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Nexus between Coping Strategies and Households' Agricultural Drought Resilience to Food Insecurity in South Africa

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Abstract: Farmers in Africa, including those in South Africa, rely on rain-fed agriculture, which exposes them to the risks of agricultural drought. Agricultural drought has become a major threat to agricultural production, including the extreme mortality of livestock in recent years, thus negatively impacting household food security. Hence, this paper is aimed at (i) assessing the coping strategies employed by smallholding livestock-farming households during food insecurity shocks, and (ii) assessing the relationship between coping strategies and agricultural drought resilience to food insecurity in the Northern Cape Province of South Africa. Interviews, more specifically survey interviews, were conducted with 217 smallholder livestock farmers. The data was analyzed using the agricultural drought resilience index (ADRI), the household food insecurity access scale (HFIAS), and structural equation modeling. Smallholder livestock farming households utilized various coping strategies, ranging from selling livestock (21%) to leasing out their farms (1%). The coping strategies of farming households included using alternative land (20%), storing food (20%), requesting feed for their animals (16%), searching for alternative employment (6%), migrating (6%), raising drought-tolerant breeds (5%), receiving relief grants (3%) and using savings and investments (2%). A statistically significant relationship between coping strategies and agricultural drought resilience to food insecurity means that these strategies have important policy implications. Implementing strategies that encourage households to protect their livelihood and utilize their assets (selling livestock) to increase their resilience is crucial for reducing food insecurity and achieving the Sustainable Development Goals (SDGs) to end hunger and poverty.

Keywords: migration; drought tolerant breeds; adaptation; relief grants; policy intervention; smallholder livestock farmers

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1. Introduction

Feeding the world's future population is one of the United Nations' Sustainable Development Goals and is also a major global challenge [1]. Food access is one of the fundamental human rights that ensures a person's freedom from hunger [2]. Globally, large portions of the population continue to struggle with food insecurity. According to the Food and Agricultural Organization of the United Nations (FAO) et al. [3], and their report on the state of food and nutrition globally, the prospect itself is not as bright as expected. The target of zero hunger, one of the Sustainable Development Goals, is not on track to be met by 2030, despite some progress. The FAO et al. [3] predict that the effect of the COVID-19 pandemic on world health and socioeconomics will worsen the most vulnerable population groups' food security and nutritional situation. Currently, billions of people cannot afford healthy and nutritious food because of high costs.

Despite being food-secure on a national level, South Africa remains food-insecure on a household level because not all households have access to sufficient food. Nearly 20% of South African households do not have sufficient food and the proportions differ according to province, population group, and household size [4]. Conflict and insecurity, climate change, poverty, and an aging population are the main causes of hunger and food insecurity in South Africa [5]. Since COVID-19 broke out, hunger ratios in South Africa have increased. More than 23% of the households in South Africa went hungry during the summer of 2020, and 70% of the households relied on government assistance. In addition, unemployment reached a record high of 32.8%, up by 2% since the pandemic began [5].

The mechanism by which food insecurity shocks are responded to differs depending on the objectives of the agents involved, as well as their levels of targeting. When faced with shocks such as a drought that threatens food security, households use a variety of coping strategies. Sassi [6] and Farzana et al. [7] pointed out that the unintended consequences of such strategies can undermine households' ability to cope with future food insecurity shocks.

Existing national and international studies, such as those by Van Dijk et al. [1], Lehmann-Uschner and Kraehnert [8], Masipa [9], Bahta [10], Meyeki and Bahta [11], and others, assessed household asset dynamics in the aftermath of severe environmental shocks, reviewed the impacts of climate change on food security and projections in sub-Saharan Africa, assessed coping strategies, and identified factors affecting livestock farmers' food security and resilience to drought. Debessa et al. [12] examined how households dealt with shocks resulting from food insecurity, as well as the relationships between coping strategies and food insecurity resilience in one of Ethiopia's food-stressed districts. The authors found a statistically significant relationship between the strategy used and food insecurity resilience.

Van Dijk et al. [1] conducted a systematic literature review and meta-analysis to assess the range of changes in global food security, projected until 2050. The authors discovered that total global food demand will increase by 56% by 2050, while the number of people at risk of hunger will increase by 8%. Looking at the asset dynamics of households when faced with environmental shock, Lehmann-Uschner and Kraehnert [8] found that the poorest households experience the most difficulty in adapting to shocks, adopting coping strategies that are costly to both short- and long-term well-being.

Masipa [9] quantified the effect of climate change on food security in sub-Saharan countries, from crop production to food distribution and consumption. Furthermore, Masipa [9] discovered that climate change, particularly global warming, affected food security through food availability, accessibility, utilization, and affordability. To mitigate these risks, there is a need for an integrated policy approach to protect arable land against global warming.

Bahta [10] investigated the strategies used by smallholder livestock farmers to cope with agricultural drought in South Africa and found that most livestock farmers sold their livestock. Furthermore, the author found that socioeconomic and institutional factors influenced smallholder livestock farmers' coping strategies. Meyeki and Bahta [11] discovered that most smallholder livestock farmers were not resistant to agricultural drought and that assets, social safety nets, and adaptive capacity indicators positively affected household resilience to food insecurity.

To the best of the author's knowledge, very few studies specifically focused on empirical evidence on the relationship between coping strategies and households' agricultural drought resilience to food insecurity. Ansha et al. [13] used a recursive framework to examine how coping strategies relate to household food security. Ado et al. [14] investigated households' coping strategies in the face of food insecurity, using a survey and the Probit model. Amoah and Simatele [15] used semi-structured questionnaires, interviews, and the sustainable livelihood framework (SLF) to investigate the coping strategies used by the rural poor to build resilience against food insecurity. Therefore, this study examined the coping strategies used by smallholder livestock farming households during food insecurity shocks and the relationship between the types of coping strategies and agricultural drought resilience in the face of food insecurity in the Northern Cape Province, South Africa. This paper employed the agricultural drought resilience index (ADRI), the household food insecurity access scale (HFIAS), and structural equation modeling. Previous studies [1,9] focused on the influence of climate change on global food security and the asset dynamics of households [8], as well as the strategies and resilience of smallholder livestock farmers [10,11]. Debessa et al. [12] assessed the coping strategies employed by households in the event of food insecurity shocks and the nexus between the types of coping strategies and resilience to food insecurity. The novelty of this paper lies in the incorporation of the household food insecurity access scale (HFIAS) and structural equation modeling. In addition, this study adds to existing knowledge by pointing out the nexus between coping strategies and the agricultural drought resilience to food insecurity of smallholder livestock farming households. The findings of this study will aid policymakers to develop appropriate policies to enhance the resilience of smallholder livestock farmers when faced with the effects of drought, which threatens food security.

