

Article

Empowering Resilience: The Impact of Farmer Field Schools on Smallholder Livestock Farmers' Climate Change Perceptions in Raymond Local Municipality

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Abstract: Experiential learning and discovery through farmer field schools (FFS) have the potential to empower smallholder livestock farmers who face heightened vulnerability to climate change. However, there are various levels of learning and discovery in FFS that can inform smallholder livestock farmer knowledge and perception. Understanding this is vital, as farmers' perceptions influence their readiness to adopt climate-smart practices, informing effective resilience-building strategies. Therefore, this study sought to investigate and assess the impact of the FFS approach on smallholder livestock farmers' perceptions of climate change, taking Raymond Local Municipality in South Africa as a case. The design followed by the study was a longitudinal survey, with three pools each signifying various FFS intervention points. The study utilized simple random sampling to collect data from 80 smallholder livestock farmers using structured questionnaires in each of the three cross-sectional pools, while descriptive statistics, Min–Max Normalization, and *t*-tests were used for analysis. The results show that there was an increase in the awareness of climate change due to the interventions of the FFS. Furthermore, there are cumulative differences between the knowledge and perception towards climate change between the three pooled cross-sections. In conclusion, participating in FFS had a significant impact on farmers' level of understanding and adaptation to climate change. The study recommends that the government and policymakers extensively promote FFS and support them financially so that they can provide more support to rural farmers as well as enhance knowledge on climate change. This study recommends the provision of workshops and awareness campaigns on climate change for farmers through FFS as this will assist farmers to be more sustainable on their farming systems and production.

Keywords: smallholder livestock farmers; climate change; farmer field schools approach; perceptions; Raymond Local Municipality



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1. Introduction

Climate change is a global challenge, and most livestock farmers in South Africa are vulnerable to its impacts, with it having affected many livestock farmers, leading to food insecurity. And it has become the focal point of most global deliberation due to its impact on various biophysical systems disturbing prime sources of food and water, through droughts, temperature surges, and variable rainfall, among others [1]. In many developing countries, most rural households reside in rural areas and suffer from food insecurity and poverty due

to the lack of food produced [2]. Livestock production in many areas in Southern Africa has been affected by many features of climate change resulting from average temperature increases, changes in rainfall amounts and patterns, and extreme events of drought that resulted in food insecurity and poverty [3].

Agriculture provides livelihood for 80% of the African population; therefore, in the wake of current trends of climate change, agriculture has become very vulnerable and thus needs to be aware of the actual climate changes [4]. Agriculture is an important sector in the South African economy and remains a significant provider of employment, especially in rural areas, as well as being a major earner of foreign exchange. However, the occurrence of climate change and variability has negatively affected agricultural production, especially rural smallholder farmers because of their dependence on nature for survival. Agriculture is one of the most climate-sensitive sectors and is directly affected by changes in physical and chemical climate conditions [5]. However, small-scale farming remains an important source of livelihood for many poor, rural households, but it is unassertive [6]. However, climate change is one of the constant threats to agriculture and is a primary developmental challenge facing the African continent [7]. Climatic and agricultural challenges are critical for farmers' knowledge and decision making as well as for their well-being. Smallholder farmers are particularly vulnerable to changes in the climate that reduce productivity and negatively affect their weather-dependent livelihood systems [7].

In an attempt to assist smallholder farmers with climate change and agricultural productivity, farmers view agricultural extension as a key element for enabling farmers to obtain information and technologies that can improve their production systems and livelihoods. However, the literature has indicated that agricultural extension services in South Africa have not been performing well, and in most cases are invisible, limited, and have not been effective in reaching the smallholder farmers with innovations and technology. On the other hand, there are different extension approaches such as the farmer field schools approach that can be assessed and used as an alternative in assisting farmers with their challenge of climate change and variability concerning production.

Farmer field schools (FFS) entail an innovative, interactive, and participatory method of learning, technology adaptation, and dissemination based on adult learning principles such as experiential learning that was established by the Food and Agricultural Organization (FAO) in 1989 in South East Asia [8,9]. In Sub-Saharan Africa, FFS had a large-scale launch in 1997 in Zimbabwe, after brief introductions in 1993 and 1995 in Sudan and Kenya, respectively [8]. They comprise gatherings of individuals with a typical interest, who get together all the time to concentrate on the "how and why" of a specific subject. They ordinarily meet consistently during a yield or livestock cycle for a half-day of examination and field work. FFS improve farmers' knowledge and adoption of beneficial practices and strengthening farmers skills to test, learn, adapt, and seek out more information [10]. Farmer field schools (FFS) are a popular education and extension approach that use experiential learning and group approach to facilitate farmers in making decisions, solving problems, and learning new techniques [11].

They were developed in 1980s by specialists from the Food and Agriculture Organization of the United Nations (FAO) in Asia and Africa [12]. The implementation of farmer field schools started in East Africa in 1995 with the Food and Agriculture Organization special program for food security which ended in 1998 [11]. The literature suggests that FFS are a participatory method of learning, technology development, and dissemination based on adult learning principles [13]. They use intensive "discovery-based" learning methods with the objectives of providing skills in such areas as integrated pest management (IPM) and empowering farmers while adding to their indigenous knowledge.

