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Research article

Empowerment of smallholder female livestock farmers and its potential impacts to their resilience to agricultural drought

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Abstract: Studies have determined the factors influencing agricultural drought resilience of smallholder farmers and implications for empowerment. Other than the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI), studies do not provide an analysis of cultural or traditional beliefs and reflective dialogues on challenges of smallholder female livestock farmers. This study uses a mixed approach that includes a survey, A-WEAI, Pearson's chi-square coefficient, and reflective dialogue to analyze these challenges. The ability to adapt to agricultural drought is influenced by factors such as access to information, credit, productive resources, and available time, all of which are different for men and women. Our study found that 61.3% and 16.4% of the female and male farmers were disempowered. Domains that contributed the most to the disempowerment of the women and men were respectively time/workload (52.97% and 31.89%), access to and decisions on credit (17.7% and 21.4%), ownership of assets (11.3% and 8.5%), input into productive decisions (10% and 9.1%) and group membership (8% and 19.13%). No significant correlation for age, marital status, or level of education versus empowerment status of women was found. A significant correlation was observed between farming experience and the empowerment status of women. Reflective dialogue during interviews revealed that women struggled with access to finance, grazing, water, stock theft, lack of training and knowledge, and intimidation by male neighbors. Such findings help inform agricultural development strategies to develop or modify existing policies to enhance the resilience of farmers to agricultural drought and empowerment. Gender-specific agricultural projects should be encouraged to empower female farmers to improve their resilience to agricultural drought. The government should assist female livestock farmers in accessing credit and developing clear policies on land tenure issues. Mentorship programs should be

encouraged to educate and support female smallholder farmers to enhance their agricultural drought resilience and empowerment.

Keywords: agricultural drought resilience; smallholder female livestock farmers; empowerment; A-WEAI; Pearson's chi-square; reflective dialogue

1. Introduction

Many regions of the world are currently experiencing some of the worst drought conditions for a number of generations [1]. In the last few decades, the increasing frequency and severity of drought events all over the world have led to in-depth investigations into their economic consequences, making use of a wide variety of theoretical approaches and methodologies to identify and estimate the economic effects [2]. Globally, agricultural drought is the costliest natural disaster compared to other natural disasters such as floods, hurricanes, tornadoes, and earthquakes. A loss caused by agricultural drought is estimated to from 6 to 8 U.S. dollars (USD) annually [3]. The impact of agricultural drought put pressure on the already scarce resources and their sustainability.

Studies have focused, in particular, on sectors such as agriculture [4,5]. Ferrari et al. [4] highlighted that water availability in Egypt is highly variable and is considered one of the biggest obstacles to socio-economic development. Agriculture is assumed to be one of the most vulnerable sectors to drought, affecting significantly through many direct and indirect mechanisms [6]. Mendelsohn and Dinar [6] highlighted that non-climatic factors such as socio-economic conditions have an inevitable impact on agriculture and further, they argue that the adaptation would be effective in response to the threats posed by climate change and that econometric models can capture the full range of economic adaptations of farmers.

Studies on the impacts of drought usually make the implicit assumption that there will always be a negative effect on the environment, the economy, and society. However, other approaches, based, for example, on the framework provided by the consumer surplus theory, try to focus on the distributive effects of drought. Musolino et al. [7] address the distributive effects of drought on agriculture, exploring and studying the characteristics, the signs, and the magnitude of the socio-economic impacts of droughts on agriculture. Further, Musolino et al. [7], based on the analysis of trends and changes in production and prices they found that drought events can create not only "losers" but also "winners". Some social groups (for example, some categories of farmers) can even "win", while others "lose" (for example, final consumers).

The challenge of coping with agricultural drought is under global scrutiny, and its implications for food security are not underestimated. It is necessary to enhance farmers' adaptive capacity and resilience [8–10]. In responding to drought, policy-makers with different stakeholders need a deeper understanding of the trade-offs involved with varying management options regarding costs and the potential impacts on economic systems. This, in turn, increases the importance of developing an appropriate framework for understanding the impacts of drought and the costs associated with different policy measures [1].

Sub-Saharan Africa experiences climate variability and has high levels of rain dependency [11]. Rising temperatures and unpredictable rainfall increase the occurrence of drought and disaster.

Agricultural drought[1] is the most damaging natural disaster due to the persistent social, economic, and environmental impact [13]. The consequent challenges are severe, especially in developing countries that rely on the agricultural sector for economic growth and food security. Vulnerability to climate change differs according to several factors and includes gender [14]. In poor households, women and children are often left exposed and deserted due to different circumstances such as male work migration and higher death rates [15]. Poverty is exacerbated by climate change because vulnerable people in society lack the necessary resources to recover once they have suffered from agricultural drought or other climate extremes [16].

Building resilience[2] against agricultural drought is a challenge in itself. This is especially true for smallholder livestock farmers who have constraints such as lack of funding, lack of transport leading to problematic access to markets, lack of market information, and limited access to the latest technology [18]. The challenges are often escalated in female farmers or female-headed households who are involved in general and livestock farming in particular. Drought affects men and women differently because gender influences power, responsibility, and roles in households and communities in general. Cultural and religious gender norms, the difference in economic opportunities, and limited access to resources contribute to the gender divide [19]. The resilience to the agricultural drought of female smallholder farmers would therefore be different from male farmers[3].

Smallholder farmers[4] in South Africa in general and in the Northern Cape Province of South Africa in particular have increased levels of vulnerability towards drought. They find themselves in a permanent state of drought and are trapped in a vicious cycle [22]. In a recent study, gender was identified to play an important role in resilience to agricultural drought in the Northern Cape Province of South Africa [22]. In the Northern Cape Province of South Africa, the percentage of female-headed households was a staggering 38.9% in 2016. This could be attributed to several factors such as male migration to find employment, widowhood, unemployment, and personal choice [23]. Many of them are involved in some form of agricultural activity to supplement their household income or improve nutrition for their families. In the recent census, it was reported that nationally 464 611 of a total of 990 210 or 46.9% households involved in livestock farming were female-headed [24].

The dynamics of agricultural drought resilience are dramatically influenced by social and gender inequalities [25]. Whether people can survive or adapt during and after a drought is affected by their access to information, social capital, credit, productive resources, savings, available time, and mobility—all of which are different for men and women [26]. Women often do not have the same access to resources as men do. Female-headed farm households have the added responsibility

[1] Agricultural drought is a water shortage on agriculture focusing on rain shortages, deficient soil water, and reduced groundwater or water reservoir levels [12].

[2] Resilience is defined as the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress [17].

[3] This manuscript is part of MSc dissertation by von Maltitz, L. [20]. The resilience of female smallholder livestock farmers to agricultural drought in the Northern Cape, South Africa. MSc dissertation, University of the Free State, South Africa.

[4] Smallholder farmers are farmers who grow subsistence livestock, completely relying on family labor and have limited resource endowment as compared to commercial farmers [21].

of managing the household, caring for the frail and sick and caring for their children. Their available time to spend farming is less than that of their male counterparts [27].

