AN ASSESSMENT OF THE CONTRIBUTION OF INDIGENOUS CROPS TOWARDS HOUSEHOLD FOOD SECURITY IN KWAZULU NATAL

By

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ABSTRACT

Indigenous crops play a significant role in providing an alternative food source for vulnerable households. In the past, these crops were commonly accessible and available but have been reduced due to urbanisation and an increase in population, among other factors. Indigenous crops have a wide variety of nutritional, medicinal, and environmental benefits. However, these crops are still characterized by weak value chains, supply chains, and negative perceptions among farming households and consumers. As such, their potential still needs to be explored. The study's main objective was to assess the interaction between indigenous crops and food security of the sampled farming households from three districts (i.e Harry Gwala, EThekwini and uMgungundlovu) in KwaZulu-Natal Province of South Africa. The specific objectives were (i) To examine the factors affecting the consumption of indigenous crops; (ii) To investigate the factors affecting market channels and food form (as it is or processed) selection of indigenous crops and (iii) To analyse the association between socio-economic factors, indigenous crops, and it's contribution to household food security.

The study used primary data from 260 farming households, which were randomly selected. Descriptive statistics were analysed using the Statistical Package for the Social Sciences (SPSS) and STATA. The binomial logit, multinomial logit, bivariate probit and extended ordered probit regression models were used to investigate the interactions between indigenous crops and various variables. The Household Food Insecurity Access Scale (HFIAS) was employed to measurehousehold food security.

The results revealed that 13.8% of farming households were food secure, 34.2% were mildly food insecure, 36.2% were moderately food insecure, and 15.8% were severely food insecure. The binomial logit regression results demonstrated that an increase in the number of females and children within a household as well as farming experience increased the likelihood of consuming indigenous crops. Monthly food expenses decreased the likelihood of consuming indigenous crops. Regarding the indigenous crops' market value perception, the findings showed that 41.9% of the participants believed indigenous crops could be easily marketed, whereas 58.1% indicated that indigenous crops could not easily be marketed. The results further showed that male size within a household was positively associated with selection of the local marketing channels. The number

of children, unemployed members in a household, total household income, and production of crops for consumption and sale negatively influenced the selection of the local market.

On the other hand, the size of the farm was positively associated with the household decision to sell their indigenous crops at an informal market, while the decision to sell in an informal market was also negatively associated with farming experience, producing crops for own consumption and sale. The number of children, education levels, farming experience, and unemployed individuals were negatively associated with the selection of formal markets. Gender and total household income positively influenced the selection of formal markets. Using the bivariate probit regression, the results revealed that farming experience positively influenced the household decision to sell the indigenous crops as fresh produce. Producing for consumption or sale negatively influenced the household decision to sell indigenous crops as fresh produce in the market. Male and farm size in the household were likely to positively influence the decision to sell indigenous crops in a processed food form while total household income was negatively associated with the decision to sell indigenous crops in a processed food form.

The extended ordered probit regression model showed a significant association between indigenous crops and household food security. The results showed that consumption and perception of indigenous crops, farming period, perceived marketing potential, required agricultural assistance, and suitable marketing channel choices significantly influenced household food security. The Chi-square association between socio-economic parameters and household food security showed that gender, household size, and monthly income were significantly associated with household food security.

The study concluded that the socio-economic factors play a significant role in the use and selection of marketing channels for indigenous crops. The decision regarding the food form by which the household sell its indigenous crops was influenced by various socio-economic factors. Farming households perceived indigenous crops as not easily marketable and associated with being largely consumed by older males. Farming households consuming indigenous crops were more likely to be food secure. It is recommended that government, extension officers and nutritionists conduct training workshops to encourage households to grow, market and buy indigenous crops. Government and policy markers need to include indigenous crops in the national food and nutrition security implementation plan and actively create formal markets for the sale of indigenous crops.

DECLARATION 1

I, Nomfundo Shelembe, declare that:

1. The research reported in this dissertation, except where otherwise indicated is my own original research.
2. This dissertation has not been submitted for any degree or examination at any other university.
3. This dissertation does not contain other person's data, pictures, graphs, or other information unless specifically acknowledged as being sourced from those people.
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Nomfundo Shelembe

As the candidate's main supervisor, I, Dr Mjabuliseni Ngidi, agree to submission of this dissertation for examination.

Supervisor's signature:  Date: 15 July 2024

Dr. Mjabuliseni S.C Ngidi

As the candidate's co-supervisors, I Prof. Tafadzwanashe Mabhaudhi and Prof. Albert Modi agree to submission of this dissertation for examination.

Co-supervisor's signature: [redacted] Date: 15 July 2024

Prof. Tafadzwanashe Mabhaudhi

Co supervisor's signature: _____ Date: 15 July 2024

Prof. Albert Modi

DECLARATION 2: PUBLICATIONS

The following papers form part of the doctoral thesis and are planned for publication.

Manuscript 1- Chapter 4

Shelembe, N., Hlatshwayo, S.I., Modi, A., Mabhaudhi, T. and Ngidi, M.S.C., 2024. Determinants of the consumption of indigenous crops among farming households of KwaZulu Natal. (Under preparation to be submitted to a journal).

Manuscript 2 - Chapter 5

Shelembe, N., Hlatshwayo, S.I., Modi, A., Mabhaudhi, T. and Ngidi, M.S.C., 2024. Factors affecting market channel selection for indigenous crops among farming households. (Submitted to journal).

The following paper forms part of the doctoral thesis and was accepted for publication.

Publication 1- Chapter 6

Shelembe, N., Hlatshwayo, S.I., Modi, A., Mabhaudhi, T. and Ngidi, M.S.C., 2024. The Association of Socio-Economic Factors and Indigenous Crops on the Food Security Status of Farming Households in KwaZulu-Natal Province. *Agriculture*, *14*(3), p.415.

All papers were conceived by Shelembe N. The data collection, analysis and writing up of the papers were also done by Shelembe N, while Ngidi M.S.C, Mabhaudhi T, Modi A.T and Hlatshwayo S.I contributed their valuable supervision, guidance, insights, and comments at every stage of their production.

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DEDICATIONS

To the individuals who knew I would complete this journey before it came to pass

Thandiwe Dlamini ingane ka Do & Mpongweni Dlamini

Mr Y.S Moodley

Lethokuhle Sam Madlala

Phumelele Shelembe

Sphesihle Shelembe

Nonhlakanipho Shelembe

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ABRREVIATIONS AND ACROYNMS

DAFF	Department of Agriculture, Forestry and Fisheries
FAO	Food and Agricultural Organisation
HFIAS	Household Food Insecurity Access Scale
IC	Indigenous crops
KZN	KwaZulu Natal
MDG	Millenium Development Goals
STATS SA	Statistics South Africa
SDGs	Sustainable Development Goals
USAID	The United States Agency for International Development
VIF	Variance Inflation Factor
WHO	World Health Organisation

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background

South Africa is nationally food secure, but a number of households remain food insecure. About 21% of the South African population experience inadequate food access and unemployment, with a significant portion consisting of women, children, and the elderly (STATSSA, 2023). Approximately, 11 million individuals have been classified as food insecure of which most are residing in the rural and peri-urban areas (Lembete, 2023). Ngema *et al.* (2018) found that in KwaZulu Natal (KZN), 54% of the sampled households from rural and peri-urban areas had a borderline consumption score. This aligned with D'Haese *et al*. (2013) who reported that KZN had a high food insecurity rate when compared to other provinces. This is similar to other provinces, where in the Mpumalanga and Limpopo province, studies have reported that most participants were mildly and moderately food insecure respectively (Hlatshwayo *et al.*, 2022; Rusere *et al.*, 2023). Similarly, studies such as Omotayo and Aremu (2020), found that in the North-West, 40.6% of the participants surveyed were food insecure.

Increased household food insecurity in vulnerable communities of KwaZulu-Natal has been linked to a general decline in the use of indigenous crops although they are readily available (Lewu & Mavengahama, 2010). This is because vulnerable communities have, overtime, negated the cultivation of indigenous crops and focused on exotic crops, regardless of their low input costs and superior adaptive characteristics to different environmental challenges. Several studies conducted on indigenous crops have implied that they generally have higher levels of various micronutrients than conventionally cultivated species (Nxusani *et al.*, 2023; Shembe *et al.*, 2023). When domesticated, indigenous crops require fewer inputs and have a higher yield in areas where the cultivation of exotic crops is challenging (Salami *et al*., 2022). However, adoption and utilization of indigenous crops remain low. Introducing indigenous crops in most places can create opportunities for greater crop diversification, reducing household food shortages and increasing productivity which can contribute to the balance of annual nutrition, providing new market opportunities, and enhance subsistence farm income and household diets (Legwaila *et al*., 2011).

A study by Kansiime *et al.* (2018) in Tanzania found that despite their nutritional advantages, income, and environmental benefits, the production and consumption of indigenous crops remains low in households due to factors such as cultural human perceptions and lack of consumer awareness about their benefits. Similarly, findings by Cloete & Idsardi (2013) indicated that the perception and knowledge of indigenous crops were found to be low among individuals and could be linked to the low levels in adoption. It is further suggested that low adoption of indigenous crops may be influenced by socio-economic factors; however, these may be area-based challenges. Challenges related to lack of production, consumption and understanding of reasons behind these issues are documented in Kenya (Merchant *et al*., 2023), Ghana (Atitsogbey *et al*., 2023), and Zimbabwe (Moyo *et al*., 2024), with limited knowledge in South African cases (Cloete & Idsardi, 2013).

Mbhenyane (2017) argued that a lack of use or popularity of indigenous crops in rural and urban areas is due to the unavailability and access of these foods in commercialised and industrialised markets. It is suggested that there is an incomplete body of literature for indigenous crops and on how to transition them from being underutilised to utilised (Mabhaudhi *et al*., 2018). According to the Department of Agriculture, Forestry and Fisheries (DAFF,2013), most arable land is primarily used for the production of maize and other exotic crops. In South Africa, exotic vegetable varieties are sold more in supermarkets and spaza shops, further diminishing the range and market for indigenous crops. Similarly, Chepkoech *et al*. (2018) highlighted that in Kenya, failure of increased production and consumption of indigenous crops has been due to commonly cultivated maize as the main staple food along with potatoes, wheat, and rice although they are constantly threatened by climate change due to increase in inputs..

Although several studies, as above-mentioned, have researched various types of indigenous crops and their association to food security, there still exists a gap within various provinces of South Africa, particularly KwaZulu Natal regarding how farming households currently interact with these crops. There is limited literature on what contributes to the low consumption, as well as the utilisation of marketing channels or the food forms, and whether this has any impact on the household food security status of KwaZulu Natal farming households. Therefore, it is important to study these interactions to improve and contribute to the knowledge of the marginalised crops.

1.2 Statement of research problem

The overdependence on three main exotic crops namely wheat, rice and maize has led to detrimental adverse effects in South Africa (Salami *et al.*, 2022). Exotic crops refer to crops that are brought into a country from different parts of the world and commonly require several inputs to cultivate productively (John, 2024). Wheat is the second most important grain produced in the country (Bester, 2014). On the other hand, maize plays a significant role in several industries in South Africa, while the high demand for rice is primarily maintained through imports. As environmental challenges such as climate change continue to increase, the country cannot solely rely on these exotic crops to sustain food demands and household diets (Mavenghama *et al.*, 2013). This is due to climate change causing rising temperatures, inconsistent rainfall patterns, and extreme weather events that negatively affect crop yields (Gbetibouo *et al.*, 2010).

The dependency on these exotic crops and environmental challenges associated with them places the rural and peri urban farming households in a vulnerable state (Qange & Mdoda, 2020). This is due to the fact that many of these farmers are unable to manage the required number of inputs and amount of land needed to cultivate these crops at the quality demanded by formal markets (Sinyolo *et al.*, 2021). Farming households are commonly characterised by limited access to resources such as land, water, and technology as well as lack of market access and poor infrastructure (Kom *et al.*, 2020). Despite their vulnerability, these farmers have been found not to fully utilise indigenous crops such as amaranthus, taro, sweet potatoes, Bambara groundnut and cowpea that can be grown in KwaZulu Natal among other provinces, that have been proposed as a solution to food insecurity and climate change issues (Akinola *et al*., 2020). Maseko *et al*. (2017) highlighted the different environmental adaptability advantages of indigenous crops and their potential to stabilise household food security among vulnerable households. This is further supported by Mabhaudhi *et al*. (2018), where indigenous crops were reported to have the potential to drive transformative change if utilised effectively. Although these crops have several nutritional, environmental, and medicinal benefits, they remain overlooked and underused. Efforts to promote these crops by the government and research centres through brochures and intervention programs have not worked (Taruvinga *et al.*, 2021).

Indigenous crops in South Africa also face a crucial market gap. These crops are rarely sold in supermarkets and seen in local markets. This is attributed to various market challenges such as

low demand, limited market access, lack of production and market information. However, further efforts to develop and diversify indigenous crops coupled with addressing market challenges and providing support to farmers, can contribute to sustainability and food security. In this study, the selected province of KwaZulu Natal is dominated by agricultural activity. Nevertheless, it is also characterised by high levels of food insecurity, unemployment rates and poverty. Numerous studies have examined household food security and its determinants in KwaZulu Natal (Masuku *et al.*, 2017; Maseko *et al*., 2022; Mncube *et al.*, 2023). However, there is limited literature on indigenous crop related factors and their impact on household food security. A few studies have researched the various aspects of the indigenous crops value chain (Senyolo *et al*., 2018; Zondi *et al.*, 2022; Mazike *et al.*, 2023), but there is limited literature on whether farmers perceive indigenous crops valuable for selling and processing through different marketing channels and the underlying factors influencing their choice of marketing channels and food form . Furthermore, the consumption rate of indigenous crops among various areas such as the Northwest province (Omotayo *et al*., 2021) and Limpopo province (Nengovhela, 2018) have been studied, yet the determinants of consumption of these crops is limited in South African research. Therefore, this study aims to assess the interaction between indigenous crops and how this affects the household food security status among farming households in KwaZulu-Natal.

1.3 Rationale of the study

Increased production, consumption, and marketing of indigenous crops by farming households can contribute to improving food security and livelihoods. There is a significant need to educate farming households about the various types of indigenous crops available and their nutritional benefits for enhancing food and nutrition security. It is important for farming households to incorporate these crops in their farming systems as they require less inputs to grow and are climate resilient. It is also imperative to understand farming households' experiences and beliefs towards indigenous crops to find ways to improve the lack of production and marketing of these crops. Therefore, the study identifies the different factors associated with household food security concerning indigenous crops. Additionally, the study seeks to understand farming household factors that affect the selection of marketing channels and food form (as it is or processed) for indigenous crops.

The study's findings and recommendations will provide knowledge to agricultural policymakers for amending and formulating agricultural policies and interventions to improve the diversity of indigenous crops in cultivation among farming households. These findings will contribute significantly to the national efforts to increase food security and reduce hunger among vulnerable households. Furthermore, the study can assist in achieving sustainability development goals one, two and thirteen, which are aimed at eliminating poverty and hunger.

1.4 Aims and Objectives

Increased production, consumption and market participation using indigenous crops was hypothesized to improve household food security among farming households. Therefore, the study aims to assess the interaction between household food security and indigenous crops to improve household food security among farming households of the KwaZulu-Natal province in South Africa.

The specific objectives were to:

- Determine the factors affecting the consumption of indigenous crops
- Investigate the factors affecting market channel and food form (as it is or processed) selection of indigenous crops
- Analyse the association between socio economic factors, indigenous crops and its contribution to household food security.

1.5 Research questions

- What are the determinants of consumption of indigenous crops amongst the farming households?
- Which factors determine the selection of marketing channels and food form (as it is or processed) for indigenous crops?
- Is there any association between socioeconomic factors, indigenous crops, and household food security among farming households?

1.6 Outline of the thesis

The study consists of seven chapters, including this introductory chapter. Chapter 2 covers the literature review of the study. It provides current theoretical and empirical evidence of indigenous crops' different forms of contribution to household food security. Chapter 3 briefly explains the different methods and materials utilised during the collection of data. The remaining chapters consists of three studies, addressing the specific objectives concerning indigenous crops' association to household food security. The last chapter discusses the conclusions and policy implications of the research findings, as well as recommendations for further research. The following further specifies the complete aspects of the study.

CHAPTER FOUR: ***Factors affecting the consumption of indigenous crops.***

Descriptive statistics and the binomial logit regression were employed to estimate the factors increasing and decreasing the likelihood of the consumption of indigenous crops.

CHAPTER FIVE: ***Factors affecting market channel and food form (as it is or processed) selection for indigenous crops by farming households.***

The multinomial logit and bivariate probit regression were used to investigate the factors affecting market channel and food form (as it is or processed) selection for indigenous crops by farming households.

CHAPTER SIX: ***The Association between Socio-Economic Factors, Indigenous Crops and its contribution to the Food Security Status of Farming Households in KwaZulu-Natal Province***

The extended ordered probit regression and Household Food Insecurity Access Scale (HFIAS) were used to analyse the association between socioeconomic factors, indigenous crops and its contribution to household food security.

CHAPTER SEVEN: ***Conclusions and Recommendations***

The study's summary, conclusions and policy implications were presented

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CHAPTER 2

LITERATURE REVIEW

EXAMINING INDIGENOUS CROPS' CURRENT ROLE IN FOOD SECURITY AMONG FARMING HOUSEHOLDS

Abstract

The discussion of food security among farming households is of significant importance across the world, particularly among vulnerable households. This chapter revieweda vast body of literature on the different theory relating to indigenous crops and household food security across South Africa. The objectives of the review were to: (i) Examine the current food security state in South Africa; (ii) Investigate the role of indigenous crops in relation to food security in South Africa; (iii) Assess the current body of literature in relation to the challenges of indigenous crops in the context of production, consumption and markets; as well as (iv) Develop a theoretical and conceptual framework about the relationship between indigenous crops and household food security. The literature showed a ten-year gap in studies involving the factors that influence the consumption of indigenous crops. Several studies also listed the different challenges faced within marketing channels among farming households. However, it was shown that limited literature exists on marketing channel selection centred on indigenous crops commodities. This was further highlighted by a gap in research focusing on indigenous crop food form availability in markets. The contribution of indigenous crops to current food systems in all aspects of the value chain remains unclear. The review emphasized the need undertake research that evolves around two frameworks, namely (i)the theory of change and (ii) the resource based theory to improve the livelihoods of farming households through the use, production, processing, selling and consumption of indigenous crops.

Keywords: Food security, indigenous crops, markets, food form

2.1 Introduction

Indigenous crops have a wide history in South Africa, where several communities have depended on them for generations (Rankoana, 2022). These crops include cereals, leafy vegetables, and several fruits. According to Muhanji *et al*. (2011), African indigenous crops such as vegetables, have been part of food systems for generations. The region is a natural habitat for more than 45,000 plant species, of which about 1,000 can be consumed, forming the backbone of traditional diets. Exotic crops such as maize, cassava and sugarcane were introduced during the colonial era, where farmers began to incorporate these crops at the expense of indigenous crops resulting in their neglect (Yang & Keding, 2009).

In South Africa, the use of indigenous crops dates to the history of modern man and was habitually obtained by collecting and not by means of cultivation. According to Ntuli *et al*. (2012), indigenous crops have been used for centuries by the Khoi-San and Bantu tribes who relied on them for sustenance. Presently, weedy indigenous crops such as *Amaranthus hybridus, Momordica foetida and Colocasia esculenta* are collected from agricultural fields and sold at road markets by rural women in provinces such as parts of northern KwaZulu-Natal. However, these crops are limited due to overharvesting and lack of cultivation as well as being regarded as weeds in commercial farming (Shacklenton *et al*., 2005; Matenge *et al*., 2011).

Over the years, with different environmental challenges such as climate change, indigenous crops have somewhat gained traction. Matalele (2022) identified sorghum as an undervalued crop that is suitable for low input agricultural systems and marginal production areas in South Africa. Similarly, Omotayo *et al*. (2020) reported that sorghum (a grain) along with Amaranthus (vegetable) and *Sclerocarya birrea* (fruit) is undervalued. Other literature such as Rankoana (2021), Nhamo *et al*. (2022), Achinolu *et al*. (2023) and Nxusani *et al*. (2023) have mentioned Bambara groundnut, milk plum, Natal plum, wild custard apple and medlar plants as important indigenous crops in South Africa. These crops have been listed as more resistant and better adapted to local pests and diseases and have the potential to enhance water, food, and nutritional security particularly in arid and semi-arid regions (Nwonwu, 2008; Mathews, 2010; Mathaba, 2017).

Indigenous crops have also played a cultural role amongst rural communities (Mushaphi *et al*., 2017) as certain crops are tied to beliefs. The cultural role of indigenous crops in South Africa is

multi-layered and deeply entwined with traditional practices among farming households from different generations (Maunder & Meaker, 2007). These crops have been commonly used for medicinal purposes tied to different beliefs (Maroyi, 2013). Fouche (2018) noted that indigenous crops have been used as an alternative healthcare system by South Africans for decades where 70% of households were found to use them for medicine. The cultural importance of indigenous crops is also noted through the different indigenous knowledge applied for sustainable crop production (Nethononda *et al*., 2012).

Although these crops have a long history within South Africa and have the potential to contribute in multiple ways within society, they are currently underused and undervalued. Hence, exploring the intricate relationship that currently lies between indigenous crops and food security is imperative to assist vulnerable farming households to better adapt to the constant changing environment. The objectives of the review were to: (i) To examine the current food security state in South Africa; (ii) Investigate the role of indigenous crops in relation to food security in South Africa; (iii) Assess the current body of literature in relation to the challenges of indigenous crops in the context of production, consumption and markets; as well as (iv) Develop a theoretical and conceptual framework about the relationship between indigenous crops and household food security.

2.2 Food security situation in South Africa

Food security is defined as achieved when all individuals at all times have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy lifestyle at all levels namely, household, national and global levels (FAO, 1996). This definition was later revised in 2002 to state that food security exists when all people, always, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life at the aforementioned levels (FAO, 2002). It is divided into four pillars namely availability, access, utilisation, and stability.

