

The impact of rainfall variability on subsistence farmers in the North West Province, South Africa

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ABSTRACT

Rainfall variability has a direct influence on agriculture and food security. Subsistence farmers are reliant on their produce for survival and are considered to be particularly vulnerable to its effects. The impacts of rainfall variability will be influenced by the manner in which subsistence farmers perceive rainfall variability and adapt to it. The purpose of this study was to investigate the impact of rainfall variability on subsistence farmers in two settlements within the North West Province of South Africa. A mixed-methods approach was employed to achieve the research aim. A standard precipitation index (SPI) was calculated to understand the rainfall variability in the study region, while a semi-structured questionnaire was used to explore perceptions on rainfall variability, as well as its impacts on subsistence farming. Rainfall data between 1903 and 2018 was used for the SPI, while 20 farmers were interviewed. The SPI analysis showed that the region was subject to a number of dry to extremely dry periods over the last 20 years. Farmers could recall many of these periods and perceived rainfall variability to have a negative impact on crop production. Although farmers were not always able to clearly differentiate between concepts such as climate and weather, they were perceptive of changes in rainfall patterns and their effect on agriculture. Subsistence farmers were found to be heavily reliant on their farming activities for survival and, therefore, vulnerable to the effects of rainfall variability.

Key Words: *Subsistence farmers, rainfall variability, drought, precipitation, climate change, standard precipitation index, North West Province, South Africa*

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TABLE OF CONTENTS

ABSTRACT.....	II
ACKNOWLEDGMENTS	III
CHAPTER 1 – INTRODUCTION	1
1.1 Introduction	1
1.2 Problem statement.....	1
1.3 Aim and objectives	2
1.4 Significance of the study.....	3
1.5 Scope of the study	3
1.6 Limitations of the study.....	3
1.7 Structure of the dissertation	4
CHAPTER 2 – LITERATURE REVIEW	5
2.1 Introduction	5
2.2 Characterization of rainfall variability and drought.....	5
2.2.1 Rainfall variability in South Africa.....	5
2.2.2 Drought	6
2.2.3 Standard precipitation index (SPI)	9
2.3 Characterization of subsistence farming.....	11
2.3.1 Definition of subsistence farming	11
2.3.2 Subsistence farming in the global context	11
2.3.3 Subsistence farming in the South African context	12
2.3.4 Contribution of subsistence farming to household food security.....	12
2.3.5 Socioeconomic challenges faced by subsistence farmers.....	13

2.4	Subsistence farmers perceptions of droughts and rainfall variability	14
2.5	The impacts of rainfall variability	14
2.5.1	Food security and availability	15
2.5.2	Food stability	16
2.5.3	Food access.....	16
2.5.4	Food utilization	17
2.6	Indigenous knowledge	17
2.7	Conclusion.....	18
CHAPTER 3 – DATA AND METHODOLOGY.....		18
3.1	Introduction	19
3.2	Study area.....	19
3.3	Research design	21
3.4	Data	23
3.4.1	Rainfall data for SPI (Objective 1).....	23
3.4.2	Development and distribution of questionnaires (Objectives 2 – 4).....	27
3.5	Analysis	28
3.5.1	Calculation of SPI (Objective 1)	28
3.5.2	Analysis of questionnaire data (Objectives 2 - 4).....	29
3.6	Validity and reliability	29
3.7	Ethical considerations.....	30
3.8	Conclusions.....	31
CHAPTER 4 – RAINFALL VARIABILITY IN THE NORTH WEST PROVINCE.....		32
4.1	Introduction	32

4.2	Characterization of rainfall variability (Objective 1)	32
4.2.1	Annual rainfall	32
4.2.2	Monthly rainfall	36
4.2.3	Droughts in the North West Province	39
4.3	Conclusion.....	42
 CHAPTER 5 – SUBSISTENCE FARMING AND RAINFALL VARIABILITY		43
5.1	Introduction	43
5.2	Demographic profile of respondents	43
5.2.1	Gender	43
5.2.2	Age.....	44
5.3	Characterization of subsistence farming in the North West Province (Objective 2).....	45
5.3.1	Nature of farming activity	45
5.3.2	Number of years' experience	46
5.3.3	Training received.....	46
5.3.4	Types of crops grown.....	48
5.3.5	Reasons for selection of certain crop types	49
5.3.6	Farming resources and field preparation	50
5.3.7	Planting and harvesting periods.....	50
5.3.8	Application of fertilizers	51
5.3.9	Application of herbicides and pesticides	52
5.3.10	Preparations for drought periods	53
5.3.11	Duration and number of growing seasons in a year	53

5.3.12	Sources of income	53
5.3.13	Support from government	54
5.4	Perceptions of subsistence farmers on rainfall variability (Objective 3).....	54
5.4.1	Understanding of fundamental concepts	54
5.4.2	Perceptions on the occurrences of droughts	56
5.4.3	Effects of rainfall variability on subsistence farmers	57
5.5	Perceived impacts of rainfall variability on crop production (Objective 4).....	58
5.6	Conclusion.....	58
5.6.1	Characterization of subsistence farming (Objective 2)	58
5.6.2	Perceptions of subsistence farmers on rainfall variability (Objective 3).....	59
5.6.3	The impact of rainfall variability on crop production of subsistence farmers (Objective 4).....	59
CHAPTER 6 – CONCLUSION.....		61
6.1	Introduction	61
6.2	Concluding remarks	61
REFERENCE LIST		65
ANNEXURE		77

LIST OF TABLES

Table 1: Major droughts that occurred in South Africa (1800s).....	8
Table 2: Major droughts that occurred in South Africa (1900s).....	8
Table 3: Drought category and period in the North West Province of South Africa	9
Table 4: SPI categories	10
Table 5: Research objectives and research methods to be employed in this study	22
Table 6: Annual rainfall statistics.....	33
Table 9: Farming expertise (in years).....	46
Table 10: Training	47
Table 11: Types of crops.....	48
Table 12: Reasons for the selection of certain crops types	49
Table 13: Farming resources	50
Table 14: Summary of reasons why farmers apply fertilizers.....	51
Table 15: Type of pesticides and herbicides.....	52
Table 16: Drought incidences recalled by farmers	56

LIST OF FIGURES

Figure 1: The location of North West Province in South Africa (a) and the two communities within the province (b).....	20
Figure 2: Overview of the research process.....	22
Figure 3: Annual rainfall for the South African Weather Service station in Potchefstroom between 1903 and 2018	34
Figure 5: Monthly variability in Potchefstroom rainfall (mm).....	37
Figure 6: Frequency histograms of total monthly rainfall at the Potchefstroom South African Weather Service station between 1903 and 2018.	38
Figure 7: The standard precipitation index (SPI) between 1903 and 2018 for different time scales for the Potchefstroom South African Weather Service station.	40

CHAPTER 1 – INTRODUCTION

1.1 Introduction

In South Africa, farmers can be broadly divided into two groups: commercial farmers and subsistence farmers (Gwebu & Mathews, 2018). Commercial farmers can be defined as farmers that produce animals and crops primarily for the commercial market, while subsistence farmers can be defined as farmers that mainly rely on their produce to provide for their own basic needs. In South Africa, subsistence farmers mostly reside in rural areas and usually farm on relatively small tracts of land. Furthermore, subsistence farmers are often under-resourced (Obi *et al.* 2012; Mabaya *et al.* 2011; Aliber *et al.* 2006) and are almost exclusively dependent on rainfall to carry out their farming activities, i.e., little or no access to irrigation systems. The combination of these factors limits the production capacity of subsistence farmers (Dorward *et al.* 2003; Aliber & Hall, 2012; Agholor *et al.* 2013; Agric-SA, 2016; Baloyi, 2010; Khapayi & Celliers, 2016) and due to their direct reliance on their produce for survival, might also increase their vulnerability. The purpose of this research was to explore the impact of rainfall variability on subsistence farmers in two communities in the North West Province of South Africa and to understand better how these farmers perceive rainfall variability and adapt to it.

1.2 Problem statement

South Africa has a dual agricultural economy, with both a well-developed commercial farming component and a less-formalized subsistence farming component (Khapayi & Celliers, 2016). Approximately 20 % of all households in South Africa were classified as so-called 'agricultural households' in 2011 (Stats SA, 2013), which can be defined as households that mainly rely on agriculture for their income or as a means of survival. However, this percentage has decreased to around 14% in 2016 and is mainly attributed to the drought experienced in southern Africa during the 2014/15 season (Stats SA, 2016). Furthermore, and as a result of the

aforementioned, agricultural production decreased by 1.6 % between the 2014/15 and 2015/16 seasons (DAFF, 2016). Although the split between commercial farmers and subsistence farmers is not evident from the data, 43.7 % of households stated their agricultural activity was their primary source of food (Stats SA, 2016), which might imply subsistence farming. It can therefore be argued that subsistence farming, in addition to commercial farming, is a vital contributor to food security, especially at household level (Aliber & Hall, 2012; Rigg *et al.*, 2018; Ashwooda *et al.*, 2019; Nchuchuwe & Adejuwon, 2012; Poulton *et al.*, 2010), but also at global level (Wiggins & Keats, 2013). Subsistence farmers are generally considered to be more vulnerable than commercial farmers to rainfall variability – the variation of rainfall across space and time – primarily due to their limited ability to adequately respond to changes (Green, 2009; Steiner *et al.*, 2018; Schleussner *et al.*, 2018). Rainfall variability has influenced rainfall formations significantly, and many dry periods have been recorded in several areas in southern Africa in recent years (Damodaran, 2018). Understanding the impacts of rainfall variability on subsistence farmers, who rely on their produce for survival, is, therefore, essential to ensure food security at household level. The manner in which subsistence farmers perceive variability must also further be explored as this understanding will affect the way in which they approach their farming practices (Dakurah, 2018; Karki *et al.*, 2019).

1.3 Aim and objectives

The aim of this study was to investigate the impact of rainfall variability on subsistence farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities of the North West Province.

The following objectives informed the aim:

1. Characterize rainfall variability in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities;

2. Characterize subsistence farming in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities;
3. Establish how subsistence farmers perceive rainfall variability in these communities; and
4. Determine the perceived impact of rainfall variability on crop production of subsistence farmers.

1.4 Significance of the study

The study contributes to the understanding of the impacts of rainfall variability on subsistence farmers. It further provides insights on the way in which rainfall variability is perceived by subsistence farmers and the manner and extent to which they adapt to it.

1.5 Scope of the study

The study mainly focused on subsistence farmers that are reliant on rain-fed agricultural practices and mainly focussed on crop farming. Furthermore, the study was conducted in only two communities – the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga Gogopa – in the North West Province of South Africa and, therefore, does not claim to generalize for the whole province or country.

1.6 Limitations of the study

The South African Weather Service weather station at Potchefstroom had to be used to represent rainfall for the study area as this station had the longest, most consistent rainfall record available for the area. It is assumed that it represents the climate of the region.

Only one female respondent was included in the sample resulting in bias with regard to the nature and extent of women's involvement in farming in the area.

1.7 Structure of the dissertation

The dissertation is comprised of six chapters:

- **Chapter 1 – Introduction.** *Introduces the problem statement, aim, and objectives of the study.*
- **Chapter 2 – Literature review.** *Provides an overview of the essential concepts relevant to the study.*
- **Chapter 3 – Data and methodology.** *Deals with the methodological approach that was used for data capturing and analysis.*
- **Chapter 4 – Rainfall variability in the North West Province.** *Characterizes rainfall variability in the North West Province.*
- **Chapter 5 – Subsistence farming and rainfall variability.** *Presents the findings on the perceptions of rainfall variability and its impacts on subsistence farming.*
- **Chapter 6 – Conclusion.** *Presents concluding remarks.*

The literature review is presented in the next chapter.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

The literature review is structured around five main themes. The first theme (2.2) provides an overview of rainfall variability and drought in South Africa, while the second theme (2.3) deals with the characterization of subsistence farming. Themes three and four deal with the perception of subsistence farmers on rainfall variability (2.4), and the impacts of rainfall variability in South Africa (2.5), respectively. The final theme (2.6) deals with the role of Indigenous Knowledge Systems (IKS) in subsistence farming.

2.2 Characterization of rainfall variability and drought

In this section, the concept of rainfall variability is explored. Rainfall variability is first discussed, followed by a discussion on droughts.

2.2.1 Rainfall variability in South Africa

According to the Intergovernmental Panel on Climate Change, most of the alterations in acute climate events observed globally have taken place since the last quarter of the 19th century (IPCC, 2007). These changes include, amongst others, regular and recurrent warm seasons, recurrent intense rainfall incidences, a boost in extreme cyclone activity in the tropical region of the Atlantic north, and extended dry periods experienced around the world. In particular, extended dry periods have become a regular occurrence in many parts of Africa, and more specifically, in its semi-arid eastern and southern regions (Abiodun *et al.*, 2019; Gebremeskel *et al.*, 2019). These regions have subsequently experienced changes in both the spatial and temporal distribution of rainfall events, i.e., rainfall variability. High-temperature ranges around the equator and the central region of the Pacific Ocean are some of the driving factors that can

be linked to rainfall shortages observed in the southern African region specifically (Schubert, 2009; Findell & Delworth, 2010). These increasing global temperatures mostly influence the rainfall formation system of the world (Huntington, 2006), including alterations in the frequency and duration of dry and wet periods. Continual changes in climate are expected to alter rainfall patterns in the region further, affecting southern African countries (Kliment *et al.*, 2011).

Rainfall variability has also been a common occurrence in South Africa over the last few decades as a considerable reduction in annual rainfall has been observed in some parts of the country, while increases in rainfall and rainfall event intensity have been observed in other parts (Walker *et al.*, 2016). For example, according to Lynch *et al.*, (2001), there was a substantial increase in the annual precipitation around Potchefstroom region during the 19th century. However massive reductions in average annual precipitation of the Limpopo region was evident during the last half of the 19th century (Warburton and Schulze, 2005). This precipitation pattern demonstrates a declining tendency in the whole country and is extremely changeable annually and is interspersed by frequent absence of rainfall (Davies, 2010; DWAF, 2008).

The country's average annual rainfall is usually around 450 mm per annum, which is already far below the global average of 860 mm per annum (Botai *et al.*, 2016), and in addition to seasonal variability; as a result of winter and summer rainfall zones; rainfall in South Africa also decreases from east to west. Annual rainfall in the north western region of the country can often be as low as 200 mm per annum. Dry periods have been increasing in frequency and intensity in recent years (Davies, 2010; DWAF, 2008). According to a publication by The South African Department of Environmental Affairs (DEA, 2010), precipitation in semi-arid regions are expected to become drier over time, i.e., less rainfall. Dennis & Dennis (2012) add that in addition to a decrease in precipitation in these regions, the dry periods can be expected to last longer in the future, while extreme rainfall events are also expected to increase.