Access to and ownership of land is not equally distributed between men and women in South Africa. The latest Land Audit Report of the Department of Rural Development and Land Reform [28] revealed that in the Northern Cape Province of South Africa, 73% of the available agricultural land is owned by men. The ownership of household plots is even more skewed, with 98% of plots owned by men. This statistic is relevant because 61.9% of the agricultural activity in the Northern Cape Province of South Africa occurs in the so-called backyards of households [24]. This directly impacts women's access to finance due to their lack of available collateral for loans to finance productive inputs [29,30].

Studies have focused on the importance of gender to agricultural drought resilience; exclusion of women from financial and institutional support; the significance of women in building resilience; perceptions between women and men on their resilience in times of drought; the influence of resources on women livestock farmers' empowerment; the correlation between empowerment and resilience; and a need to recognize gender in resilience [14,22,25,29,31–38]. None of these studies determined the factors, which influenced drought resilience of smallholder female livestock farmers and the implications thereof on empowerment.

Except for the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI), the studies did not consider cultural or traditional beliefs and reflective dialogues related to accessing finance, training, scarcity of resources, grazing, and stock theft in assessing the challenges faced by smallholder female livestock farmers. The study's objectives were to determine the factors that influence the drought resilience of smallholder female livestock farmers in the Northern Cape Province of South Africa and the implications on empowerment.

1.1. Theoretical/Conceptual framework

The conceptual framework for the resilience of women headed farm households to agricultural drought, and the implications for empowerment is depicted in Figure 1. Figure 1 illustrates how issues related to gender are linked to resilience and empowerment. Women have limited time available to them because they are responsible for household chores (cooking and cleaning) and caring for elderly family members and their children. Women's lower average income because of time constraints have a direct impact on income levels, which place further restraint on productivity. Lower income limits access to productive resources, restricted access to land and other assets (the lower average income has a spillover effect on land ownership). Due to the lack of income, it becomes very difficult for female-headed households to buy or lease land to produce and generate revenue. Limited access to and ownership of productive assets and lower educational levels can be attributed to cultural norms and diminished decision-making power. In dual-gender households, women have decision-making powers over household chores, childcare, and nutrition, whereas men control decisions relating to finance and agricultural production. Women have restricted access to finance, and rural women do not have the same access to credit as their male counterparts living in the same conditions. This is attributed to a lack of ownership of assets to offer as collateral or lack of formal employment to offer assurance for repayment. Female-headed households have limited access to labor to assist in their agricultural production. This could be attributed to a lack of financial resources to afford labor. Due to limited decision-making power and limited funds, women are often

not allowed or able to market their own product. Women are sometimes excluded from membership to cooperatives and access to extension services if they do not own land. This is made worse by a lack of support through extension services to rural farmers and cultural or traditional beliefs.

Many women still find themselves trapped by cultural beliefs such as being confined to domestic chores, unable to own land and that they must be married in order to provide for their families. Successful empowerment policies have a positive influence on the individual resilience of female farmers to agricultural drought, resulting in improved resilience of the household unit and eventually improved resilience of the community as a whole.

Further Figure 1 illustrated the relationship between empowerment and resilience. Communities, including farmers, are more vulnerable to agricultural drought when they are disempowered, marginalized, with limited access to resources, limited income, restricted mobility, low level of education, cultural biased and unable to participate in decision making, in turn, they are less resilience to agricultural drought. There are different definitions for resilience with shared characteristics [39–41]. Nearly all definitions stress the common elements of resilience: ability, mitigation, adaptation, coping, recovery, withstanding shocks, resistance, and bouncing back against shocks. Communities to make informed choices to manage shocks require access to information, the realization of rights; the ability to participate in decision making; and an asset base to act as a buffer against shock and enhance their resilience due to empowerment.

2. Materials and methods

A mixed-method (quantitative and qualitative research) was utilized in this study. Lieber [42] highlighted that qualitative methods have the advantage of providing researchers with the context of the research environment and the human aspect involved, ensuring comprehensive information that cannot be determined using quantitative methods. Quantitative methods, on the other hand, focus on the collection of data and measuring the relationship between variables. Combining the two provides more inclusive, thorough research results that can help make meaningful conclusions and recommendations. Mason [43] emphasizes the use of multiple methods to measure empowerment to be the best approach.

2.1. Study area

The Northern Cape Province of South Africa has five different district municipalities, namely Frances Baard, John Taolo Gaetsewe, Namakwa, Pixley ka Seme and ZF Mgcawu district municipalities [44]. This study focused on the Frances Baard District Municipality, which is divided into four local municipalities of Dikgatlong, Magareng, Phokwane, and Sol Plaatje [20] (Figure 2).

The Northern Cape climate is characterized by hot summers (between 30 and 40 ℃) and cold winters (below zero nightfall temperatures and frost). Coupled with low rainfall (mean annual precipitation of 200 mm), the climate is dry and relentless. The Frances Baard district has an average annual rainfall of approximately 350 mm [45].

A variety of agricultural production occurs in the Northern Cape Province of South Africa due to the vast difference in climate between the district municipalities. Livestock production remains the leading enterprise, with ±75% of agricultural households farming with animals only [24]. In South

Africa, the Northern Cape produces approximately 4% of the country's cattle, 24% of the sheep, 7% of the goats, and 1.4% of the chickens (Department of Agriculture, Forestry and Fisheries (DAFF) [45].

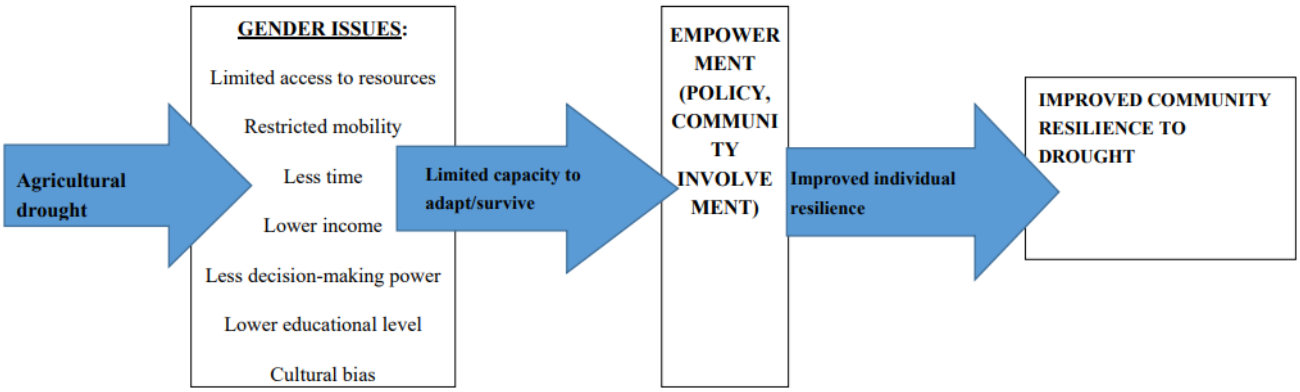

Figure 1. Conceptual framework of the impact of empowerment on drought resilience. Source: Author's compilation (2020).

Although the Northern Cape province is used to dry periods, the recent drought has crippled the agricultural sector, and recovery has been slow or non-existent. A lack of fodder and water for livestock production has placed the industry under enormous stress [45]. The suffering of smallholder farmers has been escalated due to numerous factors such as poor grazing, lack of water, lack of resources, land issue, and others. Maltou and Bahta [18] highlighted that most smallholder farmers are not resilient to agricultural drought. Factors such as lack of access to credit, lack of assistance from the government (such as training and feed) during drought, lack of social network, and not being part of co-operative contributed to their non- resilience to agricultural drought. Bahta [12] highlighted the majority of the farmers used selling their livestock as a coping and adaption strategy during drought.