2. Nexus between Coping Strategies and Households' Agricultural Drought Resilience to Food Insecurity/Conceptual Framework

According to Sassi [6], households employ four coping mechanisms when faced with food shortages. As part of these measures, they consider the quality of food consumed, increase food supply, receive assistance from neighbors, and ration food. Lehmann-Uschner and Kraehnert [8] stated that the presence of institutions (such as access to credit), drought relief, engagement in farm and non-farm activities, and consumption reduction will all influence household responses to agricultural drought. To put it another way, reducing consumption may be perceived negatively because it has a number of negative consequences, including immediate hunger as well as long-term effects on children's health and development [16].

Adverse events (agricultural drought) are hypothesized to lead to a short-term decline in assets and incomes and to long-term negative impacts on the livelihoods of smallholder livestock farmers [17]. The severe effects depend on the severity of the shocks, asset dynamics, and coping strategies. Lehmann-Uschner and Kraehnert [8] state that shocks, both directly and indirectly, affect households' resilience.

While resilience has various definitions, all these definitions share certain characteristics [18–21]. Most definitions of resilience emphasize the following characteristics: ability, mitigation, adaptation, coping, recovery, withstanding shocks, resistance, and bouncing back from shocks. In this study, resilience was defined as a household's ability to "bounce back" after being exposed to threats to its livelihood and to shocks (such as agricultural drought and food insecurity). Household resilience to food insecurity in response to agricultural drought was defined as the ability to maintain a certain level of income and well-being (food security). This was determined by the household's options for making a living and their ability to cope with agricultural drought. It refers, therefore, to both ex ante and ex post measures used in the reduction or mitigation of agricultural drought. The ability of a household to deal with agricultural drought was determined by the available options [22].

Agricultural drought was characterized by the dynamic nature of resilience, which can be divided into three categories: absorptive, adaptive, and transformative. Absorptive capacity emphasizes the ability to respond to agricultural drought with an initial, "persistent" response. Adaptive capacity deals with the ability to remain as functional as before, despite small but continuous changes in climate change shocks, such as agricultural drought. Transformational capacity refers to responding to challenges, such as droughts and prolonged disturbances, through a significant change in value, regimes, and financial, technological, and biological systems [23,24].

The FAO [25] acknowledges that food security is a highly flexible concept and that, generally, food insecurity manifests whenever people do not have adequate physical, social, and/or economic access to food. Guided by the above, food insecurity was therefore defined as a household's inability to access adequate food to meet its target consumption levels, in the face of shocks such as agricultural drought [26]. This scope was motivated by the dominant dimensions of food security in the study area, as informed by the Department of Agriculture, Forestry, and Fisheries (DAFF) and humanitarian organizations. However, the adopted definition still recognizes the central role of behavior patterns across coping strategies, as exhibited by vulnerable (and potentially vulnerable) individuals and the wider community affected, as is the case in the drought-prone Northern Cape Province of South Africa. To support this viewpoint, the study utilized the HFIAS, which has a broader measurement range of food insecurity severity status conditions, while accounting for a large spectrum of generic food security indicators. As informed by Coates et al. [27], in order to improve its performance, the standard HFIAS was modified and adapted in terms of the core food insecurity indicators to suit the context in which it was applied.

In this paper, the term "resilience to food insecurity" referred to the adaptive capacity of smallholder livestock farmers in South Africa's Northern Cape Province. According to Javadinejad et al. [28], the key mechanisms required for household resilience are social, economic, situational, and institutional preparedness. Furthermore, numerous studies have documented a wide range of factors influencing the methods and processes for achieving household resilience [16,29–32].

Fan et al. [33] proposed several frameworks for resilience analysis. However, the plethora of resilience analysis frameworks all has similar components [34]. This includes assessing the larger environment (or individual or other units of observation) in which a household resides; assessing the resources to which that household has access; determining how the shocks experienced by the household affect the household's economic returns on those uses; and assessing how the consequences of those uses may result in food and other goods and services consumption, savings, health, nutritional status, and other outcomes. As a result, resilience frameworks were frequently used to guide studies on household resilience to food insecurity [26,35,36]. In this study, a framework adapted from the work of Alinovi et al. [37] was used.

Figure 1 provides an overview of the conceptual framework for this study. The framework was chosen because it was originally proposed for analyzing households' resilience to food insecurity shocks, such as agricultural drought, in relation to coping strategies and adaptive capacities (Equations (1) and (2)). By using this framework, the study can determine the extent of variation in resilience-building among households, along with several factors influencing this variation. Assets, non-agricultural assets, adaptive capacity, social safety nets, and climate change are among the factors to be considered. These variables are regressed on the agricultural drought resilience index's (ADRI) outcome variable.

Frankenberger et al. [38] and Pasture [39] explored the relationship between coping strategies and resilience, proposing that maintaining a specific strategy can negatively impact resilience in the long run. To put it another way, negative coping strategies make it difficult to cope with future shocks. Therefore, it is possible that the level of coping strategies previously used by a household can play a part in its resilience status at a specific time (resilience to future food insecurity shocks).

The ADRI was calculated using principal component analysis (PCA) and variables related to livestock production and consumption, with and without drought seasons. Similarly, in the structural equation model, ADRI was used as an outcome variable against independent variables such as assets, adaptive capacity, social safety nets, and climate change indicators, as shown in Figure 1 and Equations (1) and (3).

