salient as they are considered as a women's crop [4]. Groundnuts are considered a women's crop as its most common use is in cooking, an activity that falls within women's traditional reproductive activities. Further, groundnuts provide proteins to children, which prevent malnutrition, whose indices currently stand at 35% for stunted growth, 4% for wasted children and 12% for underweight children in children under the age of 5, according to the Zambia Demographic and Health Survey of 2018 [26]. Soya beans (*Glycine max*) provide protein to diets and produce edible oils and animal feed. Soya bean production trends indicate increasing share of smallholder production to total national production, standing at 45% in 2019 up from 17% in 2010 [27]. Common beans are one of the six most widely produced crops in Zambia, with about 13 percent of smallholder farmers growing them in 2018 [25]. Schwartz et al. [28] explained that cowpeas have deep roots that make them extremely resistant to drought, requiring little or no irrigation after the plants have become firmly established. Further, cowpeas can grow a taproot that allows the crop to access moisture deeper in the soil.

Despite the important livelihood contributions of legumes, female and male smallholder legume farmers face numerous challenges which reduce the productivity of legumes in Zambia, limiting income earning and food security contributions of legumes. This could worsen with a changing climate. Women's vulnerability is likely to be exacerbated due to increased climate variability resulting in further reductions in their legume production. This study examined the nexus of gender, legume production and climate change/variability in Chipata city of Eastern Zambia. The study had three objectives; to (i) find out how men and women smallholder legume farmers in Chipata understand climate variability, (ii) investigate how climate variability affects smallholder farmers in legume production and (iii) identify the different challenges faced by male and female legume farmers in Chipata.

The hypotheses tested were that for (i) there were no differences in proportions of male and female farmers' articulation of climate change in the study sites and for (ii) there was an association between gender and land ownership.

Previous studies (for instance, [29,30] did not consider how gender dynamics may influence legume production in a changing climate context, an important knowledge gap. These studies restricted themselves to examining the effects of groundnut commercialisation on female producers and the groundnut value chain in the Eastern Province, respectively. Chipata was purposively selected as the study area because it is an important legume production area [31], with high levels of participation by both women and men in the sub-sector. Legumes play a significant role in the income, food and dietary diversity of rural households.

2. Literature Review—A Systematic Approach

2.1. Climate Change and Agriculture in Sub-Sahara Africa (SSA)

Climate change is defined as shifts in the mean state of the climate persisting over a decade or longer, due to natural internal changes or persistent anthropogenic changes in the atmosphere's composition or land use [32]. Climate variability goes beyond individual weather events and refers to the variability in the mean state of climate on all temporal and spatial scales [33]. There is general consensus among climate experts that people in less developed countries will be more severely affected than people in more developed nations [34,35].

The low adaptive capacity of Sub-Saharan Africa (SSA) makes it particularly vulnerable to the impacts of climate change and climate variability [36]. Besides the direct and indirect impacts of climate change and climate variability on the growth and productivity of agricultural crops [37–40], climate change projections indicate that food availability in SSA will be affected via reduced cropped area and land suitable for agricultural production [41–43]. Prolonged and more intense droughts are likely to make West Africa drier [33,36]. The impacts of climate change on crop production in Zambia are not limited to total rainfall, drought and average temperature effects, but also to intra-seasonal shocks within the rainy season [44]. Problems relating to intra-annual rainfall variability and increased temperature are compounded by political, economic, social and environmental challenges in SSA and globally [45].

2.2. Climate Change and Legume Production

Leguminous crops are a source of N (protein)-rich foods, feeds and green manures. They reduce the need for N fertilizer to support crop and pasture production [46]; support subsequent improvement of soil fertility through legume organic residues amendments [47–49]; and provide improvements in soil structural characteristics [49,50]. Additionally, legumes reduce the incidence of cereal root pathogens, and encourage beneficial microorganisms [51,52]. Leguminous crop diversification reduces the requirement for pesticides and enhances systems resilience and biodiversity [48,53]. The use of legumes in nitrogen fixation has an advantage over chemical fertilizer in that legumes are less expensive as farmers can access the seed for legumes locally and at a lower cost. Legume crops have the potential not only to supply nutrients but also improve the soil physical and chemical properties. Throughout human history, legumes have been important for soil rehabilitation and fertility maintenance in low-input agricultural systems [54]. The incorporation of legumes into smallholder farming systems improves the systems' productivity and the stability of associated cereals, and potentially increases income and reduces risk of total crop failure [54–56]. Although legumes can contribute to climate change mitigation, they are generally not considered as such [57].