2.2. *Sample design and data collection*

In this study, multi-stage sampling was used. In the first stage, the Northern Cape Province of South Africa was selected because the province is one of the main livestock-producing provinces and was declared a drought disaster area in 2019 by the South African Government. In the second stage of sampling, the four district municipalities of the Frances Baard District of the Northern Cape were chosen randomly. The district municipalities were Phokwane, Sol Plaatje, Magareng, and Dikgatlong.

The respondents were selected from a list of female smallholder livestock farmers provided by the Northern Cape Department of Agriculture, Forestry, and Fisheries (DAFF). The list contained 127 female livestock farmers (Table 2). A questionnaire was constructed according to the instructional guide on the A-WEAI [46]. The respondents had to be female smallholder livestock farmers residing in the Frances Baard District Municipality of the Northern Cape and willing to participate in the research.

To calculate the Gender Parity Index (GPI), the focus was on married women or women in a permanent relationship with men who were also actively involved in the farming operation. Additionally, data were collected from single, divorced, and widowed women to determine whether

there was any relationship between marital status and resilience to drought. Using the simple random sampling formula of Cochran [47] and Bartlett et al. [48], 93 female smallholder livestock farmers were interviewed from May to August 2019. The study was conducted in a drought year and coincided with the South African Government's declaration of a drought disaster area. Most of the data were collected by the authors with some assistance from other researchers and extension officers of the province. Table 1 provides a summary of women and men farmers interviewed per municipality.

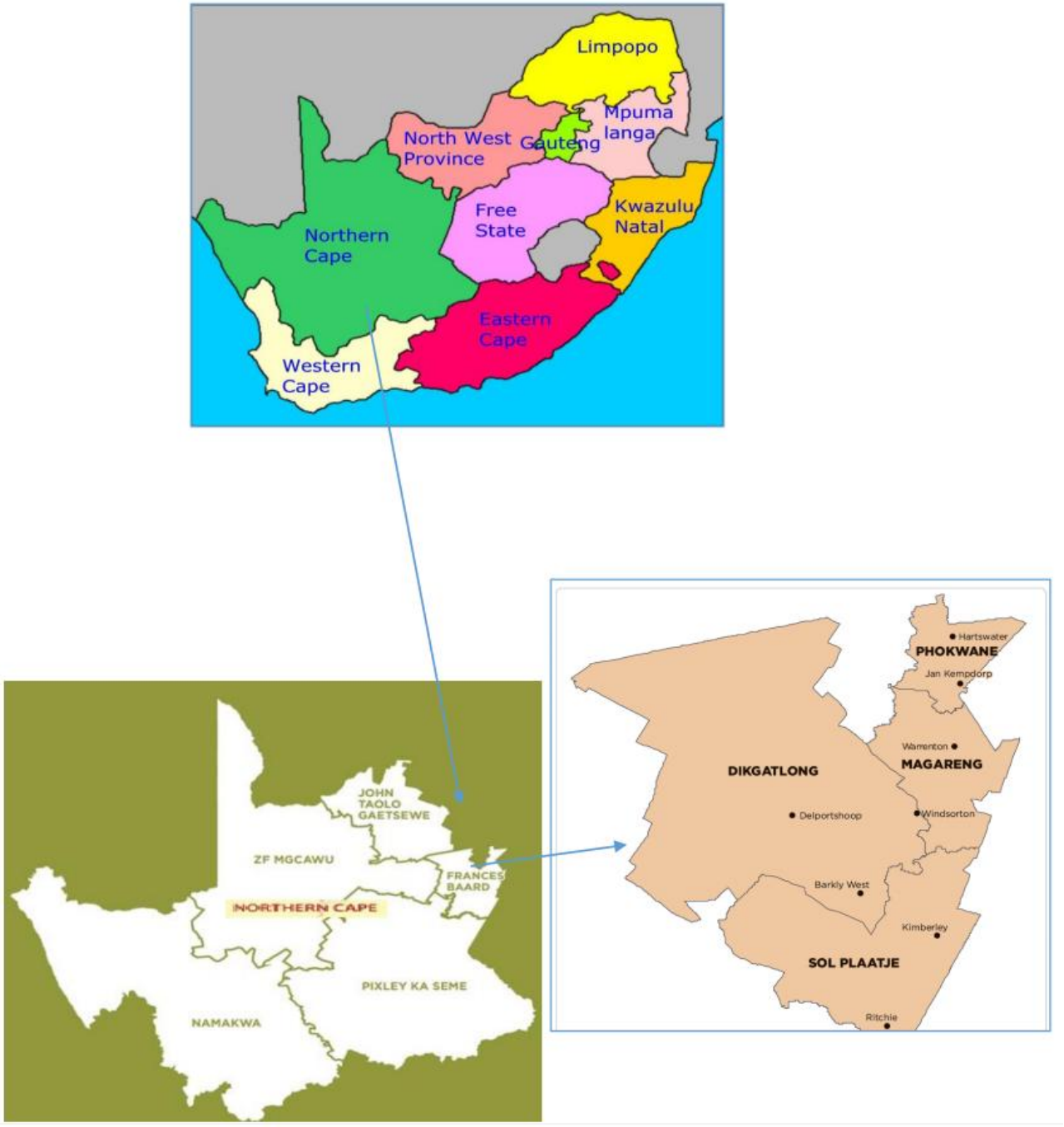

Figure 2. Frances Baard District Municipality Map. Source: Frances Baard District Municipality [44].

Table 1. Number of respondents.

Local Municipality	Number of female farmers on the list	Interviewed women	Interviewed men	Total interviewed
Dikgatlong	45	22	17	39
Magareng	21	18	13	31
Phokwane	54	37	20	57
Sol Plaatje	7	16	11	27
Total	127	93	61	154

Source*:* Northern Cape Department of Agriculture [49], and Author's compilations (2020).

2.3. Empirical specification of the model

To determine the empowerment status of the female livestock farmers who participated in the study, the A-WEAI was applied [46]. The Pearson's chi-coefficient was used to determine any possible correlation between other factors not included in the A-WEAI and empowerment. To place results in the context of the Northern Cape Province of South Africa, the reflective dialogue was utilized on challenges faced by respondents and to gather information on specific challenges such as stock theft, access to finance, scarcity of resources, and traditional beliefs, reflective dialogue was used.

2.3.1. The Abbreviated Women's Empowerment in Agriculture Index (A-WEAI)

The A-WEAI comprises two sub-indexes, namely the five domains of empowerment (5DE) and the gender parity index in empowerment within dual-adult households (GPI). Improvements in either one of these sub-indexes will increase the empowerment level in the survey area [50].

The 5DE is used to indicate both a level of general empowerment and the specific indicators that contribute the most to disempowerment. The five domains are production, resources, income, leadership, and time. At first, a disempowerment index (M_0) is calculated starting with processing the data according to the inadequacy indicators listed in Table 2. Coding was done by allocating the number 1 if the individual lacked adequacy and 0 if the individual achieved adequacy in the specific indicator. The domains, indicator names, typical survey questions, aggregation method, inadequacy cut-off, and weight of each indicator are summarized in Table 2.