They have been implemented in 90 countries worldwide, reaching an estimated 10–15 million farmers [14]. Previous studies suggest that farmer field schools improve farmers' knowledge and adoption of beneficial practices that bring positive outcomes on agricultural yields and income. A study carried out by [15] indicated that based on the case studies from Indonesia, Peru, Thailand, and Kenya, FFS are an effective approach for

enlightening farmers' learning, capacity building, and knowledge empowerment. Farmers are particularly encouraged to develop their critical thinking and make sound farm management decisions, resulting in adoption of improved practices [15]. There is substantial informal knowledge sharing that takes place within participants as they learn from field school experience and retain most of the basic knowledge they learned in these schools. Farmer field schools provide an opportunity for a closer working relationship between extension officers and farmers and at the same time provide farmers the opportunity to make an input into the work of extension officers [15].

In many developing countries, climate change has become a major challenge, and most livestock farmers are vulnerable to its impacts, with it having affected many livestock farmers, leading to food insecurity. And it has become the focal point of most global deliberation due to its impact on various biophysical systems disturbing prime sources of food and water, through droughts, temperature surges, and variable rainfall, among others [1]. In many developing countries, most rural households suffer from food insecurity and poverty due to the lack of food produced [2]. Livestock production in many areas in Southern Africa has been affected by many features of climate change resulting from average temperature increases, changes in rainfall amounts and patterns, and extreme events of drought, which resulted in food insecurity and poverty [3]. Agriculture provides livelihood for 80% of the African population; therefore, in the wake of current trends of climate change, agriculture has become very vulnerable and thus needs to be aware of the actual climate changes so that they can have a sustainable production [4]. Agriculture is an important sector in the South African economy and remains a significant provider of employment, especially in rural areas, as well as being a major earner of foreign exchange. However, the occurrence of climate change and variability has negatively affected agricultural production, especially rural smallholder farmers because of their dependence on nature for survival.

Agriculture is one of the most climate-sensitive sectors and is directly affected by changes in physical and chemical climate conditions [5]. However, small-scale farming remains an important source of livelihood for many poor, rural households, but one that is unassertive [6]. However, climate change is one of the constant threats to agriculture and is a primary developmental challenge facing the African continent [7,16]. Climatic and agricultural challenges are critical for farmers' knowledge and decision making as well as for their well-being. Smallholder farmers are particularly vulnerable to changes in the climate that reduce productivity and negatively affect their weather-dependent livelihood systems [7].

Even though smallholder farmers are faced with climate change and production, farmer field schools can be used as a substitute in helping farmers against climate change. Traditionally, these are in the form of an adult education approach, a method to assist farmers to learn in an informal setting within their environment. However, not much has been documented on the effectiveness of the farmer field schools approach on smallholder livestock farmers' perceptions of climate change. Against this background, this paper aimed to scrutinize and explore the impact of the farmer field schools approach effect on smallholder livestock farmers' perceptions of climate change among rural farmers of Raymond Local Municipality, Eastern Cape Province, South Africa.

Theoretical Framework

The theoretical framework for this research is grounded in the concepts of empowerment and resilience, particularly as they relate to smallholder livestock farmers in the context of climate change.

Empowerment, defined as the process of enhancing farmers' knowledge, skills, and decision-making abilities [17], is facilitated through farmer field schools (FFS). FFS provide farmers with opportunities for experiential learning, knowledge sharing, and skill development [18]. Through FFS, farmers are exposed to new agricultural practices, innovative technologies, and sustainable farming methods, which can enhance their capacity to adapt to changing environmental conditions, including those brought about by climate change.

Resilience, on the other hand, refers to the ability of farmers to withstand and recover from the impacts of climate change [19]. By empowering farmers through FFS, the research posits that farmers can develop greater resilience to climate change. This resilience may manifest in various ways, such as the ability to adopt climate-smart agricultural practices, diversify livelihoods, and access resources and support networks that enable them to cope with and adapt to climate change impacts.

Central to the framework is the role of perception in shaping farmers' responses to climate change. Farmers' perceptions of climate change, including their understanding of its causes, impacts, and potential solutions, can influence their willingness to adopt adaptive practices [20]. FFS are hypothesized to influence farmers' perceptions by providing them with first-hand experience and knowledge about climate change and its implications for agriculture. The theoretical framework suggests that FFS can play a crucial role in empowering smallholder livestock farmers in Raymond Local Municipality, thereby enhancing their resilience to climate change. By improving farmers' knowledge, skills, and perceptions, FFS can contribute to building adaptive capacity and promoting sustainable agricultural practices in the face of a changing climate.

In addition to the theoretical framework outlined above, it is important to consider the practical implications of the farmer field schools (FFS) approach on smallholder livestock farmers' perceptions of climate change. FFS have been widely recognized for their ability to empower farmers and enhance their adaptive capacity through experiential learning and knowledge sharing [21]. By engaging farmers in participatory activities such as field demonstrations, group discussions, and knowledge exchange sessions, FFS can help farmers develop a deeper understanding of climate change and its implications for agriculture.

Furthermore, FFS can promote the adoption of climate-smart agricultural practices by providing farmers with the necessary skills and resources to implement these practices [22]. For example, FFS can teach farmers about conservation agriculture techniques, such as minimum tillage and crop rotation, which can help mitigate the effects of climate change on soil fertility and crop yields. By encouraging the adoption of these practices, FFS can contribute to building resilience among smallholder livestock farmers in Raymond Mhlaba Local Municipality.

