DALAT UNIVERSITY JOURNAL OF SCIENCE Volume 13, Issue 4S, 2023 141-161

VULNERABLITY OF RURAL LIVELIHOODS IN NINH THUAN PROVINCE TO DROUGHT

Chau Tan Luc[a], Hoang Ha Anh[a*], Vo Thai Hiep[b], Dang Thanh Ha[a]

[a]Faculty of Economics, Nong Lam University, Ho Chi Minh City, Vietnam
[b]Ben Tre College, Ben Tre City, Ben Tre, Vietnam
[*]Corresponding author: Email: hoanghaanh@hcmuaf.edu.vn

Article history
Received: October 18th, 2023
Received in revised form: December 4th, 2023 | Accepted: December 5th, 2023
Available online: December 31st, 2023

Abstract

The risk of drought poses a significant challenge to agricultural production in Ninh Thuan Province. Therefore, this study aims to identify the factors that influence farmers' livelihood outcomes due to the impact of drought. Data were collected from a survey of 231 farmers randomly selected from the districts of Thuan Nam, Thuan Bac, and Ninh Hai. In addition to descriptive statistics, a Tobit regression model was used to identify the factors influencing livelihood outcomes during mild and severe droughts. The results showed that farmers' livelihood outcomes were generally low. The regression identified the financial (β=0.230 and 0.205), social (β=0.200 and 0.291), and human capital (β=0.195 and 0.196) impacts on farmers' livelihood outcomes from both mild and severe droughts. During mild drought years, seasonal adjustment (β=-0.009) and migration (β=0.013) were found to significantly influence livelihood outcomes. In severe drought years, government support (β=-0.030) negatively affected livelihood outcomes. There is a need to establish an early warning system for climate change and extreme weather events while simultaneously disseminating information widely to farmers so that they can take timely measures to cope. Enhancing human capital by raising awareness and skills in adapting to drought and developing comprehensive abilities to implement drought adaptation strategies is needed.

Keywords: Drought; Livelihood outcomes; Ninh Thuan; Rural households.

DOI: http://doi.org/10.37569/DalatUniversity.13.4S.1254(2023)

Article type: (peer-reviewed) Full-length research article

1. INTRODUCTION

Climate change with extreme weather conditions, such as floods and prolonged droughts, can negatively impact agricultural production (IPCC, 2007). The Food and Agricultural Organization (FAO) declared that the world has experienced a general increase in the frequency and severity of droughts, reporting that droughts have caused the deaths of over 11 million people and affected more than 2 billion (FAO, 2013). The increasing risk from drought is one of the pressures making farmers' livelihoods more vulnerable. In addition, low adaptability due to a lack of resources to cope with risks makes it increasingly difficult to sustain and develop livelihoods (Bahta, 2020). No country is immune to the impacts of climate change, and no country can face the challenges caused by climate change alone.

Vietnam is one of the countries that bears the highest burden of disasters, including drought, both in the region and globally (Nguyễn et al., 2016). Drought is a natural disaster that causes serious damage to the environment, economy, and society (Adhikari, 2018; Ogundeji & Okolie, 2022). Drought manifests as water scarcity due to insufficient rainfall, excessive evaporation, overexploitation of water resources, or a combination of these factors (Bandyopadhyay et al., 2020).

Ninh Thuan is one of the provinces in Vietnam most severely harmed by severe drought in recent years (Nguyen & Truong, 2021). Drought typically occurs when below-average rainfall persists for a season or an extended period. The increasing risks associated with drought exert pressure that amplifies the vulnerability of rural households, especially farmers. Drought reduces crop yields, diminishes cultivated areas, and increases agricultural production costs. Drought lowers the income of agricultural labor and the value of livestock (Ali et al., 2023) and thus has had a substantial impact on the livelihoods and livelihood outcomes of farmers.

Livelihood, defined as the means of living encompassing capabilities, assets, and activities, plays a crucial role in ensuring sustainable well-being and the ability to adapt to changes (Chambers & Conway, 1992). According to the Department for International Development (DFID), a sustainable livelihood is one that enables individuals and communities to recover, maintain, and enhance resources for the present generation while providing opportunities for future generations (DFID, 1999). It involves the combination of resources, capabilities, decisions, and actions that individuals or households employ to achieve their goals and aspirations. These resources and capabilities encompass natural, physical, human, financial, and social assets, and their access and use in institutions and social relationships are vital for securing people's lives (Ellis, 2000). The livelihoods of Ninh Thuan's drought-affected farmers are deeply impacted, necessitating sustainable strategies to enhance their resilience and well-being.

In summary, the abovementioned concept demonstrates that livelihood encompasses all activities people engage in to achieve their goals based on available resources, such as natural resources, capital, labor, and scientific and technological development. Furthermore, the livelihood assessment approach primarily focuses on

people. It is human effort that transforms assets or resources into livelihood outcomes. This approach is built on the belief that individuals require various types of assets to attain diverse and positive livelihood outcomes; no single asset can provide all the rich and varied livelihood outcomes that farmers seek (DFID, 1999).

The livelihood outcomes discussed in this article are what farmers attain with the resources available to each household (Amayo et al., 2021). Furthermore, the livelihood outcomes achieved by farmers can differ because tangible assets can yield varied benefits. If farmers have assured access to land (natural capital), they may also have abundant financial capital because they can use the land not only for direct production activities but also as collateral for loans. Similarly, livestock can generate social capital (reputation and community bonds) for owners while also serving as valuable physical capital (animal power). Therefore, the transformation of assets into either favorable or unfavorable livelihood outcomes depends on each individual farmer.

This study aims to enhance the livelihoods of agricultural producers under drought conditions by identifying the factors that affect farmers' livelihood outcomes. It proposes solutions for local authorities to consider and recommends appropriate policies to help farmers adapt to and improve their conditions in drought situations.

2. LITERATURE REVIEW

The World Meteorological Organization (WMO) reports that over 150 definitions of drought have been provided by scientists worldwide, leading to diverse research directions (WMO, 2006). Drought is an abnormally extended period of dry weather due to insufficient rainfall, causing a serious water imbalance, or due to a long-lasting precipitation shortage affecting various sectors and the environment (Trần et al., 2008). It can occur within a single season or persist (Sheffield et al., 2014; Wilhite & Glantz, 1985; WMO, 2006).