Regarding input into the use of generated income, the following questions were asked:

- Who normally makes decisions with regards to the specific farming activity? Self, spouse, together, another household member, or another non-household member?
- How much input did you have in the decisions making? No input, some input, or sufficient input?
- Do you feel that you can make your own personal decisions with regard to activities? No, a little bit, mostly, always?

Regarding control over use of income, participants were asked to indicate to what extent they had input into the use of the income generated by livestock farming and other activities. Questions that were asked included decision and level of freedom to make decisions regarding income and expenditures generated in the household. The achievement was allocated if the women participated in any decisions apart from the minor household expenditure. Empowerment was considered

inadequate if the women participated in the activity but have no or very little input in decisions regarding the income generated.

Table 2. The five domains of empowerment (5DE).

Dimension	Indicator name	Survey question examples	Aggregation method	Inadequacy cut-off	Weight
Production	Input in productive decisions	How much input did you have in making decisions about livestock? Do you feel that you can make your own decisions regarding this activity?	Achievement in two	Inadequate if the individual participates but does not have at least some input into decisions, does not make the decisions or feel that she could make the decisions if she wanted to	1/5
Resources	Ownership of assets	Does anyone in the household have any assets? Do you own any of them? (Livestock, equipment, etc.)	Achievement in any if not only small assets (chickens, non-mechanized equipment and small consumer durables)	Inadequate if the household does not own any asset or if the household owns the type of asset BUT she/he does not own most of it alone	2/15
	Access to and decisions on credit	Has anyone in your household taken any loans or borrowed any cash from anywhere in the past 12 months (before August 2019)? Who made the decision to borrow? How much input do you have in deciding how to use the funds?	Achievement in any	Inadequate if the household has no credit or used a source but she/he did not participate in any decisions about it	1/15
Income	Control over the use of income	How much input did you have in decisions on the use of income generated in the household? Do you feel that you can make your own decisions regarding income?	Achievement in any if not only minor household expenditures	Inadequate if participated in activity but has no input or little input in decisions about the income generated	1/5
Leadership	Group membership	Are you a member of any agricultural/religious/business groups?	Achievement in any	Inadequate if not part of at least one group	1/5
Time	Workload	Worked more than 10.5 hours in the previous 24 hours	Not applicable	Inadequate if works more than 10.5 hours a day	1/5

Note: Group membership is an indicator of leadership—because, based on A-WEAI- leadership in the community is measured by membership in economic or social groups and comfort speaking in public. Recognizing the value of social capital as a resource, membership shows whether the person is a member of at least one social or economic groups such as agriculture producers' or marketing groups, water users' groups, forest users' groups, credit or microfinance groups; informal and formal social network groups; trade and business associations; civic or charitable groups, local government groups, and other women's groups. Group membership is deliberately not restricted to formal agriculture-related groups because other types of civic or social groups provide important sources of networks and social capital that empower themselves and may also be an essential source of agricultural information or inputs.

Source: Author has and adapted from Malapit et al. [46].

In order to examine the prevalence of disempowerment of women and to provide more information on the social and cultural sphere of the research area, three questions were included in the survey:

1. Do you think the cultural view of society of a woman's role in her household influences her access to resources such as land? If no, do you think it was influenced in the past?
2. Do you think the cultural view of society of a woman's role in her household influences her access to funding? If no, do you think it was influenced in the past?
3. Do you think the cultural view of society of a woman's role in her household influences her ability to make decisions? If no, do you think it was influenced in the past?

The total inadequacy score b_i of each individual is determined by adding the weighted inadequacies of all the indicators together (equation 1):

$$b_i = W_1I_1 + W_2I_2 + W_3I_3 + \ldots W_aI_{ai} \quad (1)$$

Where I_{ai} = 1 if the individual has adequate achievements in a specific indicator a and 0 if he/she does not have adequate achievements in specific indicator a. W_a = the weight allocated to each indicator i with $\sum_a^A wa = 1$. When b_i for each individual is calculated, the inadequacy score is censored. This is done to ensure that the individual scores of the empowered do not influence the overall empowerment score. A certain cut-off value is used and the score of an individual who scores below the cut-off (g) is replaced by 0 [50]. Therefore if $b_i > g$, then $b_i(g) = b_i$, but if $b_i \leq g$, then $b_i(g) = 0$. The determining value of g (the disempowerment cut-off value) is 20%. This is based on the assumption that an individual is considered empowered when he/she has sufficient achievement in four of the five domains; in other words, has an adequacy score of 80% or greater [40]. The 5DE calculated as a disempowered headcount ratio (H_p) is indicated in equation 2:

$$H_p = \frac{d}{n} \quad (2)$$

Where d = the number of individuals who are disempowered calculated based on equation 1 and n = the total population involved in the research study.

Secondly, the intensity of disempowerment (A_p) is calculated using equation 3:

$$A_p = (\sum_{i=1}^{d} b(g))/d) \quad (3)$$

Where: $b_i(g)$ = the censored inadequacy score of individual i and d = the number of individuals that are disempowered. The 5DE is then calculated as (equations 4 and 5):

$$M_0 = H_p \, x \, A_p \quad (4)$$

$$5\text{DE} = 1 - M_0 \quad (5)$$

Once the value of M_0 is determined it can be segregated to determine the contribution of each indicator to the disempowerment of the research population. This is done using equations 6 and 7:

$$\text{Percentage contribution of indicator } k \text{ to } M_0 = \frac{WkCHk}{M0(population)} \quad (6)$$

Where:

$$M_{0population} = w_1CH_1 + w_2CH_2 + \ldots\ldots + w_5CH_5 \quad (7)$$

The censored headcount ratio for each indicator is calculated by taking the number of disempowered individuals who do not have achievement in a certain indicator, divided by the total population. They are then added together to determine the contribution that each indicator has to the disempowerment of the group. When all the contributions are added together, the total will be 100%.

2.3.2. The Gender Parity Index (GPI)

The second part of the A-WEAI is the GPI, which can only be calculated for dual-adult households. In this research, women involved in livestock farming with their husbands or partners were used for this purpose. Sixty-one dual adult households were interviewed. The GPI identifies the ratio of women who lack gender parity compared to the men in their household and the magnitude of the inequality that exists.

The purpose of the GPI is to indicate inequality between men and women of a dual-adult household. Once again, the inadequacy scores are censored to distinguish the empowered from the disempowered. A cut-off of 20% is used, but in this instance differs from the 5DE calculation. The censored inadequacy score is referred to as $b^x_i(g)$ with $b_i > (g)$ then $b^x_i(g) = b_i$,, but if $b_i \leq (g)$, then $b_i \leq (g) = g$. This is done to ensure that the already empowered individual's score does not influence the gap between the empowered and the disempowered.