Moreover, FFS can also enhance farmers' access to information and resources that are essential for adapting to climate change. For instance, FFS can facilitate access to weather information, early warning systems, and climate-resilient crop varieties, which can help farmers make informed decisions about their farming practices [23]. By improving farmers' access to these resources, FFS can empower them to take proactive measures to mitigate the impacts of climate change on their livelihoods. The theoretical framework outlined above suggests that FFS can play a crucial role in empowering smallholder livestock farmers in Raymond Local Municipality and enhancing their resilience to climate change. By providing farmers with the knowledge, skills, and resources they need to adapt to climate change, FFS can help build a more sustainable and resilient agricultural sector in the region.

2. Methodology

2.1. Study Area and Research Design

The study was conducted in Raymond Mhlaba Local Municipality (RMLM) in the Eastern Cape Province of South Africa (Figure 1). Raymond Mhlaba Local Municipality (RMLM) is in Amathole District Municipality in Eastern Cape Province. The municipality has a total population of 127,115, with the majority residing in villages, with an unemployment rate of 48.10% [24]. The municipality has a rainfall range of 43 mm, with the lowest at 19 mm, and a temperature range of 24 °C, with the lowest at 5 °C [25]. The selection of the study location within the municipality was based on the prevalence of numerous livestock farmers, a well-defined communal area for grazing and browsing, and the predominant reliance of most farmers on livelihoods derived from both livestock and crop farming [26,27]. And the area is dominated by farmers who farm cattle, sheep, and goats, using livestock farming as their source of income, and for some it is a primary

and to others is a second source of income. This study adopted a longitudinal pooled cross-sectional design to investigate the specified aspects.

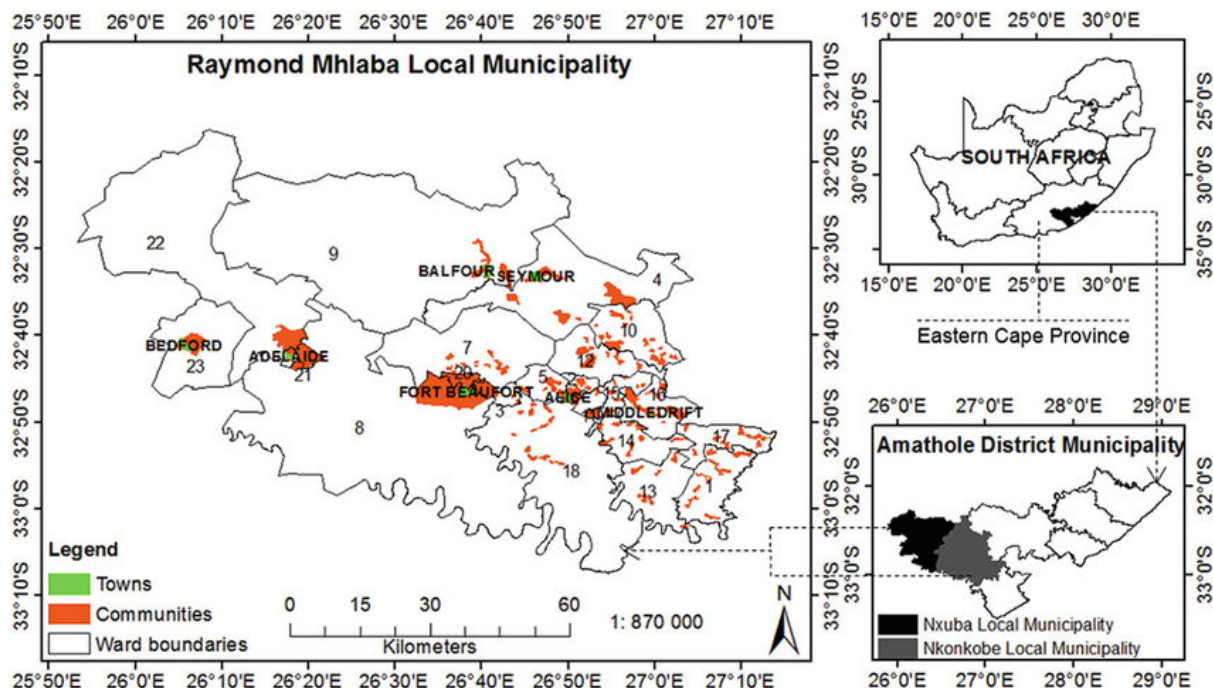


Figure 1. Location of Raymond Mhlaba Local Municipality. Source [28].

2.2. The Theory of Change Framework through FFS

Figure 2 below, provide the theory of change framework through FFS. The FFS has potential to enhance human, social, natural, and financial capital of rural communities [29]. Human capital was built in the form of critical thinking, innovation, confidence, and quality of life. Effects on social capital included mutual trust, bonding, collective action, networking, and emancipation. Natural capital was enhanced through improvements in field practices, food production, agricultural diversification, and food security. Financial capital was enhanced through increased income and profits, savings, and loans schemes, with a potential to reduce poverty. The available body of evidence was unbalanced across the capital domains, providing high coverage of the natural domain but low coverage of the human, social, and financial domains [29].

Some of the strengths of FFS include the discovery and reflection by farmers, highly separated from trained external advisors [8]. This tends to develop knowledge-intensive solutions that are inherent to farmer problems, rather than external input-intensive prescribed solutions. FFS enhance empowerment, which is a precondition in the success of community-based interventions. They are a platform for human capacity development and successful service delivery. FFS also build self-confidence, encouraging group control of the process, building group management skills [8]. It also provides a platform for farmer-to-farmer extension. Broader livelihood issues such as health and sanitation as well as nutrition can also be tackled through FFS. It can be utilized as an emergency and developmental platform for input supply, agricultural training, emergency support, and food and income security.