Based on the literature findings and the resulting framework shown in Figure 1, the coping strategies used by households in response to the shock of food insecurity were assumed to influence household resilience. Therefore, households' coping mechanisms in response to agricultural droughts that threaten their food security were investigated using surveys, as discussed in Section 3.3. This study aimed to determine the relationship between the types of coping mechanisms used and household resilience status, which is a proxy for a household's ability to deal with food insecurity shocks.

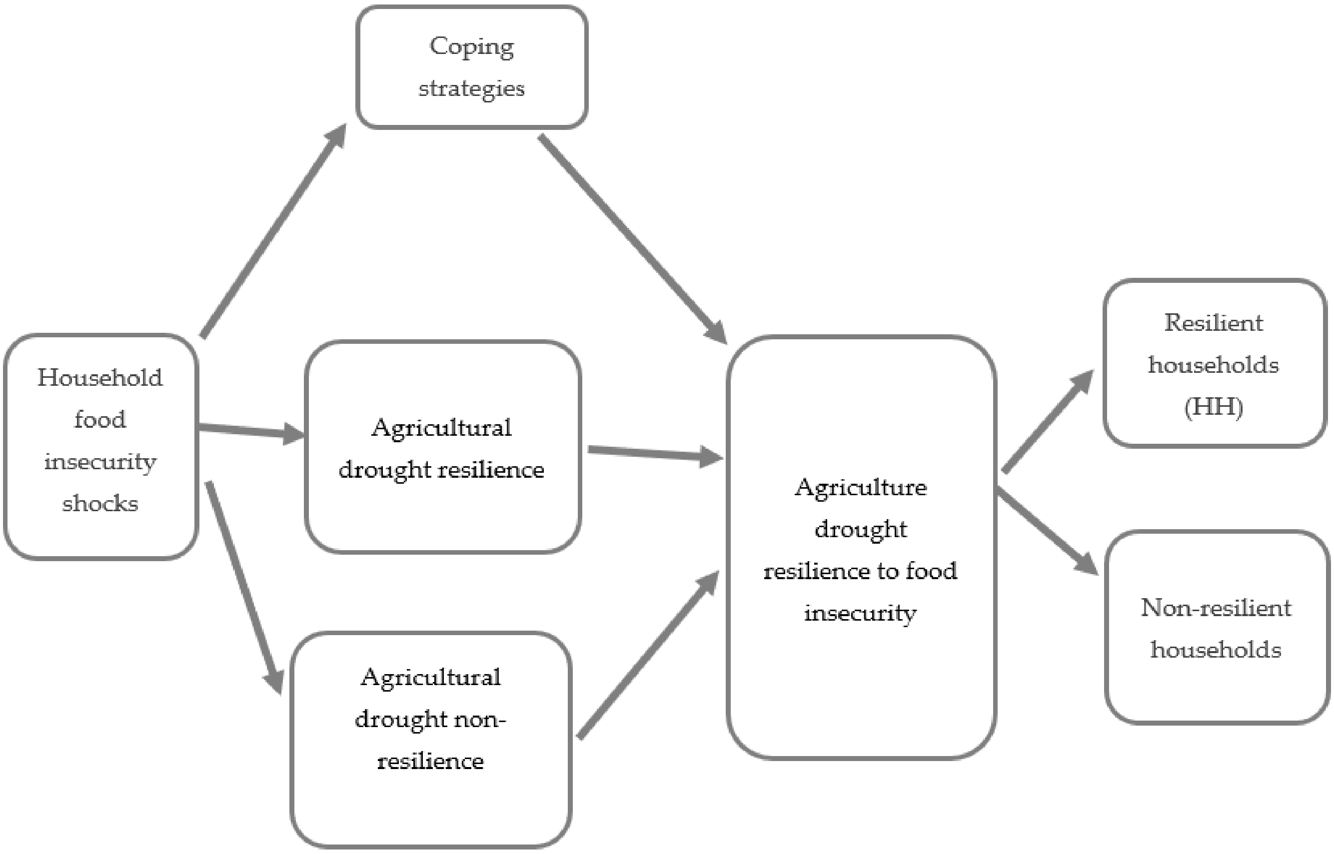

Figure 1. Conceptual framework representing the food insecurity shock–coping strategies–resilience nexus. Source: Author's adoption from observations of various studies.

3. Materials and Methods

3.1. Study Area Description

The Northern Cape is the largest and most sparsely populated province of South Africa, with Kimberley as the capital. The distances between towns are enormous, due to its sparse population and its size, which is just shy of that of the American state of Montana and slightly larger than Germany. The province is dominated by the Karoo Basin and consists mostly of sedimentary rocks and some dolerite intrusions. The south and south-east of the province is high-lying, situated 1200–1900 meters above sea level, in the Roggeveld and Nuweveld districts. The west coast is dominated by the Namaqualand region, famous for its spring flowers. The terrain is hilly to mountainous and consists of granites and other metamorphic rocks. The central areas are generally flat, with interspersed salt pans. Kimberlite (igneous rock) intrusions punctuate the Karoo rocks, giving the province its most precious natural resource, diamonds. The north is primarily in the Kalahari Desert, which is characterized by parallel red sand dunes and acacia trees on dry savanna [40].

The study was conducted in the Northern Cape Province of South Africa (Figure 2). The Northern Cape Province is situated in the northwest region of South Africa, shares international borders with Botswana and Namibia, and shares local borders with the Western and Eastern Cape Provinces in the south and the Free State and North West Provinces in the east [41]. The province's land area is 372,889 km^2, accounting for 30.5% of South Africa's total land area, with a population of 1.2 million people [42]. Frances Baard (12,800 km^2), John Taolo Gaetsewe (27,300 km^2), Namakwa (126,900 km^2), Pixley Ka Seme (103,500 km^2), and ZF Mgcawu (102,500 km^2) are the five district municipalities in the Northern Cape Province. The current research was carried out in the Frances Baard District Municipality (FBDM), which is divided into four local municipalities: Dikgatlong (2377.6 km^2), Magareng (1541.6 km^2), Phokwane (833.9 km^2), and Sol Plaatje (1877.1 km^2) [42] (Figure 2).