The household is then identified to have gender parity or to lack gender parity. A household does not have gender parity if the woman is disempowered and her censored inadequacy score is higher than the censored inadequacy score of the man in the household. Gender parity exists if she is empowered or when she is not empowered, her inadequacy score is greater or equal to that of the man in the household. To determine the ratio of women who lack gender parity, equation 8 is applied:

$$H_{GPI} = \frac{h}{c} \tag{8}$$

Where h = number of households without gender parity and c = total of dual-adult households involved in the research study. The next procedure is to calculate the average empowerment gap using equation 9:

$$I_{GPI} = \frac{1}{h}\sum_{p=1}^{h} \frac{b^{x}{}_{p}(g)^{M} - b^{x}{}_{p}(g)^{W}}{1 - b^{x}{}_{p}(g)^{M}} \tag{9}$$

Where: $b^x_p(g)^W$ = the censored inadequacy score of the women living in household p, $b^x_p(g)^M$ = the censored inadequacy score of the men living in household p, and h = the number of households lacking gender parity. Finally, GPI was calculated using equation (10):

$$GPI = 1 - (H_{GPI} \, x \, I_{GPI}) \tag{10}$$

Increasing H_{GPI} or decreasing I_{GPI} will improve the GPI score of the respondents. Then, A-WEAI is compiled by adding the two sub-indexes together according to the allocated weights of the index (equation 11):

$$A\text{-}WEAI = 0.9(5DE) + 0.1(GPI) \tag{11}$$

2.3.3. Correlation of variables

To determine whether correlations exist between empowerment and other measures that were included in the questionnaire, but not in the A-WEAI index, the Pearson chi-square statistic and *p*-value were used to calculate any significant correlations. The measures that were tested in relation to empowerment, included age, level of education, marital status, and farming experience and included the hypothesis:

H_0 = there is no relationship between variables z and empowerment; in other words, the relationship is insignificant;

H_a = there is a significant relation between variables z and empowerment.

The formula for chi-square (χ^2) is: (equation 12)

$$\chi^2 = \sum_{i,j=1}^{n} \frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}} \tag{12}$$

Where O_i = observed value of variable *i* and *j* and E_i = expected value of variable *i* and *j*. The degree of freedom was determined by the formula in equation 13:

$$df = (r - 1)(c - 1) \tag{13}$$

Where r = the number of rows or factors used for comparison and c = the number of columns in the table. Once a relationship is determined, and the H_0 hypotheses is rejected, the significance of the relationship can be calculated by using Cramer's V measure calculated by the following formula (equation 14):

$$V = \sqrt{\chi^2 / n \min{(r - 1, c - 1)}} \tag{14}$$

If V >= 0.25, the relationship is significant, if V <= 0.25 the significance of the relationship is small.

2.3.4. Reflective dialogues

Empowerment is multi-dimensional, and the social, political, economic, and psychological aspects of the specific area of research have an influence that cannot be measured easily empirically. This emphasizes the importance of reflective narrative [51]. To provide context-specific information on the challenges faced by female livestock farmers in the Frances Baard district of the Northern Cape Province of South Africa, reflective dialogues were included. This method is successfully used by organizations such as the Stichting Nederlandse Vrijwilligers [52].

Petesch et al. [53] discuss important challenges in the process of evaluating empowerment. One of them is to view empowerment action within the sociopolitical context. To address the different challenges, they advise combining both statistical and qualitative methods such as in-depth interviews to present a comprehensive evaluation of empowerment in a specific context. Mason [43] recommends combining qualitative (interviews/dialogue) and quantitative methods (survey data) to measure empowerment because the combination is best to alleviate the inadequacies of each technique. Anderson [54] highlights that collaborative dialogue has the added advantage of inclusiveness.

3. Results and discussion

3.1. Socio-economic characteristics of the farmers

One hundred and fifty-four smallholder livestock farmers were interviewed. Sixty-one (61) couples were married or in a permanent relationship, and both the men (61) and the women (61) were interviewed. Thirty-two female respondents were single, divorced, or widowed. The socio-economic characteristics of the respondents are summarized in Table 3. The average age of female and male respondents was 50 and 51 years, respectively. The advanced age of the respondents implied that farming was not an attractive option for many youths. These findings are in line with Meterlerkamp et al. [55], who found that factors such as negative stigmas surrounding agriculture and lack of support by relevant institutions were the main reasons youth found agriculture an unattractive career choice. The average educational level of the female and male respondents was in grades 9 and grade 10, respectively. A few individuals had post-matric qualifications but could not find employment and therefore concentrated on farming. Most male and female respondents relied on farming and social grants (child grants or pensions) for their livelihoods. The male respondents had on average 13 years (range 2 – 32 years) of farming experience and the women 12 years (range 1 – 40 years) (Table 3). The average household size of the respondents was five.

Table 3. Socio-economic characteristics of the respondents.

Variable	N	Min	Max	Mean
Age (women)	93	23	82	50.11
Age (men)	61	32	81	51.28
Education (women)	93	0	12	8.58
Education (men)	61	0	12	9.93
Farming experience (women)	93	1	40	12
Farming experience (men)	61	2	32	13
Household members (women)	61	2	10	5
Household members (men)	93	1	12	5
Number of cattle (women)	93	0	200	20
Number of cattle (men)	61	0	200	24
Number of sheep (women)	93	0	102	9
Number of sheep (men)	61	0	102	11
Number of goats (women)	93	0	80	12
Number of goats (men)	61	0	80	12
Time spent working/providing (women)*	93	5	14.5	11
Time spent working/providing (men)*Includes time caring for children, travelling, shopping, farming, other employment done in last 24 hours	61	6	12	9

*Note: Includes time caring for children, travelling, shopping, farming, other employment done in last 24 hours.

3.2. The Abbreviated Women's Empowerment in Agriculture Index (A-WEAI)

Table 4 summarizes the A-WEAI index findings. The A-WEAI for the area was 0.7949, and that 38.7% of the women and 83.6% of the men were empowered in the five domains of empowerment. On average, the women had 35.6% inadequate achievements in the different dimensions of the five domains. A GPI index value of 0.9118 indicated that, in general, the area had relatively high gender parity in households. The A-WEAI value of 0.7949 indicated that women's empowerment in Frances Baard District Municipality was relatively good.

Table 4. A-WEAI index.

Indicator	Women	Men
Disempowered headcount ratio (H_p)	61,3%	16,4%
Average inadequacy score (A_p)	35.6%	31.3%
Disempowerment index (M_0)	0.218	0.051
5DE index (1-M_0)	0.782	0.949
Number of observations	93	61
Percentage of women lacking gender parity (H_{GPI})	50.82	
Average empowerment gap (I_{GPI})	17.35	
Gender parity index (GPI)	0.9118	
Number of women in dual households	61	
A-WEAI ((0.9x5DE) + (0.1xGPI))	0.7949	

The individual values of the 5DE are depicted in Table 5. The dimensions contributing the most to the disempowerment of female smallholder livestock farmers are workload (52.97%) and access to and credit decisions (17.7%). Women have control or at least some form of input into the use of their family's income, but lack of ownership of assets (11.3%), lack of input into productive decisions (10%), and lack of group membership (8%) also contribute to their disempowerment. A study conducted in Tanzania on rice farmers found similar results [56]. The authors indicated that the domains contributing to the disempowerment of the women in order of importance were workload (38.19%), ownership of assets (20.18%), input into productive decisions (18.89%), access to and credit decisions (12.39%), group membership (8.73%) and control over the use of income (1.62%).