2.2.2 Drought

Definition and understandings of drought

Although the concept of drought can be dealt with through one of four understandings – meteorological drought, agricultural drought, hydrological drought, and lastly, socioeconomic

drought – they all share the same premise in that droughts occur when inadequate soil moisture is observed as a result of a decline in rainfall (Mishara & Singh, 2010; Anderegg *et al.*, 2012; Van Loon *et al.*, 2016). The four understandings, or types, of drought, can be defined as follows:

- Meteorological droughts occur when observed rainfall over a certain period and for a specific region is below the expected rainfall for that period and region.
- Agricultural droughts occur when soil moisture is not sufficient to sustain crop growth and production.
- Hydrological droughts occur when water levels in rivers, dams and underground reservoirs decrease to such an extent that water shortages are experienced.

Socioeconomic drought occurs when the demands for certain economic goods cannot be met as a result of weather-related water shortages.

The magnitude of drought is determined by its duration, severity, size of the affected area, and its impacts (Udmale, 2014; Wilhite, 2012; Howitt *et al.*, 2014; Wilhite, Sivakumar & Pulwarty, 2014). The four different types of droughts further also often differ in terms of the aforementioned. An agricultural drought, for example, will generally have a shorter time-span than a hydrological drought.

Causes of drought in South Africa

Rainfall inconsistency can be attributed as one of the primary factors driving the occurrence of drought in South Africa (Cook *et al.*, 2013; Zeng Yoon & Marengo, 2008; van Dijk & Crosbie, 2013). The El Niño phenomenon, and more specifically the El Niño Southern Oscillation (ENSO), strongly influence rainfall patterns in southern Africa and therefore has a direct influence on the occurrence of droughts. For example the ENSO warm events normally result in drought in most parts of South Africa. This was the case in 1991 and 1992 where a severe drought occurred, and a gentle drought followed during 1997 and 98 (Mason and Tyson, 2000). The warmer temperatures and lower rainfall associated with El Niño will first result in a meteorological drought being observed, followed by agricultural, hydrological, and

socioeconomic droughts if the meteorological drought persists, and as hydrological discharge and water availability becomes affected.

A historical overview of drought in South Africa

Drought records in South Africa date back to as far as the 19th century (Van Zyl & Vogel, 2009), covering a period of more than 200 years. Tables 1 and 2 provide an overview of significant drought events that occurred in the 19th and 20th centuries, respectively. Although droughts have been consistently recorded in South Africa over the last 200 years, they seem to have intensified over the last quarter of the 19th century and also towards the end of the 20th century (Van Zyl & Vogel, 2009). According to Van Zyl & Vogel (2009), 1982, 1983, 1991, 1992, saw the worst droughts in southern Africa throughout the 20th century. The agricultural sector was heavily impacted by the 1980's droughts, which resulted in estimated debts of more than R3 billion at the time (van Zyl & Vogel, 2009) while the 1991 and 1992 droughts were equally hard, causing an estimated 70 % of the crops in the region to fail.

Table 1: Major droughts that occurred in South Africa (1800s)

	1	2	3	4	5	6	7	8	9	10
Period of major drought	1812-1815	1815-1817	1827-1829	1834-1838	1844-1862	1866-1869	1876	1887-1888	1896	1898

Source: Van Zyl and Vogel, 2009

Table 2: Major droughts that occurred in South Africa (1900s)

1	2	3	4	5	6	7	8	9	10	11
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Period of major drought	1904-1908	1912-1916	1919	1922-1924	1926-1928	1930-1933	1935-1938	1960s	1970s	1980s	1990s
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Source: Van Zyl and Vogel, 2009 Droughts in the North West Province

Rainfall in the North West Province varies across an east-west gradient, with the western region receiving around 600 mm of rain per annum, while the eastern region receives only around 350 mm. Although droughts occur fairly regularly in the province (READ, 2015), Botai *et al.* (2016) reported that drought intensity in the province has increased in the period between 1985 and 2015. This aforementioned is reflected in the fact that the province was declared a drought disaster area in 2015/2016. As seen in Table 3, droughts have continually been observed in the province over the last 35 years, and extreme droughts have been observed throughout the monitoring period. The occurrence of droughts in the province, and especially the western parts of the province, is expected to increase in the future (READ, 2015).

Table 3: Drought category and period in the North West Province of South Africa

Drought category	Extreme droughts	Severe droughts	Moderate droughts	Mild droughts
Period	1985–2015	1995–2004 2005–2015	1985–1994 1995–2004	2005–2015

Source: READ (2015); Botai *et al.* (2016)

2.2.3 Standard precipitation index (SPI)

The standard precipitation index (SPI) can be defined as the number of standard deviations by which observed accumulated precipitation for a region deviates from the long-term average for that region (Soul, 1990). Standard precipitation can be used to characterize meteorological

droughts and monitor their occurrence and was first invented in 1993 by the Colorado Climate Centre (McKee *et al.*, 1993, 1995). SPI is widely used to monitor droughts (Vijendra, 2005; Wu *et al.*, 2005; Vicente-Serrano *et al.*, 2004) and also prescribed for use by the World Meteorological Organization (WMO, 2012).

Table 4: SPI categories

SPI value	Conditions
> 2.00	Extremely wet
1.50 to 1.99	Very wet
1.00 to 1.49	Wet
0.99 to - 0.99	Normal
- 1.49 to - 1	Dry
- 1.99 to - 1.5	Very dry
< - 2.00	Extremely dry

Source: Wu and Hayes (2005); Hayes *et al.* (2011)

SPI can be calculated using either daily, weekly, or monthly data (Wu & Hayes, 2005; Hayes *et al.*, 2011) and produces values that can be either positive (indicating wet conditions) or negative (indicating dry conditions), as shown in Table 4. Since SPI can be calculated for a variety of timescales, it allows for multiple applications. Depending on the drought impact, SPI values can be used to monitoring meteorological impacts (short term) as well as agricultural and hydrological impacts (longer-term). The SPI categories indicate conditions ranging from extremely wet to extremely dry, the latter of which would indicate a drought event.

2.3 Characterization of subsistence farming

2.3.1 Definition of subsistence farming

According to Wharton (2017), subsistence farming can be defined as an approach to farming where most of the farm produce is used for household consumption, and only excess produce is marketed. Commercial farming, on the other hand, can be defined as an approach to farming where most of the produce is marketed for commercial gain. Subsistence farming is usually conducted on a much smaller scale than commercial farming.

2.3.2 Subsistence farming in the global context

According to Eastwood *et al.* (2010), a large proportion of the world's rural population can be classified as subsistence farmers. The majority of this population is poor, are faced by food shortages, and lacks access to markets and services. Subsistence farmers usually produce their crops and rear their animals on small tracks of land, and are usually reliant on family members for labour (Eastwood *et al.*, 2010). According to the Food and Agriculture Organization of the United Nations, 80 % of farmers in India are considered subsistence farmers, while in Egypt and Ethiopia, this percentage is closer to 90%. In South America, these percentages are significantly lower, with 50 % and 20 % of farmers considered to be subsistence farmers in Mexico and Brazil, respectively (FAO, 2015). The differences in the proportion of subsistence farmers between countries and regions can often be a reflection of the differences in the stages of development among countries. Consequently, changes in the status of subsistence farming in a country or region are often directly related to the economic development of that country or region. Subsistence farmers generally endeavour to operate their farms as entrepreneurs and operate their firms as they raise capital and, when possible, invest in productive assets (Eastwood *et al.*, 2010). Often just the same as their commercial counterparts, they make decisions, take risks, and aim to make profits (Eastwood *et al.*, 2010; FAO, 2015; Rada & Fuglie, 2019). However, even if subsistence farmers succeed in producing excess produce, they are often unable to market these due to a variety of constraints such as access to infrastructure,

transportation, and the necessary finances (Olorunfemi, 2014; Gupta, 2013; Sathish & Patil, 2015).

2.3.3 Subsistence farming in the South African context

It has been estimated that around four million people were engaged in subsistence farming in South Africa in the late 2000s (Baiphethi & Jacobs, 2009). A large proportion of these subsistence farmers are concentrated in the former homelands established during the Apartheid era and are often isolated from expanding markets, support structures, and essential infrastructure (Cousins, 2012). As a result, most of these farmers only produce food for their own consumption, although some have been known to market their produce as well. However, the contribution of subsistence farming to the economy has not been well studied (Baiphethi & Jacobs, 2009). Subsistence farmers in South Africa usually farm with small herds of animals, of which chickens and sheep seem to be favoured, followed by cattle and goats (Stats SA, 2016). Some farmers also specialize in crop production, although this is usually done on a small scale on relatively small tracks of land. In recent years, many young men and women have opted to migrate to urban centres in search of employment opportunities (Zenou, 2011). This trend might result in a decline in subsistence farming in South Africa over the long-term.

2.3.4 Contribution of subsistence farming to household food security

Although many rural households buy foodstuff from shops, this can amount to up to 70% of their disposable income (Altman *et al.*, 2010). As a result, most households have to revert to subsistence farming to ensure household food security (Wiggins & Keats, 2013; Mavengahama *et al.*, 2013; De Cock *et al.*, 2013). According to Pinstrup-Andersen (2012), subsistence farming on its own is not sufficient to ensure that households' nutritional requirements are met. This is due to the limited number of crops that can be cultivated and the fact that many crops will only be available during certain parts of the year. As a result, subsistence farmers often have to rely

on only a few crops (and some animals) for survival. This simplified diet is often unbalanced and could lead to malnutrition.

2.3.5 Socioeconomic challenges faced by subsistence farmers

Subsistence farmers face numerous challenges that affect the extent to which they can produce crops and rear animals (Jacobs *et al.*, 2018). The following socioeconomic challenges, although not an exhaustive list, can be highlighted.

Labour issues

Most subsistence farmers do not have access to draught animals or mechanized equipment such as tractors and are, therefore, mostly reliant on manual labour (Conroy & Teweldmehidin, 2010). Due to the migration of people to urban areas in search of more lucrative employment opportunities, farmers are often faced with a shortage of manpower. Although women often assist in manual labour (Stats SA, 2016), they also have other responsibilities such as cooking and housekeeping, which limits their availability. As a result, farmers often have insufficient labour to prepare and manage fields effectively, which often affects their productivity.

Insufficient finances and equipment

Subsistence farmers generally do not have access to the necessary financial resources to acquire farming equipment (Sutherland & Burton, 2011), and often do not qualify for loans either. As a result, farmers struggle to cultivate their fields effectively. Financial constraints further limit the farmer's ability to source labour and buy resources such as fertilizer, all of which further affect their farming practices.

Insufficient government support

Subsistence farmers do not always receive adequate counsel and assistance from government officials. According to Sutherland & Burton (2011), officials often fail to advise, motivate, and support subsistence farmers adequately. As a result, farmers do not always have access to relevant information on things like weather forecasts, pests, and fertilizer use.

2.4 Subsistence farmers perceptions of droughts and rainfall variability

Understanding perceptions is essential because it has a direct influence on subsistence farmers' planning and decision-making processes (Alessa *et al.*, 2008; Danielsen *et al.*, 2005). Farmers generally perceive droughts as the primary factor influencing crop productivity and prioritize it above other factors such as the status of the soil and the use of fertilizers (Slegers, 2008). In a study conducted by Ovuka & Lindqvist (2000), it was found that farmers tend to view rain, and therefore rainfall variability, across the growth periods of their crops, and not necessarily over an annual timeframe, i.e., they tend to consider rainfall over the short-term. According to Slegers (2008), there is a relationship between a farmer's scientific understanding of rainfall and droughts and their perceptions thereof. This implies that the education level of a farmer will influence, or shape, their understanding, and perceptions of rainfall variability.

2.5 The impacts of rainfall variability

The focus of this section is on the impacts of rainfall variability on subsistence farmers in South Africa. Overall, the agriculture sector is susceptible to the effects of rainfall variability and droughts (Fauchereau *et al.*, 2009; Kusangaya, *et al.*, 2014; Ziervogel *et al.*, 2014) which can often lead to issues such as food shortages (UNDP, 2005). According to Gaoshebe (2014), rainfall variability will likely reduce agricultural production due to its impact on moisture availability in soil. In addition to the effects that it has on crop production, it also affects grass growth and, subsequently, the availability of pasture. Rainfall variation can further also cause

severe wet spells, which could potentially result in the flooding of fields and either destroying crops or hampering their growth (Mallikarjuna, 2013). In semi-arid regions, rainfall variability is likely to reduce the agricultural produce of crops such as rice and wheat (Lobell *et al.*, 2011) as it has a direct effect on crop productivity (Wheeler *et al.*, 2013).

Furthermore, rainfall variability often results in droughts that disrupt farming by limiting the growth of crops and hence, lowering productivity and subsequently affecting the livelihoods of people (UNDP, 2005). According to Wlokas (2008), rainfall variability may also have longer-term effects on soils, which will affect the fertility and harvesting potential of the soil. Consequently, food security in rural areas might be severely affected, especially in areas when people are dependent on agriculture for their livelihoods. This implies that rainfall variability adversely affects food security and the livelihood patterns of households. As a result of rainfall variability, dependence on neighbouring countries might also increase as food might have to be sourced from elsewhere (Brown *et al.*, 2008). This will likely lead to premiums on food, which will further affect subsistence farmers.

In the following sections, a number of key impacts associated with rainfall variability are emphasized.

2.5.1 Food security and availability

Food insecurity is defined as a situation where food is limited or not enough to meet the requirements of a country or region and often results from the effects of droughts. Although the Global Hunger Index (GHI) reports a reduction in global hunger levels (Grebmer *et al.*, 2015), the number of hungry people in the world continue to be unacceptably high and have been estimated to be as high as 2 billion people worldwide (Wheeler & Von Braun, 2013). South Africa has, however, reduced its GHI from 18.7 in 1990 to 12.4 in 2015, but the serious issue that still requires attention in the country remains the attainment and retainment of food security. Rainfall variability has a direct impact on food security as it affects production in the agricultural sector. Like most countries, South Africa is reliant on its agricultural sector to ensure food

security, which can, therefore, be threatened if extreme rainfall variability events and droughts occur over prolonged periods. Rainfall variability further also directly influences the food security of subsistence farmers who are directly dependent on their agricultural produce for survival. Furthermore, due to varying rainfall, achieving food security amongst subsistence farmers will require significant interventions to deal with the vulnerability brought about by rainfall variations (Mallikarjuna, 2013).

2.5.2 Food stability

Food stability refers to the ability of a household to retain food over time and is related to food security (FAO, 2009; Drimie & McLachlan 2009; Pieters *et al.*, 2013). A household's food stability can become vulnerable due to rainfall variability since rainfall is a significant factor influencing food prices (Wheeler & Van Braun, 2013; Nelson *et al.*, 2010). The food stability situation for poor households is determined by the prices of staple foods, which, if these significantly increase, will increase their vulnerability (Wheeler *et al.*, 2013).