Moreover, when combined with low water storage in surface and subsurface water systems, these combinations can lead to hydrological droughts (Trần, 2019). Hydrological drought is a sustained period of water deficiency compared with the long-term average, leading to reduced water flow and soil and atmospheric moisture and negatively impacting human activities. Drought is a natural disaster formed by a serious, prolonged lack of rainfall, adversely affecting crop growth and causing environmental degradation, famine, and disease (Durrani et al., 2021).

Over the past 30 years, drought has affected the lives of 1.3 billion people, with an impact of 53 billion dollars in the Asia-Pacific region (Swain, 2015). A notable example is the state of California in the United States, which experienced its worst drought in history from 2012 to 2015. The prolonged adverse effects of the drought affected people in California. In rural areas of California, agriculture often faces challenges such as wildfires and water shortages (Swain, 2015).

The agricultural sector remains one of the most vulnerable to climate change, with drought being the most evident manifestation. This is because agriculture is a crucial

livelihood source for farmers. Agricultural production yields food and generates employment for farmers. Therefore, extreme weather conditions significantly impact their livelihood activities (Yaro, 2004). A study in Ghana conducted by Armah et al. (2010) indicated that, on average, 70% of the population depends on farming for their livelihood, 40% of the total export earnings come from agriculture, and approximately one-third of the national income is attributed to the agricultural sector. Hence, drought has a severe impact on the livelihoods and livelihood outcomes of farmers.

Research in India has shown that drought creates water stress and affects agricultural production, the economy, and various cultural and social aspects. Despite the government implementing several policies and measures to adapt to and mitigate its impact, drought recurring every three years continues to affect people's lives in India (Bandyopadhyay et al., 2020).

In Argentina, South America, drought resulted in 6.5 million hectares of water-deficient production, affected 550,000 individuals, and left 7,825 farms lacking sufficient water for irrigation and daily activities in 2011. The mean annual rainfall between 1940 and 2014 was 407 mm, with rainfall below the mean in 60% of these years. Consequently, drought has led to desertification in the southwest portion of Buenos Aires Province (Abraham et al., 2016).

Recently, research on drought has been conducted at the national, regional, and local levels in Vietnam, involving both domestic and international experts, to develop adaptive and mitigating solutions for this natural disaster. Research projects have primarily focused on two aspects of drought: (1) studying the fundamental characteristics of drought and its impact on natural, economic, and social aspects; and (2) developing drought management models associated with adaptation and mitigation of its effects on the natural, economic, and social domains (Bùi, 2015).

However, research on the factors influencing livelihood outcomes is limited. The majority of studies have concentrated on drought, using formulas for prediction and drought assessment, proposing drought management solutions, and addressing related issues. Nevertheless, research on how drought affects livelihoods and the factors influencing livelihood outcomes is limited, with virtually no studies conducted in Ninh Thuan. This is precisely the research gap that this study aims to address.

3. METHODOLOGY

3.1. Data collection

Ninh Thuan Province has a total area of 335,534 ha, including 85,059 ha of agricultural production, 199,920 ha of forests, 2,045 ha of aquaculture, 3,827 ha of salt production, 22,412 ha of specialized land use, 5,406 ha of residential land, and 5,023 ha of rivers, streams, and specialized water surface areas. The remaining land is unused (Ninh Thuan Statistics Office, 2019). According to reports (Ninh Thuan Department of Agriculture and Rural Development, 2018) from the Department of Natural Resources and Environment, six districts in the province have experienced severe damage caused by

drought. To assess the vulnerability of household livelihoods, this study selected three districts out of the six. These districts represent distinct regions: Thuan Bac, a mountainous district; Ninh Hai, a coastal district; and Thuan Nam, a central plain district.

The sample size was calculated following the formula of Slovin from Yamane (1973) with the total population of the three selected districts in 2019 being 180,379 and the error tolerance level (e) being 7%:

$$n = \frac{N}{1 + e^2 + N} = \frac{180379}{1 + 0.07^2 * 180379} = 204 \quad (1)$$

The minimum target was 204 households. However, to avoid incomplete or missing information in the survey forms, we surveyed 300 households. These were evenly distributed among the three primary production activities of farmers in Ninh Thuan (farming, livestock, and aquaculture), with 100 households surveyed in each group. The surveyed households were randomly selected from 17 hamlets across six communes in the three districts. After data compilation and the exclusion of incomplete or inaccurate survey forms, the data from 231 surveyed households were used in this study.

3.2. Analytical methods

3.2.1. Identification of livelihood outcomes

This study adopted the sustainable livelihood framework of the Department for International Development (DFID, 1999) to measure the livelihood outcomes of farmers in Ninh Thuan Province. Livelihood includes five capital resources: human, social, natural, physical, and financial. Each capital resource is measured using several indicators, which are presented in Table 1.

Table 1. Indicators of livelihood outcomes

Capital	Indicator	Unit of measurement
Human capital	Number of participants in agricultural and fishery activities	People
	Frequency of participation in agricultural training	Times/year
	Frequency of participation in disaster prevention training	Times/year
	Education level	1. Primary school
		2. Lower secondary school (Grades 6–9)
		3. Upper secondary school (Grades 10–12)
		4. University
		5. Postgraduate studies

Table 2. Indicators of livelihood outcomes (cont.)