The main contributors to the disempowerment of men were workload (31.89%) and access to and credit decisions (21.4%), while lack of group membership (19.13%) and lack of input into productive decisions (19.1%) also played a role. The findings in Tanzania was similar for the workload (39.96%) but was followed by input into productive decisions (28%), access to and credit decisions (14.23%), ownership of assets (12.87%), leadership (4.7%), and then control of overuse of income (0.29%) [56].

Table 5. The 5DE decomposed by dimension and indicator calculated using the A-WEAI index.

Indicators	Production	Resources		Income	Leadership	Time
	Input into productive decisions	Ownership of assets	Access to and decisions on credit	Control over use of income	Group membership	Workload
Indicator weight	0.2	0.13	0.067	0.2	0.2	0.2
Women						
Censored headcount	0.108	0.18	0.570	0	0.086	0.570
% contribution	10	11.3	17.7	0	8	52.97
Absolute contribution	0.022	0.024	0.038	0	0.017	0.114
Men						
Censored headcount	0.049	0.033	0.164	0	0.049	0.082
% contribution	19.1	8.5	21.4	0	19.13	31.89
Absolute contribution	0.010	0.004	0.011	0	0.010	0.016

3.2.1. The 5DE and agricultural drought resilience

The empowerment cut-off for individuals is 20%; this implies that women who have a total inadequacy score of more than 20% are considered disempowered. The inadequacy scores were censored when calculating A-WEAI to distinguish empowered individuals from disempowered individuals based on the weights allocated to the different indicators and prohibiting empowered women from influencing the result.

3.2.1.1. Time/workload

Time/workload was the domain that contributed the most to the disempowerment of the women (52.97%) and men (31.89%) (Table 5). In time/workload related to farming, outside employment, caring for family members, caring for the household, and traveling were included. The average results for time allocation in a typical 24 hour day are depicted in Table 6.

When the respondents asked how satisfied they were with the amount of leisure time to their disposal on a scale of 1 to 10, they indicated on average 4 and 5.5 for women and men, respectively. More than half (57.3%) the married women lacked achievement in time adequacy compared to 8.1% of married men. This finding in line with Achandi et al. [56], who found that women spend on average 60% of their working time in activities that do not generate any income compared to men who spend only 23% completing the same tasks. Besides, men had outside employment (taxi drivers and shop owners), which placed a further burden on the women in the households. They had to cope with farming operations without support from their husbands. The restriction on time has spillover

effects such as lack of information (less time to access information) that in turn has a negative effect on knowledge (such as new technologies etc.), which can be used to adapt to drought and improve resilience [57].

Table 6. Average time spent on different activities in a 24-hour day.

Activity	Average time/day spent Women	Average time/day spent Men
Sleeping	8 h 06 min	8 h 30 min
Eating	1 h 36 min	2 h 12 min
Personal care	54 min	1 hour
Assisting with schoolwork	48 min	36 min
Work as employed	1 h 12 min	42 min
Farming	4 h 36 min	5 h 54 min
Shopping	18 min	12 min
Cooking	2 h 36 min	12 min
Childcare	48 min	18 min
Travelling	30 min	54 min
Watching TV/listening to a radio	1 h 48 min	2 h 24 min
Exercising	6 min	0
Social activities	6 min	18 min
Religious activities	36 min	36 min

Time constraints, therefore, had a negative impact on the agricultural drought resilience of female smallholder livestock farmers. It is important to note that availability of time or workload cannot be seen from the context with other influencing factors because women who have more time than others are not necessarily empowered or more resilient to agricultural drought [58]. This is encompassed in the A-WEAI, which considers the collective impact of different domains according to allocated weights.

3.2.1.2. Access to and decisions on credit

The second most crucial factor was access to and decisions on credit that influenced the disempowerment of 17.7% of women and 21.4% of men (Table 5). Most women (86%) did not have access to credit, of which 83.6% were married. Additionally, most (77%) of the married men did not have access to credit. This could be attributed to a lack of land deeds and other job opportunities to use as collateral to obtain loans. Isaga [59] highlighted that for smallholder farmers to increase their resilience to agricultural drought and improve efficiency; they have to access new technologies that are often expensive and require access to credit. Two of the married women who did have access to credit made the decision to use credit by themselves, whilst the rest decided together with their spouses/partners, or the spouse/partner decided on his own. In terms of grants received in the 12 months preceding August 2019, 51.6% of the women reported receiving childcare or pension grants, and 2% indicated they received grants from the Department of Rural Development and Land Reform during the drought period in the form of fodder.

3.2.1.3. Ownership of assets

Ownership of assets contributed to 11.3% and 8.5% empowerment of smallholder female and men farmers respectively (Table 5). This corresponds with Johnson et al. [60], who found that ownership of assets improved the women's ability to buffer shocks, such as agricultural drought because it allowed control in which an asset could sold or converted to income.

In terms of married female livestock farmers, 16.4% achieved adequacy in terms of land ownership, and 26.2% achieved adequacy in both large and small livestock ownership. In contrast, 23% of male livestock farmers owned land, 50.8% owned large livestock, and 29.5% owned small livestock (Table 7). This has a negative impact on the agricultural drought resilience of women as they had less control over assets.

Table 7. Ownership and control of assets.

Asset	Adequacy married women	Adequacy men
Land ownership	16.4%	23%
Large livestock ownership	26.2%	50.8%
Small livestock ownership	26.2%	29.5%
Mechanized farm equipment ownership	3.2%	8.2%
Ownership of non-farm business equipment	13.1%	34.4%
Ownership of house	32.7%	36%
Ownership of large consumables	16.4%	13.1%
Ownership of non-farm land	4.9%	6.6%
Ownership of transport (car/bakkie)	14.7%	40.9%

3.2.1.4. Input into productive decisions

An achievement was allocated when the individual had sufficient achievement in at least two of the three questions. A woman was considered disempowered if she participated in the activity, but did not have at least some input into the decision-making process. The results indicated that decision-making occurred as a team (40%), with 29% of the women having the freedom to make decisions independently. Fewer (16%) women reported that they had no input and their spouses/partners made the decisions, 6% reported that other household members such as a father or a son made the decisions, and 2% indicated that decisions were made by a non-household member such as a relative who owned the livestock, but lived somewhere else. A study conducted by Anderson et al. [61] in rural Tanzania concluded that the answer on decision-making power in the household depended on who was asked. Women and men interviewed separately in the same household often indicated that decision-making belonged to them individually.

Teamwork was practiced in this study. It improves the collective resilience to agricultural drought. CARE [29] highlighted that limitation on decision-making power has a negative impact on resilience against climate extremes such as agricultural drought. In their study, decision-making power is not confined to household-level, but extends to governmental influence. This plays a significant role in South Africa, where decisions are often forced onto beneficiaries by government and municipal departments, because assets (such as land and water) are in many cases controlled by

the government. Further, scholars such as Opondo et al. [25], Le Masson [27], Anderson et al. [61], Huyer [62], Fischer and Carr [63], and Shean and Alnouri [64] proved the negative influence of decision-making power has on resilience to climate shocks such as agricultural drought. The less decision-making power a woman has in her household or community, the less resilience she has to agricultural drought, because she cannot make the necessary decisions to mitigate risks.