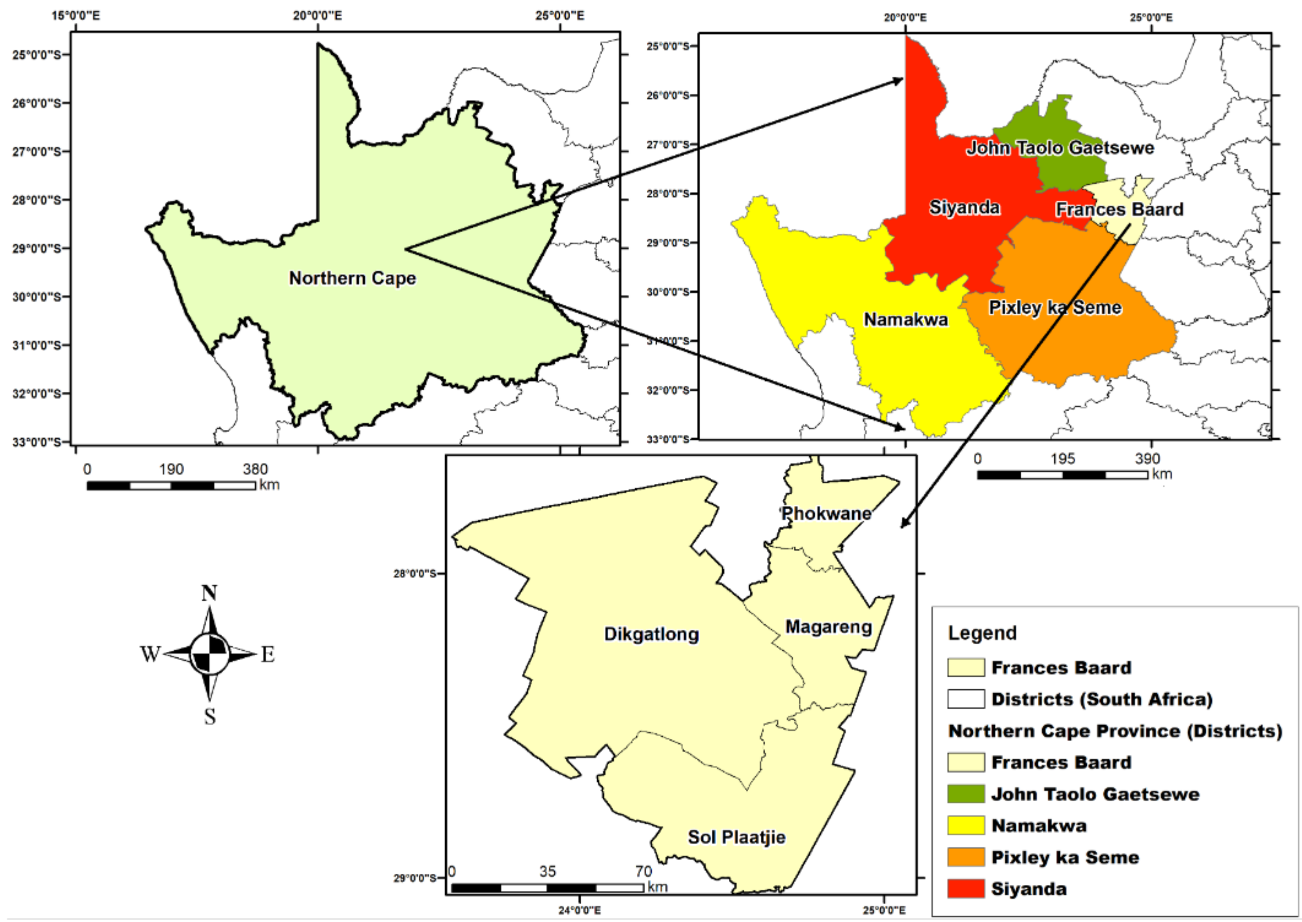

Figure 2. Maps of Northern Cape Province, the district municipalities of the Northern Cape, and the four local municipalities of Frances Baard District Municipality (FBDM). Source: FBDM [42].

The climate in the Northern Cape is arid and semi-arid. It is a large, dry area with a wide range of temperatures and topographical features. Rainfall is infrequent, ranging from 50 to 400 mm per year. The provinces' average annual rainfall/precipitation is 202 mm and is variable; for example, Kimberley experiences 497 mm of rainfall, Springbok, 195 mm, and Sutherland, 237 mm. Summer temperatures frequently rise above 40 °C. During winter, the average daytime temperatures are mild and may drop below 0 °C at night. Winter is usually frosty, with the southern area becoming bitterly cold, often experiencing snow and temperatures below −10 °C [40,43]. Evaporation levels exceed the annual average rainfall, which varies from 66 mm at Port Nolloth on the west coast to 414 mm at Kimberley, and 457 mm at Kuruman. The western areas, including Namaqualand, receive rainfall during the winter from April to September. The central, northern, and eastern parts of the province receive rain, mostly in the summer, from October to February [40].

3.2. Sample Size Determination and Sampling Procedure

The study employed a multistage sampling technique. In the first stage, the Northern Cape Province was chosen purposively because it represents the main livestock-producing province in South Africa. Additionally, the South African government declared the province a disaster area during this study [44,45]. The second stage of sampling involved the simple random selection of the FBDM using balloting. Within FBDM, four municipalities, namely, Phokwane, Magareng, Sol Plaatjie, and Dikgatlong, were purposively selected for sampling as the main livestock-producing municipalities.

A random sampling formula developed by Cochran [46], as well as Bartlett et al. [47], was used to determine the appropriate sample size for this study. Following a simple random formula, from a pool of 878 smallholder livestock farmers who applied for assistance from the national and local governments during the worst drought season ever recorded in South Africa, during the 2015/2016 crop season, 217 smallholder livestock farmers were selected. As part of the government's drought resilience activities, the government provided livestock feed, medication, improved access to resources, and provided training and information to help smallholder farmers become more resilient to drought.