However, FFS are slow in realizing their objective as they require a lot of buy-in. This is very disadvantageous in a situation where there is a need for rapid uptake of an agricultural intervention. FFS have also been considered costly, especially when compared to other extension methods. There is also loss of quality when there is inappropriate curriculum design and poor quality of the learning process [8]. Vulnerable groups also seem to be excluded in participating in the FFS.

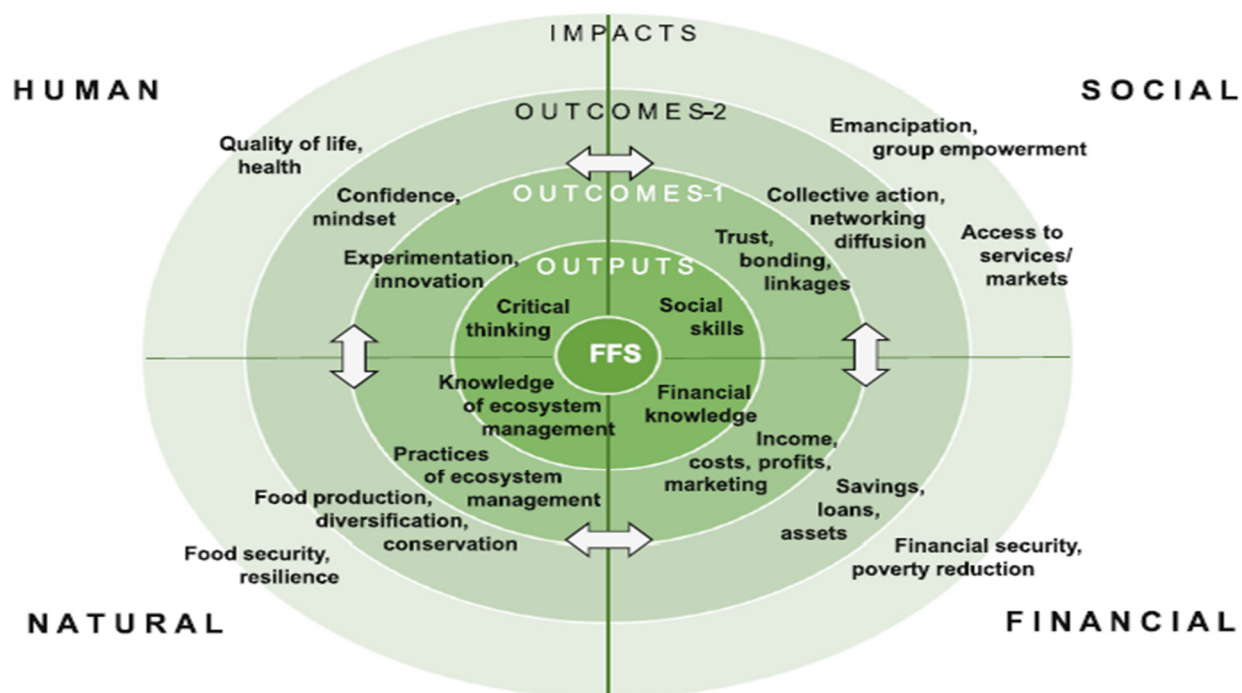


Figure 2. The theory of change framework through FFS. Source: adapted from [29].

Several studies have been conducted highlighting the impact of FFS on agriculture. In a study conducted by [9], it is suggested that FFS have a positive impact on production and income, especially amongst women agricultural producers who exhibit low literacy and small land holdings. FFS had significant impact on livestock production for farmers who had medium-sized pieces of land. The level of livestock production increased for the non-educated members of the FFS [9]. Ref. [30] found strong positive effects of FFS on food security, but little effect on poverty, and this reflected reallocation of resources towards subsistence agricultural production, with an insignificant effect on poverty. Ref. [30] highlights that even though there are positive impacts of FFS on adoption, yields, productivity, and income, there are also findings that are otherwise. However, Ref. [31] argues that farmer field schools play an important role in empowering farmers by improving knowledge, awareness, and adoption of best practices.

Data Collection and Sampling Size

The research employed primary data, gathered through a survey methodology. To facilitate data collection, a meticulously crafted structured questionnaire served as the primary tool. Both qualitative and quantitative approaches were incorporated, and a combination of purposive and random sampling methods was applied to select participants. The chosen study site was the Gaga and Msobomvu location within the Raymond Mhlaba Local Municipality, a selection made with specific intent. From this designated area, a sample size of 80 livestock farmers was randomly chosen, ensuring that only individuals actively engaged in livestock farming were included in the study. Data were collected on three occasions, the first one being without FFS intervention, whilst the next two had FFS interventions.

The population of the study was smallholder livestock farmers in Raymond Mhlaba Local Municipality. Primary data were collected through a farmer survey; the survey used a structured questionnaire developed in English and translated to isiXhosa (local language). The questionnaire covers both qualitative and quantitative research questions, which are designed to cover areas such as socio-demographic characteristics of the farmers, income sources, availability and access to services, and livestock composition, among others. The interviewers (enumerators) were trained in terms of mannerisms, the importance of

remaining as neutral as possible, and minimizing the duration of one-on-one contact with respondents. Before each interview, an informed consent form was read to the respondent. In general, farmers easily understood the procedure of the survey, and after signing the informed consent forms, farmers were generally interviewed in their homesteads, with no rewards granted to respondents for participating. A total of 80 smallholder livestock farmers participated in the study in Raymond Mhlaba Local Municipality who were randomly selected using a simple random sampling procedure.