Literature indicates that climate change will substantially affect future yields of starchy dietary staples, as well as non-staple vegetables and legumes [58–61]. A review conducted by Scheelbeek et al. [61] showed that non-staple vegetables and legumes appear to be relatively more sensitive to environmental changes than starchy dietary staples. Like

vegetables, legumes are vulnerable to the development of visual injury (which affects their marketability). This results from environmental stress and notably small bleached spots due to high trioxxygen exposure [62].

2.3. Climate Change and Gender

Studies have shown that men are more likely to have access to resources and climate-smart technologies and to possess the skills to use them and therefore may be better equipped to adapt to climate change than women [63]. Archer [11] discovered in South African farming communities that women did not have the same access as men to climate forecast information. Men preferred the radio as a medium of dissemination whereas women preferred seasonal forecasts provided through extension officers. Women are thus likely to lag behind in terms of information on the latest changes in climate, which would help them prepare and mitigate the climate shocks. More than 70 per cent of women's groups and individual entrepreneurs claimed that they had little or no support for technology and skills [64]. Technology dissemination often targets the head of the household on the assumption that the head of the household will further share the information with members of the household, however, this is not always the case [64], hence, women tend to lag behind on current climate change trends. With regards to farmers' understanding of climate change, studies have shown that both male and female farmers in SSA are aware and acknowledge the existence of climate change and variability [65].

The majority of women in vulnerable communities have no financial capacity to acquire land and can therefore only access it through marriage or by borrowing or begging [66]. Gender inequalities in access to land in many parts of Africa are well documented [67,68]. Women's lack of land tenure security may reduce their access to credit [69]. This can subsequently affect their ability to learn and execute climate adaptation strategies. This is because most of the livelihood adaptations to climate change involve financial commitment [70]. Studies have shown that female farmers perform worse than men when it comes to adoption of improved technology [4]. The capacity of a farmer to employ improved technology, including climate-smart technology, is dependent on their access to productive resources [71]. Thus, access to and control over agricultural land remains an important challenge in the adoption of appropriate climate adaptation strategies.

3. Methods

Fieldwork for the study was conducted from May to August 2019. A mixed method approach that utilized quantitative and qualitative collection and analysis of data was adopted. The study was conducted in Chipata District, the provincial headquarters of the Eastern Province of Zambia.

3.1. Description of the Study Area

Chipata city is the provincial capital of Eastern Province and covers a land area of about 6692 km² and is about 578 km away from Lusaka, the capital city of Zambia, while it is only 110km from Lilongwe, the capital city of Malawi (Figure 1). It is located between longitude 32°00' E and 33°00' E and latitude 13°00' S and 14°00' S.