3.3. Collection of Data

This study used both quantitative and qualitative methods. In addition to structured questionnaires, face-to-face interviews were conducted to collect data. Data were collected in both continuous and categorical forms on livestock production, assets, adaptive capacity, climate change, and social safety-net indicators. Face-to-face interviews were conducted, using a structured questionnaire, from October to December 2020. Ethical clearance was obtained from the University of the Free State.

3.4. Analytical Techniques

3.4.1. Agricultural Drought Resilience Index (ADRI)

The ADRI was calculated using PCA by aggregating livestock production in a normal year (WnPrn), livestock production during agricultural drought (WdPrd), the number of months in which a household consumes food produced by the household in a normal year (WcnMn), and the number of months in which a household consumes food produced by the household during an agricultural drought ($W_{cd}M_d$)(Table 1). Equation (1) is the formula for ADRI:

$$ADRI = Wt_nPr_n + Wt_dPr_d + Wt_{cn}Mo_n + Wt_{cd}Mo_d \quad (1)$$

where Wt represents each component, which is a weighted linear combination of variables determined by component loadings from the principal components, with a zero mean and unit variance.

Table 1. Principal component analysis of the agricultural drought resilience index (ADRI).

Variables	Communalities		Component Factors	Corr.ADRI
	Initial extraction		1	
Mo_n	1	0.280	0.963	0.890
Mo_d	1	0.955	0.977	0.984
Pr_n	1	0.935	0.967	0.894
Pr_d	1	0.958	0.979	0.995

Total = 3.776. Chi-square = 2224.837; Bartlett's test of sphericity is significant at $p = 0.0000$; the Kaiser–Meyer–Olkin (KMO) test of sampling adequacy = 0.636; cumulative (%) = 94.402 and eigenvalue variances (%) = 94.402.

The SPSS software, Bartlett's test of sphericity, and the Kaiser–Meyer–Olkin (KMO) test were used to analyze the data. Four variables were examined: livestock production in a normal year (Prn), livestock production during an agricultural drought (Prd), the number of months in which a household consumes food during a drought year (Mod), and the number of months in which a household consumes food produced by the household in a normal year (Mon).

Based on these conceptual underpinnings, the study determined how agricultural drought resilience to food insecurity was related to coping strategies. As shown in Table 1, there was a high correlation among variables because they were measuring the same construct. There was no doubt that both the commonalities and the initial commonalities were all greater than 0.30, a positive sign.

Based on the eigenvalue analysis, one factor was extracted. In terms of the total variance explained, 94.402% of the components account for it. According to Bartlett's sphericity test, the null hypothesis that the inter-correlation matrix is an identity matrix is true. On the other hand, as the inter-correlation matrix was not derived from a population, the variable reduction is rejected. In terms of KMO statistics, the model had a KMO value of 0.636, while the Bartlett test of sphericity showed a significant result (p = 0.000, chi-square = 2224.837).

The ADRI can be written as follows (Equation (2)):

$$\text{ADRI} = \times 0.979 + \text{Prn} \times 0.967 + \text{M0d} \times 0.977 + \text{Mon} \times 0.963 \quad (2)$$

where:

ADRI: agricultural drought resilience index,

Prn: production of livestock in a normal year,

Prd: production of livestock in a drought year,

Mon: the period (number of months) in which the household consumed food in a normal year,

M0d: the period (number of months) in which the household consumed food in a drought year,

Numerical value: weights derived using PCA (component factors).

The ADRI of the study area was calculated using Equations (1) and (2). An ADRI value of greater than zero represents agricultural drought-resilient households, whereas an ADRI value of less than zero represents households that are not resilient (vulnerable) when faced with agricultural drought. According to the ADRI values, 79% (172) of livestock-farming households were not resilient to agricultural drought, while the remaining 21% (45) were resilient. Although agricultural drought is a frequent occurrence in the Northern Cape Province, it can have a significant impact on smallholder livestock farmers, and a lack of or delay in rainfall can lead to a drop in livestock production, resulting in food insecurity.

3.4.2. Household Food Insecurity Access Scale (HFIAS)

The Food and Nutrition Technical Assistance Project (FANTA) developed the HFIAS, which was used to link agricultural drought resilience with food insecurity [27]. The HFIAS score is a tool for determining food insecurity in households over the previous months. Therefore, to calculate each household's HFIAS score, nine "frequency of occurrence" questions are posed (Table 2).

Table 2. The nine "frequency of occurrence" questions.

No.	Frequency of Occurrence Questions
1	Concern about insufficient food
2	Unable to consume preferred foods
3	Consume a restricted variety of foods
4	Compelled to eat certain foods
5	Eat smaller meals
6	Eat fewer meals in a day
7	The household does not have any food of any kind
8	Go to bed hungry
9	Eat nothing for a whole day and night

Source: Author compilation, based on Coates et al. [27].

The answers to the nine questions above determine the household's food security. Higher-scoring households are more likely to be food-insecure. Based on the HFIAS scores, households are also classified into four categories: strongly food-secure, mildly food-insecure, moderately food-insecure, and severely food-insecure.

3.4.3. Structural Equation Modeling

A structural equation model was used to investigate the determinants and relationship between households' resilience to food insecurity and smallholder livestock farmers' coping strategies/adaptive capacity. The coping strategies included in the independent variables are sorted under each category of adaptive capacity, climate change, safety nets, and assets. Factor analysis models were used to measure the latent variables using observed variables, while regression models were used to model the relationship between latent variables [36,37,48]. Equation (3) depicts the structural equation model:

$$\text{ADRI} = f(\text{ASS}, \text{ADC}, \text{SSF}, \text{CH}) \tag{3}$$

where:

ADRI: agricultural drought resilience index,

ASS: assets including HFS (Herd/flock size- cattle, sheep, and goats), AA (agricultural assets- tractors, feeding equipment, livestock trailer, water tank, and corral system), and NAA (non-agricultural assets- house, television, chairs, radio, and bed),

ADC: adaptive capacity including perception, source of income (Incsource), migration and credit,

SSF: social safety nets including cash, training, food support, water rights, equipment, sanitary latrine, farm input,

CH: climate change including agricultural drought occurrence and intensity.