2.3. Analytical Framework

Data were analyzed with the Statistical Package for Social Scientist (SPSS) software version 21.0 (IBM Corporation, Armonk, NY, USA). The study utilized Min–Max Normalization and a *t*-test to determine the impact of extension services for the farmer field schools approach on smallholder livestock farmers' perceptions in Raymond Local Municipality. The perceptions were first normalized through the Min–Max Normalization to convert the Likert scaled responses to an index that was between 0 and 1. In the Min–Max Normalization method [32],

$$\rho_{qi} = \frac{\rho_{qi(obs)} - \rho_{qi(min)}}{\rho_{qi(max)} - \rho_{qi(min)}}$$

where ρ_{qi} is the perceptive index, $\rho_{qi(obs)}$ is the observed value of the Likert scaled question *i*, $\rho_{qi(min)}$ is the global minimum value of Likert scale question *i*, and $\rho_{qi(max)}$ is the global maximum value of question *i*. Equal weighting was used to combine each of the perceptive questions to produce an overall index, Op_{qi} [33]:

$$Op_{qi} = \frac{\sum_{i=1}^k \rho_{qi}}{n}$$

where Op_{qi} and *n* are the overall perceptive index and the number of perception questions, respectively. Op_{qi} lies between the value of 0 (negative perception) to 1 (positive perception).

The *t*-test is a statistical test that is used to compare the means of two or more groups and is often used in hypothesis testing to assess whether a process or treatment influences the population of interest, or whether two groups are different from one another [34]. The *t*-test was used to compare the Min–Max Normalization measures between the three different pooled cross-sections to assess any difference in the mean perceptions. The data were then presented in the form of frequencies, percentages, tables, and figures.

The formula for the two-sample *t*-test is shown below [35]:

$$t = \frac{\mu_{FFS_1} - \mu_{FFS_0}}{\sqrt{\frac{\delta^2}{a_{FFS_1}} + \frac{\delta^2}{a_{FFS_0}}}}$$

where FFS_1 and FFS_0 are the farmer field schools 1 and 0 that were implemented and were to be compared; a_{FFS_1} and a_{FFS_0} are the means of the Op_{qi} ; δ^2 is the common variance between the two sampled periods that were compared, and it was calculated using the formula below [35]:

$$\delta^2 = \frac{\sum(x - \mu_{FFS_1})^2 + \sum(x - \mu_{FFS_0})^2}{a_{FFS_1} + a_{FFS_0} - 2}$$

The following formula was used to calculate the degrees of freedom that were used [35]:

$$df = a_{FFS_1} + a_{FFS_0} - 2$$

The same process was repeated for comparing farmer field school intervention 2 (FFS_2) with farmer field school intervention 1 (FFS_1), as well as between farmer field school intervention 2 (FFS_2) and no farmer field school (FFS_0).

The study also utilized the Likert scale to measure and test farmers' understanding of climate change using various statements related to climate change. The Likert scale

is applied as one of the most fundamental and frequently used psychometric tools in educational and social sciences research, especially in the qualitative approach [36]. Most studies use a 5-point or 7-point Likert scale method, but for the purpose of this study, a 2-point Likert scale was utilized. Table 1 provides different statements used.

Table 1. Likert scale questions used.

Measurement (1—Agree, 0—Disagree)
Climate change exists
Climate change impact temperature
Climate change prolongs draught
Climate change causes excessive floods
Climate change information is accessible
Climate change causes mortality
Climate change causes livestock diseases

3. Results and Discussion

This section discusses the study results from the analytical framework used to examine the effect of farmer field schools on farmers' perceptions of climate change. The households' characteristics were examined using descriptive statistics, and the *t*-test model was employed to examine the impact of extension services of the farmer field schools approach on smallholder livestock farmers' perceptions in Raymond Local Municipality.

Age and Gender

Table 2 reveals that the study area is dominated by men, with a minimum age of 30 and a maximum age of 78 years. However, most respondents in this study were of the age of 63 years. This implies that most male-headed households are involved in livestock farming compared to females. These results disagree with [37] in that most of the households are headed by females who are actively participating in farming, while male counterparts migrate to cities for non-government jobs. However, in a study conducted by [38], it suggests that males outnumbered females in livestock production, and they want to learn more about climate change-related issues as it affects their livestock.

Table 2. Summary statistics of the farmers' characteristics and socioeconomic factors in Raymond Mhlaba Municipality.

Variables		Raymond Mhlaba Location	
		Number	Percentage %
Gender	Male	55	69
	Female	25	31
Marital status	Single	10	13
	Married	46	57
	Widowed	5	6
	Divorced	19	24
Educational level	No formal education	21	26
	Primary school	29	36
	Secondary school	22	28
	Tertiary school	8	10
Source of income	Salary from employment	10	13
	Social grants and pensions	28	35
	Remittances	7	9
	Earnings from farming	34	43
Do you take farming as a business	No	38	48
	Yes	42	52

Table 2. Cont.

Variables		Raymond Mhlaba Location	
		Number	Percentage %
Access to extension services	No	51	64
	Yes	29	36
Access to markets	No	45	56
	Yes	35	44
Membership to CBOs	No	41	51
	Yes	39	49
	Minimum	Maximum	Average
Age	30	78	63
Household size	1	10	6
Years of farming	3	36	16.3

Source: Field survey (2021/2022).