Capital	Indicator	Unit of measurement
Social capital	Level of participation in local activities	5-point Likert scale
	Family relationships and reputation	5-point Likert scale
	Ease of receiving support from neighbors and the community in times of difficulty	5-point Likert scale
	Family's trustworthiness among neighbors	5-point Likert scale
Natural capital	Total land area	Ha
	Use of well water	1. Frequent shortages, 2. Occasional shortages, 3. Sufficient
	Use of rainwater	1. Frequent shortages, 2. Occasional shortages, 3. Sufficient
	Impact on crop cultivation	5-point Likert scale
	Impact on livestock farming	5-point Likert scale
	Impact on family health	5-point Likert scale
Physical capital	Type of housing	1. Temporary house 2. Semi-permanent house 3. Permanent house
	Total value of durable assets	Mil. VND
Financial capital	Yearly investment capital for agricultural and fishery production	Mil. VND
	Self-financing ratio	%
	Credit borrowing	0. No, 1. Yes
	Total income	Mil. VND/year
	Amount of savings accumulated during the year	Mil. VND/year

The measurement of livelihood outcomes was conducted in several steps. First, all indicators were normalized because they varied in units of measurement and scale. After normalizing, all indicators ranged from 0 to 1. Normalization used the formula:

$$indicator_{si} = \frac{s_{di} - s}{s_{\max} - s_{\min}} \quad (2)$$

Where $indicator_{si}$ is the normalized indicator of household i, s_{di} is the original value of the indicator of household i, and $s_{\min}$ and $s_{\max}$ are the minimum and maximum values of the indicator, respectively.

After normalizing, the five capital resources were calculated by combining their corresponding indicators from Table 1, using the formula:

$$capital_j = \frac{\sum_{i=1}^{n} indicator_{si}}{n} \quad (3)$$

where $capital_j$ is one of the five types of livelihood capital of household *i*. Finally, the livelihood outcomes were calculated from the combination of the five types of capital:

$$livelihoodoutcome_j = \frac{\sum_{j=1}^{5} capital_j}{5} \quad (4)$$

Because the indicators were normalized, the final livelihood outcomes also ranged from 0 to 1, with 0 being the worst outcome and 1 being the best.

3.2.2. Tobit regression

The Tobit regression model was used to identify the factors influencing farmers' livelihood outcomes, considering that the variable values were normalized within the range from 0 to 1.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_i X_i \quad (5)$$

where the dependent variable Y varies from 0 (worst) to 1 (best), depending on the livelihood outcomes achieved, β_0 represents the overall regression model's random error, β_i denotes the regression coefficients, and X_i are independent variables that influence the livelihood outcomes of farmers (Table 2).

Table 3. Summary of the variables

No.	Variable	Explanation	Unit of measurement	Expected sign	Referenced sources
Dependent variable					
1	Y	Livelihood outcome	0 to 1		(Amayo et al., 2021; Võ & Lê, 2015; Yuya & Daba, 2018)
Independent variables					
1	Ethnic	Ethnic group	1 = Kinh, 0 = Others	+	
2	HumanC	Human capital	0 to 1	+	(Amare et al., 2018; Anik et al., 2021; Balew et al., 2014; Nguyễn & Trịnh, 2017; Herwehe & Scott, 2018; Hussain & Thapa, 2012; Holman et al., 2021; Tazeze et al., 2012; Võ & Lê, 2015)

Table 4. Summary of the variables (cont.)

No.	Variable	Explanation	Unit of measurement	Expected sign	Referenced sources
Independent variables					
3	SocialC	Social capital	0 to 1	+	(Ali, 2023; Amare et al., 2018; Anik et al., 2021; Nguyễn & Trịnh, 2017; Holman et al., 2021; Zobeidi et al., 2021)
4	Perennial. crop.area	Perennial crop production area	ha	+	(Adhikari, 2018; Akinnagbe & Irohibe, 2015; Denkyirah et al., 2017; Võ & Lê, 2015)
5	Annual. crop.area	Annual crop production area	ha	+	(Adhikari, 2018; Akinnagbe & Irohibe, 2015; Denkyirah et al., 2017; Võ & Lê, 2015)
6	FinancialC	Financial capital	0 to 1	+	(Cenacchi, 2014; Herwehe & Scott, 2018; Võ, Đặng, & Nguyễn, 2020)
7	Adjusted. season	Efficiency of farming schedule adjustments	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	+	(Akinnagbe & Irohibe, 2015; Ogundeji & Okolie, 2022)
8	Water. preparation	Efficiency of advanced preparation for water demand	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	+	(Adhikari, 2018; Akinnagbe & Irohibe, 2015; Ali et al., 2023; Herwehe & Scott, 2018; Ogundeji & Okolie, 2022; Sukhija, 2008; Villamayor-Tomas et al., 2020)
9	Converted model	Efficiency of converting the farming model	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	+	(Adhikari, 2018; Akinnagbe & Irohibe, 2015; Nguyễn & Trịnh, 2017; Nguyen et al., 2021; Ogundeji & Okolie, 2022)

Table 5. Summary of the variables (cont.)

No.	Variable	Explanation	Unit of measurement	Expected sign	Referenced sources
Independent variables					
10	Livelihood. diversification	Efficiency of livelihood diversification	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	+	(Akinnagbe & Irohibe, 2015; Dumba et al., 2021; Herwehe & Scott, 2018; Nguyen et al., 2021; Ogundeji & Okolie, 2022)
11	Migration	Efficiency of temporary migration	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	+	(Bahta, 2020; Durrani et al., 2021; Herwehe & Scott, 2018)
12	Gov.support	Support from the government	1 = yes, 0 = no	+	(Bahta, 2020; Cenacchi, 2014; Dumba et al., 2021; Herwehe & Scott, 2018; Holman et al., 2021; Mwinjaka et al., 2010)
13	Information	Drought early warning information	1. Never, 2. Rarely, 3. Sometimes, 4. Often, 5. Always	+	(Amare et al., 2018; Anik et al., 2021; Balew et al., 2014; Devkota et al., 2018; Wang et al., 2020)

4. RESULTS AND DISCUSSION

4.1. Livelihood outcomes during drought in Ninh Thuan

A summary of the sample characteristics is presented in Table 3. In terms of demographics, the average education level was 1.71 (on a scale of 0 to 5 categories), indicating a need for educational improvement. The households had 4.65 members and 2.26 females on average. The average number of elderly individuals over 60 years old was relatively low at 0.28, as was the average number of children under 15 years old at 0.95. There was substantial engagement in agricultural production, with an average of 2.39 people involved per household.

In terms of finance, the population had a moderate level of nonagricultural income of 60.07 million Vietnamese dong (VND) and a total income of 130.92 million VND.

There was also a notable investment in agriculture, with an average investment of 32.87 million VND. The population relied heavily on self-financing for agricultural activities, with a self-financing ratio of 62.68%, and 74% of the surveyed population had borrowed money for agricultural purposes.