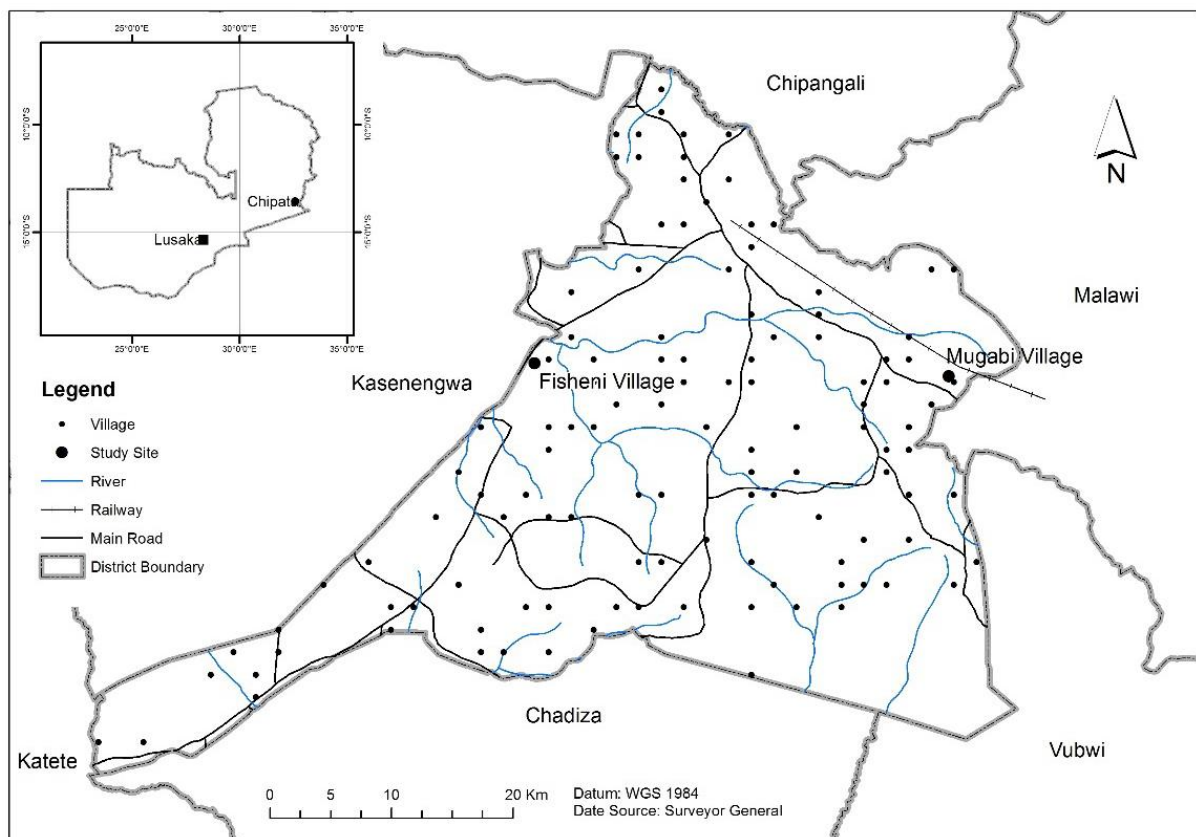


Figure 1. Location of the study area and study sites.

The Eastern Province is dominated by rain-fed crop production with 98 per cent of the 341,474 agricultural households engaged in annual crop production while 77 per cent raise livestock [72].

3.1.1. Climate of Chipata

Chipata District has a tropical type of climate with mean annual temperatures ranging from 15 °C to 26 °C. Prevailing winds are generally south-easterly and appear to have an effect on the rainfall pattern. The mean annual maximum temperatures in Chipata District range from 25.6 °C to 32.3 °C, and the highest temperatures occur in September, October and November. The lowest temperatures occur in June and July. The mean minimum temperatures in the district range between 12.2 °C in June and July to 20.1 °C in November [73]. The rain season is warm and wet and occurs from November to April [74]. However, much of the rainfall is concentrated between December and January. The district lies in agro-ecological region II, the medium rainfall area [75]. The average annual rainfall is 977.2 mm and ranges between 800 and 1000 mm. The relative humidity of the district is highest in January and February.

3.1.2. Economy of Chipata

Farming in Chipata takes place at both commercial and smallholder levels. Data covering the 2017/2018 farming season and the average hectare of land dedicated to the locally important crops are shown in Table 1.

Table 1. Hectarage and yields of selected crops produced by smallholder farmers in Chipata city.

Crop	Total Cultivated Land (ha)	Average Crop Yields (mt/ha)	Average Cultivated Land per Household (ha)	Total No. of Producers
Maize	5994.29	1.7	3.5	25,022
Groundnuts	3006.00	0.6	1.8	10,382
Soya beans	3291.25	1.0	1.2	7433
Mixed beans	788.20	0.5	0.5	2772
Cowpeas	436.80	0.4	0.3	752

Source: [76].

3.1.3. Cultural Context

According to the Central Statistical Office [77], Chipata District is dominated by the Chewa and Ngoni tribes. The two tribes extend into Malawi, Mozambique and South Africa. The Chewa originate from the Karonga kingdom in Malawi and are headed by paramount chief Karonga Gawa Undi, whose headquarters are in Katete District in Zambia. On the other hand, the Ngoni originate from South Africa. Their chief is known as *Nkosi ya Mankosi* (king of kings), paramount chief Mpezeni. Their headquarters are in Chipata District in Mtenguleni village. The Chewa are matrilineal while the Ngoni are patrilineal.