Marital Status, Educational Level, and Household Size

This study's results also reveal that households were dominated by married people with an average household size of six, with about 28% of respondents with no formal education, 28% with secondary education, 36% with primary education, and 11% with tertiary education. This should mean that the decision process of some other farmers is influenced by large household size, level of education, and their spouses, while other farmers make the decision irrespective of the next person. The literature also suggests that the level of education is very important regarding technology adoption [39]. This also implies that the higher you go in your level of studies, the more likely you are to participate in new agricultural practices as you will have more new knowledge. According to Ref. [10], the number of years in school influences farmers' participation in agricultural innovations. This also shows that farmer field schools played a major role in farmers' participation and their knowledge of climate change.

Source of Income

Income plays an important role in reducing poverty and improving food security in rural households. Concerning the source of income, the results show that about 36% of farmers from the location depend on social grants and pensions, while about 43% is generated through livestock farming. The results also reveal that about 13% generate their income through salaries and wages, while about 9% depend on remittances. Previous literature also suggests that most rural households' income in the Eastern Cape Province generate their income through social grants [40]. As the results show that about 43% generate their income through livestock production, this is a significant amount that can also be improved by further implementation of FFS to train farmers on the importance of livestock production for income generation, not only for prestige and home consumption, and this can change their views of how they see livestock farming. And at the same time, through the farmer field schools approach, farmers are able to learn about different factors affecting their livestock production, such as climatic-related factors, which will lead to more awareness of climate change.

Do You Take Farming as a Business?

Agriculture is one of the sectors in terms of the economy that maintained positive growth momentum in 2020 and into 2021, which policymakers identified as part of the sectors to drive economic recovery and job creation [41]. Results from the study area show that about 53% take livestock farming as a business and a solution to poverty reduction, improve food security, and generate their local household income. The literature also seems to suggest that farming is perhaps the most important economic sector for SA's development as it is directly linked to income generation, food security, and poverty

reduction [42]. However, as much as people are involved in farming, a reasonable amount of the farmers from the study area only engage in farming for home consumption and not for business purposes. This mindset can only be corrected through facilitation of farmer field schools in order to make people aware of the importance of farming for income generation instead of farming for home consumption. And at the same time, through study group meetings, farmers will be able to understand climatic-related factors affecting their farming practices.

How Long Have You Been Farming?

Logically, more years spent farming increases and improves one's knowledge and experience. Results from the study area show that farmers were involved in farming for about 16.3 years, and this means that farmers have more knowledge in farming, which may lead to higher returns. Livestock is one of the primary means of livelihood and income generation by smallholder farmers. The income generated from livestock is usually used to combat the negative effects of climate change through the purchase of inputs such as drought-tolerant crop varieties, of which most farmers learn about from other farmers through their study group meetings. These study groups assist farmers to learn more from one another, and they become alert of climatic factors affecting their farming practices.

Access to Extension Services

Access to extension services has an impact on farmers, either on their daily farming practices or extensive utilization of climate change perceptions and coping strategies to be used. Lack of access to extension appears to limit the available options for farmers [26]. As illustrated in Table 1, only about 36% of the study area had access to agricultural extension services, meaning most of the smallholder livestock farmers did not have access to extension services (64%). This is why there should be an implementation of farmer field schools nationally, so that farmers can meet regularly with their extension officers to discuss factors affecting them and other issues related to farming. Lack of extension services may have resulted in farmers being not fully aware of climate change impact on their livestock production.

Access to Markets

Livestock farming plays an important role in food security and reducing poverty in most developing countries. However, without market availability, it is almost impossible to achieve as farmers need markets for distribution to generate income, which will lead to households being food-secured. However, study results show that only about 44% of households have access to markets. Through study group meetings, farmers are able to share information to other farmer about different farming issues such markets and climate change impact to their livestock. Therefore, the farmer field schools approach would improve farmers' market participation and their knowledge and views on climate change.

Membership to CBOs

The main purpose of community-based organizations (CBOs) is the distribution of information to local people, arranging presentations and organizing meetings of the community groups, discussions, annual meetings and trainings, providing technical support to target groups such as farmers, resource mobilization, etc. However, the results show that only about 49% are involved in community organizations in the study area. Membership plays a crucial role in connecting farmers to markets to benefit from agribusiness, providing farmers with important training to raise their output and also providing the necessary climate change information [43]. These results are commensurate with [44], who found that organization membership increased farmers' use and adoption of CSA technologies. Therefore, farmer field schools can also do the same in order to improve farmers' awareness on climate change, which will result in improved yields and food security.

Figure 3 presents the shared perceptions of climate change by the farmers from the study area. The farmers' perceptions were categorized into seven questions, which were

measured through a reduced 2-point Likert scale with two choices (agree or disagree) as indicated in Figure 1 and were sorted into three phases, namely, the baseline phase, first intervention phase, and second intervention phase.