4. Results

4.1. Coping Strategies

When dealing with drought, farmers must have a coping strategy in place. Table 3 shows that the most common strategy for dealing with drought was selling livestock. Thus, selling livestock regulated the income fluctuations caused by drought. The smallholder livestock farming households utilized various coping strategies, ranging from selling livestock (21%) to leasing out their farms (1%). Smallholder livestock farmers used alternative land (20%), stored food (20%), requested food for their animals (16%), searched for other employment (6%), migrated (6%), raised drought-tolerant breeds (5%), received relief grants (3%), used their savings and investments (2%), and leased their farms (1%) as coping strategies (Table 3).

Table 3. Coping strategies adopted by smallholder livestock farmers in the Northern Cape Province of South Africa during a drought year.

Coping Strategies	%
selling livestock	21
alternative land	20
storing food	20
requested feed for their animals	16
searched for alternative employment	6
migrated	6
raised drought-tolerant breeds	5
received relief grants	3
savings and investments	2
leasing out their farms	1

Source: Author's compilation, based on the survey (2022).

4.2. Household Food Insecurity Access Scale (HFIAS)

The HFIAS was used to assess food insecurity. The respondents perceived food insecurity differently, depending on their level of spending power and financial well-being. The majority of respondents (71%) were concerned about not having enough food, while 62.7% ate limited amounts of food, and 60.4% ate smaller meals than they thought were necessary. More than half of the respondents (57.6%) ate fewer meals, and 55.3% ate what they did not want to eat. Less than half of the respondents (42.4%) reported not having food in the house, 36.4% went to bed hungry, and 34.1% went the entire day without eating. Food-secure households had higher resilience to food insecurity, whereas severely food-insecure households had lower resilience to food insecurity (Table 4).

Table 4. Household food insecurity access scale (HFAIS) of smallholder livestock farmers in the Northern Cape Province of South Africa during a drought year.

HFIAS	Response (%)		Frequency (%)		
			Rarely	Sometimes	Often
Worry about not having food	No	29			
	Yes	71	28.62	24.42	17.96
Not eating when you wish	No	44.70			
	Yes	55.30	18.91	24.89	11.50
Eat limited food	No	37.30			
	Yes	62.70	20.31	29.47	12.92
Do not eat what you want	No	44.70			
	Yes	55.30	27.65	19.80	7.85
Eat a smaller meal than was needed	No	39.60			
	Yes	60.40	21.20	26.27	12.93
Eat meals in a day	No	57.60			
	Yes	42.40	19.38	16.58	6.44
Go to sleep without food	No	63.60			
	Yes	36.40	18.42	11.98	6
Go the whole day without eating	No	65.90			
	Yes	34.10	18.45	13.81	1.84

Source: Author's compilation, based on the survey (2022).

Most respondents (71%) were concerned about not having enough food; their experience of this occurrence was rarely (28.62%), sometimes (24.42%), and often (17.96%). Approximately half of the respondents (55.3%) did not eat the food they wanted to eat, of which their experience of this occurrence was rarely (18.91%), sometimes (24.89%), and often (11.50%). Many respondents (62.7%) ate limited amounts of food; their experience of this occurrence was rarely (20.31%), sometimes (29.47%), and often (12.92%). Likewise, 60.4% of respondents reported that they ate smaller meals than they thought were necessary; their experience of this occurrence was rarely (21.2%), sometimes (26.27%), and often (12.93%). Less than half the respondents (42.4%) ate meals per day; their experience of this occurrence was rarely (19.38%), sometimes (16.58%), and often (6.44%). Approximately one-third of respondents (36.4%) reported that they have gone to bed hungry; their experience of occurrence was rarely (18.42%), sometimes (11.98%), and often (6%). Lastly, 34.1% of respondents reported going the entire day without eating; their experience of this occurrence was rarely (18.45%), sometimes (13.81%), and often (1.84%).

Table 5 displays household resilience to food insecurity. A food-secure household was more likely to be resilient to food insecurity because it did not experience any of the conditions of food insecurity or only experienced concern (although this was rare). In contrast, severely food-insecure households were less resilient to food insecurity. A lack of resilience was indicated if one of the following three events occurred at least once in the previous four weeks (the last 30 days): running out of food, going to bed hungry, or eating nothing for the entire day and night.

Furthermore, as seen in Table 5, it can be assumed that food-secure households with frequency scores of rarely/strong (61) were becoming more resilient over time. A frequency score of sometimes/moderate (53) indicated stable scores and implied that the household situation remained unchanged. Households with frequency scores of often/weak (36) implied that they may have needed additional services and support.

Mildly food-insecure households with frequency scores of rarely/strong (59) and sometimes/moderate (42) implied stable scores, that the household situation remained unchanged and might have needed additional services and support. However, a low frequency score of often/weak (17) implied that the households had become more vulnerable and were in need of additional services and support.

Table 5. Smallholder livestock farmer households' resilience levels to food insecurity in the Northern Cape Province of South Africa.

Categories of Food Insecurity	Frequency (score)		
	Rarely/Strong	Sometimes/Moderate	Often/Weak
Food-secure	61	53	36
Mildly food-insecure	59	42	17
Moderately food-insecure	43	56	23
Severely food-insecure	40	29	4

Note: High scores (61–100) indicate that the household is becoming more resilient over time. Stable scores (31–60) indicate that the household situation remains unchanged and that they may need additional services and support. Low scores (0–30) indicate that the household is becoming more vulnerable and is in need of additional services and support. Source: Author compilation, based on the survey (2022).

Moderately food-insecure households with frequency scores of rarely/strong (43) and sometimes/moderate (56) had stable scores, implying that the household situation remained unchanged, and that they may have needed additional services and support. However, a low frequency score of often/weak (23) implied that households had become more vulnerable and were in need of additional services and support.

Severely insecure households with a frequency score of rarely/strong (40) had stable scores, implying that the household situation remained unchanged and that they may have needed additional services and support. Low frequency scores of sometimes/moderate (29) and often/weak (4) implied that the households had become more vulnerable and in need of additional services and support.