According to Battersby (2011), in 2009, South Africa identified food security as a key focus area, building onto the Integrated Food Security Strategy as a result of high household food insecurity. Household food insecurity is aggravated by several factors such as household electricity supply, loss of income, food inflation, rising food prices, predominantly in maize and wheat that are a staple diet of low-income households (Abegunde *et al*., 2019; Sinyolo, 2020). The General

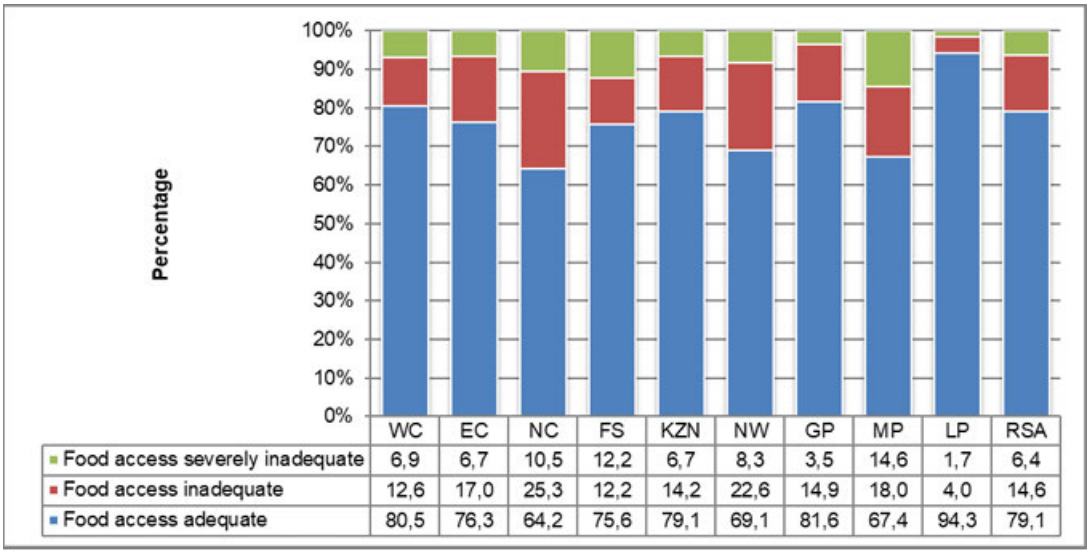
Household Survey of 2007 reported that 10.6% and 12.2% of adults and children were more likely to be exposed to hunger whilst, on the other hand, the National Food Consumption Survey of 2005 reported that 52% of households were found to experience hunger and 33% households are vulnerable to hunger (STATS SA, 2008). Constantly, food insecure and low-income households are more likely to be susceptible to food price shocks due to spending a higher share of their incomes on food. This is more expected in rural households where a widespread of hungry and malnourished individuals are mostly found in KwaZulu-Natal and Eastern Cape (Altman *et al*., 2009; Ngumbela *et al*., 2019; Sabi *et al*., 2020; Mthethwa & Wale, 2020).

In the Western Cape, during the year of 2010, 11 cities were surveyed where 77% of the households were found to be severely or moderately food insecure predominantly in rural areas (Battersby, 2011). Similarly, Swanepoel & Niekerk (2018) reported that in the Eastern Cape, 80% of the sampled households have been previously found to be severely or moderately food insecure in both urban and rural areas due to limited dietary diversity and lack of nutritional food items in their baskets. This is generally caused by the type of food items selected within a household which may be limited. Households then use several ways to cope with food limitation, supermarkets that are built-in townships and rural areas as well as spaza shops have been used as a mitigation strategy for consumers to purchase their food needs as how income dictates, as there are no transport costs. Other methods include consuming foods that are less preferred, limiting portion sizes, maternal buffering, skipping of meals and skipping eating for whole days and lack of purchasing power (Jacobs, 2009; Wheeler & von Braun, 2013).

Food security in the Limpopo province is influenced by several different socioeconomic, environmental, and agricultural factors and has been the subject of various studies in South Africa related to food security. De Cock *et al*. (2013) investigated the food security situation of rural households and the challenges they face, 53% of the sampled households were severely food insecure with household income and human capital being the main determinants of food security. Comparingly, Nevhutalu *et al.* (2023) highlighted that a significant number of households in the Limpopo province were food insecure particularly after the covid-19 pandemic. These findings are in line with Mbhatsani *et al*. (2021) who identified age, education, access to credit and land size as significant determinants of food security.

Food security in KwaZulu Natal is of no difference as a number of studies highlighted the struggle of households, smallholder and subsistence farmers on accessing food (Gumede & Napier, 2022; Jilajila *et al*., 2023; Mkhize *et al*., 2023). Among the determinants and challenges of food security in other provinces, Govender *et al*. (2017) further reported a link between nutrition education, agriculture, and food security highlighting the importance of education in farmers so as to incorporate the crops they cultivate into their food for a well-balanced diet. Moralles *et al*. (2021) also examined the link between nutrition education and food security among smallholder farmers and reported the importance of addressing food security through nutrition education in agriculture. This is further reiterated by past literature of Ngidi & Hendriks (2014) who reported how KwaZulu Natal households surveyed had 20.9% struggling with attaining a sufficient food supply.

Contrastingly, in the Mpumalanga province food insecurity studies are centered around the significant concern due to ongoing climate changes, drought, and lack of adoption of sustainable land management practices (Masekoameng & Molotja, 2016; Rusere *et al*., 2023). The province has been highly affected than most of the country as decrease in food production due to the abovementioned has resulted in food shortages among smallholder/ small scale farmers (Oduniyi, 2013; Maponya & Mpandeli, 2016; Maponya *et al*., 2022). Ndlovu and Masuku (2021) reported that a high number of households are food insecure in the rural areas of Mpumalanga. This is similar to findings from Agboola *et al*. (2023) which found 40.47% moderately food insecure households and 20.89% severely food insecure households among the rural areas of Mpumalanga. However, Oduniyi & Chagwiza (2022) reported 68% of sampled maize farmers to be food secure. Masuku *et al*. (2017) discussed the relation between government grants and food security. The majority of the rural population that depends on government grants was reported to be in the Eastern Cape and KwaZulu-Natal as these provinces contain a large proportion of rural areas which leads to limited food accessibility and thus food insecurity. Figure 2.1 further shows a similar pattern amongst households in the different provinces regarding food adequacy and inadequacy. Food inadequacy is highest in the Northern Cape (25.3%), Northwest (22.6%), Mpumalanga (18%), Eastern Cape (17.0%), Gauteng (14.9%) and KwaZulu Natal (14.2%). It should be noted that severe food inadequacy is less experienced.



	WC	EC	NC	FS	KZN	NW	GP	MP	LP	RSA
Food access severely inadequate	6,9	6,7	10,5	12,2	6,7	8,3	3,5	14,6	1,7	6,4
Food access inadequate	12,6	17,0	25,3	12,2	14,2	22,6	14,9	18,0	4,0	14,6
Food access adequate	80,5	76,3	64,2	75,6	79,1	69,1	81,6	67,4	94,3	79,1

Figure 2.1: Percentage of households experiencing food adequacy or inadequacy by province in 2021 (Source: STATS SA, 2021)

These studies underline the persistent nature of food insecurity among provinces and the need for targeted interventions to improve the food security situation in different parts of the country. Food insecurity is still challenging in South Africa, however agricultural production has been reported to help reduce food insecurity (Fanadzo, 2012; Maziya *et al*., 2017; Ngema *et al*., 2018). Mpandeli and Maponya (2014) have also shed light on the different challenges and constraints faced by farmers regarding food security with historical factors being noted as exacerbating food insecurity. Baiphethi & Jacobs (2009) argued that agricultural production for farmers decreases food insecurity of low-income households in both rural and urban areas as this increases diet diversity and decreases reliance on purchasing food in a setting of high food price inflation that low-income households are vulnerable to. Similar to this, Crush *et al.* (2011) projected that by 2030, over half of Africa's population will reside in urban areas and in turn will cause households to have smaller available space for subsistence production for consumption or sell surplus.

2.3 Description of indigenous crops

2.3.1 The role of indigenous crops to household food security

The terms indigenous, traditional, and orphan crops have been used interchangeably; however, although a similarity exists, they have different meanings. According to Modi (2003), indigenous

crops are not clearly defined in the literature, leading to confusion between indigenous and traditional crops. Similarly, Cloete & Idsardi (2013) emphasized the issue between the terms indigenous, orphan, and traditional crops. The study suggested that the terms such as indigenous, traditional, and orphan crops may seem straightforward but further examination shows an overlap and confusion pertaining how they should be defined and characterised. The South African Department of Agriculture, Forestry and Fisheries, DAFF (2013) defined indigenous crops as those originating in South Africa, including those introduced into the country and now recognised as traditional crops. It was further explained that these crops are produced and grown in the country under various weather conditions with many found in the wild.

Indigenous crops have been noted to play an important role in alleviating hunger and malnutrition in different parts of the world but are frequently neglected in research (Van Rensburg *et al*., 2004; Siwela *et al*., 2020). A study by Burchi *et al*. (2011) noted that an adequate intake of vitamins and minerals is fundamental for preventing common micronutrient deficiencies such as vitamin A, iron, and iodine deficiencies. The study further elaborates that many diseases that are related to micronutrient deficiencies could be prevented if suitable information on the importance, existence, and utilisation of indigenous crops such as amaranth, sweet potato and moringa are made accessible to households. Legwaila *et al*. (2011) reported that 60 to 85% of rural households in South Africa face food shortages for three to four months in a year and use indigenous crops to sustain their livelihoods. Additionally, indigenous crops provide employment prospects which are rare in rural areas. An example of this are indigenous fruit trees. Indigenous fruit trees were reported to contribute an estimated 42% of the household food basket for households particularly residing in rural areas (Legwaila *et al*., 2011).

According to Mkhize *et al*. (2023), indigenous crops are easy to grow, yield quickly and can tolerate challenging and demanding environments. Nhamo *et al*. (2022) stated that the introduction of these crops can be done in most places, leading to increased crop diversification and productivity. This can in turn contribute to the balance of annual nutrition, provide new market opportunities, and enhance farm income and household diet. Modi *et al*. (2006) reported that among indigenous crops such as amaranths, blackjack, and water navel, there is a significant amount of nutrients that could enhance household diets. Yet, Onomu (2023) reported that these

crops are at risk of extinction as farming households commonly utilise high yielding commercial varieties.

Similar to South Africa, in Kenya, multiple programmes to promote indigenous crops consumption and nutritional value have been implemented which led to increased uptake of these crops, particularly vegetables. However, the increase in consumption was found to insignificant in rural and peri urban areas (Bokelmann *et al*., 2022). Odendo *et al*. (2023) highlighted that failure of increased consumption of these crops in Kenya was often due to the common practice of growing maize as the main staple food crop along with potatoes, wheat, rice, and beans. These practices were increasingly threatened by the global climate change leading to aridity and increased costs of production. Additionally, Muthoni & Nyamongo (2010) argued that lack of production and consumption of these crops has resulted in an increase of micronutrient deficiencies. Mbhenyane (2017) discussed the lack of use of indigenous crops in rural and urban areas to be constituted by the unavailability of these foods in commercialised and industrialised markets. Moreover, it was reported that the limited investments made in researching and developing these crops, marginalizing them in commercial farming, further lead to loss of biodiversity and related traditional knowledge.

Among households, indigenous crops have had various uses in the past, such as medicinal purposes (e.g. easing childbirth, recovery from wounds, contraception) and agro processing (e.g. juice, jam, wines) (Nxusani *et al*., 2023; Takaidza, 2023). Van Rensburg *et al*. (2014) contended that although households may harvest different indigenous crops and use them; this does not equate to proper utilisation. Van Rensburg *et al*. (2014) further discussed that when households use indigenous crops for medicinal, agroprocessing and basic cooking, a high percentage of nutrients is lost. An example of this is the boiling and drying of the leaves of these crops which reduces vitamin content by 80% and 95%, respectively. This loss of nutrients is significantly felt by women and children through food and nutrition security. It must be noted that although indigenous crops can assist in alleviating micronutrient deficiencies, hidden hunger, poverty and ultimately food security, the establishment of and access to indigenous crops is gradually declining due to natural habitats facing pressure from population growth, development, conservation exclusions and agricultural expansion. Furthermore, indigenous crops are excluded from official statistics on economic values of natural resources (Mbhenyane, 2017).

2.4 Factors affecting the consumption of indigenous crops

The introduction of exotic crops has significantly reduced the production, consumption and use of indigenous crops and this was also argued by Bourgeois (2013). The study investigated the current approach to sustainable intensification which is mainly founded on increasing productivity while reducing environmental impacts. However, this commonly translates to quantity increase than sustainability. Bourgeois (2013) argument further emphasized the need to explore alternative pathways such as the cultivation of indigenous crops as they can adapt to different environmental challenges while investment in inputs is low. Farming households have been known to produce and market mostly exotic crops and this has been found to be a similar case in terms of consumption patterns (Jacobs, 2009). Additionally, farming households have been found to purchase exotic crops although they cultivate them, showing an alarming dependence on purchased produce (Baiphethi & Jacobs, 2009). This limits the consumption of indigenous crops although they have several beneficial properties (Akinola *et al*., 2020). Consumption of indigenous crops have been studied and have yielded different results in different countries where most of these studies are based on the high micronutrient deficiencies faced by each country or the level of food insecurity where indigenous crops can assist in alleviating these challenges and issues.

In South Africa, Cloete & Idsardi (2013) investigated the consumption of indigenous crops. The results revealed that the consumption of these crops was heavily tied to negative perceptions. Indigenous crops were labelled as food for the vulnerable or poor and utilised as a survival strategy rather than for their nutritional benefits. Furthermore, the study showed that household income was associated with the frequency of consumption, with lower income households consuming more of these crops than those of higher income households. The foundation of this study laid out the groundwork for other studies within South Africa. Mungofa *et al*. (2018) examined the rate of consumption of indigenous crops in the Limpopo province among rural areas. Contrast to Cloete & Idsardi (2013), a high number (92%) of households were found to consume indigenous crops due to their affordability and nutritional value. Furthermore, the study indicated in the Limpopo province, the most consumed indigenous vegetables were Jute (Corchorus spp), lerotho (Cleome gynandra), mokopu (Cucurbita maxima) and thepe (Amaranthus thunbergii).

The need to investigate the determinants of consumption of indigenous crops is not limited to South Africa. Ekesa *et al.* (2009) examined the access and consumption of indigenous crops in Western Kenya. The study found that over 50% of households consumed indigenous crops such as cowpeas, amaranthus and jute mallow. However, the study did not discuss the determinants of households consuming these crops. On the other hand, Kahara *et al.* (2021) investigated the determinants of consumption of African indigenous vegetables in farming household of Kenya. The study focused on socio economic factors that determine the consumption of these crops and found that the country of origin, age, marital status significantly influenced whether a household consumed these crops. Similarly, Gido *et al*. (2017) found that age, employment status, household size, market distance, awareness and income was significantly associated with the consumption of indigenous crops. The studies reviewed showed the importance of cultivating and consuming indigenous crops. In South Africa, studies that focus on the factors affecting consumption were focused on the Limpopo province. However, studies that focused on the factors affecting consumption within the KwaZulu Natal province among other provinces of South Africa are significantly limited. As production rates remain low and consumption rate differ within provinces, it is necessary to find these factors reflecting the KwaZulu Natal context. This is further discussed in Chapter five.

2.5 Factors affecting the selection of marketing channels for indigenous crops

Market channel choice selection has been studied in several African countries (Mutura *et al*., 2015; Pham *et al*., 2019; Sori & Adugna, 2022). According to Lake (2007), a marketing channel is a well-organized system of organizations and agencies that together carry out all the necessary tasks to connect producers and consumers. Marketing channels are commonly categorized by local, informal, and formal markets (Arinloye *et al*., 2015). Local markets are most convenient for farming households as they have the least costs to subtract from profits, however, local markets are limiting in consistency, stability and number of consumers (Louw *et al*., 2008). Comparingly, informal markets provide farmers with a chance to sell different grade produce to hawkers and any other clients who may not have any stringent contractual agreement and prices may be negotiated (Muhanji *et al*., 2011). Contrastingly, formal markets require high quality produce and have high marketing costs which farming households may not be able to afford. Market channel choice was studied by Nxumalo *et al*. (2019) in maize and sunflower farmers from the Northwest province of South Africa. Nxumalo *et al*. (2019) found that age, marital status, gender, credit access, education

and farming experience influenced the choice of marketing channel among maize and sunflower farmers.

On the other hand, Mothiba *et al*. (2023) only found three variables to be main drivers of market channel choice within groundnut farming households. The study found gender, employment status and vehicle ownership to be significant in market channel choice of Limpopo province farming households. Nwafor (2021) also found that household size, income received, distance to market and market availability were the main significant factors associated with market channel choice in South African coco yam farmers. These studies highlighted the important socio-economic characteristics that drive market channel choice in South Africa, although the enterprises were different. The studies also showed how limited resources such as access to credit and assets such as vehicles can hinder the participation of farming households in markets.

Mgale & Yunxian (2020) investigated market channel choice among rice farmers in Tanzania. Unpredictably, a high number of farmers were found to be selling their produce to local markets due to several hindering factors that hindered them into venturing to formal markets such as rural infrastructure, access to productive assets, market information systems and organizational membership within farmers. Market channel choice is an important factor in the agricultural value chain and can limit the growth and profits of farmers if selection is performed inaccurately. The above-mentioned studies show the need for government and private sector support and interventions to assist farmers in making better informed market channel selections. Different studies mentioned above have studied market channel choice using the multinomial logit and binary logit regression models to find the predictor variables of market choice selection among farmers. However, the areas and enterprises in which the research was conducted were different and rarely focused on indigenous crops. There is limited focus on how farmers decide on marketing channels for indigenous crops in South Africa. This information is imperative as indigenous crops have several benefits for farming households as well as vulnerable households. Any policy formations or creation of programmes will need evidence-based information on how to incentivise farmers to sell more of these crops. This is further discussed in Chapter six.

2.6 Factors affecting the selection of food form for indigenous crops

Indigenous crops have a limited amount of food form types sold in different markets in South Africa. They are currently sold as fresh, frozen meals or processed into food such as taro chips,

amaranth flour and morogo canned soup (Njomo, 2012; Schnetzler, 2018; Ramsookmohan *et al*., 2020). African studies have focused on the potential acceptance of indigenous crops processed product and their nutritional content thereof (Schnetzler, 2018; Olusanya, 2018; Ntila *et al*., 2019). Hence, wider food form selection studies are limited. Akinola (2021) explored the mainstreaming amaranth into markets and its products. The results revealed that there was poor knowledge among farmers on how to cultivate amaranth. Furthermore, amaranth was found to have the potential to break into the mainstream market given the right recipes and processing techniques. Emire & Arega (2012) investigated value adding product development and quality characterization in amaranth and wheat flour in East Africa. The results indicated that the substitution of wheat flour with amaranth can contribute significantly to food security and production of various gluten-free value-added products.

Zungu *et al*. (2020) assessed the nutritional composition of Moringa oleifera leaf powder-based snacks for improving food and nutrition security in children. The results revealed that snacks containing 1% or less of moringa leaf powder were acceptable and of higher nutritional quality when compared to other tested snacks. Furthermore, these snacks had the potential to alleviate malnutrition among vulnerable children. On the other hand, Olusanya *et al*. (2020) studied the nutritional composition and consumer acceptance of Moringa leaf powder supplemented mahewu (i.e. a famous maize based South African drink). The study found that the macro and micronutrients of moringa based mahewu had a higher composition than maize. However, the acceptance of the product was lower than that of the maize based mahewu. These studies have shown that indigenous crop processed products are less available in markets as compared to freshly sold indigenous crops. However, the development of indigenous crops' value chain has the potential to improve this access as acceptance among consumers is possible. Factors affecting food form (as it is or processed) selection are further discussed in Chapter six.

2.7 The association between socio economic factors, indigenous crops, and its contribution to household food security among farming households

Indigenous crops are an important aspect in improving household food security, this has been shown consistently in various research articles (Ayodele *et al*., 2009; Maroyi, 2011; Aworh, 2023; Du Toit *et al*., 2023). Indigenous crops play a vital role in ensuring food security, particularly through environmental challenges faced by farming households such as climate change, population

growth and developments (Chen *et al*., 2021). In addition, indigenous crops have been known to hold nutritional benefits, are resistant to drought and have been utilised as natural and organic medications in some areas of South Africa (Imathiu, 2021). Despite this knowledge, indigenous crops are not as widely produced (Sambo, 2014).

Farming households that cultivate and have access to indigenous crops have been found to be food secure (Omotayo & Aremu, 2020). Kasimba *et al*. (2018) analysed how access to traditional and indigenous crops were associated with household food security among households in Botswana. The study found that an increase in the number of traditional and indigenous crops were likely to decrease household food insecurity. These results were supported by findings of Omotayo & Aremu (2020) who found that the inclusion of indigenous crops improved household food security in households of the Northwest province in South Africa. Similarly, Mshenga *et al*. (2016) found that households that cultivated indigenous crops less as opposed to exotic crops were exposed to food insecurity and a higher adoption of indigenous crops was necessary. Additionally, factors determining the likelihood of household's acceptance of these crops were significantly linked to gender, age, farm size, education level, off farm income and number of visits to extension officer.

Socio economic factors have also shown to have impact on household food security among various regions of South Africa. Factors such as age, household size, education levels, gender and marital status have played a key factor in household food security in past studies. In the Northwest province of South Africa, Oduniyi & Tekana (2020) investigated the determinants of household food security among smallholder farmers due to persistence high poverty and unemployment rates. The findings showed that gender, household size and farming experience increased the likelihood of food insecurity whilst increase in age led to a more food secure status where more female-headed households were food secure. This was found to have a similar context in the Eastern Cape where factors such as gender, farm size and water bills influenced household food insecurity. Commonly, the studies showed a need to improve gender-based interventions that restrict female participation in agriculture. This is because factors such as gender play a significant role in household food security and understanding these dynamics is key when developing effective interventions. Females in the household are commonly the primary food producers and caregivers in South African households and any negative decisions made can greatly affect the food security of any household members. Additionally, gender disparities in access to resources such as land,

credit and education negatively affect female productivity which are important in improving food security (Akinboade & Adeyefa, 2018; Hlatshwayo *et al*., 2022). On the other hand, farming experience and size significantly influence food security due to their level of impact on agricultural productive and income generated. This is because an increase in experience commonly leads to higher yields as farmers are well adapted and can adopt better agricultural management and sound resource use (Matshe, 2009; Raheem & Worth, 2011). Similarly, farm size relates to food security due to larger farms increased capability in food production and diversification which results in higher yields and income (Oduniyi & Tekana, 2020).