2.5.3 Food access

According to Drimie and McLachlan (2009), food accessibility refers to the ability of households to either produce their own food or procure enough to meet their minimum requirements. Sakyi (2012) states that food accessibility has four main dimensions, that is, the physical dimension, the economic dimension, the social dimension, and finally, the technological dimension. Physical access refers to the availability and accessibility of physical infrastructures such as markets and transport systems to access food, as well as the availability of land to produce or gather food. Economic access refers to the affordability of food and the extent to which people are to afford food or produce their own food. Social access refers to the ability of households to access their desired food sorts and maintain a specific diet. Finally, technological access refers to the technological facilities a household must use to process, preserve and prepare food. for example, the use of refrigerators to store milk and other dairy products (modern technology), or

an electric stove that is used to prepare food. Technological accessibility can also affect rural households negatively in terms of accessing food because they may lack facilities to process, preserve, and prepare food. Rainfall variability could impact on food access by impacting one or more of the four discussed dimensions. Droughts associated with rainfall variability could, for example, lead to the unavailability of certain foods, which will directly impact the social dimension or a flash flood associated with rainfall variability could hamper accessibility to markets that will directly impact the physical dimension. In all cases, subsistence farmers will also be vulnerable.

2.5.4 Food utilization

According to the International Federation of Red Cross and Red Crescent Societies (IFRCRCS, 2007), food utilization and consumption can be defined as the manner in which food is consumed (Masekoameng, 2015). Food utilization depends on many interrelated factors, which include the quality of food, the way in which it is prepared, how it is stored, the dietary information it has, as well as the health condition of the person who consumes a particular food. Masekoameng (2015) adds that food utilization also includes the frequency at which households are consuming specific foods. Food utilization could potentially be affected by rainfall variability since the attainment of sufficient and quality diets is often dependent on water availability and quality. Therefore, in the case that rainfall variability affects the availability of clean drinking water, food utilization will also be impacted (Wheeler & Van Braun, 2013). In extreme cases where food shortages occur as a result of rainfall variability, food utilization can be severely impacted in that households will resort to any available means of nutrition. This might often result in the utilization of unconventional, expired, and even dangerous foods.

2.6 Indigenous knowledge

In this section, IKS is defined, and its linkages to subsistence farming as well as rainfall variability are described. Indigenous Knowledge Systems (IKS) is an area of study which

centres around ways of knowing, seeing, and also contemplating that which is handed down verbally from generation to generation (Taremwaaetal, 2016). According to Gaoshebe (2014), IKS can be regarded as unique, traditional, local knowledge, that exists in, and is developed around specific conditions of native people in a specific area. Every cultural group has its own local knowledge that is often culture-specific. These IKS influence their lifestyle as well as the setting of the environment in which they live. For years, people living in rural areas have relied on IKS to cultivate crops, rear animals and ensure food security. IKS provides guidance on issues such as when to plant which crop, how it should be planted, how and when it should be harvested, and how it should be preserved and processed.

According to Gaoshebe (2014), there is evidence to suggest that, over the centuries, African subsistence farmers have relied on IKS formed strategies to adapt to rainfall variability. An example of this is where IKS proposed the cultivation of various different crops on one field in anticipation of the possible impacts of changes in rainfall, i.e., mixed cropping or diversification. IKS can, therefore, affect the choices made by subsistence farmers.

2.7 Conclusion

Chapter 2 reviewed the relevant literature around the issues of rainfall variability, the occurrence of droughts, and its possible effects subsistence farming. Five themes were discussed, namely, the characterization of rainfall variability, the characterization of subsistence farming, perceptions of substance farmers on rainfall variability, and finally, the impact of rainfall variability on subsistence farmers.

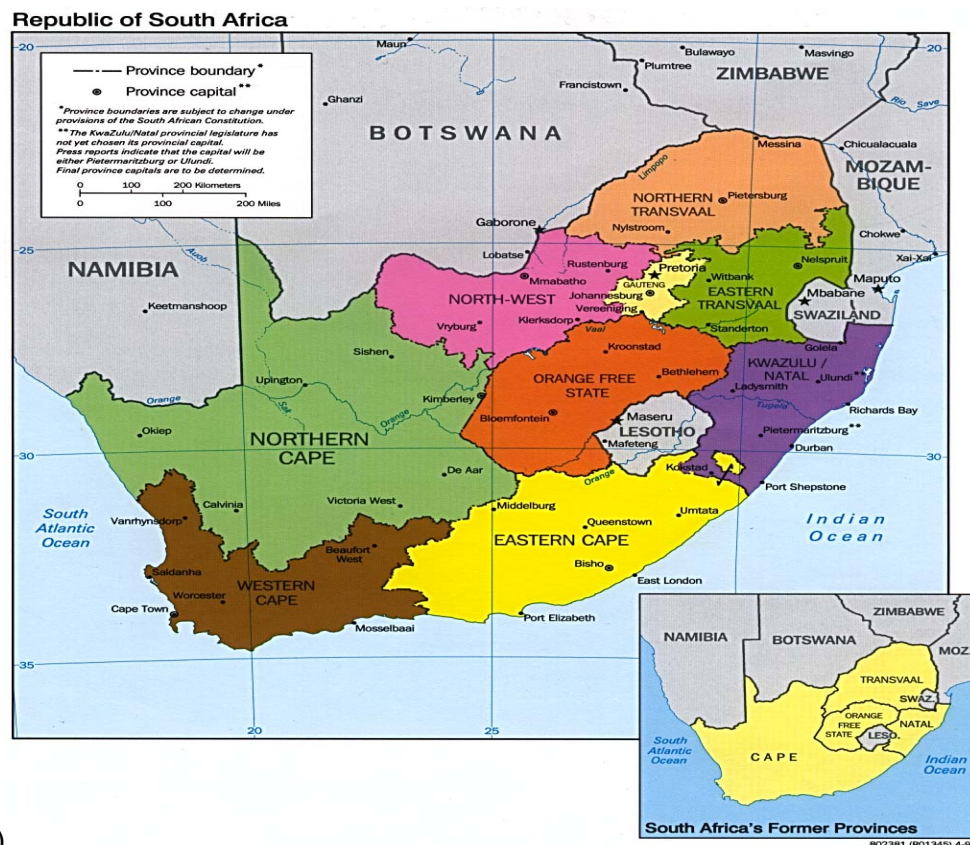
Chapter 3 – Data and methodology

3.1 Introduction

The study employed a mixed-methods approach relying on both quantitative and qualitative methods. This chapter explains the research design that was used and the methods that were employed for the capturing and analysis of data. The study area is introduced first (3.2), followed by the research design and methods (3.3). The concepts of validity and reliability (3.4), as well as the ethical considerations (3.5), applied in the study, is finally discussed.

3.2 Study area

The map below shows the location of North West Province, where the study was conducted.



(a)

(b)



(c)

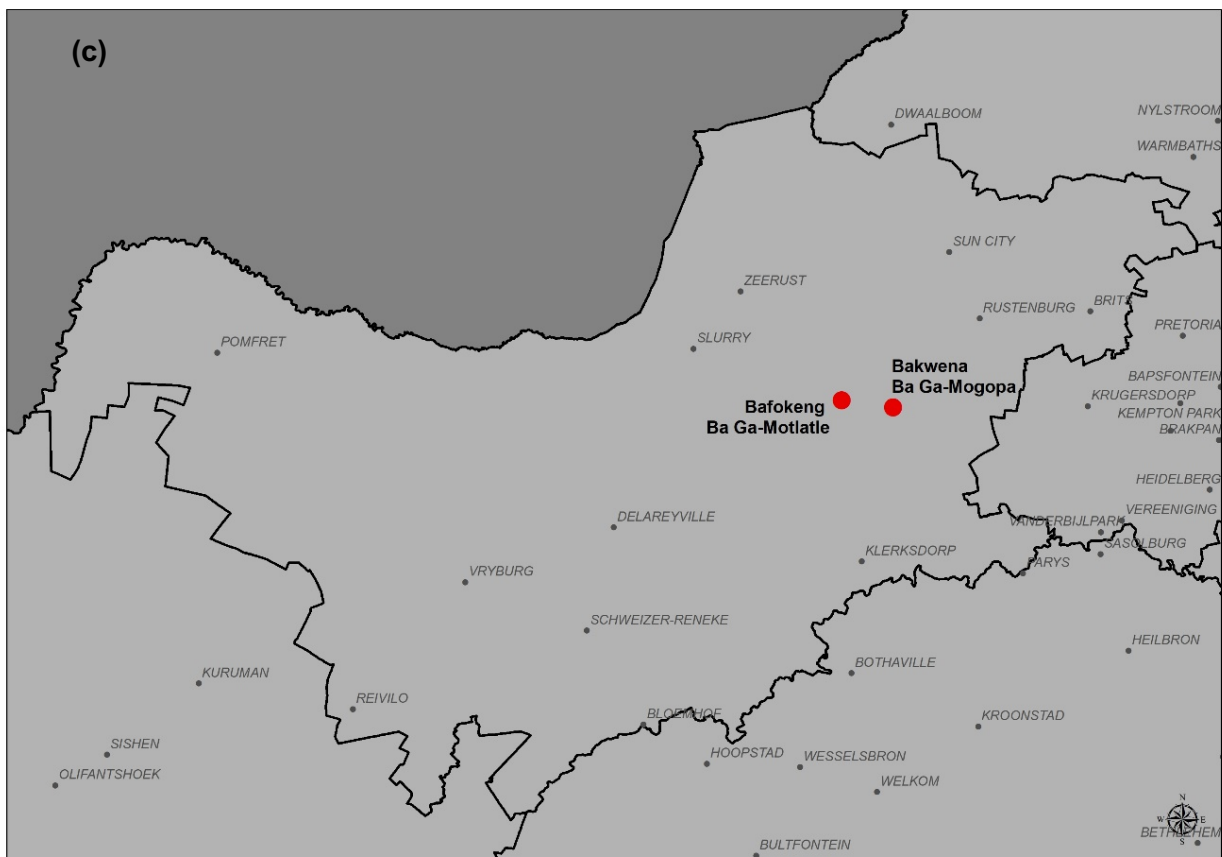


Figure 1 (Map): (a) South Africa and its neighbouring countries; (b) The North West Province in South Africa and (c) the two communities within the province.

The North West Province is situated towards the western part of South Africa and borders the Limpopo Province to the north, Gauteng to the east, the Free State Province to the south, and the Northern Cape Province to the west. The province covers an area of 116,320 square kilometres and occupies 9.5% of the total land area of South Africa. It is predominantly rural (65%), with agriculture being the main economic activity. In terms of land capability, 28% of the province is regarded as potentially arable, while a further 56.8% is considered suitable for grazing. The communities of Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga Mogopa are located in the north western region of the province in close proximity to the town of Ventersdorp. Both communities are regarded as rural communities that are relatively poor.

3.3 Research design

The research design can be defined as the blueprint of a study through which all research activities, such as data capturing and analysis, are planned. In other words, it provides the roadmap for the research, which, if followed systematically, will ensure that the research aim is successfully achieved (Rajasekar *et al.*, 2013). The research design employed a mixed-methods approach in which both quantitative and qualitative methods were used (Yin, 2008). Table 5 provides an overview of the methods that were employed to address each of the four objectives of the study, while Figure 2 illustrates the research process that was followed. The methods used for data collection, capturing and analysis will now be discussed in more detail.

Table 5: Research objectives and research methods to be employed in this study

Research objective	Data	Analysis
O1 - Characterize rainfall variability	Long-term rainfall data	SPI
O2 - Characterize subsistence farming	Semi-structured survey questionnaire	- Descriptive analysis (e.g. mean, standard deviation., frequencies. etc.); categorization. - Thematic analysis of responses
O3 - Establish how subsistence farmers perceive climate variability.		
O4 - Determine the perceived impact of rainfall variability on crops of subsistence farmers.		

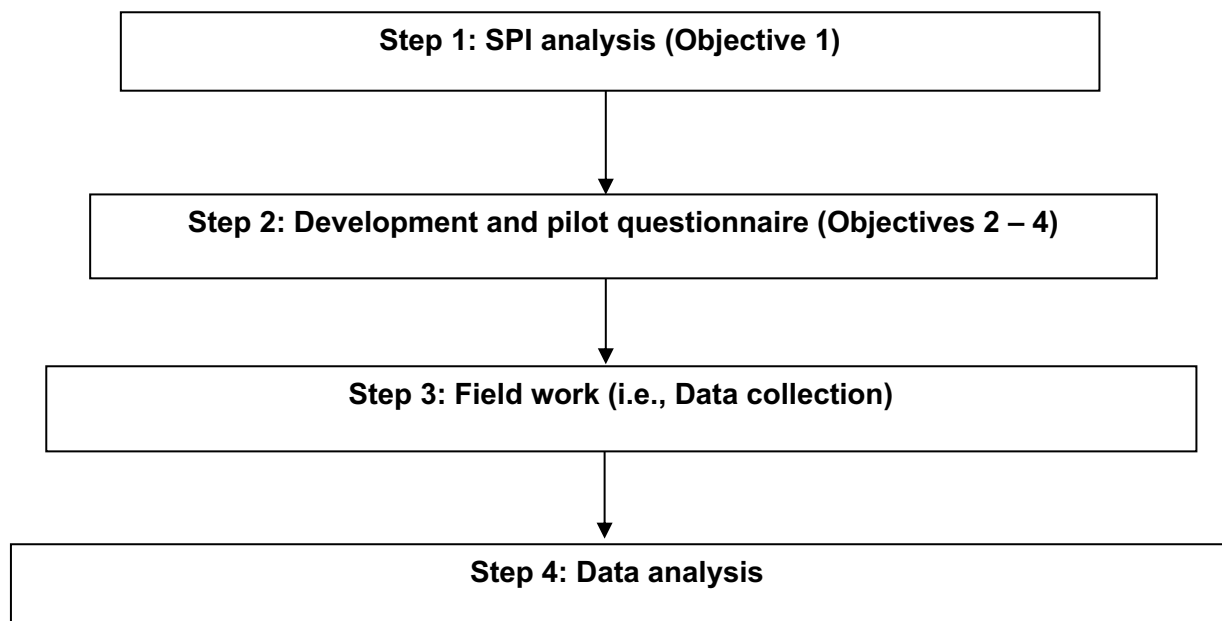


Figure 2: Overview of the research process

3.4 Data

The following sections explain the data sources and data capturing techniques that were used to obtain the data needed to complete the study.

3.4.1 Rainfall data for SPI (Objective 1)

Rainfall data for the Potchefstroom weather station was obtained from the South African Weather Service. The dataset covered the period between Potchefstroom for the period of 1903 and 2018. The dataset for the Potchefstroom weather station was the most comprehensive dataset available in close proximity to the two communities. It is assumed that the data from the station is representative of the climatic conditions for the region.

In order to calculate the SPI, a complete dataset was needed with no missing data points. It was also important to do thorough data quality control. Any missing data or erroneous observations would skew the estimate towards dryer estimates. This would have resulted in an underestimation of the severity of drought in the area. The best method to do this was to compare observations to those of another station in the same climate region; if the observations were very similar, then, the missing data would be replaced with those observations at that other station. Klerksdorp is the only other weather station with a comparable length of the record. A good comparison of the annual rainfall time series of the two stations can be seen in Figure 3; hence, the missing data in the dataset used in this study were replaced with those of Klerksdorp. Scatter plots comparing the annual and monthly observations at the two stations are shown in Figure 4.