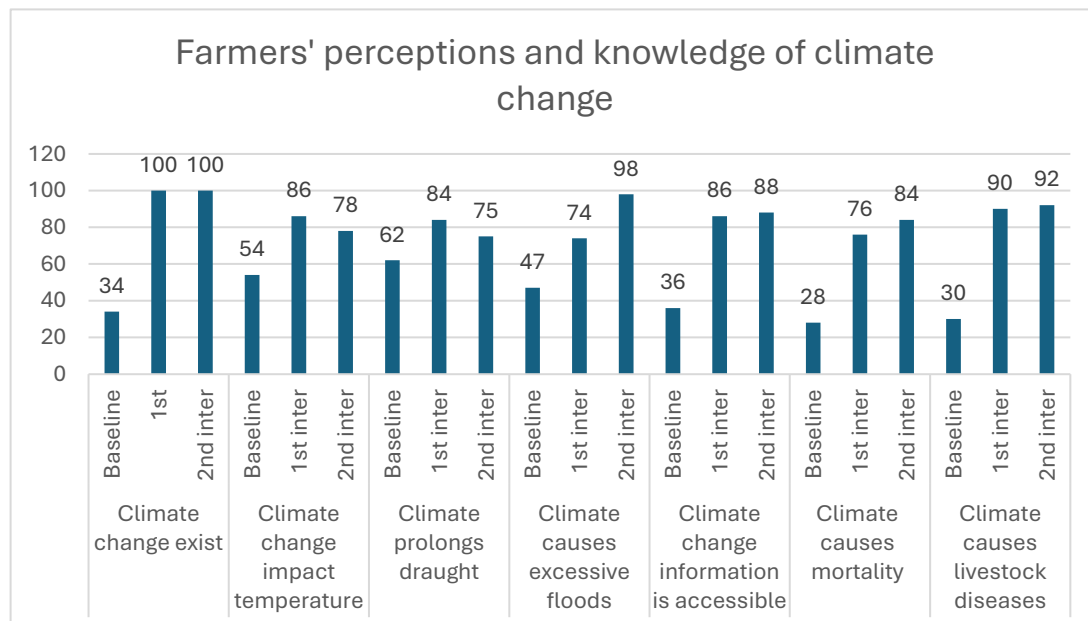


Figure 3. Shared perceptions and knowledge of climate change by smallholder farmers from the Raymond Local Municipality study area. Source: field survey (2021/2022).

Figure 3 shows the baseline, first intervention, and second intervention with seven perceptions as indicated in the figure below. In the baseline with the perception of having heard anything about climate change, 34% indicated that they had heard about climate change. With the first and second interventions, a total of 100% mentioned that they had heard about climate change. About 54% noticed the change in temperature at baseline, 86% noticed temperature changes in the first intervention, and 78% on the second intervention. Ref. [45] also agrees that most farmers notice climate change due to abnormal weather patterns. However, the results also indicated that from the initial phase, most respondents were not aware of climate change but became more understanding of the phenomenon from the establishment of the farmer field school. This is also in agreement with [31], who argued that farmer field schools play an important role in making farmers understand the effects of climate change by improving knowledge and awareness. In terms of the perception on prolonged draught, about 62% at the baseline and 84% and 75%, respectively, in the first and second interventions, farmers noticed some changes. About 47%, 74%, and 98% noticed excessive floods in the three stages of intervention, respectively. The literature also suggests that farmers are faced with complicated challenges such as drought and excessive floods at times, which results in low production [31]. With regards to the perception of farmers' access to climate change information, the results show that about 36% of respondents at the baseline, 86% at the first intervention, and 88% at the second intervention had access, which may suggest that indeed the establishment of FFS did have a positive impact on farmers' view and understanding of climate change. Furthermore, about 28% on the baseline noticed mortality due to climate change, with 76% in the first intervention and 84% in the second intervention. About 92% noticed diseases due to climate change, followed by 90% and 30% at the baseline. Overall, the figure depicts that at the baseline, the respondents were less than 55%, and the percentage increased when there was the first intervention and kept on increasing in the second intervention. The percentage of the respondents who perceived change in both temperature and rainfall in the current study was higher, implying that the level of perception is increasing gradually. These

findings are similar to [46], who found that experiencing a higher frequency of drought in the past increases farmers' perception of climate change.

3.1. Empirical Analysis

The study utilized a *t*-test to determine the impact of extension services of the farmer field schools approach on smallholder livestock farmers' perceptions in Raymond Local Municipality. In analyzing these data, the perceptive index was constructed using the Min–Max Normalization method. Results from Table 2 indicate that there was a significant difference in the perceptive index between the first FFS and no FFS. The positive mean value indicates that between the first FFS implementation and without FFS, there was positive improvement on farmers knowledge of climate change due to the facilitation of farmer field schools. In a study conducted by [47] on hunger in South Africa during the 2020 pandemic from Wave 3, similar results were achieved when the government provided food parcels and when the government did not provide food parcels. By using food parcels, food security in many households improved. When the country first experienced the first wave of COVID-19, many households could not work to provide for their families and as a result were food insecure. However, in the second phase, the government introduced food parcels to curb food insecurity, and though the use of *t*-test analysis, results showed that households' food security status improved significantly. Table 3 below provide *t*-test comparing the perceptive index of various stages of FFS interventions.

Table 3. *t*-test comparing the perceptive index of various stages of FFS interventions.

	Variable	Obs	Mean	Std. Err.	Std. Dev.	Hypothesis	<i>p</i> -Value
First intervention	PerceptiveIndex _{FFS₀}	80	0.22	0.01	0.08		
	PerceptiveIndex _{FFS₁}	80	0.30	0.01	0.08		
	Combined	160	0.26	0.01	0.09		
	Difference		0.08	0.01		H _a : diff < 0	1.00
						H _a : diff = 0	0.00
Second intervention	PerceptiveIndex ₁	80	0.30	0.01	0.08		
	PerceptiveIndex _{FFS₂}	80	0.31	0.01	0.08		
	Combined	160	0.31	0.01	0.08		
	Difference		0.01	0.01		H _a : diff < 0	0.88
						H _a : diff = 0	0.24
Overall intervention	PerceptiveIndex _{FFS₀}	80	0.22	0.01	0.08		
	PerceptiveIndex _{FFS₂}	80	0.31	0.01	0.08		
	Combined	160	0.27	0.01	0.09		
	Difference		0.09	0.01		H _a : diff < 0	1.00
						H _a : diff = 0	0.00
Change between interventions	PerceptiveIndex _{FFS₀₋₁}	80	0.08	0.01	0.11		
	PerceptiveIndex _{FFS₁₋₂}	80	0.01	0.01	0.10		
	Combined	160	0.05	0.01	0.11		
	Difference		−0.07	0.02		H _a : diff < 0	0.00
						H _a : diff = 0	0.00
						H _a : diff > 0	1.00