In Nigeria, education was found to be the main factor that affects household food security among maize farmers Ogunniyi *et al*. (2021). Similarly, Nkomoki *et al*. (2019) found that in addition to higher education levels for both the food consumption and household hunger score, livestock income, secure land tenure, increasing land size increase household food and nutrition security in Zambian farming households. On the other hand, Masa *et al*. (2020) compared two countries socioeconomic factors and food security. The study indicated that food insecurity is rife among the youth in both Ghana and South Africa. Primarily, education and land tenure provide farming households better resource management skills and stability. Higher educational achievement is linked to enhanced knowledge of agricultural practices and investments such as clear property rights among other productive assets, thus improving household food security of farmers (Nwokolo, 2015; Nkwae, 2023).

Various studies, as listed above, have investigated which factors affect household food security among different areas in South Africa. However, there is limited literature which focuses on the combined indigenous crop related factors (i.e. indigenous crops' perception, means of access, consumption) coupled with socioeconomic factors that are associated with household food security, particularly for KwaZulu Natal farming households. Therefore, an analysis of the association of socio-economic factors and indigenous crops to household food security of farming households is necessary. This will help in designing improved policy instruments for sustainable economic development among farming households. It can be concluded that more research is needed to provide current evidence-based information for policy and government interventions. This is further discussed in Chapter 7.

2.8 Review of Analytical Review techniques used in the study.

2.8.1 Household food insecurity scale (HFIAS)

The household food insecurity scale (HFIAS) is a commonly recognised tool for examining and assessing household food security. It is designed to distinctively assess the access component of household food insecurity through nine questions. These questions focus on household food access, inadequate food quality and insufficient food intake. The HFIAS tool has played an important role in different research articles when investigating the factors influencing food insecurity across the country and globally (Shekampu, 2017; Otekunrin *et al*., 2021; Lujabe *et al*., 2022) and assessing the effects of food insecurity on outcomes like malnutrition and hidden hunger (Sreeramareddy *et al*., 2015; Das & Krishna, 2018). This tool has been reviewed for validation and has demonstrated good construct validity, internal consistency and convergent validity across different contexts, hence this established it as a suitable tool for this study (Nnyepi *et al*., 2023).

Several studies have utilised the HFIAS in diverse settings including South Africa, Ghana and East Africa to investigate the determinants of household food security (Gebre, 2021; Hlatshwayo *et al*., 2022; Kolog *et al*., 2023). Chari *et al*. (2022) examined the predictor variables of food access in Raymond Mhlaba local municipality in South Africa. The study indicated that age, education levels, participation in farming and indigenous knowledge played a key role in households' food security status. Furthermore, the study discussed and stressed that the use of the HFIAS can assist and complement other information for creating food policies directed at rural communities. Mazenda *et al*. (2022) investigated the determinants of food security in the Gauteng province using the HFIAS tool. The results revealed that challenges of food access were more predominant in female-headed households and those with low levels of education. Factors such as age, gender, employment, income, social grants were major determinants in a household's food security status. Additionally, the study found that social grants were insufficient in helping households access the required amount of food consistently.

Mudzielwana *et al*. (2022) focused on the determinants of food security of irrigation farmworkers in Tshiombo, South Africa using the HFIAS tool. Contrary to the variables found to be significant among households; land size and leasing, food storage facilities and total expenditure was found to be significant factors that influence irrigation scheme farmworkers' food security. Lujabe *et al*. (2022) explored food security determinants in suburban households in the Eastern Cape province

post the Covid-19 pandemic. The study found that 77.4% of the households were severely food insecure, 13.4% moderately food insecure, 3.05% mildly food insecure and 6.1% food secure. The results revealed that gender, household size, age, employment, and household income influenced food security. The study further showed that high unemployment rates exacerbated food insecurity in the area.

2.8.2 Binomial logit regression

The binomial logit regression has been utilised for data analysis for various studies within the South African context (Sibanda & Pretorius, 2012; Mphekgwana, 2022). In the agricultural context, the binomial logit regression has been used to determine cases such as the selection and adoption of conservation agricultural practices for smallholder farmers, access to credit facilitation and barriers affecting sustainable agricultural productivity (Chauke *et al*., 2013; Muzangwa *et al*., 2017; Myeni *et al*., 2019). Binomial logit regression was used by Zaca *et al*. (2023) to analyse the factors influencing rural households in uptaking agroforestry practices. The results indicated that knowledge, attitudes, and perceptions towards agroforestry increased the adoption of agroforestry practices in addition to age, farming experience, education level and land size. Contrastingly, Liliane *et al*. (2020) found no significant association between age, gender, farming experience, income, and adoption of agroforestry practices. However, farm size and household size had a positive impact in the adoption of these practices.

Farmer participation in extension programmes has also been modelled using the binomial logit regression. Suvedi *et al*. (2017) investigated the influential factors related to extension program participation by farmers. The results demonstrated that age, education, household size and distance to extension office significantly increased the participation of farmers in extension programmes, whilst off farm employment limited it. Similarly, Anang & Ayambila (2020) explored the determinants of farmers' participation in agricultural extension programmes and its relation to labour productivity using the binomial logit regression. The study revealed that likelihood of participation increased with an increase in farming experience, farm size, access to irrigation and membership to groups but decreased with years in education and household size. In contrast to Anang & Ayambila (2020), a study by Akpan & Udoh (2016) found that household size and education levels had a positive impact in farmers participating in such programmes. This was found to be coupled with dependence ratio, farming experience, years in a social organisation, land

ownership, awareness index, membership in a political party, non-farm income and extension agent visits.

2.8.3 Multinomial logit regression

To explore market choice selection among farmers, literature shows that the multivariate, binomial logit and multinomial logit or probit regression can be utilised (Tsourgiannis *et al*., 2008; Xaba & Masuku, 2013). Based on other studies conducted on analytical tools, this study deemed the use of the binomial logit regression as inappropriate due to its limitation as it allows dependent variables to be dichotomous only. Additionally, multinomial probit regression was also eliminated as it assumes that the specified variables are all normally distributed, whereas the multinomial logit regression is advantageous as the variables do not have to be normally distributed (Ndoro *et al*., 2015), hence this allows different types of independent variables i.e. binary, continuous, and ordinal. Additionally, the multinomial logit regression addresses the selection bias that can occur in the market choice process and selection by farmers within the model (Musara *et al*., 2018).

Multinomial logit regression has been used for various enterprises in South Africa. Ndoro *et al*. (2015), found that cattle farmers face uncertainty between selling at formal markets (i.e. auctions) than locally. Cattle farmers relied on factors such as age, experience, knowledge of buyers to select between marketing channels. On the other hand, Opata (2018) used the multinomial logit regression to find the determinants of market channel choice among cocoyam farmers in Nigeria. The results indicated that age, storage costs, volume of produce marketed, distance to markets, farming purpose and size were significantly associated with how farmers selected marketing channels. The study also found that farmers that had a higher yield were more likely to utilise formal marketing channels than local. Musara *et al*. (2018) explored market channel preferences by small scale sorghum farmers in Zimbabwe. The study found that the market price of sorghum, market demand, distance to the market, dependency ratio and household income significantly influenced market channel preferences. The study also found that sorghum marketing channels are limited.

Hassan & Nhemachena (2008) analysed the determinants of farm level climate adaptation measures using multinomial logit regression. The study found that improved access to markets, extension and credit services, technology and access to farm assets were significant factors in assisting farmers better adapt to climate change. In a study by Opondo *et al*. (2017) using

multinomial logit regression, the study examined the factors affecting the levels of cassava commercialisation among smallholder farmers. The results showed that the farmers operated between low and medium commercialisation levels which were significantly influenced by amount of cassava produced, education level, gender, and marketing costs.

2.8.4 Bivariate probit regression

The bivariate probit regression has been employed to evaluate various determinants of decisions and selection of choices across different disciplines in the world (Seyoum, 2018; Gong & Johnson, 2021). It is used to yield results based on two interrelated dependent variables (Bikoue, 2021). Ouma *et al*., (2017) studied the determinants of banana market participation among farming households of Rwanda and Burundi. The results revealed that factors such as location, market information, travel time to market influenced market participation significantly. Non-price related factors such as land tenure security, labour availability, non-farm income, gender and farming experience influenced the transacted volumes of banana.

Using the bivariate probit model, Anang (2018) examined the factors influencing the adoption of mechanization and improved varieties by rice smallholder farmers from Ghana. The results illustrated that gender, age, education levels, household size and location significantly influenced both adoption of mechanization and improved varieties. Additionally, farm size, extension officer access, livestock ownership significantly influenced adoption of mechanization but not the adoption of improved varieties. In South Africa, Akinyemi & Mushunje (2019) explored the factors affecting land ownership and usage for agricultural production using the bivariate probit model. The results indicated that household head's age, participation in production and income significantly influenced land ownership and usage. Oyekale (2015) investigated the factors influencing households' cash payment for solid waste disposal and recycling behaviours in South Africa using bivariate probit regression. The results showed that variables such as social grant access and education levels were significant in the payment for waste disposal and recycling behaviour. Despite the bivariate probit being used in various scenarios in farming systems and other disciplines, it has rarely been used to investigate the factors influencing food form selection of indigenous crops among farming households.

2.8.5 Extended ordered probit regression

The extended ordered probit regression is limited in use within the agricultural field (Hlatshwayo *et al*., 2022, Cele & Mudhara, 2023). However, it has several advantages when using it in statistical analysis. The extended ordered probit recognizes the complex relationship between variables. It accounts for any combination of endogenous covariates, endogenous sample selection or self-selection bias (Gold & Taib, 2023). Furthermore, the extended ordered probit regression can accommodate continuous, binary, and ordinal independent variables (Van Binh *et al*., 2022). Similarly, Teklewold *et al*. (2013) used the extended ordered probit regression to find the predictor variables that influence farmers in rural Ethiopia to adopt multiple sustainable agricultural practices. Several factors were found to be significant, namely, the level of trust a household has in government support, credit constraints, education levels, environmental risks and threats, labour availability, market access and household networks.

In a study by Xue *et al*. (2022), the extended ordered probit was utilised to determine whether agricultural machinery harvesting services can assist in the reduction of cropland abandonment within farmers in China. The study discovered that agricultural machinery harvesting services had an increased likelihood of reducing cropland abandonment by 18.5% and could potentially reduce the proportion of the abandoned area by 20.3%. Additionally, the study concluded that these services are required for farmers to use land efficiently. On the other hand, Hlatshwayo *et al*. (2022) examined the determinants of household food security between farmers who are market and non-market participants in South Africa using the extended ordered probit analysis. The results showed that household size, having a family member with HIV and extension assistance increased the likelihood of food insecurity within a household whilst educational level, ownership of livestock, age, gender and receiving social grants increased the likelihood of food security. The study concluded that linking smallholder farmers to markets has the ability to improve their household food security status. However, the extended ordered probit regression has rarely been used to assess the interaction between indigenous crops and food security.

2.9 Theoretical framework

A theoretical framework is an existing concept that informs and guides a specific study (Claus *et al*., 2023). Agricultural studies adapt a number of theoretical or methodological frameworks from different academic disciplines (Thornton *et al*., 2023). Hence, various theories have been proposed or utilised in the analysis of farming households. The theory of change is one such theory that can be used to address government failures in optimally using agriculture for development (Zucker *et al*., 2023). The theory of change was developed by Weiss (1995) and discussed how policies, programmes and projects tend to fail due to objectives not being well stated or well researched. Weiss (1995) further argued that the attainment of long-term goals heavily relies on efficient stakeholder engagement. Moreover, the study reported that policies set cannot be well implemented if there is uncertainty about the foundation of challenges they are based on. Hence, the assumptions on which policies or programmes are based on, must be well formulated and organised.

In agriculture, the theory of change has been applied in different dynamics and challenges in order to guide policy evaluation, understand social impacts and enhance stakeholder engagement in agricultural research (Maye *et al*., 2020). The theory of change suggests that interventions can overcome challenges and create incentives to improve productivity (Douthwaite *et al*., 2020). Therefore, the study adopted the theory of change to contribute to the ongoing promotion of the integration of indigenous crops in farming systems to improve household food security. Indigenous crops production and marketing has the potential to improve farming households' livelihoods. Indigenous crops are climate adaptable, require less water and have higher harvests cycles when compared to exotic crops (Porcuna-Ferrer *et al*., 2024). Although government has set interventions on how to further promote indigenous crops, consumption of these crops has increased whilst production remains low. This is mainly because government-based programmes and policies lack set and stable value chains for indigenous crops; thus, reducing the incentive among farming households to produce them.

The study also adopted the resource-based theory where its development has been linked to David Ricardo and Bernard in 1938 (William *et al*., 2011). Barney *et al*. (2011) defines the term 'resources' as all assets which includes the expertise systems and the material that a company can use to its advantage. Moreover, the resource must be valuable, scarce, unique and cannot be

replaced. This theory suits the study well because sustainable development can only be achieved by efficient use of all available resources in the country. South Africa is known to be food secure, but this is not the case within households (Jacobs, 2009). Hence, indigenous crops were introduced as a solution to vulnerable households to improve household food security, however these crops are currently not being used to their full potential among vulnerable and farming households. Several indigenous crops have been labelled as neglected and underutilised by farmers in different areas, increasing the reliance on exotic crops. Thus, indigenous crops need to be recognised as an important resource in the agricultural sector that has not been fully exploited. Additionally, farming households need to be thoroughly trained on how to maximise this resource.

2.10 Conceptual and Empirical Framework

In estimating the specific objectives listed for this study, several research methodologies were used. The main goal of promoting the production, consumption and marketing of indigenous crops is to improve the livelihoods of vulnerable households as well as their household food security status. Figure 2.2 depicts the relationship between household food security and indigenous crops among farming households.

Figure 2.2: The contribution of indigenous crops to household food security among farming households (Adapted from Mavengahama *et al*., 2013; Qwabe, 2021 & Zulu, 2022)

The concept employed in this study is developed on the contribution of indigenous crops to household food security. The framework further explains the impact of the production, consumption, and marketing of indigenous crops among farming households, it further describes the benefits and outcomes of farming households utilising these crops. In the conceptual framework, the use of indigenous crops by producing, consuming, and selling them results in better household food security status due to decreased production costs, greater food diversity within household diets and increase in availability of income from selling these crops.

2.11 Conclusion

This chapter reviewed the different contribution of indigenous crops across South Africa. The food security current state in South Africa was described in detail. Overall, the literature showed that although a number of studies have been undertaken towards promoting indigenous crops to vulnerable households and farmers, there still exists a gap in its production and consumption. The literature also showed that several studies have focused on indigenous vegetables whereas there is limited literature on other types of indigenous crops or focus of indigenous crops as a whole. Furthermore, the literature showed that more research is required to understand the reasoning behind the crops' socio-economic standing among individuals and households. This will provide policymakers, government, and other stakeholders with information to provide evidence-based information which could assist in formulating new programmes and policies to improve the uptake of indigenous crops.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines the study area, data collection, and analysis methods utilised in this study. A brief description of the KwaZulu Natal region is provided, which is where the study was conducted, and the data collected. Intricate details on the methodology are further described in chapters 4, 5 and 6.

3.2 Description of the study area

The KwaZulu-Natal (KZN) Province was selected for this study with a specific focus on three districts: uMgungundlovu, Harry Gwala, and eThekwini. The KwaZulu-Natal province has the second-largest projected population in South Africa (19.2%) (STATSSA, 2019). In2005 and 2007, the province had one of the highest poverty rates in the country, affecting 73.5% of children, which increased household food insecurity (Govender *et al*., 2017). Furthermore, in 2011, 47% of people living in KZN survived on an income below the poverty line (Govender *et al*., 2017). The high unemployment rates and low levels of income have had an effect on the nutritional status of individuals residing in KZN. These contributing factors result in the consumption of diets high in carbohydrates, low in animal sources, and lacking variety, leading to micronutrient deficiencies (Drysdale *et al*., 2019). A high number of the South African population are unemployed and are most likely to rely exclusively on grants for income. In KZN, districts such as uMkhanyakude and Zululand have 80% of individuals living on social grants, while 16% receive a salary and 18 to 27% rely on a partner for financial assistance (Schoeman *et al*., 2010). Commonly, social grants received are primarily used to purchase food, although food access remains challenging due to unaffordability and rising food costs (Govender *et al*., 2017).

Agriculture is considered a primary contributor to household food security among vulnerable households in KwaZulu Natal. According to D'haese *et al*. (2013), the KZN province shows potential in the agricultural sector as participation in local trading of agricultural products, including vegetables, fruits, meat and poultry, eggs, nuts, roots, and tubers and legumes, has the capacity to stimulate growth in income. Some districts, such as uMgungundlovu, have the highest proportion of households growing crops for solely home consumption, whereas others, such as the

Zululand district, has households commonly growing crops for both consumption and selling (D'haese *et al*., 2013). In the Ugu district, most rural households struggle to grow crops due to a lack of seeds, fertilizers, access to water, and a high incidence of pests (Masuku *et al*., 2017). Overall, the KwaZulu-Natal province has a high number of agriculturally active households, but also has a high non-agricultural rate compared to other provinces with agriculturally active households having a low education.

Figure 3.1: A map showing KwaZulu-Natal districts (Source: KZN Municipalities, 2023)

The province is characterized by a subtropical coastline, grasslands in the east, and a wide mountain range in the west. It has a varied and verdant climate and diverse complex topography. The coast is subtropical, with inland regions becoming progressively cold. The south coast has an estimated 1009 mm annual rainfall with an annual high temperature of 24.77ºC (76.59ºF) and a low temperature of 19.7ºC (67.46ºF). The province experiences dry climates in June and high

rainfall in January (KZN Municipalities, 2023). On average, the province also experiences an estimated 106.56 millimetres of yearly rainfall (World Data, 2024).

3.3 Data Collection Method

This study utilised quantitative methods. Data collection was conducted in 2023 using structured household questionnaires. Data collected included, but was not limited to, demographics and socio-economic characteristics, perceptions, food consumption, and use of indigenous crops, naming, and how farmers value these crops economically. Zulu-speaking enumerators administered the questionnaire to the farmers. The structured question was developed through author's own synthesis where questions were formulated by analysing various literature which explored the relation between indigenous crops and household food security based.

The farmers were selected from a sampling frame using simple random proportional sampling to the District Municipalities. The sample size was calculated using the 95% confidence interval and 5% margin of error based on the sampling frame of 567 farming households, with each household having an equal chance of being selected. This yielded a sample of 260 farming households. The uMgungundlovu had a sample of 120 participants, Harry Gwala had 80 participants, and the eThekwini district had 60 participants. The selection of the study area was based on the fact that the University of KwaZulu-Natal had been doing a number of projects on indigenous crops. However, the previous studies did not assess the contribution of indigenous crops among farming households in KwaZulu Natal.

3.4 Data Analysis Methods

The quantitative data was analysed using the Statistical Software for Social Sciences (SPSS) version 28 and STATA Statistical Analyses software version 18. The descriptive statistics were performed to summarise the socio-economic characteristics of the sampled farming households. Socio-demographic factors included variables such as the age of the household head, gender, marital status, education level, employment status, and household monthly income. Other data, such as the types of crops grown by farming households, consumption patterns and marketing perceptions were collected using descriptive statistics.

Household food security was measured using the Household Food Insecurity Access Scale (HFIAS). This measure for household food security followed several papers from developing

countries (Otekunrin *et al*., 2021; Ningi *et al*., 2022; Kolog *et al*., 2023) as it is easier to implement compared to other measurement approaches. The HFIAS tool measures the food access of households sampled. It consists of nine questions relating to food insecurity access of the farming households sampled. These questions are subdivided into three divisions of questions focusing on anxiety and uncertainty about household food supply, food quality and food quantity intake in relation to the physical availability within the household in a 30-day period (Coates *et al*., 2007). Farming household scores were generated from these questions and ranged between 0 and 27.

The study employed different econometric analytical tools to achieve the specific objectives listed in Chapter 1 through the use of SPSS and STATA packages. The binomial logit, multinomial logit, bivariate probit and extended ordered probit regression models were used to interpret the data. Further model specifications where econometric analyses were applied were discussed in detail, in Chapters 4, 5 and 6 respectively to avoid repetition and redundancy.

3.5 Ethical Considerations

Ethical considerations are guidelines that direct and guide research procedures through factoring and attaining individual informed consent, voluntary involvement, keeping anonymity, and how results will be communicated with selected participants.

This means that all participant answers recorded by the researcher were captured and analysed with complete confidentiality of the participants; since the information shared by participants may be sensitive and require to be handled in a professional and considerate manner so as not to endanger any of the participants. The researcher of this study was granted permission to conduct the study by the University of KwaZulu Natal containing the following reference number HSSREC/00005365/2023, valid from the 27th of February 2023 to the 22nd of June 2024 (Please see Appendix B for approval letter).