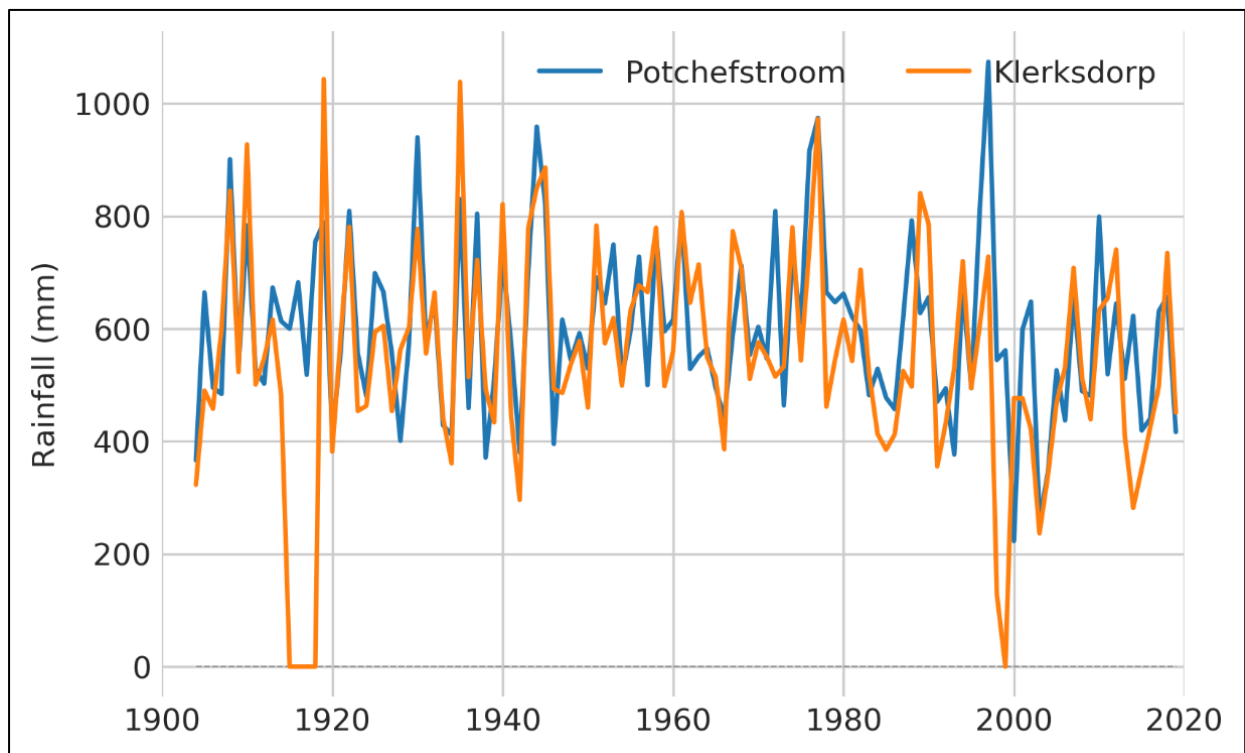


Figure 3: Raw annual rainfall for the South African Weather Service stations in Potchefstroom and Klerksdorp between 1903 and 2018.

Source: South African Weather Service

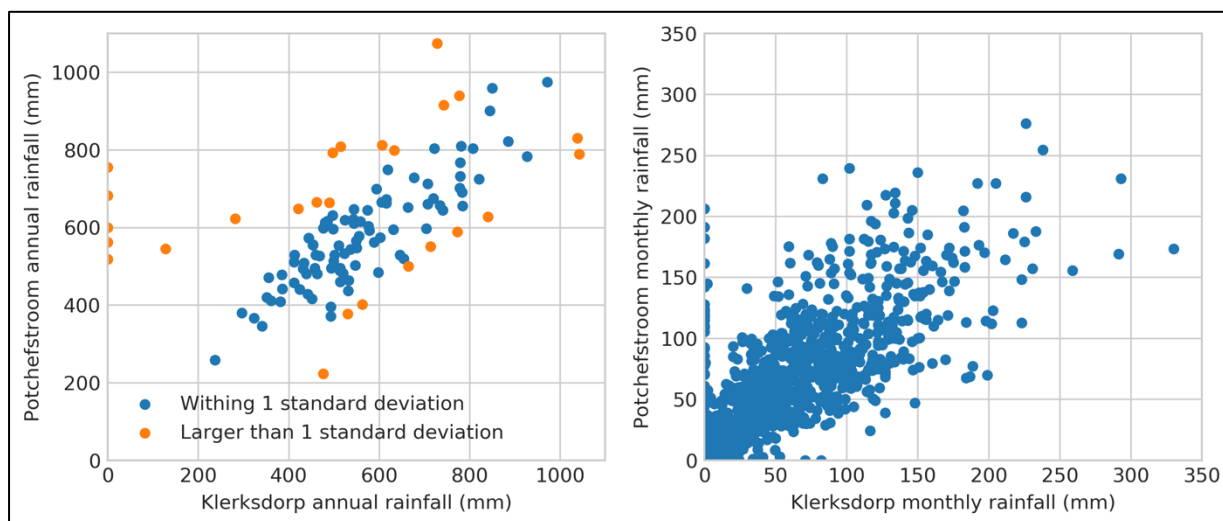


Figure 4: Scatter plot comparison of the annual (left) and monthly (right) rainfall observations at Potchefstroom and Klerksdorp between 1903 and 2018.

Source: South African Weather Service

Potchefstroom had two data points that were missing. This included January 1927 and November 1953. These data points were replaced by those of Klerksdorp, which observed 117 mm for January 1927 and 97 mm for November 1953. Additional years that were flagged for further investigation are shown in Table 6. The year 1999 had unrealistically low rainfall in Potchefstroom. The monthly records for the two stations for this year are shown in Table 6. January and February data for Potchefstroom was deemed to be erroneous and replaced with that of Klerksdorp.

A total of 4 data points of the Klerksdorp weather stations were eventually used to complete the Potchefstroom time series. Months where Klerksdorp observed more than 100 mm of rainfall than Potchefstroom are shown in Table 8. This occurred 10 times in the data record that spanned 115 years and 1380 months. It is conceivable that this large spatial variability occurs in the province. However, the accuracy and quality control of the South African Weather Service rainfall data remains a limitation of this analysis.

Table 6: Years where rainfall differed more than 1.5 time the standard deviation between Potchefstroom and Klerksdorp between 1903 and 2018.

Year	Potchefstroom	Klerksdorp	Representative
1918	788.7	1043.0	788.7
1971	808.7	515.0	808.7
1987	792.1	497.3	792.1
1996	1073.7	728.0	1073.7
1997	544.5	128.0	544.5
1998	561.6	0	561.6
1999	223.2	476.6	476.6
2013	622.8	281.9	622.8

Source: South African Weather Service

Table 7: Comparison of monthly rainfall of 1999 between Potchefstroom and Klerksdorp.

Year	Potchefstroom	Klerksdorp	Representative
Jan	0	82.0	82.0
Feb	31.0	88.4	88.4
Mar	32.0	67.0	32.0
Apr	11.4	5.2	11.4
May	24.0	27.4	24.0
Jun	0.6	1.2	0.6
Jul	0.0	0.0	0.0
Aug	0.0	0.0	0.0
Sep	0.0	3.0	0.0
Oct	16.8	43.8	16.8

Nov	26.0	38.4	26.0
Dec	81.4	120.2	81.4

Source: South African Weather Service

Table 8: Months where Potchefstroom had less than 100 mm of rainfall than Klerksdorp between 1903 and 2018.

Year	Month	Potchefstroom	Klerksdorp
1906	Mar	70.0	199.0
1934	Jan	240.0	430.0
1944	Nov	67.7	184.0
1954	March	47.2	148.0
1962	Feb	112.9	223.0
1966	Feb	173.5	330.0
1976	Feb	155.7	258.7
2006	Feb	68.6	186.8
2010	Dec	77.0	188.6
2017	Feb	169.2	291.2

Source: South African Weather Service

3.4.2 Development and distribution of questionnaires (Objectives 2 – 4)

A semi-structured questionnaire consisting of both closed-ended and open-ended questions was used to capture data for Objectives 2 – 4. The questionnaire consisted of four sections (Annexure A):

- **Section A** Demographic questions;

- **Section B** Questions on the characteristics of subsistence farming;
- **Section C** Questions on the perceptions and impacts of rainfall variability; and
- **Section D** Questions on adaption to with rainfall variability.

As a pilot study, the questionnaire was tested on three subsistence farmers who did not form part of the official sample used in the study. The feedback received from the farmers were used to improve the questionnaire and to enhance its validity and reliability. A purposeful sampling approach, in which subsistence farmers where targeted, was followed to distribute the questionnaire. In an effort to distribute as many questionnaires as possible, door-to-door visits was conducted. All farmers in the two communities (n = 30) were asked to consider participating in the study. A total of 20 farmers eventually agreed to complete the questionnaire. The questionnaire was administered by a translator (as most of the participants spoke Setswana) who captured and translated responses into English.

3.5 Analysis

3.5.1 Calculation of SPI (Objective 1)

Using the long term rainfall data for the Potchefstroom weather station, the standard precipitation index (SPI) was calculated. The SPI was calculated over the period between 1903 and 2018, but at five different temporal resolutions. These resolutions were 1 month, 3 months, 6 months, 1 year, and 2 years. The procedure proposed by McKee *et al.* (1993) and Edwards & McKee (1997) was followed to calculate the SPI. This included the following steps:

1. Compile a complete monthly rainfall dataset for the study area (this was described in section 2.4.1)
2. Sample through the time series at the relevant time scale, compiling a distribution function for each respective annual period. For example, if the scale of the SPI is monthly, this step will involve building distribution functions for all the Januaries, progressing through the next step, and then repeating it for February and the rest of the time steps.

3. Fit an appropriate statistical function to the particular distribution. For this analysis, the gamma functions were employed. This distribution has been shown to perform consistently well for dry areas over multiple time scales (Guenang & Kamga, 2014). This is defined as:

$$g(x) = \frac{1}{\beta^\alpha \Gamma(\alpha)} x^{\alpha-1} e^{-x/\beta} \quad \text{for } x > 0,$$

Alpha is the shape parameter; beta is the scale parameter; x the amount of precipitation; and tau is the gamma function.

4. The distribution is then transformed to a normal distribution.
5. Each data point in the time series for that particular scale is then presented as the probability of being observed in the context of the historical dataset.

It is then compared against the statistical magnitude for that time scale.

3.5.2 Analysis of questionnaire data (Objectives 2 - 4)

Responses from the questionnaires were digitized and stored in a Microsoft Excel format. Data were categorized and converted to tables. Descriptive statistics were calculated for quantitative measurements, while qualitative respondents were analysed for themes. The tables, statistics, and themes were used to interpret the responses for each of the questions and to identify possible trends.

3.6 Validity and reliability

According to Cooper & Schindler (2000), validity is the degree at which the study results accurately inform what is happening in a particular situation. Reliability refers to the consistency of information. For reliability, Cooper & Schindler (2000) argue that if a study is reliable, the same results would be obtained again if a survey is repeated. To address the issues of validity

and reliability, the researcher attempted to source as many participants as possible, apply appropriate methods, procedures, and techniques. Care was taken to transcribe responses in a succinct and precise manner to avoid any possibility of ambiguities, vagueness, or bias.

3.7 Ethical considerations

Cooper & Schindler (2000) state that “...*ethics is made up of norms and standards of behaviour that guide moral choices about our behaviour and our relationship with others. The goal of ethics in research is to ensure that no one is harmed or suffers adverse consequences from research activities.*” The research proposal and questionnaire were presented to a university ethical committee for approval. Throughout the research, the study adhered to the following requirements as prescribed by the code for ethical research:

- **Confidentiality:** Participants' rights to privacy were respected, and no information through which they could be identified was captured.
- **Honesty:** People's ideas were acknowledged and reported honestly.
- **Rights and obligations of respondents:** The researcher had an ethical responsibility to inform the respondents of the purpose and impacts of the research.
- **Informed consent:** The respondents were asked to consider their participation and to provide written consent if they decided to participate in the study. No one was forced to participate if he or she was not willing to do so.
- **Withdrawal:** Participants were informed that they may withdraw from the interview at any time.
- **Privacy:** The privacy of the respondents and/or participants was respected.

Permission to conduct the study was obtained from the North-West University.

3.8 Conclusions

Chapter 3 has discussed the research process followed in this study. The research design and data collection and analysis methods that were employed in this study were discussed. The next two chapters will present the findings of the research.

CHAPTER 4 – RAINFALL VARIABILITY IN THE NORTH WEST PROVINCE

4.1 Introduction

Rainfall variability impacts subsistence farmers. Pressure on food production and livestock is felt during abnormally dry and abnormally wet years. This is directly related to the climatic context of the region in question. Farmers in a dry area will adapt to these conditions as will those in areas that experience more rainfall. It is, therefore, important to characterize the local rainfall climatology in order to put the qualitative results into context. This section relates to the first objective. It will present the rainfall of the study area through the analysis of historical rainfall data for the Potchefstroom weather station, which was the station with the most comprehensive records (1903 – 2018), and representative of conditions in the region

4.2 Characterization of rainfall variability (Objective 1)

Rainfall varies on different time scales, ranging from days to decades. Each of these time scales has distinct physical phenomena that drive that particular rainfall anomaly. For the objectives of this study, it is important to consider time scales that link to the typical crops and needs of subsistence farmers in the North West Province. Rainfall variability will be discussed in terms of annual rainfall, monthly rainfall, and the SPI. The ultimate objective is to identify periods of meteorological droughts at different scales in the study area.

4.2.1 Annual rainfall

Table 9 and Figure 5 provide an overview of annual rainfall for the Potchefstroom weather station for the period of 1903 - 2018. It should be noted that the data points in figure 5 are fewer than the years from 1903-2018 because the computer programme that was used to draw the graph, which is Excel, reduces or excludes some data points depending on the size of the figure

such that the smaller the figure the more data points it excludes. Hence, in the case, of the dataset used some data points were excluded from the graph accordingly. This also applies to Figure 7. The mean annual rainfall for the 116 years is 601.1 mm. The Median is 593.6 mm, the standard deviation 148.2 mm. The lowest rainfall was recorded in 2002 and the highest in 1996. For the period before 1988, the mean is 8 mm higher than the recent 30 years. The standard deviation, as well as the inter quartal range, increased with more than 20 mm to 162.2 mm between the same two periods. It is also worth noting that both the wettest and driest years have been over served in the last 30 years.