The social network analysis revealed that the surveyed population had a moderate level of participation in local activities, with an average score of 2.75 on a 5-point Likert scale. They perceived their family relationships and reputation positively, with an average score of 3.04. There was also moderate ease in receiving support from neighbors and the community during difficult times, with an average score of 2.91. However, participation in agricultural training was relatively low, with an average of 0.83 times, as was participation in disaster prevention training, with an average of 0.27 times. The population experienced considerable financial losses during severe droughts, with an average loss of 53.66 million VND, and moderate losses during mild droughts, with an average loss of 33.67 million VND.

Table 6. Summary of the surveyed households

Factor	Variable	Unit/scale	Mean
Demographics	Education level	0–5 categories	1.71
	Household size	People	4.65
	Number of females	People	2.26
	People over 60 years old	People	0.28
	Children under 15 years old	People	0.95
	People engaged in agricultural production	People	2.39
Finance	Nonagricultural income	Mil. VND	60.07
	Total income	Mil. VND	130.92
	Investment in agriculture	Mil. VND	32.87
	Self-financing ratio	%	62.68
	Credit borrowing ratio	0 = no, 1 = yes	0.74
Social network	Level of participation in local activities	5-point Likert scale	2.75
	Family relationships and reputation	5-point Likert scale	3.04
	Ease in receiving support from neighbors and the community in times of difficulty	5-point Likert scale	2.91
	Number of participants in agricultural training	Times	0.83
	Number of participants in disaster prevention training	Times	0.27
	Losses in severe droughts	Mil. VND	53.66
	Losses in mild droughts	Mil. VND	33.67

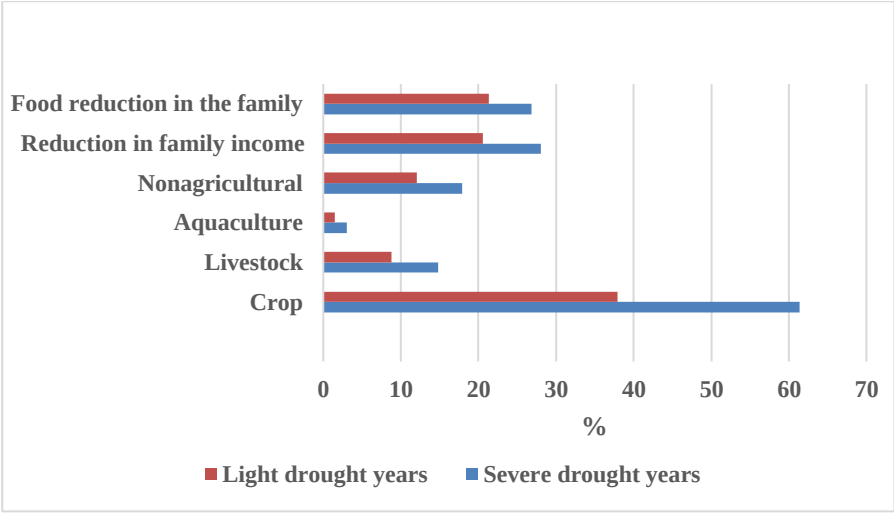

Figure 1. Levels of loss due to drought in Ninh Thuan Province

According to the survey results, it is evident that the severity of losses under severe drought conditions affects the farming sector the most, accounting for over 60% of the losses (Figure 2). But even under mild drought conditions, there is a significant impact, causing nearly 40% of the losses. This demonstrates that farmers in Ninh Thuận are experiencing the effects of drought, leading to substantial losses.

The mean livelihood outcome score of 0.36 suggests that, on average, the surveyed population has a relatively moderate level of overall livelihood success (Table 4). In terms of human capital, the highest mean scores were observed in the farming and livestock sectors, with scores ranging from 0.17 to 0.11. This indicates that individuals engaged in agriculture possess a relatively high level of knowledge and skills related to farming and livestock management. In contrast, the nonagricultural sector scored lower, indicating a relatively lower level of human capital in nonagricultural activities.

Table 7. Livelihood outcomes due to drought

Livelihood resource		Human capital	Social capital	Natural capital	Physical capital	Financial capital	Livelihood outcome
Mean livelihood outcome: 0.36							
Production	Farming	0.17	0.62	0.21	0.48	0.37	0.37
	Livestock	0.11	0.65	0.23	0.45	0.39	0.36
	Nonagriculture	0.08	0.55	0.27	0.48	0.22	0.32
Area	Ninh Hải	0.21	0.66	0.19	0.51	0.39	0.39
	Thuận Nam	0.1	0.62	0.27	0.52	0.34	0.37
	Thuận Bắc	0.21	0.52	0.08	0.29	0.33	0.29

Regarding social capital, the highest mean scores were found in the livestock sector, indicating a strong social network and cooperation among livestock farmers. Additionally,

the Ninh Hải and Thuận Nam areas exhibited higher social capital scores than Thuận Bắc. This suggests a stronger sense of community and social support in those areas.

Natural capital scores were relatively consistent across livelihood resources, with scores ranging from 0.27 to 0.08. This indicates a moderate level of reliance on natural resources in all sectors, with Thuận Bắc having the lowest natural capital score. This could imply a potential vulnerability in terms of natural resource availability in that particular area.

In terms of physical capital, the highest mean scores were observed in the farming and livestock sectors, indicating a relatively higher level of access to physical assets such as agricultural machinery and livestock facilities. Thuận Bắc had the lowest physical capital score, suggesting a potential lack of infrastructure and physical assets in that area.

Financial capital scores varied across livelihood resources, with the highest mean score observed in the farming sector. This indicates a relatively higher level of financial resources and access to credit in farming activities than in the livestock and nonagricultural sectors.

Finally, the livelihood outcomes of farmers in the districts of Thuận Nam and Ninh Hải are higher than the sample's average livelihood outcome. This is because Thuận Nam and Ninh Hải are two districts that were established when the province was newly divided in 1993. Therefore, they have more favorable economic development conditions than Thuận Bắc, a newly established district separated from parts of Ninh Hải and Ninh Sơn. Consequently, this is one of the factors affecting the livelihood resources of farmers and leading to lower livelihood outcomes.