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CHAPTER 4

FACTORS AFFECTING THE CONSUMPTION OF INDIGENOUS CROPS AMONG FARMING HOUSEHOLDS IN KWAZULU NATAL, SOUTH AFRICA

Abstract

South African farming households face a number of challenges regarding household food security, poverty, micronutrient deficiencies and hidden hunger. This is due to millions of households lacking access to food and, hence, an adequate food basket. Consumption of indigenous crops has been proposed as an intervention to help sustain vulnerable households since these crops have low production costs and are climate resilient. However, research finds the consumption of these crops across South Africa to be relatively low. The study's objective was to analyse the factors affecting the consumption of indigenous crops in KwaZulu-Natal. A sample of 260 farming households were selected using simple random sampling. The results showed that farmers commonly cultivate exotic crops such as spinach, cabbage, carrot, and butternut than any indigenous crops, except for a few cultivating taro and sweet potato. The binomial logit regression results revealed that an increase in the number of females and children within a household as well as farmer's experience increased the likelihood of consuming indigenous crops, whilst monthly food expenses decreased the likelihood of consuming indigenous crops. Evidently, there is a considerable gap between the consumption and production of indigenous crops. The findings established that although a high number of farming households indicated that they consume indigenous crops, this did not show in the crops they cultivate. The study also concluded that farming households may be more aware of the nutritional benefits of indigenous crops since an increase in the number of children in a household was linked to an increase in consumption of these crops. Additionally, experience in farming is vital as it increases the consumption of indigenous crops. The study recommends government interventions that include increasing the production of indigenous crops by including them alongside the cultivation of exotic crops. Extension work should also focus on awareness programmes to promote the nutritional benefits of consuming indigenous crops. This, coupled with training centred on indigenous crops, could incentivize farming households to cultivate more of these crops for easier access.

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Keywords: *exotic crops, indigenous crops, consumption, binomial regression*

4.1 Introduction

Worldwide food production is at a problematic junction because the race to meet several of the Sustainable Development Goals (SDGs) by the target date of 2030 seems unattainable (Moallemi *et al*., 2022). This is in particular to SDG number two, which has pressured scientists and practitioners to consider different ways to increase the supply of safe and nutritious food for current and future generations without endangering the environment. One of these approaches, which has gained popularity on international agendas, is to make better and improved use of indigenous crops, sustainable food systems, and supply chains while also exploring different ways to increase consumer demand and desirability for these crops (Mabhaudhi *et al*., 2018).

Research and agricultural subsidies through the years aimed at increasing productivity and income have tilted crop production toward a few crops, namely wheat, rice, and maize (Soto-Gómez & Pérez-Rodríguez, 2022). These crops now control international markets, accounting for 51% of world caloric consumption (Erenstein *et al.*, 2022). Market incentives for cultivating exotic crops have encouraged farmers in many parts of the world to fully abandon indigenous crops in favour of these commodities (Taylor, 2012). However, exotic crops alone cannot sustain a healthy and balanced diet for households. This is shown in countries such as Brazil, Kenya, Guatemala, India, Mali, Sri Lanka, and Turkey, where a crucial role is being played regarding the adoption of these neglected crops (Borelli *et al*., 2020). This is due to priority actions set in each country such as increasing support for their mainstreaming into food security policies and programmes (e.g., public procurement); and promoting their use to diversify farming systems.

In South Africa, despite several aspects working in its favour on the agricultural front, millions of individuals lack access to nutritiously safe food (Ndlovu *et al.*, 2022). This is primarily due to poverty, which is especially prevalent in rural areas. Many different foods are accessible within rural surroundings but have been overlooked, reducing the food security base. As a result, initiatives to address the persistent problem of food insecurity continue to reduce the diversity of the food supply by ignoring indigenous crops. Despite being underappreciated, considerable evidence from the literature reveals that indigenous crops play an essential role in the battle against hunger and food insecurity (Ngidi *et al*., 2023; Shembe *et al.*, 2023).

Indigenous crops have other significant contributions to local economies and diets, which include their contribution and conservation of biodiversity and local knowledge, as well as their ability to

provide household income (Aworh, 2023; Jacob *et al*., 2023). While the contributions of indigenous crops in the cases mentioned above are recognized in other African countries, their use in South Africa has decreased, and consumption is thus related to poverty (Ayodele *et al.*, 2009; Omotayo *et al*., 2021) and low self-esteem among rural black people, as reported by Modi *et al*. (2006). Aside from consumer views, legislation and technological factors have also played a role in the decline in these crops' consumption. According to Van Der Hoeven *et al*. (2013) and Van de Merwe *et al*. (2016), shifting from indigenous crops to cash crops and exotic plant food sources increases the risk of malnutrition and other nutrition-related non-communicable diseases, particularly in vulnerable households.

Affording a healthy food basket is another significant concern for South African households (Schoenfeldt *et al*., 2013). Low-income households spend approximately 35% of their income on food yet continue to be vulnerable to malnutrition, including over and undernutrition (Pereira, 2014). Although low-income households pay a higher cost for their food basket, there continues to be an increasing reliance on food purchases, which discourages home production and increases household food insecurity (Baiphethi & Jacobs, 2009; Akinola *et al*., 2020). To relieve these costs, numerous research has suggested an increase in consumption or inclusion in household diets of indigenous crops as they are far less costly to cultivate and have climate-resilient variants (Hadebe *et al.,*2017).

The importance of indigenous crops goes beyond their nutritional value as they have also been found to have several healing capabilities (i.e., treatment of peptic ulcers, jaundice, toothache, and intestinal helminthiasis) (Moyo *et al*., 2020). Despite that, consumption remains minimal compared to exotic crops such as spinach, kale, and cabbage (Hendre *et al*., 2019; Ngidi *et al*., 2023). It has also been discussed by Govender *et al*. (2019) that the displacement of indigenous crops by a limited major 'exotic' crops has unavoidably contributed, in part, to the limited successes of the global food systems, especially in under-developed regions. Hence, incorporating indigenous crops into the existing food systems in South Africa would assist rural households in diversifying their landscape economically and in an all-around sustainable manner. This could translate into the ability of households to provide sufficient and nutritious food at local markets for income generation.

To end hunger, achieve household food and nutrition security, and thus, meeting the United Nations Sustainable development goals necessitates improving the production, consumption, marketing, and distribution of neglected indigenous crops (Opoku, 2016). This study explores the exotic and indigenous crops that farmers grow in KZN as well as the factors that affect the consumption of indigenous crops. There might have been some changes over time since studies that have explored the consumption of indigenous crops in South Africa are more than 10 years old, such as Ayodele *et al*. (2009) and Cloete & Idsardi (2013) however, these studies are limited to the Limpopo and Northwest provinces of South Africa and need to be updated. This study is significant because it provides policymakers, producers, and consumers of indigenous crops with valuable information expected to aid in expanding the cultivation, consumption, and conservation of these crops in the rural and peri-urban areas of KwaZulu-Natal and similar settings.

4.2 Study area, sampling, and data collection technique

The study area, sampling and data collection technique have been extensively detailed in chapter three of this dissertation.

4.3 Analytical Framework

4.3.1 Binomial logit regression to investigate the determinants of consumption of indigenous crops.

A binomial logit regression was selected to investigate the predictor variables that determine the consumption of indigenous crops. The dependent variable, consumption of indigenous crops, had a binary nature, taking a value of 0 for farming households who consume indigenous crops and 1 if they do not. The regression model was chosen as suitable for the statistical technique and analysed the factors that determine whether farming households consume or do not consume indigenous crops. According to Maharjan & Joshi (2011), a binomial logit regression model is considered the appropriate model for socio-economic analysis in which both continuous and categorical independent variables are applicable. Kleinbaum *et al.* (1994) stated two primary reasons for researcher use of the logistic regression. Initially, the logistic model imposes threshold and interaction effects and allows for examining social interaction (Kleinbaum *et al*., 1994; Montshwe, 2006). Additionally, the logistic function is accommodating and straightforwardly applicable, as well as significant ease with the interpretation of the results.

The binomial logit regression has been used in several food security-based research to investigate determinants of household food security and technology adoption by farmers (Zermarku *et al.*, 2022; Dzvene *et al*., 2023; Hawas & Degaga, 2023). The probability of a household to consume indigenous crops depends on vectors of independent variables Xi and a vector of unknown parameter β the vector Xi represents farming households' socio-economic and other factors.

The mathematical formulation of the binomial logistic model is as follows:

$$\mathrm{P}i = \mathrm{E}\left(\mathrm{Y} = 1/\mathrm{X}i = \frac{1}{1+\mathrm{e}^{(\beta 0+\beta_1 \mathrm{X}1)}} \right. \quad (1)$$

The equation of the probability of a farming household consuming indigenous crops can be expressed by:

$$\mathrm{P}i = \frac{1}{1+\mathrm{e}^{-\mathrm{Z}}} \quad (2)$$

While the probability to not consume indigenous crops can be expressed by:

$$1 - \mathrm{P}i = \frac{1}{1+\mathrm{e}^{\mathrm{Z}}} \quad (3)$$

Overall, this can be expressed as:

$$\frac{\mathrm{P}i}{1-\mathrm{P}i} = \frac{1+e^{\mathrm{Z}}}{1+e^{-\mathrm{Z}}} \quad (4)$$

Referencing from above (Pi/1-Pi) is the odds ratio representing the farming households that consume indigenous crops. Using the natural log of the above equation, it is then determined that;

$$Li = \ln \frac{\mathrm{P}i}{1-\mathrm{P}i} = \mathrm{Z}i = \beta o + \beta l\mathrm{X}l + \beta 2\mathrm{X}2 + \cdots + \beta n\mathrm{X}n \quad (5)$$

Where:

Pi= is the probability of a farming household consumes indigenous crops;

Zi= is the function of explanatory variables (Xi), which is also expressed as β0 is an intercept.

β_1, β_2……βn are slopes of the equation in the model.

Li = is the log of odds ratio, which is not only linear in Xi but also linear in the parameters.

The independent variables used in the model are represented in Table 4.1 below.

Table 4.1: Variables included in the model.

Independent Variable	Type of measurement	Categorical Explanation	Prior Expectation
Number of children in household	Continuous		+
Number of males in a household	Continuous		-/+
Number of females in a household	Continuous		+
Total monthly household income	Categorical	0= R0 to R500 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= R2501 to R3500 5= R3501 to R4500 6= Greater than R4500	-
Education Level	Categorical	0=None 1=Primary 2=Secondary 3=Tertiary	+
Monthly household food costs	Categorical	0= R0 to R500 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= Greater than R2500	-
Farming Period	Categorial	0= Under 4 years 1= 4-10 years 2= 10-20 years 3= Greater than 20 years	+
Indigenous crop marketing potential	Categorical	0= Yes 1=No	-/+

(Source: Author's analysis)

4.3.2 Justification for proposed variables

The number of children refers to the number of children in each household and was captured as a continuous variable. Children need specific food and a nutritional diet to survive. This increases the costs of food within a household and exposes low-income households to a variety of shocks and food insecurity. Hence, indigenous crops are a way to mitigate household food insecurity among children as they are highly nutritious and can be cooked in several ways. Mbhenyane (2017) noted that children that consistently consume these crops were less vulnerable to hidden hunger. The number of children was hypothesized to have a positive influence on the consumption of indigenous crops.

The number of females refers to the number of females within a given households and was captured as a continuous variable. Females have been found to produce and consume indigenous crops by several studies in different countries particularly in Sub-Saharan Africa (Bhengu, 2017; Ezeanya-Esiobu *et al*., 2018). The number of females was hypothesized to have a positive influence on the consumption of indigenous crops.

The number of males refers to the number of males within a given households and was captured as a continuous variable. Studies have found different results considering the consumption of indigenous crops by males in South Africa and Africa. Kruger *et al*. (2011) found that the consumption of indigenous crops by males was correlated with their location, where males residing in rural areas consumed them and those in urban areas did not. Contrastingly, Akpa *et al*. (2022) found that males consume indigenous crops as much as females. The number of males was hypothesized to have either a positive or negative influence on the consumption of indigenous crops.

Total household income refers to the total amount of income incurred by a given household monthly and was captured as a categorical variable. Income is one of the main drivers in a household food basket and indigenous crops can be used to supplement food baskets. However, high income farming households generally do not consume indigenous crops as they may prefer exotic crops (Zondi *et al*., 2022; Rankoana, 2022). Hence, the total household income variable was hypothesized to have a negative influence on the consumption of indigenous crops.

Educational level refers to the level of education a household head has achieved and was captured as a categorical variable. Farming households who are more educated will likely consume indigenous crops for their nutritional benefits (Mbhatsani *et al*., 2011; Cloete & Idsardi, 2013). The education level variable was hypothesized to have a positive influence on the consumption of indigenous crops.

Monthly food expenses refer to the monthly food costs of a household and was captured as a categorical variable. The consumption of indigenous crops is different among low- and high-income farming households. Households with a higher number of household members will require a higher amount of food and this is a challenge among low-income farming households (Cloete & Idsardi, 2013). Indigenous crops may also be used as alternative in times of food shortages (Van de Merwe *et al*., 2016). An increase in monthly food expenses was hypothesized to have a negative influence on the consumption of indigenous crops.

Farming Period refers to the number of years a farmer has participated in agriculture and was captured as a categorical variable. An increase in farming experience increases the likelihood of consumption as these farmers are more aware of the costs and benefits of these crops (Andani *et al*., 2020). The farming experience variable was hypothesized to have a positive influence on the consumption of indigenous crops.

Perceived marketing potential refers to the perceived value of indigenous crops in the market and was captured as categorical variable. Whether farming households find indigenous crops of great value depends on their perception and knowledge of these crops. Studies have shown that indigenous crops carry a negative perception of being poor man's food (Ekesa *et al*., 2009; Van de Hoeven *et al*., 2013; Mabhaudhi *et al*., 2018). The perceived marketing potential variable was hypothesized to have either a positive or negative influence on the consumption of indigenous crops.

4.4 Results and Discussion

4.4.1 Socio-Economic Characteristics of the Sampled Farming Households

The survey was conducted in three districts within the KwaZulu-Natal province in South Africa. Table 4.2 presents an overview of the demographic characteristics of the study participants. The descriptive results showed that more respondents were female than male, with 63.5% of farmers

being female. These findings align with various studies (Abegunde *et al*., 2019; Anderson *et al*., 2021; Hlatshwayo *et al*., 2022) in South Africa, indicating that more women participate in household agriculture. This is unsurprising as government efforts to promote women in agriculture are being intensified (Chipfupa *et al*., 2021). The results also showed that farmers were scattered among the different age groups, with the highest number of farmers being older than 65 years (22.3%). This was followed by ages 35 to 44 (18.5%), and after that, a similar number for the ages of 25 to 34 years (16.5%) and 45 to 54 years with 16.9%. Farmers between the ages of 55 and 64 years had only 15.0%, and the ages of 18 to 24 years had only 10.8% of the sample.

Table 4.2. Demographic characteristics of farming households.

Variable	**Frequency (n)**	**Percentage (%)**	**Variable**	**Frequency(n)**	**Percentage (%)**
Gender			**Marital Status**		
Male	95	36.5	Married	115	44.2
Female	165	63.5	Unmarried	145	55.8
Age (Years)			**Employment Status**		
18–24	28	10.8	Unemployed	98	37.7
25–34	43	16.5	Full time	41	15.8
35–44	48	18.5	Part-time	28	10.8
45–54	44	16.9	Informal	5	1.9
55–64	39	15.0	Grant/Pension recipient	85	32.7
65+	58	22.3	Self-employed	3	1.1
Total Household monthly income			**Education Level**		
R0-R500	48	18.5	None	11	4.2
R501-R1000	48	18.5	Primary	71	27.3
R1001-R1500	45	17.3	Secondary	144	55.4
R1501-R2500	40	15.4	Tertiary	34	13.1
R2501-R3500	25	9.6			
R3501-R4500	30	11.5			
>R4500	24	9.2			

A higher number of the respondents were unmarried, with approximately 55.8% of the respondents found to be unmarried compared to 44.2% of the married respondents. Most household respondents (55.4%) had obtained secondary education, with very few attending post-high school education. Approximately 37.7% of the respondents were unemployed, and 32.7% reported being recipients of social grants. The unemployment levels were slightly higher than those in the rest of the country, where 33.5% of the population in South Africa is unemployed (STATSSA, 2024). Most farming households had an income of ZAR 0–500 and ZAR 501–1000, with 18.5% of the households from each range reporting having received such an income per month.

4.4.2 Cultivated versus purchased crops among farming households.

Participants were asked which crops they commonly cultivated throughout the year. Within the sample size, 63.8% of farming households cultivated exotic crops such as maize, cabbage, beans, spinach, and potatoes. Other common vegetables produced by the farmers were onions, carrots, green peppers, chilies, butternut, sugarcane, and beetroot**;** 23.5% grew a mix of exotic and indigenous crops, which included sweet potato, intufeshe (wild kale/Ethiopian kale) and amadumbe (taro). Some farming households grew taro or sweet potatoes, with a small number cultivating imbuya (amaranthus) and intufeshe (wild kale/ Ethiopian kale).

The highest category of crops cultivated were exotic crops (i.e. maize, cabbage and spinach) followed by a mix of exotic and indigenous crops (i.e. inclusion of sweet potato and taro). This is in line with results from other literature, which widely considers that introducing exotic crop varieties to Africa reduces the production and consumption of indigenous crops (Smith & Eyzaguirre, 2007; Keding *et al*., 2009). The crops mentioned above were commonly cultivated for food (62%) when compared to other categories**,** whereas growing solely for the market was found to be 5%. Growing crops for both food and the market was found to be 19.5% and 13.6% as a hobby. This infers that although farmers indicated that they consume indigenous crops, this does not necessarily translate to their cultivation as more focus is placed on exotic crops. It further suggested that farmers place more importance on producing exotic crops for consumption and selling.

On the other hand, farming households were asked whether they purchase any crops in supermarkets although they cultivate a wide range of crops. Results showed that a high number (92.6%) of participants purchase vegetables within the sampled farming households. This indicates

that although farmers may be practicing farming, they continue to purchase vegetables in the formal market. The results also showed that farming households purchase crops such as butternut, tomatoes, spinach and cabbage. This suggests that farmers are not utilizing their land efficiently or may be experiencing the following challenges (a) most crops grown do not produce the required yield; (b) farmers practice monocropping, which does not allow diversification and creates a gap for other vegetables in a household's food basket; (c) They do not have the required information or support to successfully farm and sell their produce. These results are in line with those of Baiphethi & Jacobs (2009) who discussed the increasing reliance among farming households of supermarkets although they participate in agriculture.

4.4.3 Consumption of Indigenous Crops

Participants responded on their consumption preferences in relation to indigenous crops, shown in Figure 4.1. The results showed that 88% of farming households were reported to consume indigenous crops, and 12% did not. This contradicts past research where the consumption of indigenous crops has been low in South Africa (Ayodele *et al.*, 2009; Cloete & Idsardi, 2013; Mbhenyane, 2017).

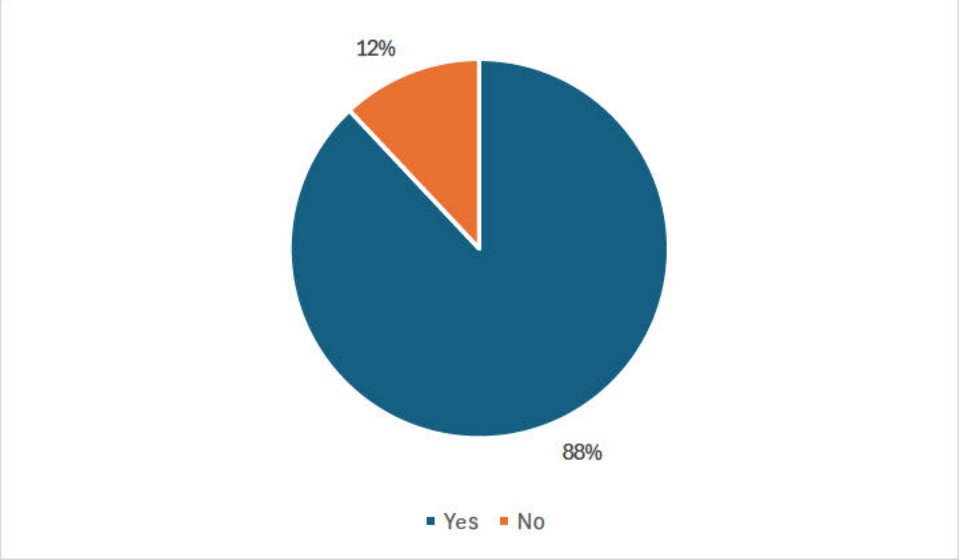

Figure 4.1: Consumption rate of indigenous crops among farming households in KwaZulu Natal (Source: Field survey, 2023)

Figure 4.2 further shows the reasoning behind the consumption and non-consumption of these crops. The highest reason for consumption was the perception of their nutritional value (32%),

followed by tradition (19%). Participants also reported these crops as not costly (14%), readily available (11%), assists with medical conditions (9%) assists in lack of food (4%), tasty (4%), and all of the above (11%). The results show a more positive relationship building with indigenous crops among rural and peri-urban areas as the reasoning for consumption in prior years was mainly due to lack of food (Yang & Keding., 2009; Faber *et al*., 2010; Mungofa *et al*., 2018). However, it must be noted that the results indicated that farming households need to be made aware of these crops' adaptive components (i.e. water efficiency and adaptability to different environmental conditions).

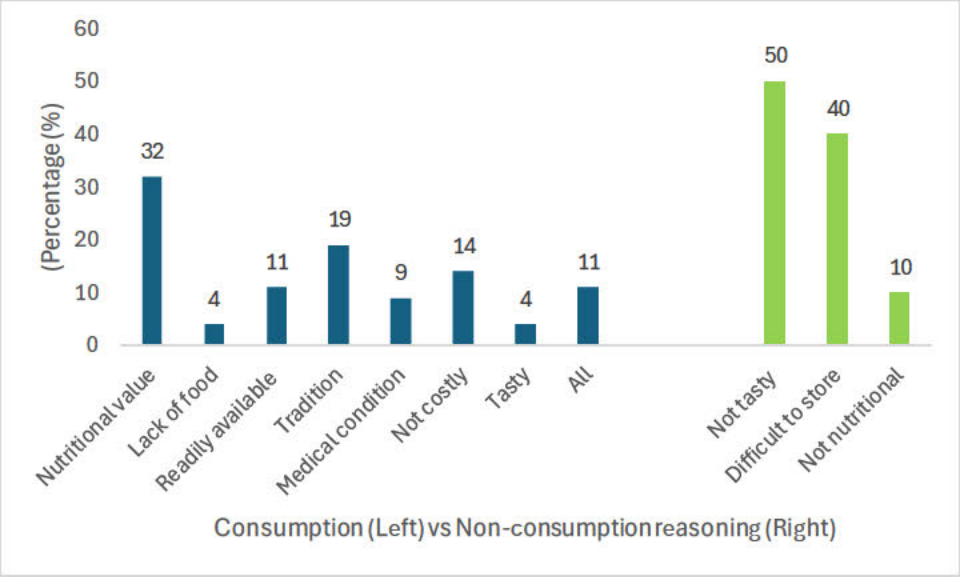

Figure 4.2: Reasons for the consumption and non-consumption rate of indigenous crops among farming households in KwaZulu Natal (Source: Field survey, 2023)

Participants shared their reasons for non-consumption such as taste (50%), low nutrition (10%), and difficult to store for long periods (40%). This was further explained by how farming households perceived these crops. Farmers were asked who they believed should consume indigenous crops. The results revealed older women (38.8%), followed by all individuals (35.4%), older men (18.8%), young men (5%) and with a small number selecting young women (1.9%) were perceived to be most suitable. The results suggested a somewhat positive perception towards these crops as all individuals were listed as the second highest. However, older women were selected slightly higher. This is similar to past findings that cited how women, compared to men,

were found to be mostly utilizing these crops for food and medicinal purposes (Cloete & Idsardi, 2013; Van der Hoeven *et al.*, 2013; Bvenura *et al.*, 2014).