4.3. Nexus between Coping Mechanisms and Resilience of Households

Only 21% of households were resilient to food insecurity shocks. After establishing the coping strategies and the level of resilience, the discussion shifted to the relationship between coping strategies and household agricultural drought resilience regarding food insecurity in the Northern Cape Province of South Africa (Table 6). The HFS (ß = 0.33), AA (ß = 0.09), and NAA (ß = −0.02) influenced households' resilience to food insecurity. Households' resilience to food insecurity was positively impacted by HFS and AA indicators. Compared to the other asset components, the HFS indicator was the most important. During agricultural drought, smallholder livestock farmers sold their livestock to improve their resilience and as a way to adapt.

An analysis of the impact of adaptive capacity on food insecurity was conducted using four dummy variables (Equation (3) and Table 6). The migration indicators, as shown in Table 5, contributed positively to the households' ability to cope with food insecurity. The regression model demonstrated that migration (ß = 0.04), income source (ß = −0.12), perception (ß = −0.18), and credit (ß = −0.25) contributed to food security. Table 5 shows that all social safety-net indicators were positively related to households' resilience to food insecurity. As a result of the regression model, it was determined that garden equipment (ß = 0.20), farm input (ß = 0.15), training (ß = 0.12), water rights (ß = 0.11), food support (ß = 0.08), cash (ß = 0.04), and sanitary latrines (ß = 0.04) were the most significant variables.

Drought occurrence and drought intensity, two variables related to climate change and focusing on agricultural drought, had a negative and significant impact of 10% on household resilience to food insecurity (Table 6). Drought intensity (ß = −0.02) and occurrence (ß = −0.12) influenced the regression model.

Table 6. Results of the structural equation modeling.

Variables	Unstandardized Coefficient		Standardized Coefficient	Sig.
	ß	Std.error	ß	
Constant	11.37	2.09		
Assets (ASS)				
Herd/flock size (HFS)	3.44	0.68	0.33	0.00 ***
Agricultural assets (AA)	37.49	27.57	0.09	0.18
Non-agricultural assets (NAA)	−2.80	10.00	−0.02	0.78
Social safety nets (SSF)				
Cash	0.04	0.06	0.04	0.52
Training	0.10	0.06	0.12	0.09 *
Food support	0.06	0.06	0.08	0.30
Water rights	0.11	0.08	0.11	0.15
Garden equipment	0.27	0.11	0.20	0.012 **
Sanitary latrine	0.04	0.08	0.04	0.61
Farm input	0.12	0.06	0.15	0.032 **
Adaptive capacity (ADC)				
Perception	−0.15	0.06	−0.18	0.007 ***
Incsource	−0.24	0.13	−0.12	0.077 *
Credit	−0.54	0.16	−0.25	0.001 ***
Migration	0.06	0.11	0.04	0.60
Climate change (CH)				
Frequency	−0.05	0.03	−0.12	0.090 *
Intensity	−0.01	0.03	−0.02	0.83

*** 1%, ** 5%, * 10% significant. Source: Author's findings.

5. Discussion

According to the literature, households' responses to food insecurity include a variety of coping strategies. The Global Sustainable Development Report [49] asserts that people begin to rethink their consumption habits when anticipating a food shortage, rather than waiting until they are completely without food. Such situational changes in consumption habits are often viewed as short-term adjustments. Still, this can remain a normal habit, even when non-consumption-based strategies are employed. In particular, this is true when a community has faced long-term food insecurity, in terms of access and/or availability.

The majority of the respondents in this study indicated that they utilized livestock sales as coping strategies. This implied that smallholder farmers used livestock as a coping and adaptation mechanism because they sold livestock during agricultural droughts to enhance their resilience. Taking this into account, few respondents varied their livelihoods in any way, which left them vulnerable to drought issues. These findings are consistent with those of Acosta et al. [50], who investigated the role of livestock as a household coping strategy against climate shocks and discovered that livestock portfolios serve as a buffer against the effects of drought, supporting household income and consumption. To mitigate the impact of agricultural drought, it is necessary to diversify livelihood strategies through income-generating activities, both within and outside agriculture. As Kiani et al. [51] highlight, agricultural diversification raises farmers' adaptive capacity for the adoption of agricultural diversification and will enable them to generate tangible benefits by increasing their income through adopting sustainable agricultural livelihoods. These findings align with Bahta [10], who found that smallholder farmers sold livestock to cope with agricultural drought.

The ADRI found that most respondents were not able to cope with drought in agriculture. Therefore, governments and industry stakeholders should assist smallholder livestock farmers in improving their robustness. Assistance may include fodder, livestock medication, improving access to resources, and increasing the participation of smallholder farmers in drought-resilient agricultural activities, through training and information dissemination. This study concurs with Matlou and Bahta's [52] findings that most farming households in the Northern Cape Province were not drought-resistant. Furthermore, the findings are consistent with those of Adzawlaa et al. [53], who discovered that a lack of rainfall has a negative impact on farming household resilience.

The majority of respondents were concerned about not having enough food. This implied that most of the smallholder livestock farmers were vulnerable and needed assistance from governments and industry stakeholders to enhance their resilience. Hussein et al. [54] found similar results when households faced uncertainty about food availability. The authors found that 53.2% and 24.1% reported eating food that was insufficient in terms of quality and quantity, respectively. Half of the participants in the study (50.6%) also reported being unable to eat their preferred foods. Nearly a quarter (23.4%) reported eating smaller portions of meals, while 16.8% of households reported eating fewer meals. The overall food insecurity rate was 56.5%. Ansah et al. [55] reported similar findings, where high scores indicated that households had become more resilient, whereas low scores indicated that households had become more vulnerable and required additional assistance.

The structural equation modeling analysis revealed that assets, adaptive capacity, safety nets, and climate change indicators played a significant role in households' resilience to food insecurity. Consequently, a farming household's resilience to agricultural drought increased with the possession of additional assets. Households' safety nets increased when their assets increased; the more aware they were of climate change, the more resilient to agricultural drought they became. The results of this study are consistent with previous research indicating that more assets may make a household resilient to food insecurity [26,55–57]. The literature suggests that resilience is an essential step toward developing coping strategies and improving adaptive capacity [58].