Among the Ngoni, land is bequeathed to male heirs, on the assumption that daughters will marry and access land through their husbands. In other words, land is inherited through the male lineage and property passes from fathers to sons. Women have secondary rights because they can only have access to land through their husbands and sons. Among the Chewa, land is inherited through the women. Male children inherit land from their mother's brothers. Whether a couple settles in the husband's village (virilocal), the wife's village (uxorilocal) or in a neutral village (neolocal) influences the basic pattern of inheritance in both matrilineal and patrilineal cultures. For men in matrilineal households, the most basic form of land tenure security is provided by stable marital relations [78]

3.2. Data Collection Methods

Data were collected through (1) Semi-structured interviews, (2) Focus Group Discussions (FGDs) and (3) key informant interviews. A total of 172 legume smallholder farmers were interviewed. The sample comprised of 86 women and 86 men. The sample size was determined through a priori power analysis calculation using the software G-power 3.2. This sample size of 172 provided a statistical power of 90% for detecting moderate effect size at a (two tailed) 0.05 level of significance [79].

Stratified random sampling was used to select the smallholder legume farmers. Using this method ensured that both male and female smallholder legume farmers were included in the sample. This method of sampling ensures that the resulting sample is distributed in the same way as the population in terms of the stratifying criterion [80]. For each gender group, it was ensured that married, single, divorced and widowed farmers from Mugabe and Fisheni villages were part of the sample. The interviews were conducted over a period of three weeks. Permission to conduct research was obtained from the traditional leadership of each chiefdom before the start of fieldwork, as per custom, while, and prior to the interview, informed consent was obtained from each farmer that was interviewed.

Focus group discussions (FGDs) were similarly carried out in the two villages of Fisheni and Mugabi between May and June 2019. In each village, three-in-one FGDs were conducted as follows: a group consisting of women, a group of men and a mixed-gender group. The men's and women's only group had their discussions separately, before they were brought together in plenary to make the third mixed-gender group. The initial separation into single-gender groups was important to minimize any potential influence of cultural norms that could otherwise limit participation in the discussions based on gender. Willingness to fully engage in a group discussion is instrumental in generating useful data and can be achieved more readily within a homogenous group [81].

An average of 10 discussants, all of whom were legume farmers, was selected from each of the two villages. The discussants were purposively selected based on a display of knowledge during the survey. It was ensured that different age ranges were represented. The facilitators asked the discussants to explain trends in climate that had been observed in their area, how these trends had affected legume production in their area and how they had addressed them. The men's only groups were facilitated by two research assistants, while the women's groups were facilitated by the first author.

After the separate discussions were completed, the groups were combined to have a joint discussion. The first author facilitated the joint discussants while the research assistants observed and recorded both verbal and non-verbal communication by the discussants. Digital recorders and field notebooks were used for recording, after informed consent was obtained. All the discussions were carried out in the local dialect of the area, *ChiNgoni*. The discussions were held from the village squares, in both villages.

Key informants were purposively selected and interviewed using an interview guide. The interview guide listed three questions on climate trends in the study sites' legume production and gender. The rest of the questions asked depended on the responses to the earlier questions and the knowledge of the key informant on the subject matter. The key informants comprised two village headpersons, a senior chief, two agricultural extension officers, two senior citizens that were very long-time residents of their respective areas, one representative from Community Markets for Conservation (COMACO) and one representative from Share Africa Zambia (SAZ). COMACO trains farmers in conservation agriculture and engages them in contract farming of food legumes. SAZ is an agricultural NGO focused on contract farming of legumes. The key informant interviews were conducted in both English and *ChiNgoni*. Responses were recorded in a notebook, after informed consent was obtained.

Quantitative data collected during the semi-structured interviews was analysed using descriptive and inferential statistics. The descriptive statistics included means and ranges while two-sample Z-proportional, two independent sample *t*-tests and chi square tests were used for inferential statistics. All the tests were conducted at a 5% level of significance. Qualitative data were analysed using content analysis, whose themes were decided upon before the analysis on the basis of the study objectives. The results were further disaggregated by gender of the respondents or discussants. Gender disaggregated data results in a clearer and fuller understanding of women's and men's lives, and the gaps that persist between them. The statistical data analysis software Minitab 18 [82] was used to analyse the quantitative data and the qualitative data analysis software QDA Miner 3.2 [83] was used for qualitative data analysis. It was important to disaggregate the results by gender to avoid masking gender differences that could exist.

4. Results and Discussion

4.1. Legume Smallholder Farmers' Experiences of Climate Change

Results from the semi-structured interviews show that male and female smallholder legume farmers had similar experiences of climate change/variability (Table 2).

Table 2. Male and female smallholder farmers' experiences of climate change/variability in Chipata.