In general, the livelihood outcomes of Ninh Thuận farmers do not exhibit significant variation between groups. However, the data indicate that the livelihood outcomes and resources of the Raglai ethnic group are lower than those of the Cham and Kinh ethnic groups. Additionally, farmers in the district of Thuận Bắc have lower livelihood outcomes than those in the districts of Thuận Nam and Ninh Hải.

4.2. Factors influencing livelihood outcomes under drought conditions

The ethnic variable suggests that much of the population (0.48) belongs to the Kinh ethnic group (Table 5). In terms of human capital, the mean score is 0.15, indicating a relatively low level of human capital resources. Social capital, on the other hand, has a higher mean score of 0.73, indicating a stronger social network and cooperation. The area of perennial crop cultivation is relatively low at 0.27 hectares, whereas the annual crop area is larger at 4.41 hectares. Financial capital has a mean score of 0.36, indicating a moderate level of financial resources. The adjusted season, converted model, water preparation, and livelihood diversification variables have mean scores of 1.24, 0.73, 2.49, and 3.25, respectively, suggesting varied levels of effectiveness and engagement in these aspects. The migration variable has a mean score of 0.53, indicating a moderate level of migration within the population. Government support and access to information have

mean scores of 0.81 and 3.18, respectively, indicating relatively high levels of government support and access to information among the surveyed population.

Table 8. Variables in the Tobit regression model

Variable	Unit of measurement	Mean
Livelihood outcome	0 to 1	0.36
Ethnic	1 = Kinh, 0 = Others	0.48
HumanC	0 to 1	0.15
SocialC	0 to 1	0.73
Perennial.crop.area	ha	0.27
Annual.crop.area	ha	4.41
FinancialC	0 to 1	0.36
Adjusted.season	0. Never used, 1. Completely ineffective, 2. Very little effectiveness, 3. Moderately effective, 4. Highly effective, 5. Completely effective	1.24
Convertedmodel		0.73
Water.preparation		2.49
Livelihood diversification		3.25
Migration		0.53
Gov.support	1 = yes, 0 = no	0.81
Information	1. Never, 2. Rarely, 3. Sometimes, 4. Often, 5. Always	3.18

The results of the Tobit model analysis on the factors influencing the livelihood outcomes of farmers are presented in Table 6. The explanatory variables are as follows.

Human capital has a statistically significant positive influence on livelihood outcomes at the 1% significance level (β = 0.230 and 0.205 in mild drought and severe drought, respectively). This implies that farmers by gender, educational attainment, family size, engagement in other economic activities, farming experience, and a larger labor force participating in production tend to achieve better livelihood outcomes than those with fewer labor resources. Furthermore, farmers with members involved in agricultural promotion and training on disaster risk reduction significantly impact livelihood outcomes, regardless of whether they are facing severe or mild drought conditions.

Social capital also has a strong and statistically significant influence on livelihood outcomes at the 1% significance level (β = 0.200 and 0.291 in mild drought and severe drought, respectively). This suggests that active participation by farmers in local community activities provides favorable conditions for information exchange and a better understanding of the drought situation, which positively affects livelihood outcomes. Additionally, the level of trust and reliability within the community is another factor influencing the successful implementation of livelihood strategies (Ali et al., 2023; Nguyễn & Trịnh, 2017; Võ, Đặng, Châu, & Nguyễn, 2020; Holman et al., 2021; Zobeidi et al., 2021).

Financial capital, which includes credit access, loans, and income from nonfarm activities, significantly affects livelihood outcomes at the 1% statistical significance level (β = 0.195 and 0.196 in mild drought and severe drought, respectively). This indicates that farmers who have access to financial resources and credit tend to have better livelihood outcomes than those who do not (Anik et al., 2021; Denkyirah et al., 2017; Herwehe & Scott, 2018; Võ & Lê, 2015).

Both the annual crop area (rice, maize, onion, garlic, and ornamental flowers) and perennial crop area (grapes, apples, and other fruit trees) variables have a positive correlation with livelihood outcomes in severe drought conditions at the 1% statistical significance level (β = 0.013 and 0.014, respectively). This suggests that farmers with larger areas dedicated to annual and perennial crops tend to have better livelihood outcomes. Diversifying crop types, changing cropping patterns, improving soil conditions, and adjusting planting and irrigation schedules, particularly drip irrigation, contribute to these positive results (Akinnagbe & Irohibe, 2015; Denkyirah et al., 2017). Some drought-resistant crops, short-cycle crops, and those with lower water requirements, such as onions, garlic, grapes, and apples, continue to be cultivated by farmers. Local knowledge indicates that while these crops can adapt to drought conditions, they may face price fluctuations during harvest.

The factors related to farming seasonal adjustments negatively affect livelihood outcomes and temporary migration (β = -0.009), with a corresponding statistical significance level of 5% when mild drought occurs (Dumba et al., 2021). In mild drought conditions, farmers can proactively harvest early by planting crops sooner or do the opposite. Additionally, they may shorten or extend the production period. However, these actions do not yield favorable livelihood outcomes for farmers. Therefore, during the severe drought from 2015 to 2016, some farmers had to resort to temporary migration to seek food support, employment, or even lease their farmland to others. This underscores the severity of the drought from 2015 to 2016.

Furthermore, due to limited coping capabilities and the low availability of livelihood resources, farmers are vulnerable to drought conditions (Bahta, 2020). Hence, some households may migrate to larger cities or other locations within the province to increase their income and improve their livelihoods, significantly affecting their livelihood outcomes (β = 0.013).

Last, factors such as changing the production model (β = 0.014), actively managing water resources (β = -0.005), and government support (β = -0.030) all have a significant impact on livelihood outcomes during severe drought conditions. These findings are consistent with the previous studies of Bahta (2020), Herwehe & Scott (2018), and Mwinjaka et al. (2010). The changing production model has a strong impact on farmers' livelihood outcomes. In severe drought conditions, water resources may be insufficient for crop cultivation, affecting livestock as well. Some farmers may shift to alternative activities, such as salt production. Additionally, in areas frequently affected by drought and where agricultural production is not viable, farmers may transition to industrial activities.