4.4.4 Determinants of indigenous crops' consumption among farming households

The binomial logit regression was used to assess the determinants of indigenous crop consumption among farming households. The dependant variable was binary, where participants indicated whether or not they consume indigenous crops. Table 4.3 represents the results of the binomial logit regression where the reference category was selected as "consumes indigenous crops". Prior to estimating the selection model, the possibility of multicollinearity issues was examined using the Variance Inflation Factor (VIF). Multicollinearity is essential for testing and improving the reliability of inferences made. This study tested multicollinearity through the VIF, where a value of greater than ten suggests a multicollinearity problem among the independent variable(s) used. All variables were found to be below 10 (Please see appendix 1 for full table).

The overall model was statistically significant (p=0.000), and the Nagelberke R squared was found to be 0.373, showing that the independent variable accounted for 37.3% of the variability in the dependent variable. The Hosmer and Lemeshow test were found to be non-significant (0.4264), as required when running a binary logistic regression. The coefficient and odds ratio were used to understand how the various independent variables affect these crops' consumption. Only significant variables are discussed in Table 4.3 below.

Table 4.3: Determinants of indigenous crops' consumption among farming households

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Number of males in the household	-0.177	0.205	0.743	1	0.389	0.838
Number of females in a household	0.497	0.210	5.597	1	**0.018****	0.608
Number of children in a household	0.610	0.243	6.271	1	**0.012****	1.840
Total Household Income						
R0 to R500	0[b]		12.439	6	**0.053***	
R501 to R1000	0.329	1.031	0.102	1	0.750	1.390
R1001 to R1500	1.280	1.159	1.221	1	0.269	3.597
R1501 to R2500	-0.985	1.118	0.777	1	0.378	0.373
R2501 to R3500	-2.600	1.633	2.534	1	0.111	0.074
R3501 to R4500	0.785	1.352	0.337	1	0.561	2.193

Greater than R4500	1.073	1.347	0.634	1	0.426	2.923
Education Level						
None	0[b]		4.341	3	0.227	
Primary	-0.465	1.271	0.134	1	0.714	0.628
Secondary	-1.502	1.207	1.549	1	0.213	0.223
Tertiary	-2.171	1.356	2.561	1	0.110	0.114
Monthly Food Expenses						
R0 to R500	0[b]		12.415	4	**0.015****	
R501 to R1000	1.011	0.788	1.646	1	0.200	2.749
R1001 to R1500	1.677	1.127	2.212	1	0.137	5.348
R1501 to R2500	-0.499	1.105	0.204	1	0.651	0.607
Greater than R2500	-4.015	1.963	4.181	1	**0.041****	0.018
Farming Period						
Under four years	0[b]		8.245	3	**0.041****	
4 to 10 years	0.699	0.751	0.865	1	0.352	2.011
10 to 20 years	1.227	0.855	2.061	1	0.151	3.412
Greater than 20 years	4.643	1.691	7.540	1	**0.006*****	103.834
Indigenous crops: Marketable	0[b]					
Indigenous crops: Unmarketable	-0.006	0.543	0.000	1	0.990	0.994
Constant	2.629	1.520	2.989	1	**0.084***	13.856

Mean VIF	2.80
Prob>Chi^2	0.000
Hosmer and Lemeshow	0.4264
Nagelberke R^2	0.373
Number of observations	260

***=significant at the 0.1 level **= significant at the 0.05 level ***= significant at the 0.01 level**

An increase in the number of females had a significant value and positive coefficient. This meant that an increase in the number of females within a household by one unit resulted in an increase in the likelihood of consuming indigenous crops. This is in line with results from Ayinde *et al*. (2017) and Atuna *et al*. (2022), who reported that females consume indigenous crops more than males. The results also coincided with that of Bhengu (2017) who found that females highly consume indigenous crops. The results also showed the number of children as having a significant value

with a positive coefficient. An increase in the number of children by one unit within a household resulted in an increase in the likelihood of consuming indigenous crops. The results suggested that increasing indigenous crop consumption in children results in a more nutritional meal. These results coincide with several studies where an increase in the consumption of indigenous crops among children was associated with good nutritional status (Kucich & Wicht, 2016; Omotayo *et al*., 2021).

The monthly food expenses variable had a significant value and negative coefficient. An increase in the amount of income spent on a household food basket per month decreased the likelihood of a household consuming indigenous crops. This suggests that households who can afford to purchase a larger food basket, will have a greater number of food choices and may not prefer to include indigenous crops as part of their diet due to various reasons. This is not expected with the current economic state in South Africa. Food price hikes considerably influence household food security in South Africa. For instance, as a result of the recent coronavirus pandemic, prices for foods such as ginger, garlic, red meat and chicken have risen substantially, placing pressure on the welfare of households (Ningi *et al*., 2021). Furthermore, due to COVID-19 challenges, households are unable to match household costs due to decreased incomes and hence cannot afford a healthy and nutritious food basket. These findings are consistent with Cloete & Idsardi (2013), where monthly household costs and low household income were found to increase the consumption of indigenous crops.

The farming period variable had a significant value and positive coefficient. An increase in the amount of experience a farmer had, increased the likelihood of indigenous crops consumption in a household. The results implied that farmers with more experience in agriculture will have more nutritional knowledge of the different types of indigenous crops and may consume them more. On the other hand, the results could mean that farmers with more experience may cultivate these crops as they require less inputs to grow. These results concur with those of Andani *et al*., (2020) who noted that farmers with a higher amount of experience had a greater likelihood of utilising indigenous crops.

4.5 Conclusion and recommendations

The study's objective was to analyse the different factors that affect the consumption of indigenous crops among farming households. The results showed that farmers commonly cultivated exotic

crops such as spinach, cabbage, carrot, and butternut than any indigenous crops, except for a few cultivating taro and sweet potato. The binomial logit regression results revealed that the number of females and children within a household as well as farmer's experience increased the likelihood of consuming indigenous crops, whilst monthly food expenses decreased the likelihood of consuming indigenous crops.

Evidently, there is a huge gap between the consumption and production of indigenous crops. The study concluded that although a high number of farming households indicated that they consume indigenous crops, this did not show in the crops they cultivate. It was also concluded that when households have children, there is a great need to secure nutritional food, and caregivers turn to indigenous crops. Furthermore, experience in farming is vital as it increases the consumption of indigenous crops. Therefore, the study recognises the need for increased awareness and recommends the adoption of a great number of climate-adapting indigenous crops among farming households to be cultivated and consumed. Furthermore, government interventions are necessary in providing production information on indigenous crops.

4.6 References

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CHAPTER FIVE

FACTORS AFFECTING THE CHOICE OF MARKETING CHANNELS AND FOOD FORM FOR INDIGENOUS CROPS IN KWAZULU NATAL

Abstract

Market channel and food form (as it is or processed) selection may affect and influence production and sales of various produce. Indigenous crops in South Africa are mostly sold in local rural markets and to hawkers in town. These crops are less common in the formal markets due to a number of factors. This paper investigated the factors affecting market channel and food form choices that farmers make when producing and selling indigenous crops. About 260 farmers were selected using simple random sampling procedure from three districts, namely uMgungundlovu, Harry Gwala, and eThekwini. Multinomial logit and bivariate probit regression models were used to analyse the factors affecting the choice of marketing channels and food form. The majority of (58.1%) the participants perceived that indigenous crops are not easily marketed. Results of the multinomial regression showed that selecting the local marketing channel was positively influenced by the number of males within a household. The number of children, unemployed members in a household, total household income and producing indigenous crops for the purposes of consumption and selling negatively influenced the selection of the local market. On the other hand, selecting the informal market was positively influenced by farm size and negatively influenced by farming experience and utilising crops for both consumption and market. The number of children, education levels, farming experience and individuals unemployed was negatively associated with the selection of formal markets. Gender and total household income positively influenced the selection of formal markets. The bivariate probit model showed that farmer's experience positively influenced farming households selecting to sell their produce raw, whereas crop use negatively influenced it. Farming households selecting to sell processed indigenous crops was positively influenced by number of males and farm size. However, it was negatively influenced by total household income and crop use. It was concluded that farming households do not generally believe indigenous crops cannot be easily marketed. Additionally, farming households' selection of marketing channels is highly associated with socio-economic characteristics. This suggests that it may take more time than previously perceived for farming households to grow and market indigenous crops as opposed to exotic crops. Additionally farming households may not have enough resources to participate in processing of indigenous crops. There

is a need for the government and other stakeholders to strongly promote the sale and processing of indigenous crops. A deliberate effort should be made to build informal and formal markets for the sales of indigenous crops.

Keywords: Farmer preference, food security, marketing channels, food form, indigenous crops

5.1 Introduction

African agricultural systems have always included indigenous crops, but most of the continent's nations have not given them precedence when crop development occurs (Mabhaudhi *et al.,* 2018). They have not been of thoroughly interest in research agendas or agricultural advisory platforms for farming households, which tend to emphasize enhanced exotic crops. This further limits the sustainability goals that should be reached by 2030, thus comparing the continued high population trends and unemployment rates, South African researchers have suggested the use of indigenous crops to assist in alleviating household food insecurity in vulnerable households (Mbhenyane, 2017; Imathiu, 2021). These crops have been found to be climate resilient and less costly to cultivate in addition to other medicinal benefits (Van de Merwe *et al.,* 2016).

Yet, marketing channels and food form for indigenous crops in South Africa are stagnant and limited. Marketing channels are defined as a place where the produced goods by the farmer can be sold to consumers, retailers or other buyers in its raw form or processed. In this study, three marketing channels were identified, namely, local, informal, and formal markets for indigenous crops. Food forms are defined as the different forms of indigenous crops that can be sold as fresh, raw, and processed into a product to satisfy consumer demand. Contrary to other African countries such as Kenya and Zambia where demand has risen significantly for these crops in both informal and formal markets (Arumugam *et al.,* 2022), in South Africa demand remains stagnant. However, recent research reports that some indigenous crops such as *Amaranthus spp., Cleome, Dovyalis, Plectranthus, and Vigna* have been suggested to have high potential for market demand in South Africa (Zondi *et al.,* 2022). Indigenous crops have the potential to be sold in various market channels yet are less common in formal markets due to a number of challenging factors, such as low levels of acceptability and access, limited market information, a lack of processing technologies, intrinsically weak value chains, and technologies to drive indigenous crops to larger commercial markets (Muhanji *et al.,* 2011; Lotter *et al.,* 2014; Leakey *et al.,* 2022).Current accessible marketing channels available for sales of indigenous crops and their food form types

such as local and informal channels are characterised by inadequate and inconsistent consumer demand and supply (Mahlangu *et al*., 2020). This results in farming households having limited power to negotiate better prices and end up accepting a non-profitable price for their commodity. Having these crops included in various marketing channels can transform the huge dependency on wheat, maize and rice and open doors to other additional opportunities that could be established from full use of the potential of indigenous crops (Omotayo & Aremu, 2020). Furthermore, they can assist in household food insecurity through income generation. With household food insecurity rife, farming households have commonly utilised indigenous crops for consumption but rarely to sell and receive income in South Africa, Eastern Africa, and Southeast Asia (Weinberger, 2006; Van de Merwe *et al*., 2016). The perception of these crops among farming households have resulted in them being less valued which showed in the reduced and even non-production (Cloete & Idsardi, 2012; Akinola *et al.,* 2020). Mbhenyane (2017) argued that the lack of use of indigenous crops in rural and urban areas by farming households is constituted to the inavailability of these foods in commercialised and industrialised markets. Furthermore, these crops are marginalized in commercial farming, which in turn leads to the further loss of biodiversity and related traditional knowledge. Ekesa *et al*. (2009) reported that gathering indigenous crops is regarded as of low class and this is due to indigenous crops being associated with poverty and primitive practice. In addition, the cultural value of these crops is annually declining as priority has shifted to growing exotic plants that suit urban tastes, have readily available information in terms of cultivation despite their inferior nutrition content.

Several socioeconomic factors have been identified in affecting marketing channel choices. In a study by Kiprop *et al*. (2020) focused on Kenya to find the determinants of market channel choices for indigenous chicken farmers; it was found that educational levels, age, and household size were significant factors that affected market choices. Farmers with higher education levels selected formal markets such as supermarkets and brokers to sell their produce, whilst age and household size were found to be insignificant. Wanasinghe & Sachitra (2022) found that age, gender, education level and household size were found to be statistically significant in the market choice selection of vegetable farmers in Sri Lanka. Similarly, Nwafor (2021) found that age, household size, additional income were significant variables in the factors affecting market channel choices among smallholder cocoyam farmers in South Africa.

Understanding how markets themselves turn into entry obstacles, particularly for indigenous crops, has not received enough attention. Taking African leafy vegetables for example, there is hardly any research about value chain analysis of these crops although there are several studies of their nutritional range (Chivenge *et al.,* 2015; Nyandanu & Lowor, 2015; Imathiu, 2021). On the other hand, indigenous crops are only sold raw with a few markets selling processed products such as amaranthus flour (Schnetzler, 2018). This further discourages farmers from integrating these crops into their production and marketing plans. A critical gap exists in the local rural development policy. When farmers based in rural/ peri-urban areas dread to sell produce due to decreased awareness, rural inequality could become further aggravated under a market system that consistently supports commercial farmers who focus on exotic produce over subsistence and farming households who focus on indigenous crops. Therefore, it is appropriate to conduct this type of socioeconomic analysis to produce data that will help all actors better organise the value chain. Several papers have researched the potential of whether these crops can be commercialised and the optimal production areas for these crops (Omotayo & Aremu, 2020; Mudau *et al.,* 2022; Nhamo *et al.,* 2022 Zondi *et al.,* 2022). Taking Zondi *et al*. (2022), the study focused on the impact of market participation of indigenous crops within smallholder farmers but did not cover market channel choice for indigenous crops. Arumugam *et al*. (2022) focused on the determinants of market outlet choices for African indigenous vegetables, however the study was based in Zambia. On the other hand, there is a death in literature that focus on indigenous crops' food form. Thus, a gap exists to investigate whether farming households find these crops valuable enough to cultivate and sell in various marketing channels and as different raw or processed products. The choice of market channel and food form for indigenous crops plays a significant role in making a huge difference in achieving the required production goals. This paper set out to determine the predictor variables associated with farmer's selection of suitable marketing channels and food form for indigenous crops and the reasoning behind these preferences.

5.2 Study area, sampling, and data collection technique

The study area, sampling and data collection technique have been outlined in chapter three.

5.3 Analytical Framework

5.3.1 Multinomial logit regression analysis to investigate the factors affecting market channel selection for indigenous crops.

The quantitative data were analysed using STATA statistical software (version 18) and the Statistical Package for Social Sciences (IBM SPSS), version 28. A multinomial logistic regression modelling approach was used to explore potential relationships between the predictor variables that regulate why farmers either selected local, informal, or formal or all markets as the suitable market for indigenous crops (the outcome variable) against a set of independent variables (explanatory variables). The dependent variable was a categorical variable presented by 0 = Local market; 1= Informal market; 2= Formal market and 3= All markets. "All markets" was used as a reference variable. The independent variables are listed in Table 6.1 and represent the possible factors that influence the farming households' choice within the listed markets. Additionally, the study addressed the biases noted in the literature by applying the multinomial logit regression in STATA that accounts for selection bias (Musara *et al*., 2018).

Multinomial logistic regression is a prominent statistical technique utilised in decision research involving more than two numerous options. The multinomial logistic regression employs a general logit transformation, which is the logarithm of the probabilities of a specific result level relative to the reference level (Greene, 2003). Multinomial logistic regression is an extension of logistic regression when the outcome variable contains more than two discrete outcomes. Model coefficients or Beta and odd ratios can be used to summarise the effects of the model's explanatory variables on the outcome. An odd ratio is the ratio of the chances of an outcome level relative to a reference outcome level (no perceived change).

The multinomial logit analysis model for this study specifies the relationship between the probability of choosing option A_i and the set of explanatory variables X as specified by Green (2003):

$$\text{Prob}\ (A_i = \text{j}) = \frac{e^{\beta_j x_j}}{\sum_{k=0}^{j} e^{\beta_k k}}, \text{j} = 0,1 \ldots \text{J} \qquad (1)$$

Where βj is a vector of coefficients on each of the independent variables x. Equation (1) could be normalized to remove indeterminacy in the model by assuming that the probabilities could be estimated as:

$$\text{Prob}\ (A_i = j \mid X_i) = \frac{e^{\beta_J x_i}}{1+\sum_{k=1}^{J} e^{\beta_k x_j}}, j = 0,2..J, \beta_0 = 0 \qquad (2)$$

The independent variables are represented Table 1.

5.3.2 Bivariate probit regression to analyse the factors affecting food form selection among farming households.

The bivariate probit regression model was used to analyse which factors influence food form selection among farming households. Farming households had the choice between selecting indigenous crops to be sold in markets either fresh/raw or processed into a product for consumer needs and demand. The model consisted of two binary dependent variables that were ran simultaneously. Each dependent variable asked participants a yes or no question which was coded using 0= Yes and 1= No. The independent variables used in the model are listed in Table 5.1.

The bivariate probit regression model is best suited for this study as it can effectively handle two dependent variables or scenarios in a unified network (Ding *et al*., 2023). It is also advantageous because it can effectively deal with potential correlation effects and endogenous problems that may arise between the selection of food forms given. Farming households face a number of choices with regard to production and marketing, several of which are interrelated such as selecting to sell indigenous crops produced as fresh in the market or to sell them processed into a product. Hence, the study utilises the bivariate model to estimate influencing factors between these two decisions where the two binary outcomes may be correlated, having a correlation of ρ. If the correlation of the two dependent variables is significant, it validates the use of the bivariate probit or logit. However, if the two dependent variables are found to be insignificant, they can be analysed separately (Greene, 2003).

The bivariate probit model may be written as a continuous latent variable measuring propensity, utility, and preferences (Anang, 2018). Let Y_1* represent whether farming households prefer to sell indigenous crops fresh in the market and Y_2* represent whether farming households prefer to

sell indigenous crops processed in the market. The study follows the approach of Anang, (2018) where:

$$Y_1*=x1\beta+e1 \quad (1)$$

$$Y_2*=x2\beta+e2 \quad (2)$$

The observed choices are represented by the latent variables Y_1* and Y_2* in equation 1 and 2, this is further shown in equation 3 and 4 below:

$$Y_1 = \begin{cases} 1 & \text{if } Y_1^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

$$Y_2 = \begin{cases} 1 & \text{if } Y_2^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

Equation 5 represents the error terms e_1 and e_2 which are dependent and normally distributed:

$$E[e_1] = E[e_2] = 0, \text{var}\,[e_1] = \text{var}\,[e_2] = 1 \text{ and } \text{cov}\,[e_1, e_2] = \rho \quad (5)$$

Where an insignificant value of ρ proves no endogeneity bias and models can be estimated separately. However, as mentioned prior a significant value indicates the existence of an interrelation within the dependent variables and can be estimated together to produce unbiased results. Equation 6 shows the log likelihood for the bivariate probit model:

$$L= \prod_{y_1=0} \Phi(-x_{y_1}\beta_{y_1=1,y_2=1})\Phi_2(x_{y_1}\beta_{y_1}, x_{y_2}\beta_{y_2}, \rho) \prod_{y_1=1,y_2=0} \Phi_2(x_{y_1}\beta_{y_1}, -x_{y_2}\beta_{y_2}, -\rho)$$

Where:

Φ is the standard univariate normal cumulative distribution and Φ_2 is the standard bivariate normal cumulative distribution with correlation ρ. Equations (1) and (2) are simultaneously estimated

using maximum likelihood yielding unbiased parameter estimates for β and ρ. The independent variables are presented in Table 5.1.

Table 5.1: Variables used in model.

Proposed Variable	Type of measurement	Definition/Coding	Prior Expectation	Prior Expectation
Dependant Variable			**Market Channels**	**Food Form**
Marketing Channel for indigenous crops	Categorical	0= Local 1= Informal 2= Formal 3= All markets (Base outcome)		
Food Form Fresh or processed	Two binary dependent categorical variables	**As it is** 0= Yes 1=No **Processed** 0= Yes 1= No		
Independent variables				
Number of males in household	Continuous		+	+
Number of females in household	Continuous		+	+
Number of children in household	Continuous		+	+
Number of formally employed members	Continuous		+	+
Number of casually employed members	Continuous		-	-

Number of unemployed members	Continuous		-	-
Total Household Income	Categorical	0= R0 to R500 (Base) 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= R2501 to R3500 5= R3501 to R4500 6= Greater than R4500	+/-	+/-
Education Level	Categorical	0=None (Base) 1= Primary 2= Secondary 3= Tertiary	+	+
Years of farming experience	Categorical	0= Less than 4 years (Base) 1= 4 to 10 years 2= 10 to 20 years 3= Greater than 20 years	+/-	+/-
Farm Size	Categorical	0= Small (Base) 1= Medium 2=Large 3= Very Large	+	+
Crop Use	Categorical	0= Food (Base) 1= Market 2= Hobby 3= Food+ Market	+/-	+/-
Indigenous Crop marketing Potential	Categorical	0= Yes (Base) 1= No	+/-	+/-

(Source: Own analysis, 2023)

5.3.3 Justification of proposed variables

The number of males and females' variable represents the number of males and females in a given household and were captured as a continuous variable. Males are commonly known to have decisioning power in farming activities when married. A study by Carter *et al*. (2017) and Lee *et al*. (2020) found that males have more decisioning power due to acquiring land in their name when married. Furthermore, in female-headed households, sons make decisions related to farming matters. However, for both males and females it is assumed that both will likely need to maximise income when making decisions related to farm operations. The number of males and females' variables were hypothesized to have a positive influence on a farming household selling their produce to more formal markets and preferred food form**.**

The number of children variable represents the number of children in a given household and was captured as a continuous variable. An increase in the number of individuals regardless of their gender or age is expected to incentivise household members to sell their produce in formal markets for better opportunities and income in order to be able to afford various domestic needs such as a healthy food basket (Bekele & Hirko, 2018; Demisse *et al*., 2022). The number of children was hypothesized to have a positive influence on a farming household selling their produce to more formal markets and preferred food form.