Climate Change/Variability Experiences	Men (%)	Women (%)	Two Proportion z Test
Late on-set	48.8	51.2	$Z = -0.31, p = 0.752$
Shorter rainy season	48.8	55.2	$Z = -1.55, p = 0.122$
Excessive rainfall)	52.3	47.8	$Z = 0.62, p = 0.536$
Intra-seasonal droughts	50.6	49.4	$Z = -0.31, p = 0.757$

Some respondents lamented that planting times were not known because of uncertainties of when the rains would start. The late onset of the rainy season affected planting

time for all legumes for both genders. A long-term resident of the study area that was interviewed as a key informant complained that:

Planting of legume crops had been delayed due to uncertainties as to when rain would start. In addition to uncertainty, even when rains began, it would rain continuously for two weeks, which meant that planting was to be delayed further.

Umar [63] recently reported that male and female smallholder farmers in six districts of Eastern Province (including Chipata) had similar experiences of climate change, namely late onset of a shortened rainy season, intra-seasonal drought and higher temperatures. The late onset of a shortened rainy season characterised by intra-seasonal droughts is common to both studies. The higher temperatures reported in this much larger study could be because her study area included results from the valley areas renowned for their typically higher temperatures, which seem to have further risen.

4.2. Effects of Climate Change/Variability on Legume Production

Both male and female smallholder farmers reported that common beans were adversely affected by excessive rainfall (Table 3).

Table 3. Smallholder farmers' views on climate change effects on legumes, Chipata, Zambia.

Effect of Climate Change	Men's Views	Women's Views
Effect on common beans	Some men (34.9%) reported heavy downpours as being disastrous to common beans as it caused the flowers to drop off.	Some women (23.3%) reported that heavy downpours affected the flowering of beans.
Effect on groundnuts	47% mentioned low yields due to witch weed while 20.9% noted prolonged rainfall. Intra-seasonal droughts led to small and empty pods.	23.3% noted low yields due to witch weed while 27.9% noted prolonged rainfall. Intra-seasonal droughts led to small and empty pods.
Effect on soya beans	Excessive rainfall made fields impassable and delayed weeding. Intra-seasonal droughts led to small and empty pods.	Intra-seasonal droughts led to small and empty pods.
Effect on cowpeas		Not much affected as it performs well during drought periods.

Their common experiences were that common beans were more affected during flowering time. The flowers, which mature to produce the beans, drop off due to heavy downpours, resulting in low or no yields at all.

Witch weed (*Striga asiaticapa*) is a pernicious weed triggered by excessive rainfall [84]. The weed is likened to a witch because it has devastating effects on groundnuts yield. Witch weed was reported to have extensive and very fibrous roots which 'choke' or entangle pods and also hardens the soil, such that pods are retained in the ground during harvest. A young male FGD participant from Fisheni village explained that the presence of witch weed in his groundnut fields had lowered his groundnut production. Similar views were expressed by three female focus group discussants from the same village.

There was agreement in the women's focus groups that female smallholder farmers were more affected because they did not have an opportunity to weed on time because of their gender roles. During the short periods without rain, women divided their time between household chores and weeding. In most instances, by the time they were done with the house chores, the rains would start again, making it difficult for the women to

weed the legume fields under their control. In the same vein, a key informant from Share Africa Zambia (SAZ) observed that:

Women were more affected by climate variability especially groundnut production compared to their male counterparts. Groundnut fields need to be free from weeds and women were good at that as they keep their groundnuts fields clean like they sweep their houses. Therefore, continuous rain affects the groundnuts especially during weeding period, because there is no time for weeding.

In the men's only focus group discussions, the common view was that soya bean fields became waterlogged and impassable after heavy and prolonged rains, which delayed weeding. Noteworthy here is that women did not cite soya beans as being affected by heavy and prolonged rainfall. Furthermore, men and women gave different reasons for the delay in weeding. For the men, the delayed weeding was due to waterlogged fields while for the women, it was due to time constraints induced by their reproductive or domestic gender roles.

Some men (27.9%) reported to have planted maize first because of the late onset of rainfall. The delay in planting aggravated the low crop productivity, which disproportionately affected married women. The focus group discussants explained that legume planting was delayed for married women as they worked on maize fields controlled by their husbands before they worked on their legume fields. Conversely, unmarried women planted legumes simultaneously with other crops and sometimes even started with the planting of legumes. The female discussants observed that unmarried women's legume yields were thus slightly higher, especially for groundnuts, than those for married women, because the unmarried planted their crop at the onset of the rainy season, unlike the married ones as decisions of when to plant were made by their husbands. Ref. [85] had likewise observed that women were expected to give priority to working in fields belonging to the heads of their households.