Both actively managing water resources and government support have a negative impact on livelihood outcomes. Under severe drought conditions, changing the agricultural production model does not yield effective results, leading to unfavorable livelihood outcomes due to insufficient water for ponds and the irrigation of nurseries. Government support during drought conditions is essential. However, the model results indicate that government support has a negative impact on livelihood outcomes. This suggests that government support for water and food provisions creates dependency among farmers, leading to reliance on the government and a lack of proactive drought coping strategies. This, in turn, affects their livelihood outcomes. Therefore, the government should focus on providing capital, seeds, materials, technology, and disease prevention support to enable farmers to achieve better livelihood outcomes. A study conducted by Zobeidi et al. (2021) in Iran found that governments and policymakers should strengthen the capacity-building potential of agricultural extension systems and provide training on drought adaptation through information technology and communication for farmers. Additionally, investments in education to enhance farmers' knowledge and reduce the impact of drought, thus minimizing vulnerability, should be made to improve livelihood outcomes for farmers.

Table 9. Estimated regression model

Variable	Mild drought		Severe drought	
	coefficient	P> |t|	coefficient	P> |t|
Ethnic	-0.005	0.413	0.001	0.026
HumanC	0.230***	0	0.205***	0
SocialC	0.200***	0	0.291***	0
Perennial.crop.area	0.002	0.416	0.013***	0
Annual.crop.area	-0.002	0.163	0.014***	0
FinancialC	0.195***	0	0.196***	0
Adjusted.season	-0.009**	0.017	0.005	0.094
Convertedmodel	-0.004	0.211	0.014***	0
Water.preparation	0.001	0.575	-0.005**	0.012
Livelihood.diversification	0	0.65	-0.002	0.224
Migration	0.013***	0	-0.001	0.322
Gov.support	-0.009	0.282	-0.030***	0
Information	-0.003	0.42	0.002	0.597
Constant	0.185***	0	0.066***	0.004
Log likelihood	275.74		277.06	
LR Chi-square	259.28***		305.23***	

Note: *, **, and *** indicate statistical significance levels of 10%, 5%, and 1%, respectively.

In summary, the factors influencing farmers' livelihood outcomes during mild drought conditions include five factors: human capital, social capital, financial capital, seasonal adjustment, and temporary migration. Among these factors, seasonal adjustment has a negative impact on farmers' livelihood outcomes. In addition, eight factors influence farmers' livelihood outcomes during severe drought conditions: human capital, social capital, financial capital, annual crop area, perennial crop area, production model change, active water resource management, and government support. Among these factors, active water resource management and government support have negative impacts on farmers' livelihood outcomes.

5. CONCLUSION

Natural disasters such as drought always pose a serious threat to farmers' livelihoods and directly impact the socioeconomic situation of Ninh Thuan Province.

The surveyed farmers generally exhibited a low level of education and were mainly engaged in agricultural production, indicating a potential need for educational improvement and a reliance on agricultural activities for livelihood. In terms of finance, farmers in Ninh Thuan have a moderate level of income and investment in agriculture, with a reliance on self-financing and borrowing for agricultural purposes. The social network analysis suggests a moderate level of participation in local activities and positive family relationships, but relatively low engagement in agricultural and disaster prevention training. The population also faces financial losses during drought events.

The livelihood outcomes of farmers are generally low, with little variation among different household groups. However, certain factors positively impact farmers' livelihoods, with financial, human, and physical capital being significant contributors. This highlights the importance of local governments facilitating access to low-interest loans and improving financial resources for farmers. Moreover, investing in human resources by providing education and information about drought adaptation is essential. Additionally, agricultural mechanization and better infrastructure can help farmers be more efficient and improve their livelihoods.

On the other hand, some factors have a negative impact on livelihood outcomes, including seasonal adjustments and water resource management. Furthermore, government support has a notably negative influence. This suggests that government assistance in terms of food and water supplies can sometimes lead to dependency and passivity among farmers in coping with drought. Hence, government support should be tailored to the specific needs and conditions of different household groups, production sectors, and regions to be more effective and support farmers in improving their livelihoods.

In conclusion, the government must take various measures to help farmers adapt to and enhance their livelihoods during drought conditions. These measures should include facilitating access to financial resources, investing in human capital, and improving physical resources. Currently, many programs and plans have been implemented in the province to help people adapt to drought. For example, in 2020, Ninh

Thuan Province requested the Ministry of Agriculture and Rural Development to develop the Tan My irrigation system into a multi-purpose canal to serve irrigation, daily life, and production in the province. The Ninh Thuan Provincial Party Committee (2021) issued Resolution No. 12-NQ/TU on the climate change adaptation program for 2021 to 2030. The Department of Agriculture and Rural Development of Ninh Thuan Province directed the Provincial Center for Clean Water and Rural Environmental Sanitation to review and develop plans to invest, repair, and upgrade the domestic water supply system to urgently accelerate construction progress and put the water supply system into operation in the third quarter of 2023. Moreover, government assistance should be provided to encourage self-reliance and active responses among farmers rather than creating dependency. This approach will help farmers better cope with drought and ultimately improve their livelihood outcomes. There is a need to establish an early warning system for climate change and extreme weather events while simultaneously disseminating information widely to farmers so that they can cope in a timely manner. Enhancing human capital through raising awareness and skills in drought and adaptation and developing comprehensive abilities to take action in implementing drought adaptation strategies is also needed.

REFERENCES

Abraham, E. M., Guevera, J. C., Candia, R. J., & Soria, N. D. (2016). Dust storms, drought and desertification in the southwest of Buenos Aires Province, Argentina. *Revista de La Facultad de Ciencias Agrarias*, *48*(2), 221-241.