The number of formally employed variable refers to the number of individuals in a given farming household with stable employment. Stable employment provides a household with diversified choices on how to plan and invest their income. Formally employed household members are able to invest their income in any necessary production and marketing costs as compared to households with casually or unemployed individuals (Banyte *et al.*,2011; Zhang *et al*., 2014). The number of formally employed variable was hypothesized to have a positive influence on farming households selling indigenous crops to more formal markets and preferred food form**. The number of casually employed** variable refers to the number of individuals with "as needed basis" employment without the expectation of permanent or long-term contract employment. **The number of unemployed** variables refers to the number of individuals who are unemployed in each household. Casual employment and unemployment directly affect market channel choice and food form (as it is or processed) by limiting the funds available to a farming household to run a farm operation efficiently and successfully (Khaphayi & Celliers, 2016). Farming households who have a higher

number of casually employed or unemployed members commonly rely on the social grants and are unable to meet the financial requirements for formal markets. The number of casually employed and unemployed variable was hypothesized to have a negative influence on farming households selling indigenous crops to more formal markets and preferred food form.

The total household income variable refers to the total amount of income a household incurs from various sources on a monthly basis and was captured as a categorical variable. Income is a significant factor in market channel and food form choice among farming households. This is attributed to low-income households unable to afford transactions costs for more formal markets when compared to high income households (Nyaga *et al*., 2016; Kiprop *et al*., 2020). The total household income variable was hypothesized to have either a negative or positive influence on farming households selling indigenous crops to more formal markets and preferred food form.

The education level variable refers to the highest level of education achieved by the head of the household and was captured as a categorical variable. The educational level of a household head is utilised as a measure of the farmer's ability to retrieve and efficiently utilise information. An increase in education levels is known to improve a farmer's information seeking behaviour, adoption of agricultural innovation and is a significant determinant of market channel choice (Ndoro *et al*., 2015; Mossie *et al*., 2020). The education level variable was hypothesized to have a positive influence on farming households selling indigenous crops to more formal markets and preferred food form.

Years of farming experience variable refers to the number of years a farmer has practiced agriculture and was captured as a categorical variable. A farmer's experience can increase knowledge and confidence, resulting in efficient production and produce for the market. Mukarumbwa *et al*., (2018) and Nxumalo *et al*., (2019) found that farming experience among crop producers plays a key role in improving the navigation of a farmer within the market. The farming period was hypothesized to have either a negative or positive influence on farming households selling indigenous crops to more formal markets and preferred food form**.**

The farm size variable refers to the amount of land a farmer utilises for the production of various crops and livestock and was captured as a categorical variable. Increase in availability of land has been found to increase the production of indigenous crops (Rifin *et al*., 2015; Andani, 2020;

Kudama, 2020). The farm size variable was hypothesized to have a positive influence on farming households selling indigenous crops to more formal markets and preferred food form**.**

The Crop use variable refers to the different uses of crops produced by a household and was captured as a categorical variable. Farming households generally utilise crops produced for food or selling or both (Vusani & Kogeda, 2012). These uses are prioritised in terms of the scale of operation and available resources (Ngugi *et al*., 2007; Zondi *et al*., 2022). The crop use variable was hypothesized to have either a negative or positive influence on farming households selling indigenous crops to more formal markets and preferred food form.

The perceived marketing potential variable refers to whether a given farming household believes indigenous crops could be easily marketed and was captured as a categorical variable. Onomu (2023) noted that farmers in Africa lack awareness of the potential market value of indigenous crops and that may be the key reason for low production. The perceived marketing potential variable was hypothesized to have either a negative or positive influence on farming households selling indigenous crops to more formal markets and preferred food form**.**

5.4 Results and Discussion

5.4.1 Marketing Perceptions of Indigenous crops

The results showed that a higher number of participants (58.1%) believed indigenous crops could not be easily marketed, whereas 41.9% believed they could be. Some of the reasons included by the participants were that these crops are more nutritious than people currently perceive them to be (27.7%), nutritious but lack well-structured advertisements (5.6%), lack of knowledge among communities of their benefits (22.5%), required exposure in urban areas (13.4%), possible better prices in supermarkets as compared to exotic crops (9.5%), healthy (3.0%), all individuals can consume them (15.2%), good for the youth (2.2%), and could possibly fill a market gap (0.9%). Participants who perceived indigenous crops as not easily marketable shared these crops should not be sold as they grow naturally(20.0%) and cannot be cultivated in great numbers (80.0%). This contradicts the results from Opondo & Owuor, (2018) and Nyawurata *et al.* (2019), who pointed out that indigenous crop farmers in areas such as the Limpopo and Mpumalanga provinces of South Africa, Zimbabwe and Kenya who formerly specialized in exotic vegetables switched their

attention and diversified their output by focusing on indigenous crops as their new stream of income.

Participants were asked whether these crops could be sold as fresh from the farm.. A high number of participants (90.8%) believed these crops should be sold fresh and (9.2%) did not. Secondly, participants were then asked whether or not these crops could be sold processed. The results showed that 28.8% of the participants believed indigenous crops should be sold processed whereas 71.2% did not. This was attributed to reasons such as indigenous crops seeming appealing when packed in a different form rather than fresh (24.1%). Additionally, selling these crops fresh was listed as more risk-averse and less costly. Participants who believed these crops should be sold processed reasoned that when these crops are processed, it is too costly for the farmer (16.7%), while others shared that there would be limited income as these products would be new on the market (27.8%), some shared indigenous crops would have a higher demand if sold in different product types (29.9%) and some believed it would be too risky to venture into. These results suggest a low perceived value of indigenous crops from participants. This could be due to a need for more information on the processing of indigenous crops and limited research in this regard. These results coincide with Ngcoya & Kumarakulasingam (2017), which found that a few farming households process indigenous crops at a small scale and only for household consumption.

Participants were asked which market channels would be most suitable for indigenous crops. This was represented in four categories: local, informal, formal and all markets. Among the participants who perceived these crops to be easily marketable, 40.1% reported that indigenous crops can be marketed in all markets, including local, informal, and formal markets. On the other hand, closely following, 38.8% reported that these crops could only be sold locally, while 11.4% reported that they could be sold formally, and 9.7% reported that they could be sold informally. These results show that farming households are reluctant to market these crops at a larger, more stable channel as most participants are divided between local and all markets. This coincides with the results of Mahlangu *et al*. (2020), which found that indigenous crops have better opportunities in rural and possibly informal markets than any other marketing channel. On the other hand, farmers may be torn between the two marketing channels due to the costs incurred when selling crops in informal and formal markets.

The highest number of participants (36.9%) reported that there would be less risk and traveling costs associated with local markets when selling these crops. This was followed by reports that these crops have limited exposure regardless of whether a farmer wants to sell beyond the local market (26.7%). In contrast, other respondents reported that people are less likely to purchase these crops if sold elsewhere rather than locally (22.5%). Other reasons included that some of these crops are easily accessible to all individuals and readily available, making selling them redundant (13.9%). These reasons suggest that farmers consider these crops as risky in the informal and formal market because there is a lack of exposure of these crops among consumers which could translate to a low demand.

Farmers who listed the formal market as suitable for indigenous crops reported that the formal market would allow the introduction of increased variety (43.8%) and expand the opportunity for greater income for farmers (38.8%). Other reasons included increased exposure for these crops (10.7%) and widening of the market (6.6%). Participants shared their reasoning for listing informal markets as most suitable for indigenous crops. These included participants sharing that individuals from peri-urban and urban areas would be able to get access (35.7%) and informal markets are better equipped to handle indigenous crops due to flexibility in grading and required quality (32.5%). Other participants shared that street vendors can help promote these crops as streets are commonly busy (30.2%) and informal markets would increase the demand for these crops (1.6%). These results show that farmers are willing to produce and sell these crops yet are limited due to the uncertainty of whether these crops would be purchased. Notably, farmers are aware that these crops need increased awareness, particularly in peri-urban and urban areas, and that selling these crops in several kinds of markets can increase their exposure and, ultimately, market value.

5.4.2 Factors affecting market channel selection for indigenous crops using multinomial logit regression.

Multinomial logit regression was used to determine the predictor variables that regulate why farmers selected the type of market they use to sell indigenous crops (Table 5.2). Prior to estimating the selection model, the possibility of multicollinearity issues was examined using the VIF function in STATA. The results of the VIF values of the independent variables were found to be below 10 as required where the mean value was presented in Table 5.2. (Please see appendix 1 for full table). The overall model fit well with the data and was statistically significant (0.000). Only

statistical variables found to be significant were discussed, and all markets were selected as the reference or base outcome variable for the dependent variable. The results in Table 5.2 below, presents the different factors that affect market channel choice.

Table 5.2: Factors influencing market channel choice selection using the multinomial logit regression

	Coefficient	Robust S.E.	P>Z	Coefficient	Robust S.E.	P>Z	Coefficient	Robust S.E.	P>Z
	Local Market			Informal Market			Formal Market		
Number of males	0.327	0.178	**0.067***	-0.292	0.362	0.420	0.681	0.283	**0.016****
Number of females	0.139	0.176	0.432	0.252	0.377	0.504	0.497	0.313	0.113
Number of children	-0.199	0.113	**0.080***	-0.437	0.303	0.148	-0.754	0.296	**0.011****
Number of formally employed	-0.363	0.339	0.285	0.595	0.427	0.164	0.229	0.371	0.537
Number of casually employed	-0.288	0.210	0.171	0.202	0.356	0.571	-0.458	0.342	0.182
Number of unemployed	-0.263	0.133	**0.048****	-0.038	0.273	0.891	-0.402	0.225	**0.074***
Total Household Income									
R0 to R500	Base			Base			Base		
R501 to R1000	0.773	0.877	0.378	-1.449	1.437	0.313	-2.127	1.588	0.181
R1001 to R1500	0.016	0.868	0.985	-0.548	1.352	0.686	-1.264	1.601	0.430
R1501 to R2500	0.694	0.876	0.428	-0.396	1.364	0.772	2.760	1.662	**0.097***
R2501 to R3500	-0.163	1.246	0.896	0.081	1.639	0.960	1.329	1.427	0.993
R3501 to R4500	-2.075	1.019	**0.042****	-2.836	2.363	0.230	1.325	1.219	0.991
Greater than R4500	-2.279	1.024	**0.026****	-0.541	1.538	0.725	3.336	1.801	**0.064***
Education Level									
None	Base			Base			Base		
Primary	0.060	1.022	0.953	-2.809	2.039	0.168	-2.381	1.347	**0.077***
Secondary	0.291	1.031	0.778	-0.034	1.613	0.983	-2.771	1.293	**0.032****
Tertiary	0.784	1.215	0.519	1.762	1.877	0.348	-2.503	1.553	0.107
Farming Period									
Less than 4 years	Base			Base			Base		
4 to 10 years	-1.239	0.766	0.106	-1.444	1.281	0.259	-1.896	0.982	**0.054***
10 to 20 years	-1.356	0.840	0.107	-2.974	1.550	**0.055***	-1.859	1.146	0.105
Greater than 20 years	-0.766	0.870	0.379	0.018	1.540	0.991	-5.760	2.282	**0.012****
Farm Size									
Small	Base			Base			Base		
Medium	-0.467	0.468	0.319	1.329	1.076	0.216	-0.574	0.787	0.466
Large	-0.607	0.639	0.342	2.049	1.230	**0.096****	0.441	1.013	0.664
Very large	-1.509	2.251	0.995	5.459	2.252	**0.015****	0.589	2.098	0.779
Crop Use									
Food	Base			Base			Base		
Market	-0.209	0.898	0.816	-1.272	1.703	0.455	1.072	1.423	0.451

Hobby	-0.198	0.567	0.727	-1.291	1.288	0.316	0.678	1.012	0.503
Food + Market	-1.735	0.557	**0.002*** **	-4.943	2.064	**0.017** **	0.355	0.809	0.661
Indigenous crop marketing potential									
Yes	Base			Base			Base		
No	0.306	0.414	0.461	-0.444	0.723	0.539	-0.586	0.686	0.393
_cons	0.843	1.452	0.561	0.450	2.213	0.839	0.989	2.080	0.635
Log Likelihood	-164.187								
LR Chi2	136.240								
Pseudo R2	0.293								
Prob>Chi2	0.000								
Akaike's information criterion	423.578								
Bayesian Information criterion	541.406								
Mean VIF	2.261								
Number of observations	260								

***=significant at the 0.1 level **= significant at the 0.05 level ***= significant at the 0.01 level ns= not significant (Source: Field survey, 2023)**

Local market channel selection

The number of males within a household was found to have a significant value and a positive coefficient. All other variables held constant, an increase in the number of males by one unit increased the likelihood of a farmer selecting local markets as more suitable than all markets. The results suggest that males may have decision-making power in whether or not these crops could be sold if produced and may prefer local and formal marketing channels instead of all markets. This is in line with Lee *et al*. (2020), who found that males in households have more decision power than females when selecting marketing channels for produce. This is because male-headed households are commonly characterised by the male being given authority over land use and income retrieved from agricultural produce from that land (Twyman *et al*., 2015; Carter *et al*., 2017).

The number of children in a given household was found to have a significant value and negative coefficient. All other units held constant, an increase in the number of children decreased the likelihood of selecting local marketing channels for indigenous crops. This suggests that an increase in the number of children leads to a higher demand for stable household income and food. Selling indigenous crops locally may not yield stable income for a household, forcing household members to seek other marketing opportunities for these crops. This is confirmed by results of

Umberger *et al*. (2010) and Demisse *et al*. (2022) which found that dependent children within a household are a significant factor in determining market channel choice of farmers in Indonesia. This is because farmers select to sell in formal marketing channels, which allows them to support their children's education and other domestic needs.

Similarly, the number of unemployed individuals in a given household was found to have a significant value and a negative coefficient. All other units held constant, an increase in the number of unemployed household members decreased the likelihood of a farmer selecting local markets compared to all markets. This contrasts with expected results and suggests that a lack of employment may require farming households to sell indigenous crops to all markets to get substantial household income.

Total household income was found to have a significant value and negative coefficient. An increase in household income decreased the likelihood of selecting local marketing channels for indigenous crops as opposed to all markets. This suggests that farming households with smaller income may reserve their income for other investments as opposed to market costs related to selling indigenous crops to informal and formal markets. However, farming households with a higher income may be able to afford marketing costs related to selling to informal and formal markets such as transport costs. This is similar to the findings by Opata (2018) and Kiprop *et al*. (2020), who found that transport costs were a significant variable in how farmers selected between local and formal marketing channels in Kenya and East Nigeria for their produce.

Farmers utilizing crops produced for food and market purposes only were found to have a significant value and negative coefficient. A farmer moving from utilizing crops for consumption only to using them solely for food and market decreased the likelihood of farmers selecting local markets as suitable rather than all markets. The results of crop use suggest that farmers who use these crops for consumption and sales prioritise selling and may consume the remaining. The results coincide with Ngugi *et al*. (2007) and Marson (2022) where in Eastern Africa, farmers who cultivate indigenous crops for the market prefer to sell them in formal and informal markets as it widens the opportunity to sell at a better price than in local markets where farmers are mostly price takers and consume what is left.

Informal market channel selection

Farming experience was found have a significant value and negative coefficient. An increase in the farming experience in years decreased the likelihood of selecting informal marketing channels for indigenous crops. This suggests that as farmer experience increases, farmers prioritize which crops to grow and sell according to their resources and market demand. Farming households may not likely sell to informal markets due to their observations through the years of indigenous crop demand. This is in line with Mukarumbwa *et al*. (2018) and Nxumalo *et al*. (2019), who found that farmer experience was significant in the market channel choice of maize and sunflower. This was because experience in farming led to farmers being more aware of their shortcomings and demand and supply relationships.

Farm size was found to have a significant value and positive coefficient. An increase in farm size from small to large increased the likelihood of selecting informal markets as more suitable for indigenous crops. This could indicate that farming households with more extensive land can potentially diversify and produce different types of crops, including indigenous crops, to sell in informal markets. These results are in line with that of Andani (2020) where it was found that an increase in land ownership for farmers results in increased indigenous crop production and diversification. Farming households with a larger amount of land may also prefer informal markets compared to the various challenges farmers face when trying to penetrate formal markets. This leads to farmers believing the informal market is better suited for indigenous crops as they receive direct profits from what they sell and consume the rest. This coincides with the work of Abukutsa-Onyango (2002) and Ngugi *et al*. (2007), where in Western Kenya, all indigenous crops cultivated by farmers in the villages near the markets are sold in rural and/ informal markets due to exotic crops being sold more in formal markets.

The results further showed that farming households who cultivate crops for food and markets were found to have a significant effect and negative coefficient. This means farmers who cultivate crops for consumption and sales were less likely to select informal marketing channels for indigenous crops. This could mean farming households prefer formal markets only or believe in mixing and utilizing all markets for selling indigenous crops. Using formal or all types of markets increases the chances of selling off all indigenous crops produced. The results also show a greater knowledge of the benefits of these crops as formal markets can increase the amount of income accumulated.

These results coincide with results from Van der Hoeven *et al*. (2013), Taruvinga & Nengovhela (2015) where the awareness of indigenous crops led to a greater understanding of their value and further have a positive perception of them.

Formal market

The number of males in a given household was found to have a significant value and positive coefficient. The results demonstrated that an increase in the number of males within a household increased the likelihood of farming households selecting formal markets for selling indigenous crops. These results suggest that when males make decisions for a household, local and formal markets may be preferred. These results are similar to those of Carter *et al*. (2017) where males make decisions related to the farm to maximise profit.

The number of children in a given household was found to have a significant value and negative coefficient. An increase in the number of children and unemployed household members decreased the likelihood of selecting the formal market as suitable for indigenous crops. The results suggest that individuals who are unemployed but have an increased number of children may have limited income and need help to purchase all resources required to produce the quality required for formal markets. This suggests that farming households may not want to focus only on formal markets. These results are in contrast to Moyo *et al*. (2024) who found that unemployed household members are more likely to participate in the commercialisation of African indigenous vegetables in formal and informal markets of Zimbabwe. This was because farming households who had an increased number of unemployed members could invest a higher amount of time to the selling of these crops.

In South Africa, unemployed household members commonly rely solely on farming and social grants for household income and, hence, may need to participate in all channels to improve household food security. However, although these farmers may want to participate, capital investments to produce, maintain, and properly store produce of indigenous crops may hinder them from participating and may be limited to local markets only. This aligns with results from Khaphayi & Celliers (2016), where unemployment significantly limited farmers from progressing to the commercial scale or sector.

Total household income was found to have a significant value and positive coefficient. An increase in household income increased the likelihood of farming households selecting formal markets for

indigenous crops. This suggests that farming households pursue formal markets when they are able to afford the different transactional costs that are incurred in selling produce within formal markets. These results coincide with Nyaga *et al.* (2016), who found that with increased household income, farmers in Kenya were able to invest in proper machinery, cold storage facilities, and value addition, which allowed them to participate in formal markets fully.

Education levels and farming period was found to have a significant value and negative coefficient. An increase in farming experience and education levels decreased the likelihood of farming households selecting formal markets to sell indigenous crops. This suggests that farming households are aware of the current market situation of indigenous crops in South Africa. Indigenous crops have not fully penetrated the formal market in South Africa due to weak value chains and low demand by consumers (Senyolo *et al*., 2018). Several studies have emphasized the importance of improving indigenous crops' value chain as an incentive for farmers to produce and sell them (Weinberger & Pichop, 2009; Chagomoka *et al*., 2013; Moyo *et al*., 2022). However, these studies have been more focused on other African countries, such as Malawi, Kenya, and Mozambique, with limited studies in South Africa. Contrastingly to the results Mossie *et al*., (2020) who found that Northwest Ethiopian farmers who are well educated tend to sell their produce in lucrative formal markets. However, these farmers focused on crops such as onions.

Farmers have several challenges when trying to penetrate the formal market, although they may prefer it. Hence, numerous farming households struggle to reach formal agricultural markets. Although this may continue to not improve their household food security status or access to adequate income and, hence, an adequate food basket according to their household size, they may still find informal marketing channels more suitable for indigenous crops. This is because there are fewer opportunities in formal markets for farming households, mainly due to the inability to maintain the quality standards required. Several studies have confirmed that farming households cannot participate beyond informal markets because of input costs, infrastructure etc. which leads to them utilising local and/ informal channels (Sivhiya, 2022).

5.4.3 Factors affecting indigenous crops' food form selection using bivariate probit regression.

The bivariate probit regression was used to determine the predictor variables that regulate why farmers selected the type food form that should be sold in the market in regard to indigenous crops

as shown in Table 5.3. Two binary independent variables namely, fresh (raw) and processed were used as the dependent variables. The bivariate probit necessitates that the two dependent variables are correlated (Anang, 2018). The validity of the estimation was confirmed by testing the statistical significance of the ancillary parameter rho which measures the correlation of the residuals from the two models which was found to be significant at the 5% level (0.020). This result further validates the use of the bivariate probit model. The Breusch-pagan/ cook-wesberg test was conducted to test for heteroskedasticity. The results showed a p-value of 0.3542, thus indicating the absence of heteroskedasticity. The mean VIF is also presented in Table 5.3.