Table 9: Annual rainfall statistics for Potchefstroom between 1903 and 2018

	Full time-series		Before 1988		After 1988	
Number of years	116		86		30	
Mean	601.1		617.4		554.2	
Standard deviation	148.2		140.4		162.2	
Minimum	258.6	In 2002	366.4	In 1903	258.6	In 2002
25 % percentile	495.4		520.8		447.6	
Median	593.6		598.5		522.7	
75 % percentile	673.3		701.0		647.1	
Maximum	1073.7	In 1996	974.2	In 1976	1073.7	In 1996

Source: South African Weather Service

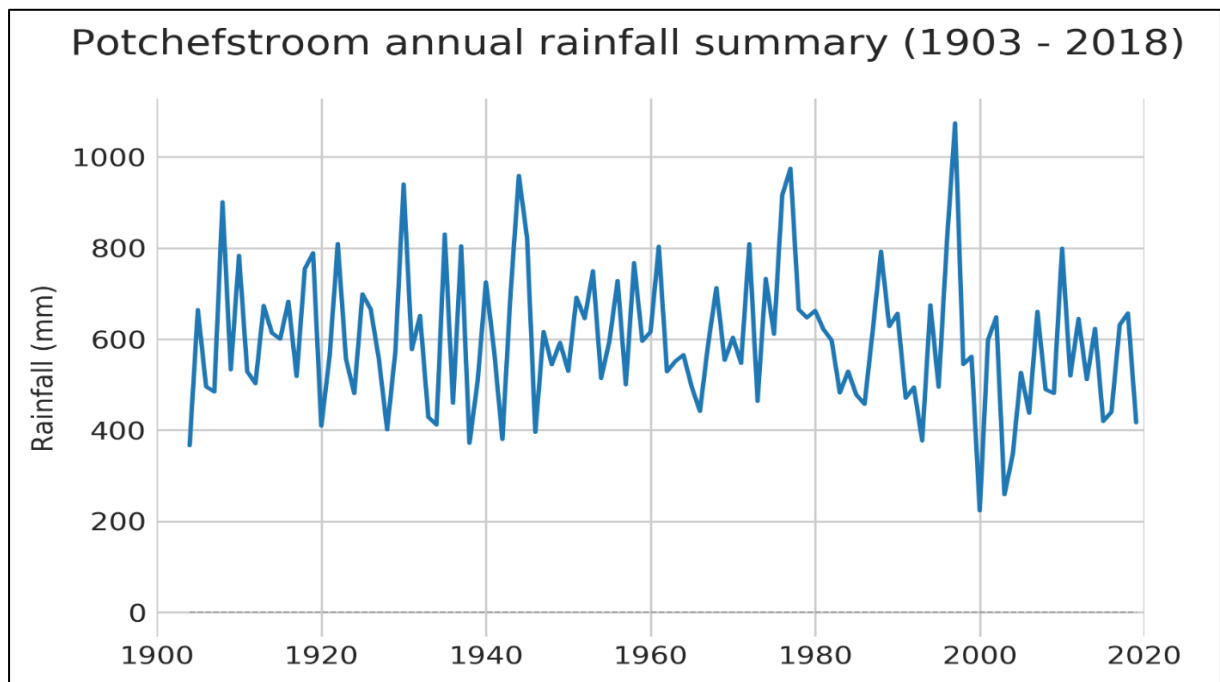


Figure 5: Annual rainfall for the South African Weather Service station in Potchefstroom between 1903 and 2018

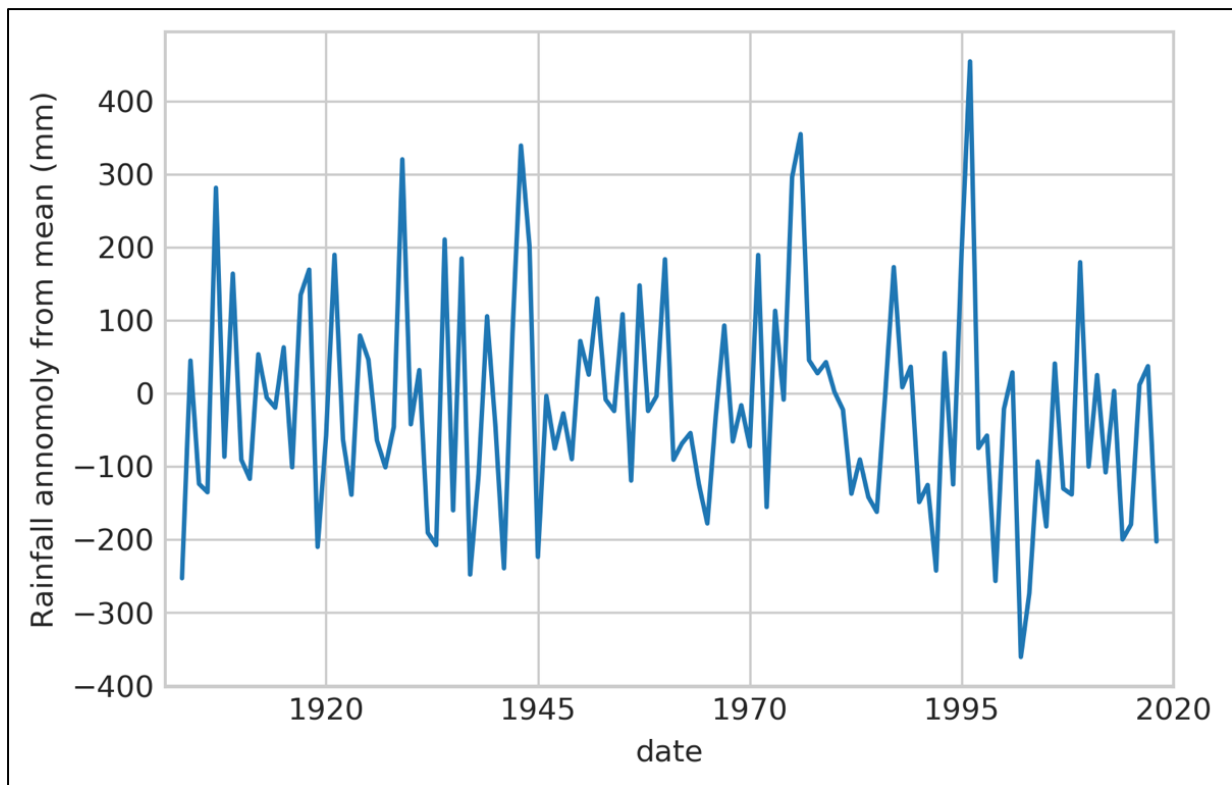


Figure 6: The anomaly of annual rainfall from 1960 to 1990 mean at the Potchefstroom South African Weather Service station.

Source: South African Weather Service

Figure 7 shows the anomaly of annual rainfall from the mean of the period 1960 to 1990. In this period, there was a departure from the long-term mean rainfall; the rainfall was higher than that of other periods. A Mann-Kendel trend test shows no trend, and did not achieve significance, for the whole time series (Z-statistic of -1.3 and a p-value of 0.2077). It also does not show a trend or a significant p-value for the period 1990 to 2018 (Z-statistic of -0.02 and p-value of 0.9851). A t-test for the periods in Table 9, however, shows a statistically significant difference in the mean annual rainfall for the last 30 years.

4.2.2 Monthly rainfall

Figure 8 shows the monthly rainfall variability in Potchefstroom. The rainfall season starts in September and ends in March. Some rainfall is observed during late autumn and winter. The month with the highest mean monthly rainfall is January (104 mm), closely followed by December (101 mm). High variability of rainfall can be observed with standard deviations half the mean for the months with the most rainfall, approaching the mean in the transition months, and multiple times the means of the winter months.

Table 10: Monthly rainfall statistics for Potchefstroom between 1903 and 2018.

	Number of months	Mean monthly rainfall	Standard deviation of monthly rainfall	Minimum monthly rainfall	25% percentage of monthly rainfall	50% percentage of monthly rainfall	75% percentage of monthly rainfall	Maximum monthly rainfall
Jan	115	104	53	0	61	97	136	254
Feb	116	91	49	8	58	78	113	239
Mar	116	78	46	1	46	72	97	276
Apr	116	43	36	0	15	35	58	160
May	116	18	21	0	2	9	28	110
Jun	116	7	15	0	0	1	9	104
Jul	116	6	15	0	0	0	4	83
Aug	116	9	17	0	0	0	10	100
Sep	116	18	23	0	1	8	26	118
Oct	116	51	40	0	24	45	62	231

Nov	115	75	42	0	41	76	103	170
Dec	116	101	48	22	61	91	132	236

Source: South African Weather Service

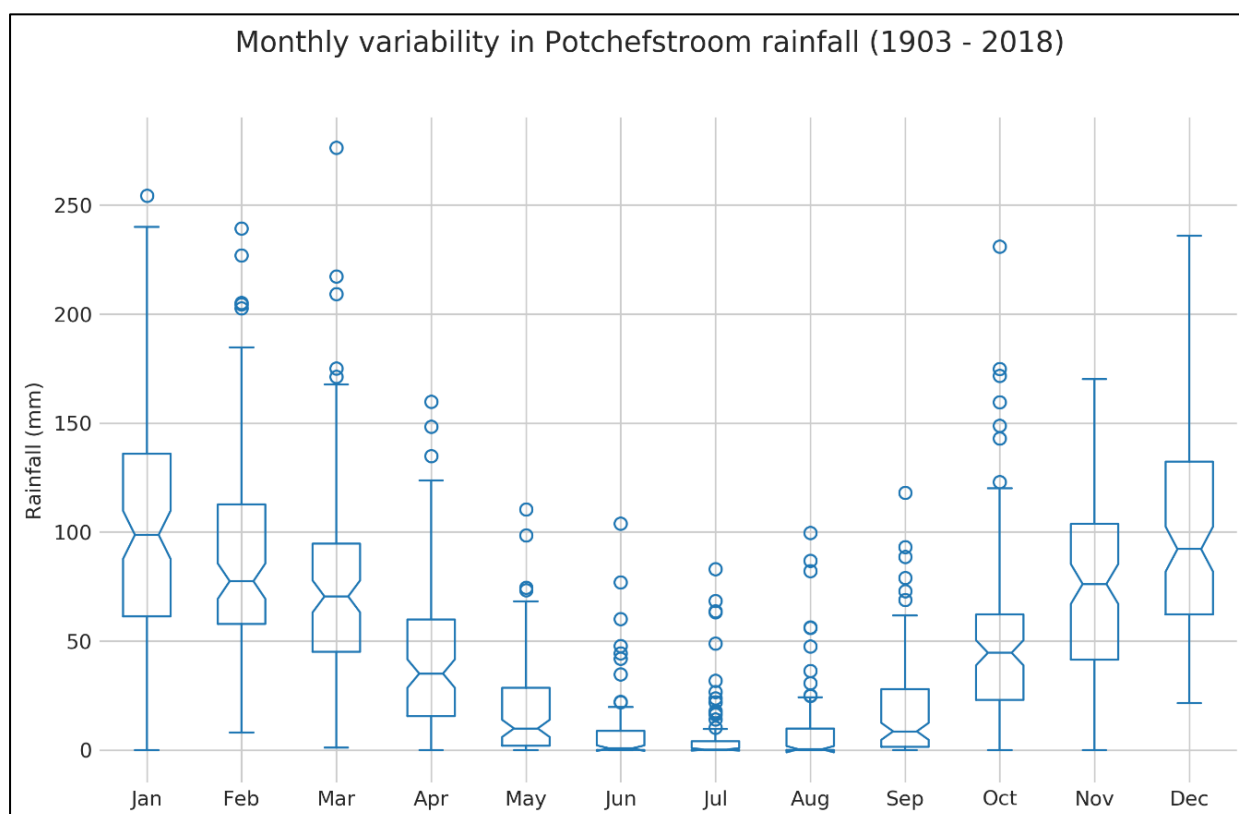


Figure 7: Monthly variability in Potchefstroom rainfall (mm)

Source: South African Weather Service

Months with the highest recorded rainfall include March 1921 (276.3 mm), January 1976 (254.4 mm), and February 1996 (239.4 mm). The start of the rainy season can be delayed to even November.

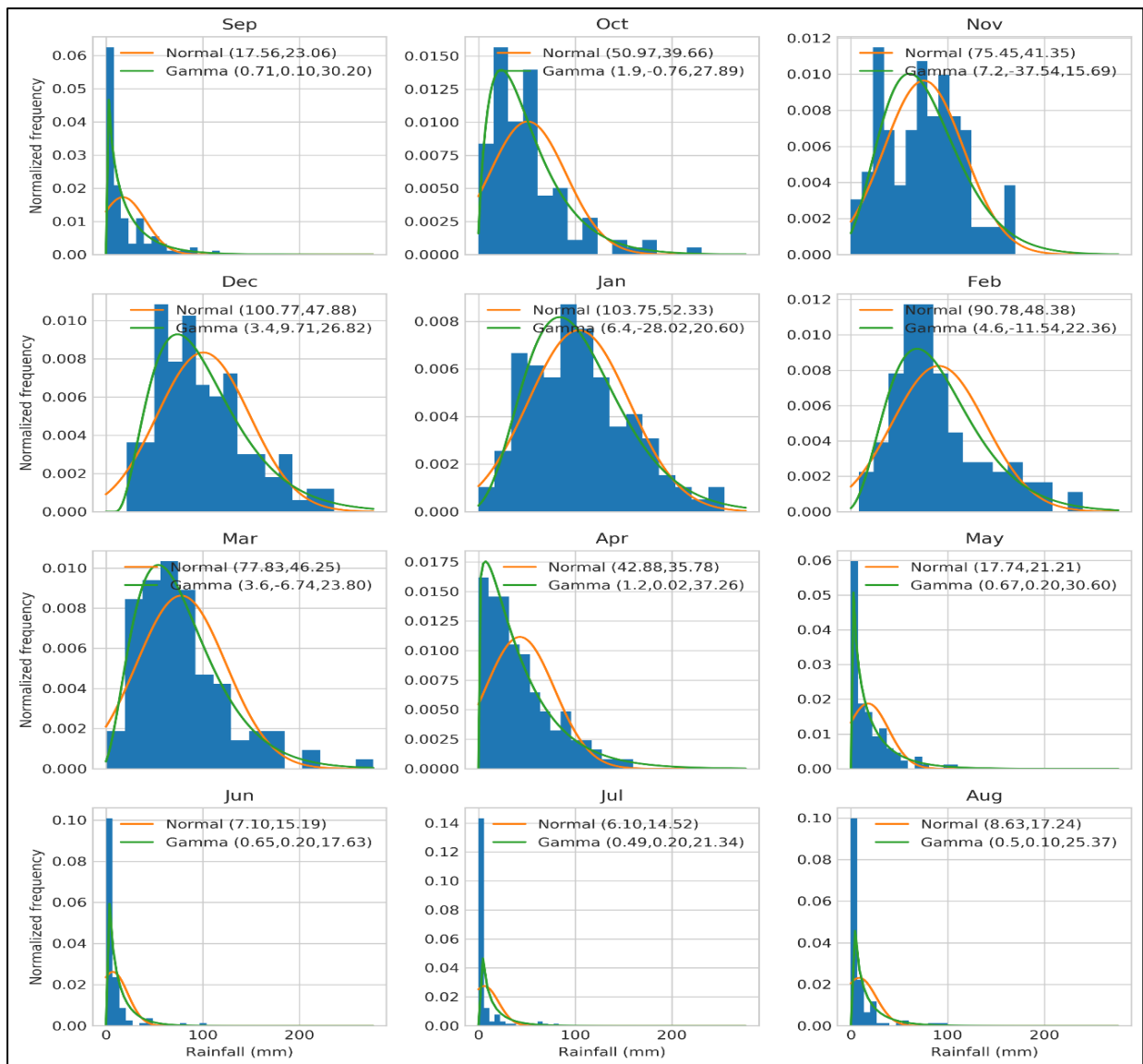


Figure 8: Frequency histograms of total monthly rainfall at the Potchefstroom South African Weather Service station between 1903 and 2018.