A male discussant from Fisheni village shared his experiences of the late onset of the rainy season and commented that, "If I could get a machine to bring rain, I would do so because climate change has greatly contributed to high poverty levels in my household which is as a result of low soya bean production". Chapoto et al. [25] observed that soya beans were sensitive to changes in weather conditions, especially dry spells. On the contrary, Ref. [86] states that soya beans are a versatile crop because it embraces diverse climatic conditions, something not done by other crops.

A 68-year-old divorced woman from Mugabi village narrated the following:

Previously, I used to have good sales from high yields of groundnuts, but today my income is very low. I can no longer grow enough groundnuts, because am constrained by age and increased climate variability has contributed to low yields. I now depend on my relatives and friends for help. I neither can nor even manage to do piece work because of my age.

This seems to suggest that climate variability has worsened the situation for the woman and others like her. A reduction in the size of land cultivated that usually accompanies an increase in age should at least have enabled her to cultivate a small piece of land.

Cowpea growing was mainly common among female smallholder farmers, with about 90% of them reporting growing the crop and only 10% of the men reporting the same. The older women dominated the growing of cowpeas; most respondents (90%) growing it were between the ages of 47 and 72. Differences in crop preferences between men and women usually reflect gender differences in gender roles [87,88]. For example, cowpea processing in West Africa is an important source of agricultural-based income and is a 'golden grain' for many women entrepreneurs, where it is used to produce a golden fried donut snack [88]. Groundnut production is dominated by female smallholder farmers and is considered a female-controlled crop. Therefore, groundnuts offer a great potential for increasing incomes among women and nutrition [25]. In contrast to the production of groundnuts, soya bean production is dominated by male farmers and it is grown as a cash crop [64]. Cowpeas were reported to be drought resistant by the older women, most of

whom preferred growing cowpeas to common beans. One widow woman lamented during an FGD that although the crop was not affected by intra-seasonal droughts, flash floods affected it. She added that she could not stop growing cowpeas because they had been grown by her great grandparents, and not the common beans, which were new in her time.

Results from questionnaires and FGDs were similar. Thus, the understanding of climate change and climate variability by male and female legume farmers was similar. However, female farmers were more adversely affected by climate change and climate variability because of their gender roles. We argue that women are more affected because of the value they place on legumes, the provision of nutritious food to their families.

4.3. Challenges Faced by Male and Female Smallholder Farmers during Legume Production

Male and female respondents were asked about climate-related challenges they faced during legume production. Almost a third of the male respondents thought that men experienced legume production challenges due to household headship roles while only 10% of the women thought that men faced climate-related challenges during legume production due to this reason (Table 4).

Table 4. Challenges faced by male and female legume farmers.

Gender	Women's Views	Men's Views
Men	10.3% of female respondents noted that men faced challenges by virtue of being household heads	33.7% of male respondents noted that men faced challenges by virtue of being household heads
Women	66.7% of female respondents attributed women's challenges to their triple gender roles while 4.6% said lack of coping strategies.	44.6% of female respondents attributed women's challenges to their triple gender roles while 2.4 said lack of coping strategies.
Men and women	18.4% of female respondents thought male and female farmers faced similar challenges	18.1% of male respondents thought male and female farmers faced similar challenges while 1.2% believed neither had coping strategies

Both men and women attributed women's more numerous and more daunting tasks when it came to legume production to women's triple gender roles. Because women are responsible for childcare and cooking, they ensure that food legumes are available for household use as they are important cooking supplements. This agrees with previous reports that women's productivity potentials are constrained in several ways; the first being women's commitments as both farm and household managers. Secondly, from both a political and social point of view, women have unequal access to farmland compared to their male counterparts, and in cases where they do, they are weakened by land tenure security [44,89]. This has the potential to significantly affect the productivity of female smallholder farmers. Another reason is the limited channels through which women can access production inputs such as improved varieties and agricultural extension services compared with the men [90].

Some respondents elaborated that legumes were women's crops and thus women faced more challenges during their production. The men and women that perceived both genders to be similarly challenged during legume production attributed this to either the challenges faced being the same or both lacking coping strategies (Table 4).