Benefits that protect vulnerable households from food insecurity are social safety nets. The indicators of social safety nets positively impacted household resilience to food insecurity. Adzawlaa et al. [53], Dasgupta et al. [59], and Dejene and Cochrane [60] all agreed with this study's findings; however, Chakona and Shackleton [61] disagreed. Dasgupta et al. [59] highlighted the link between the social safety net and food insecurity. In the study by Adzawlaa et al. [53], social safety-net indicators significantly and positively impacted household resilience to food insecurity. Dejene and Cochrane [60] found that social safety nets are significant predictors of food insecurity. Chakona and Shackleton [61] found that there was no significant influence of social grants (social safety) on household food security as the funds were insufficient to fulfill all household members' needs.

There was a negative and significant impact of climate change (the frequency and severity of droughts) on household resilience to food insecurity. This implied that the dry and relentless climate, due to low annual precipitation, reduced livestock production in the province. The findings of this study concurred with those of Bahta and Myeki [62], who found that agricultural droughts impacted food production and food security.

This study only included smallholder livestock farmers in South Africa's Northern Cape Province and excluded smallholder crop farmers.

6. Conclusions

This study examined smallholder livestock farmers' coping strategies in the event of food insecurity shock, and the relationship between the types of coping strategies and their agricultural drought resilience to food insecurity in South Africa's Northern Cape Province. The most common strategy for dealing with drought was selling livestock, and the majority of smallholder livestock farmers (79%) were not drought-resilient. The indicators of assets, social safety nets, and adaptive capacity had a significant impact on household resilience to food insecurity. Climate change indicators had a negative and significant impact on households' abilities to cope with food insecurity. In other words, the greater the assets (such as livestock) of a farming household, the more resilient it would be to agricultural droughts. The findings also revealed that households benefited from social safety nets.

The Northern Cape Province has a hot summer climate combined with low rainfall (200 mm annually). Due to the dry and unforgiving climate, livestock production is reduced. In response to this issue, the government and stakeholders need to strengthen drought-relief programs to enhance the inhabitants' resilience to food insecurity, by focusing on less resilient smallholder farmers to increase their persistency, adaptability, and how they cope with agricultural drought.

The findings implied that firstly, to mitigate the impact of agricultural drought, it is necessary to diversify livelihood strategies via income-generating activities both within and outside agriculture. Secondly, the more assets a farming household owned, the higher their resilience to agricultural drought. The findings further indicated that benefiting from the social safety nets provided support for individual households. Therefore, governments and industry stakeholders should assist smallholder livestock farmers in improving their robustness. Assistance may include fodder, livestock medication, improving access to resources, and increasing the participation of smallholder farmers in drought-resilience agricultural activities through training and information dissemination.

The study recommends that improving policy is crucial to enhance the resilience of smallholder livestock farmers. The policy should not be limited to drought relief but should also improve various coping strategies. This includes encouraging smallholder farmers to raise drought-tolerant breeds, along with the acquisition of more resources and assets. The government needs to work with stakeholders to enhance the resilience of smallholder farmers by supporting the less resilient farmers. Improved access to agricultural credit and farm inputs and, subsequently, the accumulation of assets will reduce their vulnerability to food insecurity. In addition, the government should address off-farm employment as a source of income, and strengthen social safety nets, including providing training and disseminating information to smallholder farmers regarding drought preparation. As a result, these policies will aid smallholder farmers in being more resilient in times of climatic shock.

In general, this study's findings suggested that governments and non-governmental policymakers should focus on improving the resilience of smallholder farmers by expanding their access to resource bases, reducing food insecurity, and delivering timely drought relief.

This study used primary data collected through face-to-face interviews to assess the impact of agricultural drought on the resilience of smallholder farming households in the Northern Cape Province. The COVID-19 pandemic caused some data collection delays, and the language barrier was also a limitation. The most widely spoken languages in the Northern Cape Province are Afrikaans and Setswana (local South African languages), making communication between the researcher and the respondents difficult.

The study recommends that future research in developing countries should concentrate on the impact of agricultural drought on nutritional security for smallholder and commercial livestock and crop farmers, which was beyond the scope of this study.

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Glossary

AA	Agricultural assets
ADC	Adaptive capacity
ADRI	Agricultural Drought Resilience Index
ASS	Assets
Bartlett's test of sphericity	Compares an observed correlation matrix to the identity matrix
CH	Climate change
Chi-square	A statistical test used to examine the differences between categorical variables from a random sample in order to judge goodness of fit between expected and observed results.
°C	Degrees Celsius
COVID-19	Coronavirus disease 2019
DAFF	Department of Agriculture, Forestry and Fisheries
FANTA	Food and Nutrition Technical Assistance Project
FAO	Food and Agriculture Organization of the United Nations
FBDM	Frances Baard District Municipality
GOAL	An international humanitarian response agency
HFIAS	Household Food Insecurity Access Scale
HFS	Herd/flock size
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
Km^2	Square kilometer or kilometer squared
KMO	Kaiser–Meyer–Olkin
Mod	Number of months that a household consumed food in a drought year
Mon	Number of months that a household consumed food in a normal year
Mm	Millimetre
NAA	Non-agricultural assets
NRF	National Research Foundation
PCA	Principal component analysis
Prd	Production of livestock in a drought year
Prn	Production of livestock in a normal year
p-value	Measure of the probability that an observed difference could have occurred just by random chance
SDGs	Sustainable Development Goals
SLF	Sustainable livelihood framework
SPSS	Statistical Package for the Social Sciences
SSF	Social safety nets
Stats SA	Statistics South Africa
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
UNDESA	United Nations Department of Economic and Social Affairs
USAID	United States Agency for International Development
Wt	Weight—the loading of components of the first principal weights determined
WcnMn	Weight for the number of months during which the household consumed food in a normal year, multiplied by the actual amount of food produced
WcdMd	Weight for the number of months during which the household consumed food in a drought year, multiplied by the actual amount of food produced
WdPrd	Weight of livestock production in during drought year multiplied by the actual number of livestock produced
WFP	World Food Program
WHO	World Health Organization
WnPrn	Weight of livestock production in a normal year, multiplied by the actual number of livestock produced

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