Figure 9 shows the frequency histograms of total monthly rainfall at the Potchefstroom South African Weather Service station between 1903 and 2018. The first observation is that the distributions of rainfall vary for the different months; it is not distributed equally monthly. It is limited in winter, that is, in the months of June, July, August, and September with a minimum rainfall of about 0 mm (for all the months) and a maximum rainfall of about 125 mm (in

September). The distributions of rainfall are more skewed towards zero in winter than in summer, and it varies more in summer than in winter, as would be expected

4.2.3 Droughts in the North West Province

Figure 11 shows the standard precipitation index (SPI) between 1903 and 2018 for different time scales for the Potchefstroom South African Weather Service station, while Figure 12 shows the SPI between 2014 and 2019. The general observation is that rainfall variability has increased over time with extreme rainfall events observed with higher frequency. Dry to extremely dry periods seems to have intensified in frequency since the 1990's. In the period between 2000 and 2010 the following seasons are regarded as seasons in which dry to extremely dry conditions were experienced: 2002/2003, 2004/2005, 2006/2007, and 2012/2013. The intensity of these dry spells, however, seems to have become less intense in the last few years, with the 2015/2016 season being the driest. Some very wet to extremely wet periods were also observed during the period, but none have been observed since the 2000s when considering one-year and two-year averages.

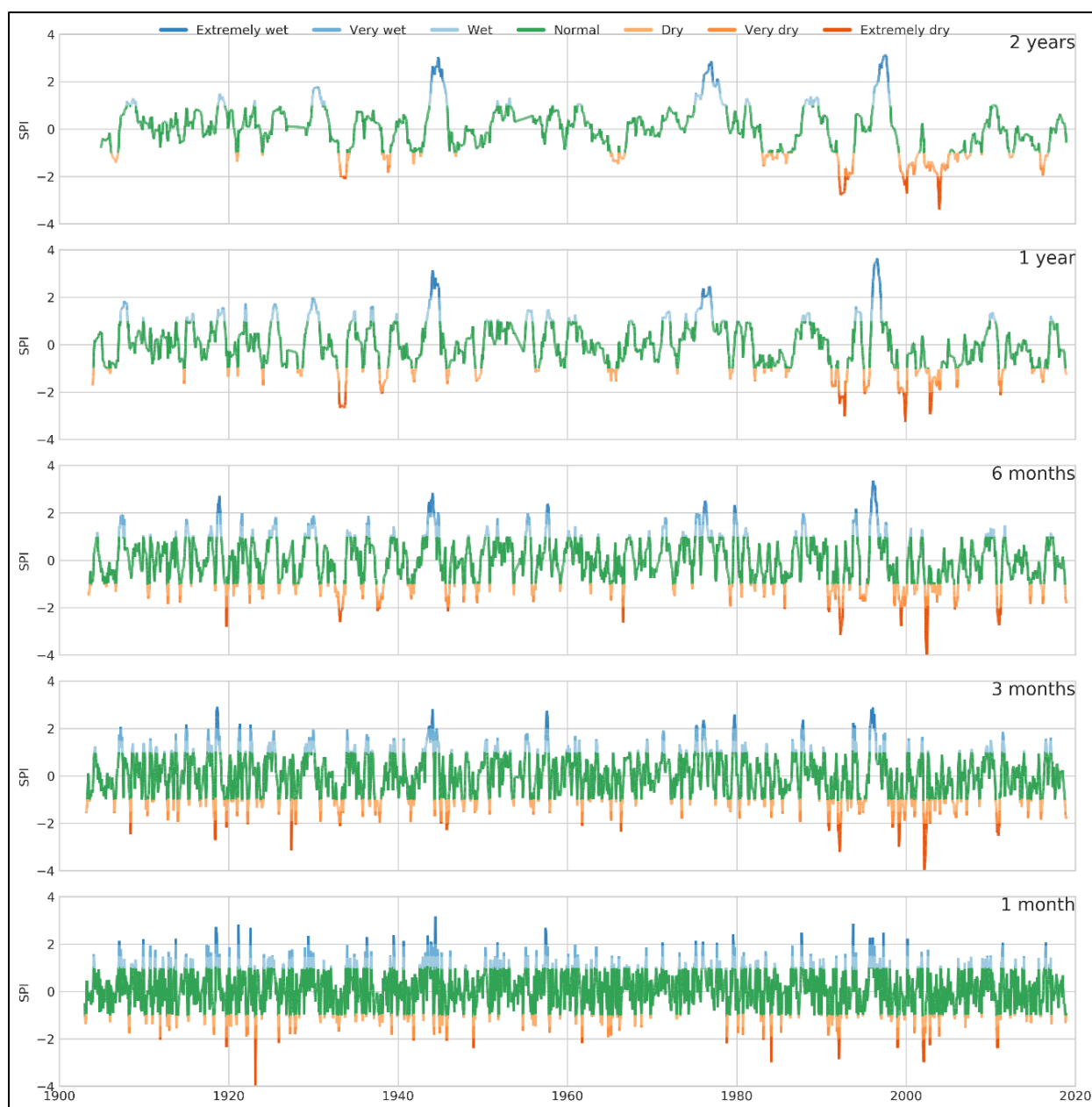


Figure 9: The standard precipitation index (SPI) between 1903 and 2018 for different time scales for the Potchefstroom South African Weather Service station.

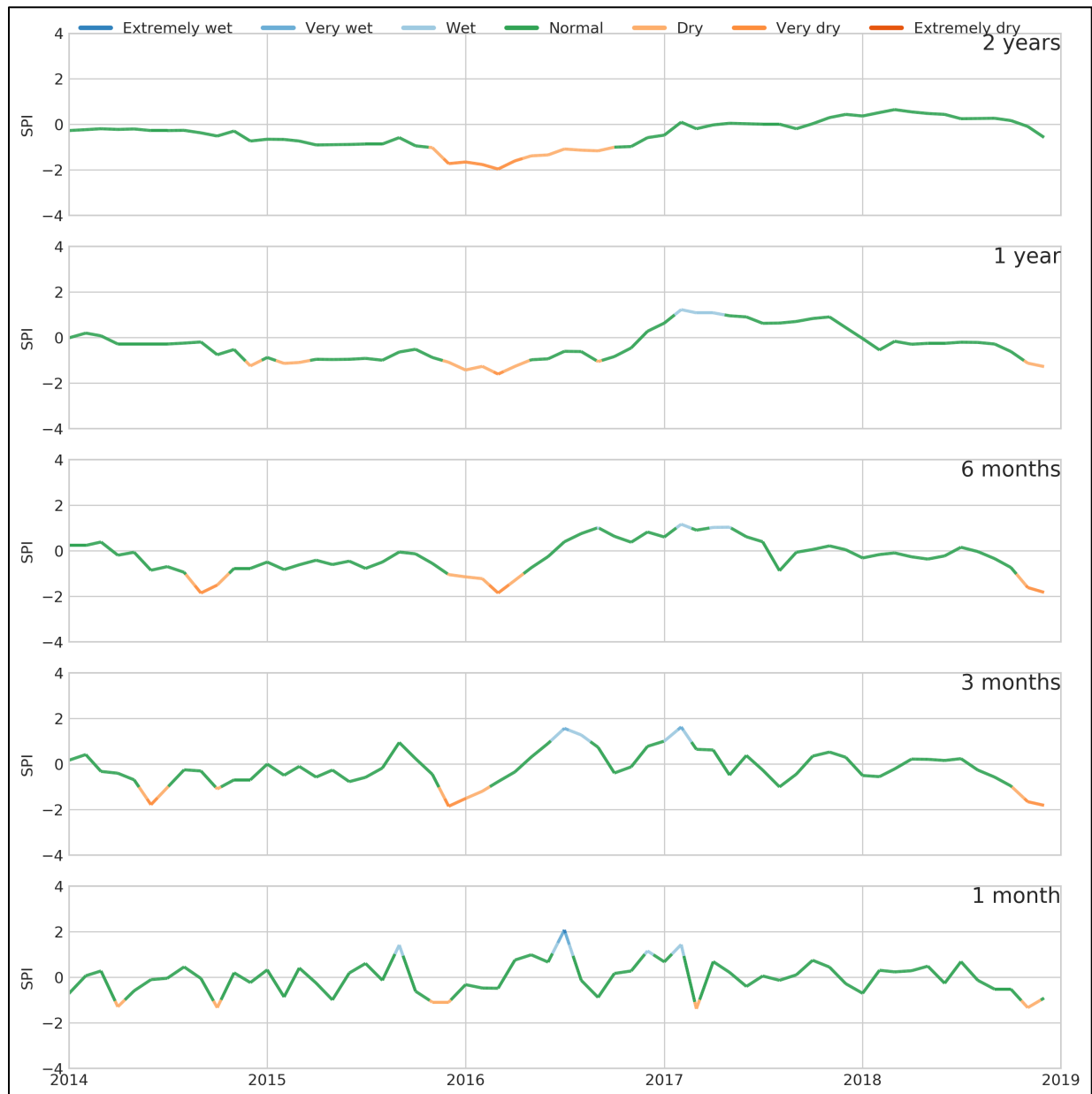


Figure 10: The standard precipitation index (SPI) between 1903 and 2018 for different time scales for the Potchefstroom South African Weather Service station.

4.3 Conclusion

This chapter presented data on rainfall variability in the region as measured for the Potchefstroom South African Weather Service rainfall station. There seems to be a trend of decreasing annual rainfall in recent years, i.e. the area is becoming drier. The data shows that rainfall varies considerably between months, but is consistently higher in summer months between November and February. Rainfall variability, in general, seems to have increased over time, which supports the findings of Moeletsi *et al.*, (2011) which says that there was a reduction in annual rainfall in some parts of South Africa, as well as a significant boost in rainfall throughout the wet season in other parts (see also Kusangaya *et al.*, 2014). The SPI analysis further indicated that the occurrence of dry to extremely dry spells has been on the decrease since the latter half of the 1990s.

CHAPTER 5 – SUBSISTENCE FARMING AND RAINFALL VARIABILITY

5.1 Introduction

Chapter 4 presented data on the rainfall variability observed in the Potchefstroom region between 1903 and 2018. This chapter presents the results obtained through the questionnaires and specifically addresses **Objectives 2, 3, and 4**. **Objective 2** entailed the characterization of subsistence farming in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities, while **Objective 3** investigated subsistence farmer's perceptions on rainfall variability and droughts. **Objective 4**, finally, dealt with the perceived impacts of rainfall variability on the crop production of subsistence farmers.

5.2 Demographic profile of respondents

As discussed in Chapter 3, 20 farmers completed questionnaires, of which 17 were from the Bakwena Ba Ga-Mogopa community and 3 from the Bafokeng Ba Ga-Motlatle community. The two groups were treated as one as they lived in close proximity and are very similar. The gender and age characteristics of the respondents will now be discussed.

5.2.1 Gender

Table 11 shows the number and percentage distributions of respondents by gender. The majority of respondents (95%) were male, which might imply that very few women are directly involved in agriculture, and more specifically, subsistence agriculture in the sampled communities. This does not mean that women are not involved at all, but are likely not in charge of the farming activities. This finding partially agrees with other statistics (HSRC, 2012; Stats SA, 2016), which indicates that women are still largely marginalized in the South African agricultural sector. However, the difference between male and female-headed agriculture

households in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities is more extreme than in South Africa in general (Stats SA, 2016). This finding however might have been biased by the fact that the sample used in this study may not have been a good representative of the entire target population.

Table 11: Gender

Gender	Number	Percentage (%)
Male	19	95
Female	1	5

Source: Author

5.2.2 Age

Table 12 shows the frequency and percentage distributions of respondents by age group. The majority of farmers (50%) fell in the age group of 46 - 50 years, followed by the 50+ age group (35%). This compares to national statistics, which indicate that approximately 62% of agricultural household heads (for all types of agriculture) in South Africa, and 64% in the North West Province, were older than 46 years of age (Stats SA, 2016). This number also agrees with other studies, such as Van den Berg (2013), who sampled three villages in the Limpopo Province and found more than 70% of subsistence farmers to be older than 51 years. These numbers suggest that younger people are generally not very involved in subsistence farming, especially not as household heads. Like in the case of gender, this finding might have been biased due to the fact that the sample used in this study may not have been a good representative of the entire target population.

Table 12: Age

Age group	Frequency	Percentage (%)
31-35	1	5.0
36-40	1	5.0
41-45	1	5.0
46-50	10	50.0
51+	7	35.0
Total	20	100.0

Source: Author

5.3 Characterization of subsistence farming in the North West Province (Objective 2)

This section presents the finding for the characterization of subsistence farming in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities and deals directly with **Objective 2**. The following sub-sections each reflect on a different characteristic of subsistence farmers and together provide a characterization.

5.3.1 Nature of farming activity

The results indicate that only 40% of farmers practice subsistence farming on a full-time basis, while the rest of them regard themselves as part-time farmers. This is because many of the farmers have to find additional sources of income to sustain their families. These sources of income were reported to often be in the form of part-time jobs and, in most cases, were in towns and on farms in close proximity to their communities. This implies that many subsistence farmers are unable to sustain themselves and their families through their farming activities alone.

5.3.2 Number of years' experience

All of the farmers that participated in the study had more than 5 years but less than 15 years of farming experience (Table 13). A total of 55% reported having 5 – 10 years of experience, while the remaining 45% reported 10 – 15 years. When comparing these figures to the ages of farmers, it suggests that most farmers only started farming at the age of 30 or older. This suggests that they first attempted other means of employment before starting to farm. It might also be that farming land only became available to them in their 30s. This would then also explain why none of the participants in the study were younger than 30 years of age. This finding might also have been biased due to the fact that the sample used in this study may not have been a good representative of the entire target population.