Adhikari, S. (2018). Drought impact and adaptation strategies in the mid-hill farming system of Western Nepal. *Environments*, *5*(9), 101. https://doi.org/10.3390/environments5090101

Akinnagbe, O., & Irohibe, I. (2015). Agricultural adaptation strategies to climate change impacts in Africa: a review. *Bangladesh Journal of Agricultural Research*, *39*(3), 407-418. https://doi.org/10.3329/bjar.v39i3.21984

Ali, M. A., Karim, Md. R., & Osman, M. A. (2023). Impact of drought on sorghum production and its adaptation strategies in Baki District, Awdal Region, Somaliland. *Advances in Research*, *24*(1), 24-31. https://doi.org/10.9734/air/2023/v24i1930

Amare, Z. Y., Ayoade, J. O., Adelekan, I. O., & Zeleke, M. T. (2018). Barriers to and determinants of the choice of crop management strategies to combat climate change in Dejen District, Nile Basin of Ethiopia. *Agriculture & Food Security, 7*, 37. https://doi.org/10.1186/s40066-018-0188-y

Amayo, F., Akidi, I. L., Esuruku, R. S., & Kaptui, P. B. (2021). Farming methods and the livelihood outcomes of women in Eastern Uganda. *Journal of Agricultural Extension and Rural Development*, *13*(3), 182-191. https://doi.org/10.5897/JAERD2021.1249

Anik, A. R., Rahman, S., Sarker, J. R., Al Hasan, M. (2021). Farmers' adaptation strategies to combat climate change in drought prone areas in Bangladesh.

International Journal of Disaster Risk Reduction, *65*, 102562. https://doi.org/10.1016/j.ijdrr.2021.102562

Armah, F. A., Yawson, D. O., Yengoh, G. T., Odoi, J. O., & Afrifa, E. K. A. (2010). Impact of floods on livelihoods and vulnerability of natural resource dependent communities in Northern Ghana. *Water*, *2*(2), 120-139. https://doi.org/10.3390/w2020120

Bahta, Y. T. (2020). Smallholder livestock farmers coping and adaptation strategies to agricultural drought. *AIMS Agriculture and Food*, *5*(4), 964-982. https://doi.org/10.3934/agrfood.2020.4.964

Balew, S., Agwata, J., & Anyango, S. (2014). Determinants of adoption choices of climate change adaptation strategies in crop production by small scale farmers in some regions of central Ethiopia. *Journal of Natural Sciences Research*, *4*(4), 78-93

Bandyopadhyay, N., Bhuiyan, C., & Saha, A. K. (2020). Drought mitigation: Critical analysis and proposal for a new drought policy with special reference to Gujarat (India). *Progress in Disaster Science*, *5*, 100049. https://doi.org/10.1016/j.pdisas.2019.100049

Bùi, T. T. H. (2015). *Nghiên cứu ảnh hưởng của hoang mạc hóa đến sản xuất nông nghiệp ở tỉnh Bình Thuận trong bối cảnh biến đổi khí hậu.* Viện Hàn Lâm Khoa học và công nghệ Việt Nam.

Cenacchi, N. (2014). *Drought risk reduction in agriculture: A review of adaptive strategies in East Africa and the Indo-Gangetic Plain of South Asia* (IFPRI Discussion Paper 1372). International Food Policy Research Institute.

Chambers, R., & Conway, G. R. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century* (IDS Discussion Paper 296). Institute of Development Studies.

Denkyirah, E. K., Okoffo, E. D., Adu, D. T., & Bosompem, O. A. (2017). What are the drivers of cocoa farmers' choice of climate change adaptation strategies in Ghana? *Cogent Food & Agriculture*, *3*(1), 1334296. https://doi.org/10.1080/23311932.2017.1334296

Devkota, N., Phuyal, R. K., & Shrestha, D. L. (2018). Perception, determinants and barriers for the adoption of climate change adaptation options among Nepalese rice farmers. *Agricultural Sciences*, *9*(3), 272-298. https://doi.org/10.4236/as.2018.93021

DFID. (1999, April). *Sustainable livelihoods guidance sheets.* Department for International Development.

Dumba, H., Danquah, J. A., & Pappinen, A. (2021). Rural farmers' approach to drought adaptation: Lessons from crop farmers in Ghana. In N. Oguge, D. Ayal, L. Adeleke, & I. Da Silva (Eds.), *African handbook of climate change adaptation* (pp. 1033-1051). Springer International Publishing. https://doi.org/10.1007/978-3-030-45106-6_29

Durrani, H., Syed, A., Khan, A., Tareen, A., Durrani, N. A., & Khwajakhail, B. A. (2021). Understanding farmers' risk perception to drought vulnerability in Balochistan, Pakistan. *AIMS Agriculture and Food*, *6*(1), 82-105. https://doi.org/10.3934/agrfood.2021006

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.

FAO. (2013). *Drought*. Food and Agricultural Organization.

Herwehe, L., & Scott, C. A. (2018). Drought adaptation and development: Small-scale irrigated agriculture in northeast Brazil. *Climate and Development*, *10*(4), 337-346. https://doi.org/10.1080/17565529.2017.1301862

Holman, I. P., Hess, T. M., Rey, D., & Knox, J. W. (2021). A multi-level framework for adaptation to drought within temperate agriculture. *Frontiers in Environmental Science*, *8*, 589871. https://doi.org/10.3389/fenvs.2020.589871

Hussain, A., & Thapa, G. B. (2012). Smallholders' access to agricultural credit in Pakistan. *Food Security*, *4*, 73-85. https://doi.org/10.1007/s12571-012-0167-2

IPCC. (2007). *Climate change 2007: The physical science basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Mwinjaka, O., Gupta, J., & Bresser, T. O. N. (2010). Adaptation strategies of the poorest farmers in drought-prone Gujarat. *Climate & Development*, *2*(4), 346-363. https://doi.org/10.3763/cdev.2010.0058

Nguyen, H. T., & Truong, T. C. (2021). Analysis of trends in drought with the non-parametric approach in Vietnam: A case study in Ninh Thuan Province. *American Journal of Climate Change*, *10*(1), 1. https://doi.org/10.4236/ajcc.2021.101004

Nguyễn, Q. H., & Trịnh, Q. T. (2017). Sử dụng thông tin thời tiết để thích ứng với biến đổi khí hậu trong sản xuất nông nghiệp: trường hợp nghiên cứu thí điểm ở xã Kỳ Sơn, huyện Kỳ Anh, tỉnh Hà Tĩnh. *Tạp Chí Khoa Học Nông Nghiệp Việt Nam*, *15*(8), 1014-1021