3.2.1.5. Group membership

Of the 93 women interviewed, 84 belonged to some form of community group such as church/religion-based, AFASA (African Farmers Association of South Africa), or a producers group. A lack of group membership contributed 8% and 19.13% to the disempowerment of the women and men, respectively (Table 5). Tambo [65] confirmed that group membership positively influences resilience to climatic shocks such as agricultural drought.

To be a group member, either formal or informal, to enhance women's resilience. Social networks such as farmer's associations and church groups help the farmers meet and train each other on drought mitigation strategies and support each other when drought occurs. Members of social networks share mutual assistance and support when the need arises, such as providing farming knowledge and food in inadequate food supplies. Further, Hassen [66] and Bahta et al. [67] highlighted that members of the group could call on each other for help and have rights and access to some resources because of their group membership status. Further, Iglesias et al. [68] established that when farmers participate in local institutions, their vulnerability to drought significantly reduces and enhances their resilience. Their involvement in planning and other activities influences the social networks in such a way that they will develop social capital to mitigate drought risk.

3.2.1.6. Control over use of income

In this category, respondents indicated that they had sufficient input into decisions with regard to income generated in their households. The different income-generating activities were listed as livestock production, outside the business (non-farm economic activities), and income from non-farm employment. Based on the criteria, all of the women in the study achieved adequacy as well as the men. It, therefore, had no impact on the disempowerment of respondents. The impact that controls over the use of income has on empowerment and resilience to agricultural drought is clear. A woman who has control or at least sufficient input in household or individual income is more resilient to agricultural drought as she can make the necessary decisions to mitigate risk when needed. This is also highlighted by numerous authors such as Khapung [32], Gali éet al. [69], and Akter et al. [70].

3.2.2. Gender parity index (GPI)

The GPI was calculated to indicate levels of inequality in a household in terms of the five domains of empowerment (5DE). The first component of the GPI, as shown in equation 8, was 0.508197 and implied that 50.8% of the women involved in dual-adult households did not experience gender parity relative to the men in their household. The second component of GPI, the average empowerment gap calculated in equations 9 and 10, was 0.9118. A gender parity value of 1 indicated complete gender parity whilst a value below 1 indicated the relative gender parity between men and

women in the same household [50]. The value of 0.9118, therefore, indicated that the gender parity in the survey area be relatively high. Similar studies in Bangladesh, Guatemala, and Uganda by Alkire et al. [50] resulted in GPI values of 0.899, 0.813, and 0.898, respectively. This indicates that gender parity in these three countries is also relatively high, with Guatemala the lowest of the three.

3.3. Components not included in the A-WEAI

The information included in the questionnaire that did not form part of the A-WEAI Index was the influence of cultural norms on the empowerment of women in society as well as age, educational level, marital status, and years of farming experience of female farmers. Social or cultural norms regarding certain aspects pertaining to gender, such as land and other important asset ownership have a definitive influence on empowerment, as demonstrated in a study by [71]. If a woman does not own assets, she does not have control over the associated income generation. Except for one divorced woman, all the respondents answered that they did not think the current cultural view of a woman's role in her household affects her access to resources, access to funding, or role in the household. They all agreed that it had improved drastically from the past. However, when observing the results, some cultural norms were visible when comparing the difference in time spent per activity between men and women. Women spent more time on childcare, cooking, and assisting children with schoolwork than men (Figure 3). In the comparison provided in Table 7, it is clear that men dominate in ownership of assets, which negatively impacts women's empowerment.

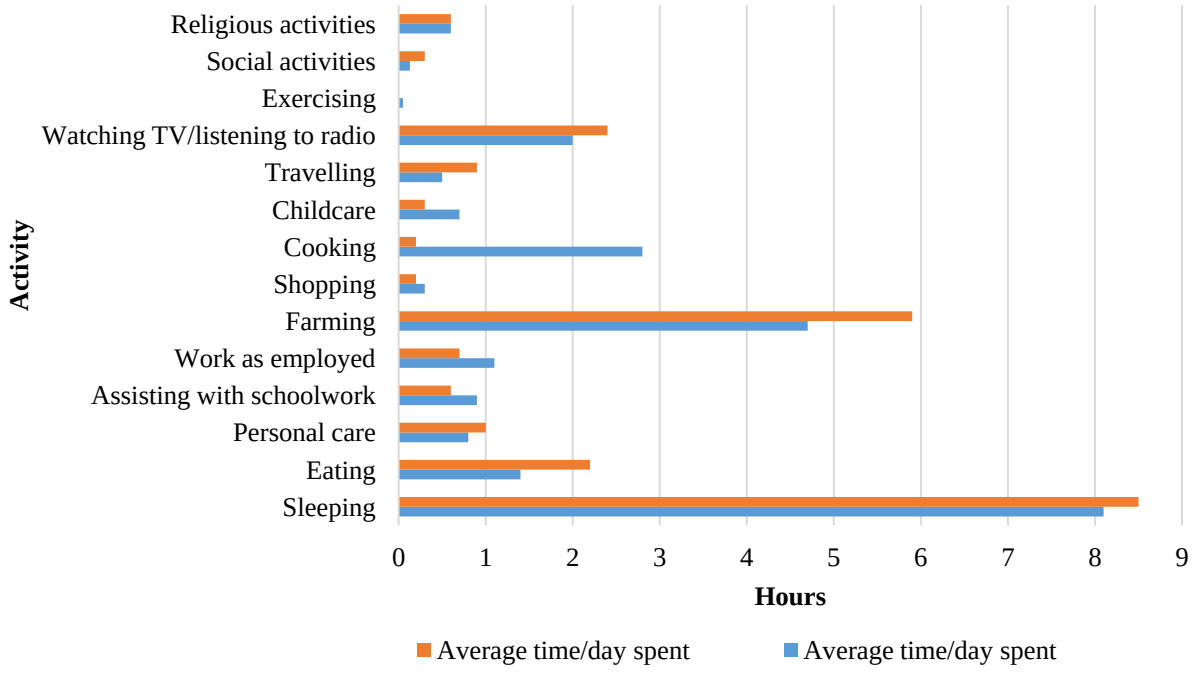

Figure 3. Comparison between the average amounts of time spent per activity amongst men and women.

3.4. Correlation of variables

The Pearson chi and Cramer's V test were conducted using equations 12 to 14. Using the chi-Square distribution, the *p*-value of 0.7644 and χ^2 value of 1.8438 indicated that the H_0 is accepted, which implied that there was no significant relationship between the age of the women and their empowerment status in the study area. The result was confirmed by the Cramer's V of 0.0704 which was very small (Table 8). Alkire et al. [40] found mixed results on research conducted in Bangladesh, Guatemala, and Uganda. In Bangladesh and Guatemala, age had a significant correlation with female empowerment. This was attributed to the fact that many women younger than 26 years were typically daughters or daughters-in-law of older women in the household and the majority of women older than 55 years were less active in farming enterprises and more reliant on their sons/family members. The Uganda results were similar to our findings, where age did not significantly correlate with empowerment status.

Regarding the correlation between marital status and empowerment status, the *p*-value of 0.6046 and χ^2 value of 1.8475 indicated that the H_0 was accepted. In other words, there was no significant relationship between the marital status of the women and their empowerment status. This is further confirmed by the Cramer's V of 0.0813, which was very small. A study by Opiyo et al. [72] in Kenya, however, observed a positive correlation between empowerment and marital status. This implies that single, divorced, or widowed women were more vulnerable to climate-induced stresses such as agricultural drought than married women.