Table 13: Farming expertise (in years)

Farming experience (in years)	Frequency	Percentage (%)
0-5	0	0
5-10	11	55
10-15	9	45
15-20	0	0

Source: Author

5.3.3 Training received

Although none of the farmers reported any formal training in the form of diplomas or degrees, the majority are exposed to some sort of training in the form of workshops or short training courses (Table 14). Just over half of the participants (55%) attended workshops offered on a

monthly basis by either the Department of Agriculture or non-governmental organizations (NGOs). Farmers stated that workshops gave them insights on better ways of managing their farms with the aim of maximizing crop and animal production, thereby eventually ensuring food security. Reported topics that were covered included things like what cultivating methods should be applied when growing certain crop types, how and when fertilizers should be applied, which crops to plant at what times, how and when pesticides should be applied, and how drought conditions should be managed. Some of the respondents also reported attending practical training sessions, which were offered by a wide range of stakeholders from government departments to private agricultural firms. Only two participants reported receiving no form of training. This finding might also have been biased due to the fact that the sample used in this study may not have been a good representative of the entire target population.

Table 14: Training

Nature of Training	Service provider	Frequency
Workshop	Dept. of Agriculture or NGO	11
Practical training	Dept. of Agriculture, Dept. of Rural Development, NGO, Buhle Agricultural Academy, or other private companies	7
No training		2
		20

Source: Author

5.3.4 Types of crops grown

Farmers reported planting maize, sunflower, beans, peanuts, and vegetables (Table 15). All of the farmers planted sunflowers as either their primary or secondary crop. It was further found that maize and sunflower were often planted together. Only three farmers did not plant maize, and all three planted only sunflowers. Although the majority of farmers diversified their crops by planting maize and sunflowers, only four farmers diversified beyond this diversification. Two farmers reported planting beans in addition to maize and sunflowers, while one reported also planting peanuts and another reported also planting vegetables. These results support the literature (e.g., Mavengahama *et al.*, 2013 and Walker *et al.*, 2011), which suggests that the major crops grown by subsistence farmers in South Africa include maize and that other minor crops such as peanuts, dry beans, tobacco, and potatoes, are sometimes added in an effort to diversify, but also to replenish soil nutrients.

Table 15: Types of crops

Primary crop	Secondary crop	Other crops	Frequency
Maize	Sunflower		13
Sunflower			3
Maize	Sunflower	Beans	2
Maize	Sunflower	Peanuts	1
Maize	Sunflower	Vegetables	1
			20

Source: Author

5.3.5 Reasons for selection of certain crop types

Farmers provided a variety of reasons for why they opted to plant specific crops (Table 16). Interestingly, the main reason provided by farmers was the ability of a crop to withstand drought conditions, as is evident from the response of one farmer who stated that **“I select my crop based on the way in which it can deal with drought.”** Although the majority of farmers decided on crop types based on its drought resistance capabilities, others chose to plant certain crop types based on the effort it takes to maintain the crop and based on the recommendations from officials from the Department of Agriculture. Other reasons provided were the availability of funding and the theft risk associated with a crop.

Table 16: Reasons for the selection of certain crops types

Reason	Frequency
Crop selected based on the ability to withstand drought	6
Crop selected based on maintenance effort	3
Crop selected based on a recommendation from the government	3
Crop selected depending on the rainfall availability	1
Crop selected to ensure food availability	1
Crop selected for a trial	1
Crop selected based available funds	1
Crop selected based on risks of crop theft on the farm.	1
No response	3
	20

Source: Author

5.3.6 Farming resources and field preparation

The majority of farmers (95%) reported that they have access to the necessary resources needed for farming (Table 17). Resources mentioned included tractors, planters, disc ploughs, fertilizer, seed, and pesticides. Only one respondent indicated having no access to resources, stating that **“I don’t have farming resources because I lack money for buying seeds, fertilizers, and farm equipment.”** Although farmers did not own all the equipment mentioned, the equipment was accessible through various means. Farmers reported that they mostly prepare their fields by ploughing with some sort of mechanized equipment. Farmers mostly prepared their fields for planting before the end of November (75%), although some reported going into December (25%), depending on the rainfall pattern. Seeds were mostly planted using mechanized equipment such as planters.

Table 17: Farming resources

Farming resources	Frequency
Tractor, planter, disc plough, fertilizers, seeds, pesticides and cultivator	19
No farming resources	1
	20

Source: Author

5.3.7 Planting and harvesting periods

Most farmers (85%) reported that they started planting their crops somewhere between November and January, depending on the season. Harvesting times were reported to be between June and July. Some farmers stated that there seems to be a shift in planting dates and that they often now have to plant in January. This change can be ascribed to the effects of climate change and its impact on weather patterns. It is important to note that farmers do field preparations, and attempt to plant timeously with the objective of timing the rainfall season.

However, about half of the farmers indicated that, although they plan, planting is often delayed due to changes in rainfall patterns. It was also stated that these delays eventually often affect their harvesting season as well.

5.3.8 Application of fertilizers

Farmers offered a variety of reasons for applying fertilizers to their fields (Table 18). The most frequently mentioned reason (65%) can be summarised by the comment of one farmer who stated that he applies fertilizer because “...it [is] **effective, good at giving a high yield and contains all the nutrients for the plants.**” Fertilizers were therefore used mainly because of their ability to increase expected yield. Although farmers could not always provide the exact composition, it was established that all farmers applied some form of chemical fertilizer. Three of the farmers indicated that they apply fertilizer because of the advice they received after analysis of soil samples were conducted. This is indicative of a shift towards a more scientific approach to farming amongst some farmers. One farmer stated that fertilizer was used to manage the PH of the soil, while three others did not provide clear reasons.

Table 18: Summary of reasons why farmers apply fertilisers

Reasons	Frequency
Apply fertilizer because it contributes to high yield and offers nutrients for the plants	13
Apply fertilizer because it was recommended through the analysis of soil samples	3
Apply fertilizer because it assists in controlling the Ph in soil	1
No clear reasons supplied	3
	20

5.3.9 Application of herbicides and pesticides

The majority of farmers indicated that they use only herbicides on their fields (12), while a few (2) also reported using pesticides. One farmer reported using both herbicides and pesticides, while five reported using neither. These farmers explained that they rely on other methods to manage weeds and opt to plant crops that are resistant to most pests. The reasons offered for using herbicides were their ability to kill weeds and the fact that they are often provided to farmers by the Department of Agriculture. Some respondents, however, also mentioned the use of herbicides for killing insects in addition to killing weeds. This might be indicative of the erroneous use of herbicides in some cases.

Table 19: Type of pesticides and herbicides

Type of pesticides or herbicides	Reason	Frequency
Herbicides only	• Effective on killing weeds • Supplied by the Department of Agriculture • Kills pests	12
Pesticides only	• It is effective in killing pests	2
Combination	• To kills both pests and weeds	1
No use reported		5
		20

5.3.10 Preparations for drought periods

Approximately 50% of farmers stated that they prepare themselves for the possibility of drought in some way. These farmers reported that they employ strategies such as saving food, saving money, and selling sunflowers to get the money that could sustain them in periods of drought. Some farmers further stated that they rely on insurance policies to assist them during periods of droughts (10%). Those who reported that they generally do not prepare themselves for droughts argued that they do not prepare for drought because they “**do not know when the drought will strike**” (40%) and “**do not have money and irrigation systems**” (20%) to use in planning. The group of farmers that did not prepare was also the farmers that reported to be most affected by periods of droughts.

5.3.11 Duration and number of growing seasons in a year

Farmers only planted crops in one growing season, which was effectively the summer season. The length of the season reported was affected by the crop type but was generally between six and seven months. This is expected as the region is characterized by only one rainy season in which rain-fed crops can be planted.

5.3.12 Sources of income

As mentioned earlier, many farmers do not depend exclusively on farming for their survival. Some farmers reported having jobs that bring additional income into the household. However, regardless of additional jobs, income from farm produce was still cited as the primary source of income for most farmers, followed by income from temporary or part-time jobs and financial support from family members working in urban areas. In addition to these sources of income, some farmers also reported receiving government grants as well as other forms of government support, which is further discussed in the next section.

5.3.13 Support from government

The majority of farmers (80%) stated that they are dependent on government assistance in terms of both technical and financial assistance. The government, through the Department of Agriculture, Forestry, and Fisheries, offers training and workshops, provides seed, fertilizers, pesticides, farm equipment, tractors, diesel, planters, and disc ploughs to assist farmers. The government's intervention and assistance are to objectively empower subsistence farmers in order to maximize farming production. In so doing, unemployment, poverty, and hunger are alleviated. However, according to some of the respondents, government grants for farming are not available every year. Four respondents (20%) said that the government is not doing enough to support them.

5.4 Perceptions of subsistence farmers on rainfall variability (Objective 3)

This section presents the finding on the perceptions of subsistence farmers on rainfall variability, i.e., **Objective 3**. The literature review noted the importance of considering the perceptions of subsistence farmers as they are indicative of the knowledge and understanding that farmers have on rainfall variability, which in turn, influences their response strategies.

5.4.1 Understanding of fundamental concepts

Climate

Farmers had varied understandings of climate and used different terms to explain it. Some farmers accurately defined climate rainfall and temperature patterns prevailing over a region over a long period of time. Others took a more short-term approach, describing it as the temperature and rainfall conditions experienced on any given day.

Weather

Most farmers understood the weather as specific conditions that are experienced at a given locality. Phrases such as **"hotness or coldness of a place"**, **"how wet or dry a place is"**, and **"sunny or cloudy"** were used. Some farmers explicitly stated that weather concerns the changes in temperature and rainfall **"on a day to day basis"**.

Rainfall variability

Although the term rainfall variability was not well known to participants, they commented on their understanding of the concept of drought. The general perception of farmers was that drought means **"not having rain, or having a shortage of water"**. The phrases shared by the respondents included: **"little or no rainfall"**, **"when crops cannot grow well because of little rain or too much heat"**; and **"low percentage of water to grow up plants"**. Most farmers linked the concept of drought to its effects on crop production.

Climate change

All the respondents agreed that conditions are changing. The following excerpts provide some insight into their understanding:

"...we now have many droughts because of lack of rainfall these times are not like in the past."

"...climate is hotter and drier because in some years the rainfall is very little or not at all."

"...rain is becoming short nowadays unlike in the past."

"...the rain does not come on time, sometimes it comes late, it does not rain the time we expect it, and we plant late sometimes."

"...rainfall do not occur one time and overheating during some months."

"...rains are abnormal - some parts of the province receive low and others more rainfall percentages."

Almost all the respondents (90%) were of the opinion that the weather/climate conditions are changing, i.e., referring to climate change, and that it would continue to change. Only one participant did not respond to the question. Furthermore, the vast majority of the respondents (90%) agreed that climate change is affecting them as farmers.

5.4.2 Perceptions on the occurrences of droughts

Although all farmers did not report experiencing droughts, events were mentioned for almost every year between 2006 and 2018, except for 2008, 2009, and 2010 (Table 20).

Table 20: Drought incidences recalled by farmers

Year mentioned	Frequency of mentions
2006	1
2007	1
2008	
2009	
2010	
2011	1
2012	2
2013	2
2014	4
2015	4
2016	1
2017	3
2018	2

Although farmers did not necessarily recall seasons of drought, they mentioned years which they recalled to be drier. From the SPI analysis presented in Chapter 4, the following seasons were regarded as seasons in which dry to extremely dry conditions were experienced: 2002/2003, 2004/2005, 2006/2007, 2012/2013, and 2015/2016. Many of these dates were mentioned by farmers, with the more recent events being mentioned more frequently. Interestingly, 2017 was mentioned by the farmers but did not reflect in the SPI results (except for a few months with low rainfall).

5.4.3 Effects of rainfall variability on subsistence farmers

Upon explanation of the concept, most farmers were of the opinion that rainfall variability has adverse effects on subsistence farming as it decreases the yield of crops and, subsequently, the farm income. Asked about why they would say rainfall variability is to blame, farmers provided the following responses:

“...lack of enough rainfall causing crops to die.”

“...drought causing damage to sunflower and reducing the yield.”

“...crops suffering from getting enough water during the growing of seedlings.”

Farmers, therefore, mainly associated rainfall variability with the absence of rainfall and moisture in the soil. The impacts are explored further in the next section.

5.5 Perceived impacts of rainfall variability on crop production (Objective 4)

This section relates to **Objective 4** and presents the perceived impacts of rainfall variability on subsistence farming. Rainfall variability is perceived to affect subsistence farmers, mainly due to its association with the occurrence of droughts and changes in rainfall patterns. Farmers reported that the effects of rainfall variability could lead to crop failure, lower yields, and to a lesser extent, longer growing periods. It should, however, also be noted that some farmers stated that in periods of higher rainfall, also associated with rainfall variability by some of the farmers, high yields are often experienced.

Farmers further stated that they plant crops with an expected yield in mind. This expectation depends on various factors, such as rainfall, resource availability, and management practices. Expected yields can be categorized into three groups which are, conservative yield, likely yield, and target yield. More than half of the farmers (60%) stated that expected rainfall and observed variability in rainfall affected their expectations. It was implied that expectations are often lowered as a result of rainfall variability.

5.6 Conclusion

5.6.1 Characterization of subsistence farming (Objective 2)

Subsistence farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities in the North West Province are mainly reliant on agriculture for their survival and as a primary source of income. The following characteristics of subsistence farmers in these communities can be highlighted:

- Sunflowers and maize are the crops that are most frequently planted by farmers, and very few farmers diversify beyond these crops.
- The ability of a crop to withstand drought is the leading factor when farmers make decisions on what to plant.
- Farmers generally have access to the resources needed to prepare and plant their fields.

- Farmers usually prepare their fields for planting around November and start planning once the rain arrives. They tend to plan their planting time according to the expected rain period.
- Farmers mainly rely on fertilizers and herbicides to improve their yield.
- Many farmers are well aware of the risks associated with droughts and make an effort to prepare for it.
- Farmers are heavily reliant on government support in the form of grants, resources, and advice to enable them to farm successfully.
- Farming remains a major source of income and food for farmers.

It should be noted that because of the nature of the sample and the fact that the characteristics of the respondents could not be extrapolated to the characteristics of all the subsistence farmers in the region, conclusive statements that assign the characteristics of the respondents to characteristics of the entire subsistence farming population in the area were avoided.

5.6.2 Perceptions of subsistence farmers on rainfall variability (Objective 3)

Although farmers were not always able to accurately differentiate between the concepts of weather and climate, the vast majority of farmers perceived climate change as a reality, and were able to describe its effects. Farmers were able to, at least to some extent, identify periods in which high rainfall variability was experienced in the region. Farmers perceived rainfall variability as having a negative impact on them. They associated rainfall variability mostly with the absence of precipitation and argued that it leads to a decrease in yield and also loss of income.

5.6.3 The impact of rainfall variability on crop production of subsistence farmers (Objective 4)

Drought reduces the ability of plants to grow well and could, in extreme cases, result in crop failure. Farmers perceived rainfall variability to affect the success of their crops in that it

potentially produces lower yields as a result of a decrease in rainfall. Farmers further stated that it is difficult to estimate potential yield in the face of rainfall variability and that expectations often have to be adapted. A final impact of rainfall variability is its impact on the food security of subsistence farming households. When rainfall variability negatively affects yield and production, households will have less food to consume and sell and this might lead to situations where farmers are unable to support their families.