The FGDs revealed more nuanced positions (Table 5). The men's only group from Mugabi village observed that women were more vulnerable to climate variability because when yields are low, the women cannot cope with climate stress. The men's group from Fisheni village observed that married women had an advantage of producing higher legume yields because their husbands took the responsibility to water the fields during

drought spells, while women without spouses reportedly had lower yields as they found watering of fields to be arduous.

Table 5. Excerpts of FGDs on legume production challenges.

Men Discussants	Women Discussants
“Legumes are not the only crops which provide income. I grow different crops which generate income for my household” [divorcee aged 46, Mugabi village].	“Women are more affected with climate variability because they are engaged in many household chores at home ensuring that everyone had food” [divorcee, aged 40, Mugabi village].
“Women are vulnerable because they cannot get involved in providing bicycle services, sale of sand” [married aged 55, Fisheni village].	“Crop failure makes me more vulnerable to hunger because I rely solely on the sale of legumes” (widow, aged 43, Fisheni village).
“I have a big piece of land. I sold part of it” [single, aged 37, Fisheni village]. “I am a head of the family and naturally I need to have my own piece of land [married aged 47, Fisheni village].	“If I had the means to own land, I would be a happy person, but I have no means to own land. We are usually constrained by customs and traditions” [Single, aged 39, Fisheni village].
“Men have other coping strategies such as selling sand, brick molding and gardening” [Married, aged 50, Fisheni village].	I obtain food and income from legume crops and “I place great value on legumes because I am a woman who provides food for my family and I cannot afford to buy cooking oil, instead I extract oil” [widow, age 50, Mugabi village].

The women’s only groups from Fisheni and Mugabi villages averred that women were more affected by climate variability because they were engaged in many roles at home to ensure that all household members had food. They contended that women were the main providers of food for their families and they thus bear a greater burden to fulfil this task when climatic events affect their (legume) crops. *“Women feel obliged to ensure household food security even when they have not discussed with their husbands,”* observed one member. Scholars reporting on gendered effects of climate change among smallholder farmers generally note that male and female farmers have different abilities to adapt to climate change due to their varied access to resources and differentiated exposure to vulnerabilities [63,91]. Further, women seem to suffer more negative impacts of climate change because of socio-cultural norms regarding gender roles [92].

Women reported to have challenges in accessing productive resources such as land, information, seed and credit. Although the male discussants reported owning land, the majority of the female discussants reported only having access rights to land through their husbands. A large majority (89.2%) of the male respondents said that they owned land while only slightly more than half (55.7%) of the women reported owning land. There is an association between gender and land ownership ($\chi^2 = 24.112$; $p < 0.01$), with significantly more men owning land. Some women rented land. Limited access to land had a negative impact on women’s legume production to the extent that women did not have control over land in the two patrilineal villages. Among the Ngoni people where the study was conducted, land is passed on to male heirs. It is expected that daughters will marry and access land through their husbands. In other words, land passes from fathers to sons. Thus, women commonly access land through their husbands and male children [71]. Access to customary land favours men over women [93]. Although options to purchase land exist, most women in vulnerable communities have no financial capacity to purchase land and can therefore only access it through marriage, by borrowing or begging [66]. Gender inequalities in access to land in many parts of Africa are well documented [68].

The majority of the single female discussants from Mugabi village lamented that if they had the means to obtain their own land, they would have been food and income

secure, unlike the prevailing situation, which limited their access to land. For women that rented land, their already low crop incomes were channelled towards payment of rentals for the farmland. This happened in the midst of increased climatic variability which has aggravated their already low legume yields. Results from a nationally representative survey of rural agricultural households in Zambia revealed that men dominated decision making in 88% of male-headed households while women dominated in 96% of female-headed households [94]. Doss, 2011 [95] similarly posited that, although both male and female smallholder farmers face a number of constraints in accessing productive resources, the constraints are more acute among female farmers who also face barriers in accessing certain resources such as land, extension services and inputs with which to adapt to climate variability.

The study also observes that female farmers could not afford to buy hybrid legume seed to plant. In view of the lack of seed, female legume farmers reported to have mostly used recycled hybrid seed, which resulted in low yields. In the words of a female discussant from Mugabi village: *“My groundnuts do not do well because I use recycled seed. My productivity is further affected by the interruptions in rainfall during the growing season”*. A discussant from the men’s FGD echoed the same sentiment; *“Our legume production is low due to seed access challenges. There is no company that gives us seed like they do with maize”*.