Table 5.3: Factors affecting indigenous crops' food form (as it is or processed) selection among farming households.

	Fresh Produce			**Processed Good**		
Variables	**Coefficient**	**S. E**	**P>Z**	**Coefficient**	**S. E**	**P>Z**
Number of males	-0.0310	0.085	0.715	0.165	0.091	**0.070***
Number of females	0.075	0.097	0.437	-0.118	0.101	0.243
Number of children	-0.093	0.072	0.190	0.028	0.059	0.639
Number of formally employed	0.078	0.136	0.564	-0.126	0.142	0.373
Number of casually employed	0.056	0.104	0.592	-0.006	0.113	0.955
Number of unemployed	-0.006	0.071	0.922	-0.022	0.076	0.772
Total Household Income						
R0 to R500	**Base**			**Base**		
R501 to R1000	0.098	0.435	0.823	-0.466	0.469	0.321
R1001 to R1500	-0.194	0.444	0.661	-0.886	0.477	**0.063***
R1501 to R2500	-0.032	0.464	0.9450	-0.323	0.497	0.515
R2501 to R3500	0.174	0.607	0.774	-1.340	0.644	**0.037****
R3501 to R4500	-0.084	0.514	0.869	-0.253	0557	0.650
Greater than R4500	0.139	0.483	0.773	-0.086	0.539	0.873
Education Level						
None	**Base**					
Primary	0.167	0.475	0.726	-0.520	0.484	0.282
Secondary	0.479	0.467	0.304	-0.523	0.483	0.279
Tertiary	0.400	0.543	0.461	-0.169	0.568	0.766
Farming Period						
Less than 4 years	**Base**			**Base**		
4 to 10 years	0.772	0.352	**0.028****	-0.276	0.344	0.423
10 to 20 years	0.533	0.402	0.184	-0.193	0.391	0.621

Greater than 20 years	0.599	0.441	0.175	0.093	0.433	0.830
Farm Size						
Small	**Base**			**Base**		
Medium	-0.123	0.239	0.607	0.552	0.244	**0.024****
	0.396	0.316	0.209	1.046	0.333	**0.002****
Large						*
Very large	0.279	0.851	0.743	0.264	0.814	0.746
Crop Use						
Food	**Base**			**Base**		
Market	-6.442	2.046	0.997	-1.011	0.504	**0.045****
Hobby	-0.204	0.304	0.501	-0.207	0.321	0.519
Food + Market	-0.564	0.269	**0.037****	-0.661	0.262	**0.012****
Indigenous crop marketing potential						
Yes	**Base**			**Base**		
No	-0.134	0.209	0.522	-0.111	0.213	0.605
_cons	-1.160	0.670	**0.083***	1.368	0.690	**0.047****
Log Likelihood	-218.181					
Prob>Chi2	0.020					
Akaike's information criterion	542.361					
Bayesian Information criterion	716.639					
Mean VIF	2.261					
Number of observations	260					

***=significant at the 0.1 level **= significant at the 0.05 level ***= significant at the 0.01 level ns= not significant (Source: Field survey, 2023)**

Fresh produce form

The farming period variable was found to have a significant value and positive coefficient. An increase in the number of years in farming experience, increased the likelihood of a farming household selecting to sell their produce fresh from the farm rather than processed. This is in line with results by Mukarumbwa *et al*. (2018) and Korzun (2020) who found that as farmers gain experience, they become more knowledgeable and confident in the decision they make in the market. Furthermore, they are able to navigate around consumer demand and supply such as identifying low market demand for processed indigenous crop products.

The crop use variable was found to have a significant value and negative coefficient. When farming households cultivate crops for the use of consumption and selling, it decreased the likelihood of selling these crops fresh from the farm. This may suggest that some farming households may want to invest in selling their produce as both fresh and processed to increase profits but are limited by

market demand. This can assist in efficiently utilising all the produce harvested on the farm. On the other hand, the results may also suggest that farming households' priority may be to either sell off their produce or consume most of it depending on household needs. This aligns with results from Mahlangu *et al*. (2020), Hlatshwayo *et al*. (2022) and Zondi *et al*. (2022) where farming households decide on the how produce is utilised depending on household needs.

Processed form

The number of males variable was found to have a significant value and positive coefficient. An increase in the number of males increased the likelihood of selling indigenous crops as processed goods. This is expected, as similar to market channel choice where an increase in males resulted in an increase in the likelihood of selling indigenous crops in formal markets. Farming households may start venturing into other forms of selling indigenous crops once exposed to formal markets. This is in line with Osondu *et al*. (2015) and Reynolds *et al*. (2020) where male-headed households base their farm decisions on income maximisation.

The total household income variable was found to have a significant value and negative coefficient. An increase in total household income decreased the likelihood of selling indigenous crops as processed goods. This suggests that farming households are risk averse in terms of utilising their income in processing indigenous crops as they have not entirely penetrated formal markets in South Africa. This is in line with results from Khoza *et al*. (2019) where increased total household income if limited, did not allow farmers to invest in the processing of their produce. However, this contradicts results by Nyaga *et al*. (2016) where total household income resulted in farming households being able to afford transaction costs to sell in different markets.

The farm size variable was found to have a significant value and positive coefficient. An increase in farm size resulted in an increased likelihood of selling indigenous crops processed. This suggests that farming households with a higher amount of land available can produce enough products to process and diversify with other crops. This coincides with results from Fallahinejad *et al*. (2022) where farm size was found to give farmers the opportunity to venture into different enterprises without risking main enterprises.

The crop use variable was found to have a significant variable and negative coefficient. Farming households utilising crops to consume and sell or for selling only have a decreased likelihood in

selling indigenous crops as processed. This suggests that farming households may not have enough inputs to venture into selling processed goods of indigenous crops. These results are supported by Ngugi *et al*. (2007) who noted that farming households do not have all the required sources to undertake selling indigenous crops processed. Furthermore, these results coincide with those of Khoza *et al*. (2018) who discussed that a low number of smallholder farmers participated in processing of their produce due to financial difficulties. Similarly, Barrett *et al*. (2010) who found that smallholder farmers only invested in processing their produce when farmers are able to sell their produce in supermarkets.

5.5 Conclusion and Recommendations

Marketing channels and food forms for indigenous crops in South Africa continue to be limited and stagnant. Indigenous crops are rarely sold in formal markets as opposed to the commonly sold exotic crops. South Africa still needs to work on several factors to facilitate a larger platform for these crops compared to other Sub-Saharan countries such as Kenya and Zambia, where indigenous crops are becoming more established. The study aimed to investigate the factors affecting market channel and food form selection. The results showed that 41.9% of the participants believed these crops could be easily marketed, whereas 58.1% did not. Participants were also found to differ in opinions on which market channel was best suited for these crops, where 40.1% said "all markets" and 38.8% selected local markets only. The multinomial logit regression results showed that the number of males within a household positively influenced the selection of the local marketing channel. The number of children, unemployed members in a household, total household income, and production of indigenous crops for consumption and selling negatively influenced the selection of the local market. On the other hand, selecting the informal market was positively influenced by farm size and negatively influenced by farming experience and utilising crops for both consumption and market. The number of children, education levels, farming experience, and unemployed individuals were negatively associated with the selection of formal markets. Gender and total household income was positively influenced by the selection of formal markets.

Farmer's experience positively influenced farming households selecting to sell their produce fresh from the farm, whereas crop use negatively influenced it. Farming households selecting to sell processed indigenous crops was positively influenced by number of males and farm size.

However, it was negatively influenced by total household income and crop use. It was concluded that farming households do not generally believe indigenous crops cannot be easily marketed. Additionally, farming households' selection of marketing channels is highly associated with socio-economic characteristics. This suggests that it may take more time than previously perceived for farming households to grow and market indigenous crops as opposed to exotic crops. Additionally farming households may not have enough resources to participate in the processing of indigenous crops. There is a need for the government and other stakeholders to strongly promote the sale and processing of indigenous crops. A deliberate effort should be made to build informal and formal markets for the sales of indigenous crops. Policies aimed at improving indigenous crops markets should be based on these factors.

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CHAPTER SIX

THE ASSOCIATION BETWEEN SOCIO-ECONOMIC FACTORS, INDIGENOUS CROPS AND ITS CONTRIBUTION TO FOOD SECURITY STATUS OF FARMING HOUSEHOLDS IN KWAZULU-NATAL PROVINCE

Abstract

Indigenous crops have been proposed as part of a solution for household food security and sustainable farming systems. However, they have been overlooked and underutilised by households and farmers despite their potential contribution to household food security. The objective of this paper was to determine the association of socio-economic factors and indigenous crops with the household food security of farming households. About 260 farming households were selected using a simple random sampling procedure. The food security status was measured through the use of the Household Food Insecurity Access Scale (HFIAS). The Chi-square test and extended ordered probit regression model assessed the relationship of socio-economic factors and indigenous crops with household food security status. The results from the HFIAS showed that farming households were largely in the mildly and moderately food-insecure categories, with 34.2% and 36.2% of the sampled farmers found in these categories, respectively. The Chi-square test showed a statistically significant relationship between food security status and socio-economic factors. Young men and everyone were perceived to be the ones likely to consume indigenous crops. Consumption of indigenous crops was found to be associated with food security. The results also showed that farming experience positively contributed to the food security status of the farming households. Selling indigenous crops in a formal market was found to be associated with food security compared to selling in an informal market. The study concluded that consuming indigenous crops was associated with improved food security. Furthermore, the identification of an appropriate market for sales of indigenous crops is imperative. The study recommends that government, extension officers, and nutritionists must conduct training workshops to encourage households to grow, market and buy indigenous crops. Government and policymakers need to include indigenous crops in the national food and nutrition security policy and create formal markets for indigenous crops.

Keywords: *Extended ordered probit model; food security status; indigenous crops; household food insecurity access scale*

6.1 Introduction

The agriculture system is a crucial industry that contributes significantly to alleviating socio-economic problems by fostering development and food security (Rudolph *et al*., 2017; Ndhleve *et al*., 2021). It is vital in economic growth, employment creation, poverty alleviation, and food and nutrition security (Masuku *et al*., 2017; Meyer, 2019) . It is characterised by commercial agriculture, which utilises 87% of the agricultural land, with only 13% scattered among emerging and subsistence agriculture (Greenberg, 2019). About 8.5 million individuals in South Africa depend on agriculture for employment and income, with the sector contributing to about 9.5% of the Gross Domestic Product (GDP) (STATSSA, 2023). Similarly, agriculture is the main source of work and income in many parts of Southern Africa (Ransom, 2015) where the large increase in the South African population through the years places great pressure on the country's food production and the need to provide more nutritious food for vulnerable communities (Mazvimavi *et al*., 2010). Thus, increasing agricultural productivity depends on effective measures to reduce poverty and hunger, particularly in vulnerable groups.

As rural and peri-urban area residents continue to be vulnerable, farming has been key to the survival of households. It contributes significantly to households' caloric intake, ranging from 42% to 58% (Raphela *et al*., 2021). Subsistence and smallholder agriculture further contribute to improving dietary diversity and food security, reducing the need for overreliance on purchased food (Olayemi & Nirmala, 2016). Poor households in South Africa generally lack the purchasing power to buy food from the markets (Jacobs, 2009). Therefore, involvement in indigenous crop production is seen as an alternative towards making food available and accessible for these households. Indigenous crops are an alternative that is less costly for farming households to produce. Indigenous crops are a plausible pathway towards attaining the 2030 Sustainable Development Goals (SDGs) of no poverty, zero hunger, and gender equality (Mabhaudhi *et al*., 2016). These crops have been proposed due to their climate-resilient nature and adaptability among several environments (Gruber, 2017). While these crops have been labelled as an integral part of household food security, they are considered poor man's food among individuals (Van der Merwe *et al*., 2016). Some common indigenous crops in South Africa include sorghum, amaranthus, and sweet potatoes (Sanders *et al*., 2015). Indigenous crops can generally help cropping systems to become more sustainable whilst aiding the rise in population to ensure long-term food supply while minimising adverse effects on land, water, and air (Matenge *et al*., 2016).

Despite the advantages of these crops, there are also several challenges that farming households face when cultivating indigenous crops. These challenges include the unavailability of seed and cultivating material, lack of market infrastructure, and competition from exotic crops such as maize, spinach, and cabbage (Coles, 2018). Individuals from rural and urban areas generally cultivate and purchase exotic crops rather than indigenous crops as they are perceived to be more nutritious and tastier. This preference for exotic crops decreases indigenous knowledge transfer from older to younger generations and deprives people of consuming less costly nutritious foods (Idowu, 2008). Other challenges include genetic erosion, vulnerability to pests and diseases, and unavailability of varieties. This shows the need for breeding programmes to introduce new genotypes for improved traits and innovative technology to improve their production and adoption (Backerberg & Water, 2010). The challenges also include limited agricultural production, a lack of resources, inadequate transportation infrastructure, poor yield and quality, lack of market access, and lack of agricultural credit and land (Ndhleve *et al*., 2017).

To fully reap the benefits of indigenous crops and address the SDGs relating to food and nutrition security, it is important to include female- and youth-headed farming households. Female-headed households participating in farming are more food insecure than male-headed households. Although males and females have limited agricultural resources, female-headed households are more limited due to cultural, traditional, and socio-economic factors (Modirwa & Oladele, 2012). This creates the need for targeted programmes to empower female farmers to reduce their vulnerability to food insecurity (Tibesigwa & Visser, 2015). Moreover, this underlines the continued need for extensive support in production and marketing information for female-headed households to improve household food security (Tshikororo *et al*., 2024)

Additionally, several papers list these crops as having low consumption rates, being underutilised, not being fully documented, and having limited production information (Senyolo *et al*., 2018; Mabhaudhi *et al*., 2018; Leakey *et al*., 2022). This limits the growth and variety of production, consumption, agro-processing, and strengthening of the market value chain for indigenous crops. Farming households in South Africa are further characterised by unstable food availability (through their production with limited resources) and access (through limited income and high rates of unemployment), thus requiring more definitive and detailed information on producing these crops at a better scale to supply household needs and incur revenue.

Thus, it is important to explore whether farming households' perspectives on these crops' marketing potential, access, and marketing avenues affect their overall household food security status. Several papers have investigated how the awareness and perception of indigenous crops on individuals affect household food security in South Africa (Modi, 2003; Mabhaudhi *et al*., 2018; Zondi *et al*., 2022; Zulu *et al*., 2022). Mabhaudhi *et al*. (2018) pointed out that a gap exists in mainstreaming indigenous crops in South Africa because there is a lack of broad knowledge of these crops, negative perceptions from farmers, and reliance on exotic crops across the country. Similarly, Modi (2003) found that subsistence farmers of KwaZulu-Natal (KZN) had limited knowledge of indigenous crops and did not attach much importance to them. However, the study by Modi (2003) did not focus on the association of indigenous crops with household food security. On the other hand, Zondi *et al*. (2022) found that socio-economic factors affected the food security status of several households producing indigenous crops. However, the focus was on the Limpopo and Mpumalanga provinces of South Africa. The studies did not focus on the KwaZulu-Natal province, which has many households involved in agriculture. There is limited information that links both the socio-economic factors and indigenous crops together with their potential to improve food security. In light of this background, this study is designed to provide insight into the link between socio-economic factors, indigenous crops, and household food security status.

6.2 Study area, sampling, and data collection technique

The study area, sampling and data collection technique are the same as in chapter three.

6.3 Analytical Framework

6.3.1 Household Food Insecurity Access Scale

The quantitative data was analysed using the Statistical Package for Social Sciences (IBM SPSS), version 28 and STATA version 18. Household food security was measured using the Household Food Insecurity Access Scale (HFIAS). It comprises of nine questions about the farming households sampled access to food insecurity. These questions were broken down into three sections that concentrate on the following topics: anxiety and uncertainty regarding the availability and quality of food in the home, as well as food consumption in terms of quantity and quality throughout the course of a 30-day period (Coates *et al*., 2007). These questions yielded farming family scores, which varied from 0 to 27 which were grouped into four main categories: namely, food secure, mildly food insecure, moderately food insecure and severely food insecure.

The HFIAS tool examined three aspects of food insecurity: (1) feeling anxious and uncertain about the household's food supply, (2) changing one's diet's quality, and (3) consuming less food overall. Nine questions made up the tool, which inquired about dietary, or food consumption modifications households made due to having few resources to buy food in the 30 days before the survey interview date. The measurement followed a continuum that started with worry over food availability, then a decline in the quality and amount of food, and finally, going to bed hungry and without food all day and night. Based on the nine items, there were four progressively more severe levels of food insecurity. They were either in a state of food security or mild, moderate, or severe food insecurity.

6.3.2 Extended Ordered Probit Regression to Determine the Association between Indigenous Crop Factors and Household Food Security

An extended ordered l regression was used to investigate the association between indigenous crops and the household food security of the sampled households. The extended ordered probit model is suited for modelling with an ordered categorical dependent variable and accommodates issues with selection bias. To properly assess the factors affecting household food insecurity within the sample, this study used the ordered categories of the HFIAS ($Q_1 = 1$; food secure: 0–1), $Q_2 = 2$ (mildly food insecure: 2–8), $Q_3 = 3$ (moderately food insecure: 9–17), and $Q_4 = 4$ (severely food insecure: 18–27) as the dependent variable in the ordered probit regression (Wooldridge, 2010; Gujarati, 2013; Mudzielwana *et al.*, 2022). The respective category for food security is unobserved and is denoted by the latent variable Qi*. The latent equation below models how Qi* differs with characteristics.

$$Qi* = X_i$$

The difference in the value that individual i derives from being food secure, slightly food secure, moderately food insecure, or severely food insecure is measured by Qi *; *i* is equal to 1, 2, 3, ... n, where n is the total number of respondents. Every individual is a member of one of the four groups, and X is an exogenous variable vector. Hence, taking the value of 4 if the household was severely food insecure and 1 if a household was food secure, the implied probabilities are as follows (Mudzielwana *et al*., 2022):

$$\Pr\{Q_i = 1|X_i\} = \Phi(-X_i\beta),$$
$$\Pr\{Q_i = 2|X_i\} = \Phi(\mu_2 - X_i\beta) - \Phi(\mu - X_i\beta),$$
$$\Pr\{Q_i = 3|X_i\} = \Phi(\mu_3 - X_i\beta) - \Phi(\mu_2 - X_i\beta),$$
$$\Pr\{Q_i = 4|X_i\} = 1 - \Phi(\mu_3 - X_i\beta).$$

where μ_i is the parameter estimated jointly with β, and where the above probabilities enter the likelihood function, the maximum likelihood is used for estimation. The β coefficients are interpreted in terms of the equation's underlying latent variable model. Thus, the probabilities of farming households falling between 1 and 4 can be written as follows;

$$\Pr(Q_i = 1) = \Phi(X_i\beta_1)$$

where $\Phi(\cdot)$ is the cumulative distribution function of the standard normal. Table 6.1 below represents the dependent and independent variables used in the model. The independent variables were then hypothesized on their expected effect on the dependent variable.

Table 6.1 A priori expectations for the explanatory variables used in the models.

Proposed Variable	Type of Measurement	Definition	Hypothesised Effect on HFIAS
Dependant Variable			
Household Food Insecurity Access Scale (Extended Ordered Regression)			
Independent variables			
Indigenous crop access	Categorical	0 = Cultivation from own garden, 1 = Cultivation from cultivated lands from other farmers/gardens, 2 = Collection from wild velds or forests	−
Indigenous crop consumption	Categorical	0 = Yes and 1 = No.	−
Farming period	Categorical	0 = Under 4 years, 1 = 4 to 10 years, 2 = 10 to 20 years, and 3 = Greater than 20 years.	+/−
Indigenous crops' perception	Categorical	0 = old women; 1 = old men; 2 = young women; 3 = young men; 4 = everyone	+/−

Required farm assistance	Categorical	0 = Seeds, 1 = Garden tools, 2 = Fencing, 3 = Shielding net, and 4 = Soil–analysis	
Indigenous crops' perceived marketing potential	Categorical	0 = Yes and 1 = No	+/–
Indigenous crops are a suitable marketing channel	Categorical	0 = Local market only, 1 = Informal market only, 2 = Formal market only, and 3 = All markets	+/–

Source: Own analysis.

6.3.3 Justification for Proposed Variables

Indigenous Crop Access: Indigenous crop access refers to how farming households access indigenous crops. It was divided into three categories whereby farming households may either cultivate these crops in their home gardens, cultivate from other cultivated lands, or possibly collect from forests or wild velds where they naturally grow. Access to indigenous crops differs across different African countries. In South Africa, access to indigenous crops is limited to cultivation and collection in the wild, but these crops are not commonly accessed through formal markets such as supermarkets (Senyolo *et al*., 2018). Contrastingly, in countries such as Kenya, indigenous crops are readily available in supermarkets (Gido *et al*., 2017). Consistent access to indigenous crops in various ways has been linked to household food security (Masuku & Bhengu, 2021). Indigenous crop access was hypothesised to positively influence household food security.

Indigenous Crop Consumption: Indigenous crop consumption refers to whether a farming household consumes or does not consume indigenous crops. Consumption of indigenous crops has been suggested to improve access to nutritional household food baskets for poor communities and vulnerable households (Ekesa *et al*., 2009). The number of times a household consumes indigenous crops can contribute significantly to the diet of household members and, thus, their food security status. An increase in the consumption of indigenous crops was hypothesised to positively influence household food security.

Farming Period: The farming period refers to the years a farming household has participated in agriculture. This was divided into four categories: under 4 years, 4 to 10 years, 10 to 20 years, and greater than 20 years. Increasing the number of years a farming household participates in agriculture increases exposure to information and experience. The number of years a farming

household has acquired in cultivating different crops in their home gardens exposes them to different practices, diversifying their diet and improving their yield (Sekhampu, 2017). This can lead to stable food security if utilised well (Oduniyi & Tekana, 2020). An increase in the number of years of farming was hypothesised to positively influence household food security.