The following chapter provides the concluding statements of the study.

CHAPTER 6 – CONCLUSION

6.1 Introduction

Chapters 4 and 5 presented and discussed the results. This chapter presents the conclusions and recommendations of the study based on the findings from these chapters. Concluding remarks are provided for each of the study objectives.

6.2 Concluding remarks

It has been found that:

- Sunflowers and maize are the crops that are most frequently planted by farmers, and very few farmers diversify beyond these crops.
- The ability of a crop to withstand drought is the leading factor when farmers make decisions on what to plant.
- Farmers generally have access to the resources needed to prepare and plant their fields.
- Farmers usually prepare their fields for planting around November and start planning once the rain arrives. They tend to plan their planting time according to the expected rain period.
- Farmers mainly rely on fertilizers and herbicides to improve their yield.
- Many farmers are well aware of the risks associated with droughts and make an effort to prepare for it.
- Farmers are heavily reliant on government support in the form of grants, resources, and advice to enable them to farm successfully.
- Farming remains a major source of income and food for farmers.

Objective 1: Characterize rainfall variability in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities.

The analysis showed that the average rainfall seems to be decreasing over time. In recent years dry to extremely dry conditions were experienced in: 2002/2003, 2004/2005, 2006/2007, 2012/2013 and 2015/2016. In addition to these dry spells, rainfall variability seems to be increasing over time. This implies that both dry to extremely dry conditions, as well as wet to extremely wet conditions, might become more frequent in the future. As a general trend, the area is becoming drier. This increase in variability, coupled with a trend of lower average annual rainfall, will ultimately have an impact on subsistence farmers. It can be expected that this impact will become more significant over time as the area becomes drier, especially as farmers are reliant on rainfed agriculture for survival.

Objective 2: Characterize subsistence farming in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities.

The literature indicated that South Africa has a dual agricultural economy, with both well-developed commercial farming and subsistence farming in rural areas. According to Baiphethi & Jacobs (2009), approximately 4 million people were involved in subsistence farming in the late 2000s. Subsistence farming is not only a critical contributor to food security in South Africa, but also offers a means of occupation for many people. According to literature, most subsistence farmers in South Africa produce food for their own consumption, although some do market their products as well (Baiphethi & Jacobs, 2009). This was also the case for farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities in the North West Province who were found to be heavily reliant on their farming produce for survival. It was established that farmers in these communities were mainly male and older than 40 years. Farmers had limited formal training and depended on input from government officials and workshops to inform their farming practices.

Decisions on which crops to cultivate was mainly influenced by the ability of crops to withstand drought and maize and sunflowers were found to be favoured by farmers. Farmers generally did not diversify beyond these two crops, and only in isolated cases did farmers plant more than two crops per year. Farmers generally had access to the resources needed to cultivate their fields and were often supported by the government with access to implements, fertilizers, herbicides, and seeds. Subsistence farmers, however, still struggle to produce high yields and are generally still struggling to survive. It could be argued that subsistence farmers are heavily dependent on government support for their survival.

Objective 3: To establish how subsistence farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities perceive rainfall variability and droughts

According to the literature, it is essential to understand perceptions as they have a direct influence on the planning and decision-making processes of subsistence farmers (Alessa *et al.*, 2008; Danielsen *et al.*, 2005). Although farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities were not always able to clearly distinguish between the concepts of climate and weather, they were able to describe the effects of climate change as they perceive it. Farmers generally perceived rainfall patterns as changing and stated that rainfall was decreasing in their region. They also stated that they expect rainfall to become less in the future since it has become more erratic, and that the rainfall season seemed to have moved to later in the year.

Farmers generally related rainfall variability to droughts and therefore associated rainfall variability mostly with the absence of precipitation. Farmers were, furthermore, able to identify periods in which they were subject to droughts. These periods mostly coincided with verified drought periods as discussed in Chapter 4.

Objective 4: To assess the perceived impact of rainfall variability on crops of subsistence farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities

According to Sledgers (2008), farmers generally perceive droughts as the primary factor influencing crop productivity. This perception was confirmed in the study as subsistence farmers in the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa communities viewed rainfall variability as the most significant factor affecting their yield. Although some of the farmers attempted to plan for periods of drought, they still struggled to maintain adequate yields during such periods. It was further found that rainfall variability has a direct impact on the livelihoods of subsistence farmers as it affected their income and food sources.

The aim of this study was to investigate the impact of rainfall variability on subsistence farmers in the North West Province of South Africa. The study focused on two communities in the province, namely, the Bafokeng Ba Ga-Motlatle and Bakwena Ba Ga-Mogopa. The study concludes that rainfall variability is directly affecting the livelihoods of subsistence farmers in both of these communities. Due to their socio-economic status and their dependency on external role players, such as government, subsistence farmers are even more vulnerable to changes in rainfall as even a small difference in yield could have significant implications for them.

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ANNEXURE

THE IMPACT OF RAINFALL VARIABILITY ON SUBSISTENCE FARMERS IN THE NORTH WEST PROVINCE, SOUTH AFRICA

Introduction

You are requested to participate in a research study conducted by Edward Serumga-zake (student) under the supervision of Dr. Dirk Petrus Cilliers (main study leader) and Dr. Reolof Burger (co-study leader), from the North-West University – Department of Geography and Environmental Management. The results will form part of a master's thesis in Geography and Environmental Management. You were purposively selected as a possible participant in this study because of your involvement and experience in farming in the region.

Purpose of the study

The study investigates the impact of rainfall variability on subsistence farmers.

Procedures

If you volunteer to participate in this study, you would be requested to do the following:

- Agree to an interview.
- Share your knowledge and experiences.

Potential risks and discomforts

No risks or discomforts of the interviewee are foreseen. If any situation should occur, the interview will be stopped.

Potential benefits to the interviewee and/ or society in general

The study contributes to the understanding of the impacts of rainfall variability on subsistence farmers. It further provides insights on the way in which rainfall variability is perceived by subsistence farmers and the manner and extent to which they adapt to it.

Compensation: No money will be paid, but cooldrinks and snacks will be available during the interview.

Confidentiality: All information will be treated as confidential, and the identities of participants be revealed.

Interviewee consent

I _____ confirm that the above information was explained to me in a language and in manner that I understood. I hereby volunteer to take part in the study.

Signature_____Place_____Date_____

Researcher confirmation

I _____ hereby confirm that the contents of this document was explained to the participant in a language and manner that he /she could understand.

Signature_____Place_____Date_____

The questionnaire will take about 30 minutes to complete.

If you need more information about the research, please contact the following persons:

Study leaders:

1. Dr. Dirk Cilliers

Tel: +27 (018) 2991589

Email: dirkcilliers@nwu.ac.az

2. Dr.Roelof Burger

Tel: +27 (018) 299 1589

Email: roelofburger@nwu.ac.za

Researcher:

3. Serumaga-Zake, E

Tel +27 (063) 383 1020

Email: eserumagazake@yahoo.com

- *Please complete the questionnaire diligently, as your responses are critical in ensuring the quality of the research.*

Thanking you, Edward Serumaga-Zake.

QUESTIONNAIRE

Section 1: Personal details

Please indicate your choice with a cross (X) in the appropriate box.

1.1 Gender: Male ☐ Female ☐

1.2 Age (years):
20 – 25 ☐ 26 – 30 ☐ 31- 35 ☐
36 – 40 ☐ 41- 45 ☐ 46 -50 ☐
51&< ☐

1.3 Village name :

Bafokeng Ba Ga-motlatle

Section 2: Characterisation of subsistence farming

2.1 Nature of farming activity(Choose one):

Full time

Part time

Other
(specify)

2.2 How long have you been farming?

< 5 yrs

5-10 yrs

10-15 yrs

> 15 yrs

2.3 Have you received any training?

Yes

No

If yes, what and where?

.....
.....

2.4 What types of crops do you plant? (List them)

.....

.....

2.5 Have you always been planting this/these crop (s)?

Yes

No

Why? Since when?

.....

.....

2.6 What is (are) the size (s) of your farming field (fields)?

.....

2.7 Please give the percentage for each of your farm products.

Name of crop	Percentage of yield %	Contribution to livelihood (in %)
1.		
2.		
3.		
4.		
5		
6		
7		

% Total = 100%

% Total = 100%

2.8 How do you use your crops? *Insert X in the right box*

Name of crop	Home consumption	Animal feed	Sell to the market
1.			
2.			

3.			
4.			
5.			
6.			
7.			

2.9 Please, describe the kind of farming practice used in your farm/s.

2.9.1 When do you plant and harvest?

.....

2.9.2 How long and often is the growing season in a year?

.....

2.9.3 Do you apply fertilizers or not? If yes what kind of fertilizers and why?

.....

.....

2.9.4 Do you apply pests or not? If yes what kind of pests and why?

.....

.....

10. Do you have the farming resources needed to carry out effective farming? If yes or not what are the resources?

.....

.....

11. How do you prepare the land?.....

12. When do you prepare the land?.From.....to.....,

.....

13. How do you plant the seeds?.(e.g. manual or using a tractor/machines)

.....

.....

14. How do you decide on crop planting? (e.g. are the certain crops adaptable to drought events)

.....

.....

.....

15.How do prepare for times of drought? (E.g. saving food, water, money, irrigation)

.....

.....

.....

16. What is (are) your main source(s) of income (including those of off –farm, if any)? Name them from the highest to the lowest

.....

.....

.....

17. State the resource(s) that are contributing to your a living? Name them from the highest to the lowest

.....

.....

.....

18. Do you get or utilize some services or help from government, NGOs or farmers co-operation?
If yes what services?

.....

.....

.....

19. What is the main contributor to your living? (E.g. Farm, off farm income, government grants, support from family)

.....

.....

.....

.....

Section 3: Perception of substance farmers to rainfall variability particularly droughts

3.1 What is your understanding of the words:

3.1.1.Weather.....

.....

3.1.2.Climate.....

.....

3.1.3.Drought.....

.....

3.2 Did or have you experienced a drought presently or in the past? If yes when? And how often has the drought(s) occurred?

.....

.....

.....

.....

.....

3.2.1 When last was (were) the rainfall period (s)?

.....

.....

3.3 Do you think the climate have changed or changing? If yes why?

.....

.....

.....

3.4 Do you think the climate will continue to change?.....

3.5 Is climate change affecting you as farmers?.....

3.5.1 If yes to question 3.5, how does climate change affect you?

.....

.....

.....

3.6. How do you cope or adapt to the changing climate especially drought times?

.....

.....

.....

.....

Section 4: The impact rainfall variability on the typical crops of subsistence farmers

4.1 Please rate the impact of climate variability on subsistence farming in your community. Please use numbers from 1 to 5 where appropriate (where 1 = strong negative impact; 2 = negative impact, 3 = no impact or no relevance; 4 = positive impact, 5 = strong positive impact). Please leave spaces blank where information is not available.

Impact	Number
1. Drought (No rainfall period)	
2. Moderate rainfall	
3. High rainfall	
4. Soil moisture	
5. Air moisture	
6. Irrigation	
7. Deeper crop roots	

4.2 How does rainfall variability especially times of drought affect typical crops on your farm? (Rainfall variability means changes in the amount of rainfall over a time).

.....

.....

.....

4.3 Please rate the amount of harvest per crop type per growing season (i.e., rainfall times and drought times). Use 1 to 5, where 1 = very low amount, 2, 3, 4 and 5 = very high amount).

Name of crop	High Rain fall period	Normal rainfall period	Drought period
1.			
2.			
3.			

4.			
5.			
6.			
7.			

4.4 Do you receive expected amount of harvests or not? If not why?

.....

.....

4.7 What would be the consequences of drought in your community in future? Please, explain.

.....

.....

.....

.....

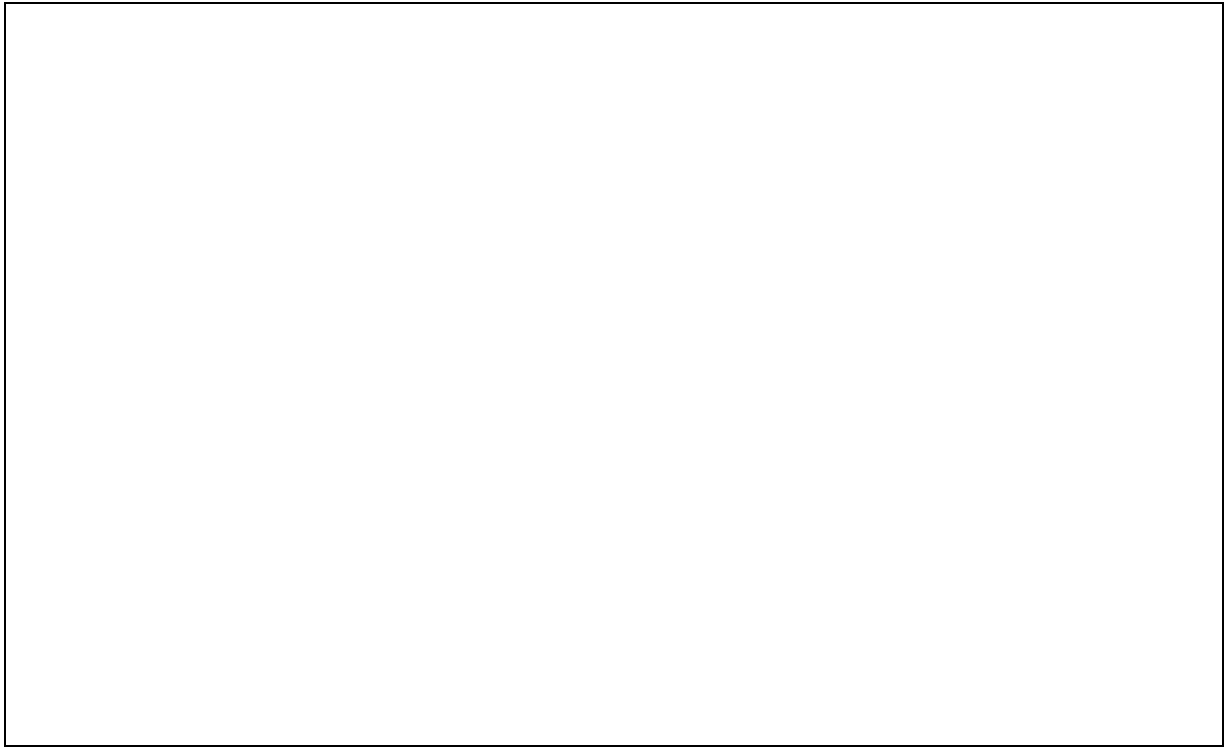
4.6 As a farmer what are the problems/ challenges are you facing? Please, list them

.....

.....

.....

4.7 We might have left out very important information. Please provide any further information you consider relevant in the context of this survey, or indicate additional persons that you think should be contacted in your community.



Thank you for your cooperation!