Nguyễn, T. H., Nguyễn, T. T., Trần, Đ. Q., Nguyễn, Đ. H., Mai, T. N. (2016). Đánh giá khả năng thích ứng với biến đổi khí hậu cấp hộ gia đình tại huyện Hòa Vang, thành phố Đà Nẵng. *Tạp Chí Khoa Học ĐHQGHN*, *32*(2S), 140-152

Nguyen, T. L. H., Fahad, S., Nguyen, A. T., Tran, T. T. H., Nguyen, H. C., & To, T. N. (2021). Assessment of farm households' perception, beliefs and attitude toward climatic risks: A case study of rural Vietnam. *PLOS ONE*, *16*(12), e0258598. https://doi.org/10.1371/journal.pone.0258598

Ninh Thuan Department of Agriculture and Rural Development. (2018). *Report 553/BC-SNNPTNT on results of implementation in 2018, tasks and solutions for implementation in 2019 in the agriculture sector.*

Ninh Thuan Provincial Party Committee. (2021). *Resolution No. 12-NQ/TU on the climate change adaptation program for 2021 to 2030*. Ninh Thuan, Vietnam.

Ninh Thuan Statistics Office. (2019). *Ninh Thuan statistictal yearbook 2019*. Statistical Publishing House.

Ogundeji, A. A., & Okolie, C. C. (2022). Perception and adaptation strategies of smallholder farmers to drought risk: A scientometric analysis. *Agriculture*, *12*(8), 1129. https://doi.org/10.3390/agriculture12081129

Sheffield, J., Wood, E. F., Chaney, N., Guan, K., Sadri, S., Yuan, X., Olang, L., Amani, A., Ali, A., Demuth, S., & Ogallo, L. (2014). A drought monitoring and forecasting system for sub-Sahara African water resources and food security. *Bulletin of the American Meteorological Society*, *95*(6), 6. https://doi.org/10.1175/BAMS-D-12-00124.1

Sukhija, B. S. (2008). Adaptation to climate change: Strategies for sustaining groundwater resources during droughts. *Geological Society, London, Special Publications*, *288*(1), 169-181. https://doi.org/10.1144/SP288.13

Swain, D. L. (2015). A tale of two California droughts: Lessons amidst record warmth and dryness in a region of complex physical and human geography. *Geophysical Research Letters*, *42*(22), 9999-10,003. https://doi.org/10.1002/2015GL066628

Tazeze, A., Haji, J., & Ketema, M. (2012). Climate change adaptation strategies of smallholder farmers: The case of Babilie District, East Harerghe Zone of Oromia Regional State of Ethiopia. *Journal of Economic and Sustainable Development*, *3*(14), 1-12.

Trần, T., Nguyễn, V. T., Ngô, S. G., & Hoàng, M. T. (2008). *Xây dựng bản đồ hạn hán và mức độ thiếu nước ở Nam Trung Bộ và Tây Nguyên*. Viện Khoa Học Khí Tượng Thủy Văn và Mô Trường.

Trần, T. T. (2019). *Đánh giá ảnh hưởng của hạn hán đến sinh kế dân cư nông thôn tỉnh Ninh Thuận*. NXB. Khoa học xã hội.

Villamayor-Tomas, S., Iniesta-Arandia, I., & Roggero, M. (2020). Are generic and specific adaptation institutions always relevant? An archetype analysis of drought adaptation in Spanish irrigation systems. *Ecology and Society*, *25*(1), 32. https://doi.org/10.5751/ES-11329-250132

Võ, T. H., Đặng, T. H., & Nguyễn, N. T. (2020). Phân tích các yếu tố ảnh hưởng đến quyết định áp dụng chiến lược thích ứng với biến đổi khí hậu của hộ nuôi tôm nước lợ tại Bến Tre. *Tạp Chí Nông Nghiệp & Phát Triển Nông Thôn*, *18*, 31-41.

Võ, T. H., Đặng, T. H., Châu, T. L., & Nguyễn, N. T. (2020). Đánh giá tính dễ bị tổn thương của hộ nuôi tôm thẻ chân trắng thâm canh ven biển tỉnh Bến Tre do biến đổi khí hậu. *Tạp Chí Nông Nghiệp & Phát Triển Nông Thôn*, *15*, 112-121 .

Võ, V. T., & Lê, C. D. (2015). Các yếu tố ảnh hưởng đến kết quả sinh kế của nông hộ ở Đồng bằng sông Cửu Long. *Tạp Chí Khoa Học Trường Đại Học Cần Thơ*, *38*, 120-129.

Wang, W., Zhao, X., Cao, J., Li, H., Zhang, Q. (2020). Barriers and requirements to climate change adaptation of mountainous rural communities in developing

countries: The case of the eastern Qinghai-Tibetan Plateau of China. *Land Use Policy 95,* 104354. https://doi.org/10.1016/j.landusepol.2019.104354

Wilhite, D. A., & Glantz, M. H. (1985). Understanding the drought phenomenon: The role of definitions. *Water International*, *10*(3)*,* 111-120. https://doi.org/10.1080/02508068508686328

WMO. (2006). *Drought monitoring and early warning: Concepts, progress, and future challenges.* World Meteorological Organization.

Yamane, T. (1973). *Statistics: An introductory analysis* (3rd ed.). Harper and Row.

Yaro, J. A. (2004). Theorizing food insecurity: Building a livelihood vulnerability framework for researching food insecurity. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, *58*(1), 23-37. https://doi.org/10.1080/00291950410004375

Yuya, B. A., & Daba, N. A. (2018). Rural households livelihood strategies and its impact on livelihood outcomes: The case of eastern Oromia, Ethiopia. *Agris on-line Papers in Economics and Informatics*, *10*(2), 93-103. https://doi.org/10.7160/aol.2018.100209

Zobeidi, T., Yazdanpanah, M., Komendantova, N., Sieber, S., & Loehr, K. (2021). Factors affecting smallholder farmers' technical and non-technical adaptation responses to drought in Iran. *Journal of Environmental Management*, *298*, 113552. https://doi.org/10.1016/j.jenvman.2021.113552