A key informant from the district office of the Ministry of Agriculture confirmed that legume farmers were not provided with seed for them to plant. Another key informant, from Community Markets for Conservation (COMACO), explained that the company only gives seed to those farmers that consent that they will conserve the environment through the application of the principles of conservation agriculture. To conclude the results and discussion section, it is surmised that climate change, variability and gender are important factors in the production of legumes in Chipata, but the outcomes are also influenced by the socio-cultural, economic and policy context (Figure 2). These factors can combine in various ways, to produce a wide array of outcomes.

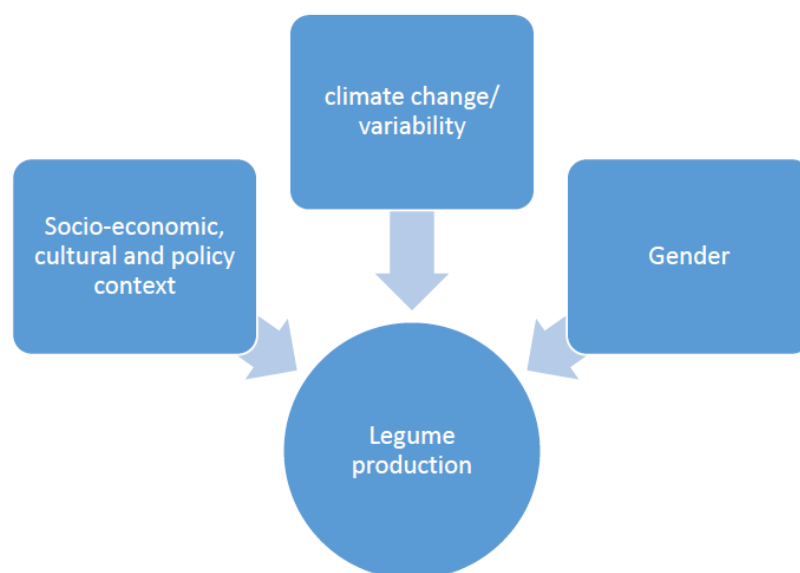


Figure 2. Interaction of factors in smallholder legume production.

The cultural context which emphasized women’s reproductive roles has led to an association of food legumes with women, unless and until they become important cash crops. Cash crops, including legumes, are perceived to be controlled by men, who as the traditional household heads are responsible for cash-income-earning activities. Zambia’s agricultural policy has historically focused on maize [96]. Unlike women, men have many coping strategies to adapt and mitigate the negative effects of climate variability, as they engage in various income-generating activities such as mining and selling sand, brick

moulding and provision of bicycle services. Due to local gender norms, women do not generally engage in these productive activities.

5. Conclusions

The study finds that male and female smallholder legume farmers in the study area had similar experiences of climate change/variability. In general, both male and female legume farmers reported that nowadays the rainy season starts later, is characterized by heavy downpours, which continue for several days at a time, then disappear for several weeks, resulting in intra-seasonal drought, only to have the periods of rainfall back for several more weeks before the rainy season ends. The study further reveals that climate change/variability has resulted in yield penalties for legume production for both male and female smallholder farmers, albeit not always for the same reasons.

Women face specific challenges related to their triple gender roles. Due to their reproductive roles such as cooking, childcare, firewood and grass collection, they suffer from time poverty and labour shortages. This leads to weeds overrunning their fields and the concomitant legume yield losses. Because women are responsible for cooking family meals, they are more vested in legume production for household use, and thus suffer more from low yields. Women's lower access to productive resources including hired labour and early maturing legume seed means that they endure more negative outcomes from extreme climatic events and have a much harder time recovering from the effects of such events than men. Thus, the results of the study have wider implications on the mediating role of gender gaps to smallholder farmers' ability to adapt to climate change.

The study recommends that agricultural extension agents include climate-smart agriculture (CSA) in their farmer training. CSA, as promoted in Zambia, includes legume production in its package. Thus, improved smallholder farmer knowledge of CSA will deal with the twin challenges of climate change/variability and low yields of legumes. Local efforts to promote the production of legumes could include strategies such as community legume seed multiplication, improved seed provision and community seed distribution networks that promote gender equitable access to improved seed. Local seed sharing networks would further result in diversified and climate-smart seeds. Agricultural development actors ought to mitigate the mediating role of gender gaps by ensuring their interventions address the different outcomes of climate change for male and female legume farmers, in particular and more generally.

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