There was no significant relationship between the level of education and empowerment status, confirmed by the *p*-value of 0.4079, χ^2 value of 3.9856 and the very small Cramer's V of 0.1035. A study by Achandi et al. [56] highlighted a significantly positive correlation between empowerment and level of education. This was attributed to the fact that more educated women had more input in decisions.

Last but not least, there was a significant relationship between the farming experience of the women and their empowerment status, which implied that experience added to knowledge and resilience. This result was confirmed by *p*-value of 0.01957 and χ^2 value of 9.8841. There were mixed results from other studies. In Indonesia, both significant and insignificant correlations between empowerment status and years of farming experience were found in different agricultural projects across the country, highlighting that women's empowerment has to be viewed in the context of the area it relates to [73].

3.5. Context-specific dialogue/reflective dialogue

The challenges faced by female smallholder livestock farmers in the Northern Cape Province of South Africa were in many ways similar, but also different from female smallholder livestock farmers in other parts of the world. The relationship between gender and resilience is not simple and must be viewed objectively considering the influence of and relationship between gender and knowledge, power, and decision-making within the specific social, political and environmental setting [74]. To put this into context and provide an all-encompassing view on the topic, important dialogue discussing specific challenges were included to provide more information in terms of problems. It involved sharing dialogue and experiences, which positively influences change in

communities. During dialogues, engaged female farmers voiced their challenges and concerns, which are summarized in Table 9.

Table 8. Correlation between variables.

Correlation between age and empowerment			
Age group	Women empowered		
	No	Yes	Total
23–32 years	8 (61.5%)	5 (38.5%)	13
33–42 years	13 (72.2%)	5 (27.8%)	18
43–52 years	13 (65%)	7 (35%)	20
53–62 years	13 (56.5%)	10 (43.5%)	23
>62 years	10 (52.6%)	9 (47.4%)	19
Total	57 (61.3%)	36 (38.7%)	93
Cramer's V	0.07040	Pearson chi^2 statistic	1.8438
p-value	0.7644	*df*	4
Correlation between marital status and empowerment			
Marital status	Women empowered		Total
Single	10 (66.7%)	5 (33.3%)	15
Married	39 (63.9%)	22 (36.1%)	61
Widowed	5 (45.5%)	6 (54.5%)	11
Divorced	3 (50%)	3 (50%)	6
Total	57 (61.3%)	36 (38.7%)	93
Cramer's V	0.0813	Pearson chi^2 statistic	1.8475
p-value	0.6046	*df*	3
Correlation between educational level and empowerment			
Education level	Women empowered		Total
Below primary	5 (83.3%)	1 (16.7%)	6
Grade 1–4	5 (71.4%)	2 (28.6%)	7
Grade 5–7	12 (70.6%)	5 (29.4%)	17
Grade 8–10	18 (62.1%)	11 (37.9%)	29
Grade 11–12	17 (50%)	17 (50%)	34
Total	57 (61.3%)	36 (38.7%)	93
Cramer's V	0.1035	Pearson chi^2 statistic	3.9856
p-value	0.4079	*df*	4
Correlation between farming experience and empowerment			
Farming experience	Women empowered		Total
1–5 years	20 (80%)	5 (20%)	25
6–10 years	11 (64.7%)	6 (35.3%)	17
11–15 years	13 (44.8%)	16 (55.2%)	29
More than 15 years	9 (41%)	13 (59%)	22
Total	53 (56.9%)	40 (43.01%)	93
Cramer's V	0.1882	Pearson chi^2 statistic	9.8841
p-value	0.01957	*df*	3

The results indicated that female smallholder livestock farmers struggled with stock theft, finding enough clean water for their animals, and funding to purchase the necessary infrastructure (such as fencing). Their lack of any form of collateral to secure a loan prohibited them from farming efficiently. Some of the women were intimidated by neighboring male farmers. A need exists for continuous training on cattle health and herd management. An efficient gender-specific funding mechanism must be constructed to assist female smallholder livestock farmers. Training remains in high demand and should be prioritized on a more regular basis.

Table 9. Reflective dialogue.

Dialogue relating to	Challenges
Access to finance	86% of the women said that they did not have access to finance to ensure farming efficiency. "Our hands are tied. Our animals are subjected to lack of water close to the grazing area and we can't extend a pipeline for water because we can't secure a loan to enable us to do so." "Our fences next to the road is old and rusted. Our goats break them, looking for extra grazing and endangering motorists. We can't afford new fencing and the bank does not want to offer us a loan because we do not have a job or own any land." "We struggle to find enough water for our livestock. We do not have money to afford fencing and tools and to pay a herder to see that the livestock does not run into the road."
Training, sufficient water and grazing	62% of women said that they needed training and struggled to feed their animals in times of drought. "The communal grazing areas are overcrowded. Our lambs die of disease because of the overexposure in the communal area. We need the training to increase our knowledge of livestock farming and practical assistance so that we understand how to do things." "During drought is it very expensive to feed the animals. The grazing is not enough and we struggle to afford feed. Medicine also expensive and when the available water dries up, the animals must walk far distances each day to get to the water."
Stock theft	98% of the women indicating that stock theft was a big challenge "The theft of our animals is out of hand. We need land so that there is more space available for our animals."
Intimidated by male farmers	15% of the women indicated that they were intimidated by male farmers who threatened to poison their animals "Most of us have a 30-year lease from the government. The male neighbors, however, uses the land unlawfully and is threatening to poison our cattle if we try to chase their animals away. This forces us to buy extra feed for our cattle because we do not have enough grazing."

4. Conclusions and recommendations

Female smallholder livestock farmers in the Northern Cape Province of South Africa face many challenges influencing their vulnerability to agricultural drought. The majority of women livestock farmers were disempowered and less resilient to agricultural drought compared to men livestock

farmers. The main attributes of the disempowered women were time/workload, access to and decisions on credit, ownership of assets, input into productive decisions, and group membership. Livestock women farmers in dual households experienced relatively good gender parity. It is important to note that male smallholder livestock farmers were not necessarily resilient to agricultural drought, but were more resilient than their female equivalents.

The agricultural drought experienced in the Frances Baard District Municipality of the Northern Cape Province of South Africa has had a severe impact on farmers, especially smallholder farmers and even more female smallholder farmers. Hence, the study recommends that methods to mitigate risk must be increased. Women in each community should work together to help each other in terms of time availability, such as an afterschool center managed by some of the women, with remuneration. This would enable other women to spend more time farming and developing their own business or even finding full-time employment. The government should provide a clear policy on land-related issues so that farmers can access credit. Female farmers should be empowered to make their own decisions through training. Group membership must be further encouraged, and a women's farmers union can concentrate on the specific challenges of female farmers.

Ethical clearance

We obtained an ethical clearance certificate from the University of the Free State Research Ethics Committee, and our reference number is UFS-HSD2019/1191.

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Conflict of interest

We declare that this work is original academic research carried out by the authors and we confirm that this manuscript has not been submitted elsewhere and is not under consideration by another journal. We declare no conflicts of interest.

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