The table describes the results of multiple *t*-tests comparing perceptive indices between different groups at different intervention stages. First Intervention: Perceptive Index FFS_0 vs. FFS_1. The mean perceptive index increased by 0.08 from FFS_0 to FFS_1. The *p*-value for the difference was greater than 0, which was less than 0.05 (0.00), indicating that the increase is statistically significant. The null hypothesis was rejected that there was no difference between the indices and concludes that the first intervention had a

significant positive effect. Second Intervention: Perceptive Index FFS_1 vs. FFS_2. The mean perceptive index increased slightly by 0.01 from FFS_1 to FFS_2. The p -values indicate that this increase is not statistically significant ($p > 0.05$). We failed to reject the null hypothesis that there is no difference between the indices, suggesting that the second intervention did not significantly change the perceptive index. Results from Table 2 show that there was no significant difference in the perceptive index between the second FFS and the first FFS. Thus, the perceptions were not affected by the second FFS. This might be because farmers were already aware of the climate change-related issues from the information given in the initial stages of FFS meetings. Overall Intervention: Perceptive Index FFS_0 vs. FFS_2. The mean perceptive index increased by 0.09 from FFS_0 to FFS_2. The p -value for the difference was greater than 0 and was less than 0.05 (0.00), indicating that the increase was statistically significant. The null hypothesis was rejected in that there was no difference between the indices and concluded that the overall intervention had a significant positive effect, which implies that farmer field schools play a positive role on farmers awareness of climate change. Change between Interventions: Change in Perceptive Index FFS_ (0–1) vs. FFS_ (1–2). The change in perceptive index decreased by 0.07 from FFS (0–1) to FFS_ (1–2). The p -value for the difference was less than 0 and less than 0.05 (0.00), indicating that the decrease was statistically significant. The null hypothesis was rejected in that there was no difference between the changes in indices and concluded that the change between the first and second interventions was significantly different.

3.2. Summary of the Findings

- First intervention: There was a significant and positive effect on the perceptive index.
- Second intervention: There was no significant effect on the perceptive index.
- Overall intervention: There was a significant and positive effect on the perceptive index.
- Change between interventions: There was a significant decrease in change from the first to the second intervention.

4. Conclusions and Recommendations

This study was conducted in Raymond Mhlaba Local Municipality (RMLM) with the aim of understanding the impact of farmer field schools (FFS) on eighty livestock smallholder farmers' shared perceptions of climate change. The study made use of the t -test and descriptive statistics to analyze the data. The shared perceptions of climate change by farmers were categorized into seven questions that had two choices or a binary response (yes or no), and they were divided into three phases, namely, a baseline, the first intervention phase, and the second intervention phase. The results indicate that socio-economic factors such as gender, marital status, educational level, and access to extension services and markets influence the participation of livestock farmers in FFS. The results confirmed that a higher percentage of respondents perceived climate change. Furthermore, the descriptive results reveal that about 34% of the farmers did not hear anything about climate change-related issues at the baseline, but after the first and second interventions, 100% of the farmers mentioned that they had heard about climate change. This means that the FFS approach has an impact on livestock smallholder farmers' understanding of climate change in the study area, and this can be noted on all the shared perceptions. The findings emphasize the pivotal intervention of FFS in the awareness and perceptions about climate change of the livestock smallholder farmers. Moreover, the empirical results using the t -test methods indicate that there was a significant difference in the perceptive indexes between the no FFS, the first FFS intervention, and the second FFS intervention. First intervention: Perceptive Index FFS_0 vs. FFS_1, the mean perceptive index increased by 0.08 from FFS_0 to FFS_1. Second Intervention: Perceptive Index FFS_1 vs. FFS_2, the mean perceptive index increased slightly by 0.01 from FFS_1 to FFS_2. Overall Intervention: Perceptive Index FFS_0 vs. FFS_2, the mean perceptive index increased by 0.09 from FFS_0 to FFS_2. Change between Interventions: Change in Perceptive Index FFS_ (0–1) vs. FFS_ (1–2), the change in perceptive index decreased by 0.07 from FFS (0–1) to FFS_ (1–2). Participating

in FFS has served as a crucial platform for knowledge exchange, empowering farmers to develop sustainable practices and make informed decisions. FFS have spread adaptation knowledge and skills by conducting comparative studies, establishing agribusinesses, training members, distributing inputs, organizing field days, and integrating village savings throughout the seasonal calendar. Conversely, based on the study results, this study recommends that the government and policymakers establish farmer FFS and support them financially so that they can provide more support to rural farmers as well as enhance their knowledge. This study recommends the provision of climate change training, workshops, and awareness campaigns on climate change for farmers through FFS. FFS is an important tool in capacity building, the generation of new knowledge, and information flow and farmer-to-farmer communication. The findings are that of the capacity of the FFS experience to bring a sense of real vitality into the interactions between extensionists and farmers as this will assist farmers being sustainable in their farming practices and produce.

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