Indigenous Crops' Perception: In this study, indigenous crops' perception refers to which individuals farming households perceive as those who should be consuming indigenous crops. This was divided into older women, older men, young women, young men, and everyone. In essence, all individuals should consume indigenous crops to gain their nutritional advantages. However, individuals' negative perceptions of these crops have led to a decline in their consumption, ultimately linked to household food security (Dweba & Mearns, 2011). According to Gido *et al*.(2017), although indigenous crops are more nutritious than popular and commonly consumed exotic crops, negative attitudes constrain efforts to increase the consumption of indigenous crops (Mayekiso *et al*., 2017). This is further exacerbated by most exotic crops being easily accessible in markets whilst indigenous crops are rarely sold. Although various initiatives have changed consumers' perceptions of indigenous crops, exotic crops are still far more popular (Van der Hoeven *et al*., 2013). Perceptions of indigenous crops were hypothesised to have a negative or positive influence on household food security.

Required Assistance: The required assistance variable refers to the production inputs that farming households listed as required to improve yield, income, and food purchasing power. These were divided into seeds, garden tools, fencing, shielding nets, and soil analysis services. Farming households receiving support from either government/research institutions through extension work have been linked to household food security (Tesfamariam *et al*., 2018; Antwi-Agyei & Stringer, 2021). This was hypothesised to have a positive influence on household food security.

Indigenous Crops' Perceived Marketing Potential: This variable refers to whether farming households perceived indigenous crops as marketable. Considering that several studies have found the perception of indigenous crops to be negative (Akinola *et al*., 2020; Omotayo & Aremu, 2020; Ngidi *et al*., 2023), it is expected that farming households may find indigenous crops unmarketable. However, it is important to find out whether farmers negatively perceiving these crops will have any influence on their household food security status.

Indigenous Crops Marketing Channel: This variable refers to the marketing channels farming households find suitable for indigenous crops. This was divided into four categories: local, formal, informal, or all markets. Indigenous crops are less popular in markets due to low levels of acceptability and access, limited market information, lack of processing technologies, and intrinsically weak value chains (Senyolo *et al*., 2018; Zondi *et al*., 2022). This limits the number of indigenous crop producers and may affect household food security in the long term. How farming households select marketing channels was hypothesised to negatively or positively influence household food security depending on the channel selected.

6.4 Results and Discussion

6.4.1 Prevalence of Food (in)Security Amongst the Sampled Farming Households

Food (in)Security Situation amongst the Farming Households

The prevalence of food security was measured through the use of HFIAS. Table 6.2 shows the percentage of farming households that experienced food shortages 30 days before the survey.

Table 6.2: Percentage response to HFIAS occurrences

HFIAS Occurrence Questions					
In the Past 30 Days, Did You or Any Member of the Household:			**Frequency of Occurrence (%)**		
	Yes	**No**	**Rarely (1–2 Times)**	**Sometimes (3–10 Times)**	**Often (More Than 10 Times)**
Worry about not having enough food	65.8	34.2	47.9	37.4	14.6
Not able to eat the kinds of foods you preferred	77.7	22.3	28.7	40.1	31.2
Have to eat a limited variety of foods	68.1	31.9	46.9	24.3	28.8
Have to eat some foods that you really did not want to eat	76.9	23.1	30.0	42.5	27.5
Have to eat smaller meals than you felt you needed	66.2	33.8	34.9	34.6	12.8
Have to eat fewer meals in a day	70.0	30.0	36.3	49.5	14.3
Ever had no food to eat of any kind in your household?	49.2	50.4	49.2	33.6	17.2
Go to sleep at night hungry	40.4	59.2	26.7	61.9	11.4
Go a whole day and night without eating anything	41.9	58.1	27.5	61.5	5.5

Most households (77.7%) indicated that they could not consume the foods they preferred because they lacked resources. This was followed by households who indicated that they had to eat some foods they did not want. In terms of frequency of occurrence, most households (31.2%) indicated that for more than 10 times in the past 30 days, prior to the survey, they could not eat the foods they preferred. These higher percentages indicate that farming households experience some levels of food insecurity.

The level of household food insecurity is shown in Figure 6.1 below. The analysis for food insecurity status indicates that 13.8% of the farming households were food secure, 34.2% were mildly food insecure, 36.2% were moderately food insecure, and 15.8% were severely food insecure. These results show that several farming households within the three districts experienced some difficulties in accessing a healthy and nutritious food basket. These results align with those from Thornton (2016) and Ryckman *et al*.(2021), who reported that households could not access and maintain a healthy food basket throughout the month due to unemployment and many household members needing food.

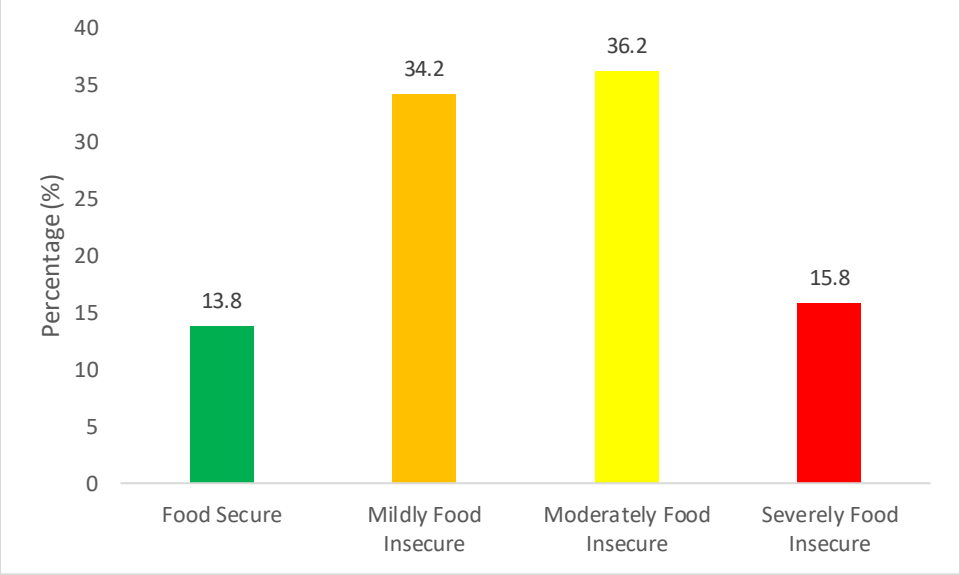

Figure 6.1: Household food insecurity occurrence

6.4.2 Factors Associated with Indigenous Crops and Their Contribution to Household Food Security

Factors affecting the food security status were analysed using the Chi-square test and the extended ordered probit model. The former analysed the effect of socio-economic parameters on household

food security, while the latter model was used when analysing the effect of indigenous crops on household food security.

Association between Socio-Economic Parameters and Household Food *(in)Security

Table 6.3 presents the association between socio-economic characteristics and food security. A statistically significant relationship exists between the food security status and gender, household monthly income, and number of household members ($p < 0.01$). The findings in Table 6.3 show more female farming households, and more female-headed farming households are food insecure than male-headed households. These results are not surprising because it is reported by various studies in South Africa and Africa in general that while more women are involved in smallholder agriculture, farm finances or income and associated decisions reside with males (Pelekamoyo & Umar, 2019; Hlatshwayo *et al*., 2021).

Table 6.3 Household socio-economic profile of four levels of food (in)security.

Demographics	Food-Secure	Mildy Food-Insecure	Moderately Food-Insecure	Severely Food-Insecure	X^2
Gender					
Male	9	41	28	16	0.057 *
Female	27	48	66	25	
Marital Status					
Married	19	38	41	17	0.904
Unmarried	17	51	53	24	
Number of HH members	36	89	94	41	0.051 *
Employment Status					
Unemployed	15	32	35	16	
Employed	12	34	21	10	0.608
Grant recipient	9	23	38	15	
HH Monthly income					
R0 to R500	5	11	11	5	
R501 to R1000	3	21	34	16	0.059 *
R1001 to R1500	11	20	28	6	

R1501 to R2500	5	13	7	3	
R2501 to R3500	5	4	4	4	
R3501 to R4500	2	7	7	2	
>R4500	5	13	3	5	
Educational Level					
None	5	9	15	7	0.525
Primary	9	22	20	10	
Secondary	15	50	57	22	
Tertiary	7	13	8	6	

* = significant at the 0.1 level

The results also show that the number of household members is significantly associated with household food insecurity. This means that the higher the number of household members, the more the household experiences food needs. This could be because a higher number of household members requires larger food basket household costs, enough for the larger household size. Household monthly income was also significantly associated with household food (in)security. The more income the household had, the higher the chances it was food secure. Likewise, if the household had less income, the chances of experiencing food insecurity were higher. Income enabled households to access food they could not grow and to buy the implements they needed to grow indigenous crops. The advantage of having access to purchasing power is that households can also buy quality food to improve their nutritional status.

6.4.3 Factors Associated with Indigenous Crops and Household Food Security

Extended ordered probit regression was used to assess the factors affecting food security among the farming households in study areas. The dependent variable was an ordinal scale that categorised participants through the HFIAS score to determine their household food security status. The dependent variable was coded as 0 = food-secure, 1 = mildly food-insecure, 2 = moderately food-insecure, and 3 = severely food-insecure. Table 6.4 represents the results where the coefficients of the extended ordered probit model do not entirely represent the magnitude of the effects of the explanatory variables. Hence, marginal effects were also computed in Table 6.5. Multicollinearity was tested for each independent variable via the variance influence factor (VIF) wherethe mean is presented in Table 6.4 below.

Table 6.4: Factors associated with indigenous crops and household food security.

Variables	Coefficient	S. E	$p > z$
Indigenous crop access			
Collection from own garden	(Base)		
Collection from cultivated lands	−0.027	0.249	0.913
Collection from wild veld or forest	−0.388	0.283	0.170
Indigenous crop consumption			
Yes	(Base)		
No	1.174	0.468	**0.012** **
Farming Period			
Under 4 years	(Base)		
4 to 10 years	−1.015	0.293	**0.001** ***
10 to 20 years	−1.117	0.318	**0.000** ***
Greater than 20 years	−1.164	0.332	**0.000** ***
Indigenous crops' perception			
Old women	(Base)		
Old men	−0.006	0.278	0.983
Young men	−1.344	0.454	**0.003** ***
Everyone	−1.083	0.237	**0.000** ***
Indigenous crops' marketing potential			
Yes	(Base)		
No	−0.400	0.183	**0.029** **
Perceived suitable marketing channel			
Local market only	(Base)		
Informal market	0.845	0.435	0.052 *
Formal market	−0.956	0.363	**0.008** ***
All markets	1.041	0.211	**0.000** ***
Required Assistance			
Seeds	(Base)		

Garden tools	0.091	0.354	0.796
Fencing	−0.286	0.254	0.260
Soil analysis	1.060	0.404	**0.009** ***
Irrigation	1.423	0.688	**0.038** **
/HFIAS CATEGORIES			
cut1	−2.988	0.436	
cut2	−1.223	0.409	
cut3	0.199	0.390	
Log-likelihood	−192.724		
Wald chi2	83.180		
Prob > Chi2	0.000 ***		
Akaike's information criterion	425.443		
Bayesian information criterion	490.598		
Mean VIF	1.88		

* = significant at the 0.1 level; ** = significant at the 0.05 level; *** = significant at the 0.01 level; ns = not significant.

The findings in Table 6.4 illustrate that consuming indigenous crops will likely positively influence food security. This means that consuming indigenous crops increased the likelihood of food security among farming households. These results coincide with those of (Cloete & Idsardi, 2012; Mabhaudhi *et al*., 2018), who reported that increasing the consumption of various indigenous crops might lead to a stable food security status. The greater number of years a household has been involved in farming increased the likelihood of being food secure. This means that farming experience is associated with a likelihood of being food secure. This is confirmed by the marginal effect results in Table 6.5, which show that farmers with more years of participation in agriculture are likely to fall under food-secure and mildly food-insecure households. This could suggest that farming households with greater experience or exposure have a better understanding and knowledge of the benefits of growing and consuming indigenous crops. Additionally, farming households with years of experience are well informed regarding farmer support programmes, which they likely take advantage of to include indigenous crops in their farming activities. These results coincide with Modi (2003) andMbatha *et al*. (2021), who reported that farming experience gained through farmer support programs equips farmers with updated agricultural information,

which results in better production, yields, and efficient cooperatives that increase the likelihood of household food security.

The findings of this study also show that young men and everyone were perceived as those who should be consuming indigenous crops. This means that young men and everyone will likely be food secure from consuming indigenous crops. While the results suggest that young men and everyone consuming indigenous crops are likely associated with being food secure, the findings of Chakona & Shackleton (2019) as well as Omotayo & Aremu (2020) clearly stated that the consumption of indigenous crops across age groups is still uncommon, with a limited exception for older people. The current recognition of indigenous crops as perceived in this study may be associated with the perceived medicinal benefits of these crops.

Regarding the marketability of indigenous crops, the findings of this study indicate that sales of indigenous crops are associated with food insecurity. However, the results further showed that if a household happens to sell the indigenous crop in a formal market, they are perceived as likely to be food secure compared to those who would sell in the informal market. This suggests that farming households who select informal and all markets as more suited for these crops are more likely to be food insecure. The perception is not far from South Africa's realities, where indigenous crops are generally associated with poverty. Therefore, poor households who normally buy from informal markets do not normally consider buying these crops.

On the other hand, when these crops find themselves in formal markets like Woolworths, where Amadumbe are being sold, the cost is higher and, therefore, is likely generating more money for the farmers. These results also align with Senyolo *et al*. (2018) where, for example, African leafy vegetables had weak value chain actors, transactions based on spot markets, lack of technical advice on production, and deficiency of contractual agreements between actors. Similarly, Imathiu (2021) found that limited advances in agronomic advice hinder the improvement of indigenous crops' market value chains and provide lesser incentives for their continued production and marketing. This reiterates that if indigenous crops were sold in a more formal market, this would increase the incentive to cultivate them among farmers.

The soil analysis information and irrigation systems were associated with food insecurity. This means that assisting farming households with soil analysis and irrigation systems alone may not be enough to help them improve their yield and make a considerable living out of the indigenous

crops. Moreover, farming households might not translate the information correctly or purchase the additional nutrients the soil requires. This is in line with results from Ijatuyi *et al*. (2018) and Mutengwa *et al*. (2023), who found that emerging or smallholder farmers required additional assistance during production as they did not have adequate land or proper information to navigate through the different challenges that open-field production has. Furthermore, farmers commonly residing in rural and peri-urban areas also lack tools to sustain well-managed soils and sufficient water supply for domestic needs and irrigation. This may heavily reduce yields, although farmers may have received agricultural support through seeds, garden tools, and fencing (Naicker *et al*., 2023).

Table 6.5 further shows the analysis of indigenous crop factors that influence household food (in)security; however, it differentiates from Table 6.4 by showing the odds ratio, standard error and significance values for each category of the dependent value. This allows for a more in-depth analysis of how each independent factor relates to each food (in)security category in the dependent variable. Significant results are further discussed below.

Table 6.5: Extended ordered probit analysis marginal effects of factors associated with indigenous crops and household food security.

Categorical	Variables	Food Secure			Mildly Food Insecure			Moderately Food Insecure			Severely Food Insecure		
		Odds Ratio	Standard Error	$p > z$	Odds Ratio	Standard Error	$p > z$	Odds Ratio	Standard Error	$p > z$	Odds Ration	Standard Error	$p > z$
Indigenous Crop Access	Own Garden	Base											
	Cultivated Lands	0.003	0.031	0.913	0.004	0.041	0.913	−0.003	0.027	0.913	−0.005	0.045	0.914
	Collection from wild velds or forests	0.057	0.043	0.189	0.055	0.038	0.148	−0.051	0.037	0.171	−0.061	0.044	0.169
Consumption of Indigenous Crops	Yes	Base											
	No	−0.094	0.024	0.000 ***	−0.217	0.082	0.008 ***	0.047	0.032	0.140	0.265	0.125	0.034 **

Farming Period	Under 4 years	Base											
	4 to 10 years	0.088	0.024	0.000 ***	0.190	0.056	0.001 ***	−0.053	0.022	0.015 **	−0.225	0.073	0.002 ***
	10 to 20 years	0.103	0.031	0.001 ***	0.204	0.058	0.000 ***	−0.067	0.028	0.019 **	−0.241	0.075	0.001 ***
	>20 years	0.111	0.035	0.002 ***	0.210	0.059	0.000 ***	−0.073	0.030	0.014 **	−0.247	0.076	0.001 ***
Perception of Indigenous Crops	Old women	Base											
	Old men	0.000	0.018	0.983	0.001	0.064	0.983	0.000	0.013	0.983	−0.001	0.069	0.983
	Young men	0.197	0.096	0.041 **	0.216	0.049	0.000 ***	−0.221	0.087	0.011 **	−0.192	0.052	0.000 ***
	Everyone	0.139	0.034	0.000 ***	0.201	0.048	0.000 ***	−0.166	0.039	0.000 ***	−0.175	0.046	0.000 ***
Required Assistance	Seeds	Base											
	Garden Tools	−0.012	0.046	0.789	−0.015	0.059	0.804	0.012	0.045	0.791	0.015	0.060	0.802
	Fencing	0.046	0.044	0.295	0.037	0.030	0.212	−0.043	0.040	0.282	−0.040	0.033	0.228
	Soil Analysis	−0.084	0.023	0.000 ***	−0.211	0.081	0.009 ***	0.059	0.236	0.012 **	0.236	0.107	0.028 **
	Irrigation	−0.093	0.023	0.000 ***	−0.279	0.119	0.019 **	0.032	0.074	0.666	0.340	0.200	0.089 *
Indigenous crops' perceived marketing potential	Yes	Base											
	No	0.052	0.023	0.026 **	0.067	0.034	0.047 **	−0.050	0.024	0.041 **	−0.069	0.032	0.033 **
Indigenous crops' perceived marketing channels	Local Market Only	Base											
	Informal Market Only	−0.117	0.046	0.010 **	−0.131	0.090	0.146	0.114	0.047	0.015 **	0.134	0.086 *	0.120
	Formal Market Only	0.244	0.100	0.014 **	−0.031	0.047	0.511	−0.152	0.049	0.002 ***	−0.061	0.021 **	0.004 ***
	All market	−0.132	0.032	0.000 ***	−0.173	0.038	0.000 ***	0.126	0.031	0.000 ***	0.179	0.037 **	0.000 ***

Note: Dy/dx (odds ratio) represents the discrete change of variable from 0 to 1 (or 2….). HFIAS (Y) is the dependent variable and is represented by four levels, starting from food secure ascending to severely food insecure. *, **, ***: significant at 10%, 5%, and 1%.

As discussed above, farming households that did not consume indigenous crops were more likely to be food insecure. Table 6.5 additionally supports that by showing significant values and negative coefficients in the food-secure and mildly food-insecure categories. However, a positive odds ratio value and significant results can be observed in the severely food-insecure category. This means

those who do not consume these crops will likely be severely food insecure. This reiterates the importance of these crops in ensuring household food security.

Farming experience increased the likelihood of a household being food secure. This is shown through the positive odds ratio and significant results in the food-secure and mildly food-insecure categories. Mildly food-insecure households likely had slightly less farming experience than food-secure households. On the other hand, the moderately food-insecure and severely food-insecure households had negative odds ratios and significant results. This was expected as farming experience assists farmers in becoming better equipped in their practice and improving their ability to cultivate several crops. Additionally, experience in farming allows farming households to join cooperatives, allowing them to sell their produce in larger markets if combined with other farmers. These results also imply that increased farming experience may increase productivity, thereby contributing to household food security status.

Farming households who perceived older men and everyone as those who should consume indigenous crops were found to be more likely to be food secure or mildly food insecure, as observed through the significant values and positive odds ratio. This suggests that when farming households positively perceive indigenous crops, such as when everyone consumes them, it can improve household food security and possibly their livelihoods. Farming assistance in the form of soil analysis and irrigation equipment increases the likelihood of a household being food insecure. This is shown by the positive odds ratio and significant values in the moderately and severely food-insecure categories. These results also suggest that although farming households require assistance in the form of inputs to be successful in their chosen enterprises, training is also vital for improving overall yields as they may lack the information necessary to produce the required quality and yield within the resources they have. Regarding the marketing results, these results suggest that farmers can be more food secure when selling indigenous crops in formal instead of local and informal markets.

6.5 Conclusions and Recommendations

Improved production and increased variety of indigenous crops cultivated can significantly improve household food security. Greater awareness of these crops is still imperative in South Africa. Indigenous crops are vital because they can adapt to marginal conditions, can contribute to resilient agriculture and sustainable food systems, and are highly nutritious. This study aimed to

determine household food security status predictors related to indigenous crop factors among farming households. Gender, household size, and monthly income had a considerable likelihood of contributing to food security. The extended ordered probit model showed that perception, consumption of indigenous crops, farming period, and marketing of indigenous crops significantly influenced household food security. The lack of formal markets for indigenous crops contributes negatively to food security. Low market availability and lack of market knowledge and skills to form, run, or become part of a formal indigenous crop food chain contribute to challenges relating to the sale and purchase of them.

This study also concluded that consuming indigenous crops is associated with improved food security status. Farming households not consuming these crops may have severe food insecurity. Generally, male-headed households were found to be more food secure compared to female-headed households. Therefore, female-headed households were more vulnerable to food insecurity. There is a need for targeted programmes to assist and promote female participation in agriculture, particularly in cultivating indigenous crops. To attain the 2030 SDGs, particularly of zero hunger and food security, female- and youth-headed households should be included in the farming-related activities. Government, extension officers, and nutritionists must conduct training workshops to encourage households to grow, market, and buy diversified indigenous crops. Government and policymakers need to include indigenous crops in the national food and nutrition security policy and create formal markets for indigenous crops.

The study results are based on data collected in the KwaZulu-Natal province and may not be generalised as a standard view of all farming households nationally and internationally. There is a need to conduct similar studies across all nine provinces of South Africa. This study focused on food access as part of the elements of food security. Future studies need to include the nutrition element of food security.

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CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

Indigenous crops have the potential to play a vital role in improving the food and nutrition security outcomes of the farming and generally all South African households. Increasing the cultivation and incorporating indigenous crops into household farming systems can alleviate poverty for vulnerable households. With government interventions to stabilize marketing channels for indigenous crops, farming households can be incentivized to cultivate and sell them, thus, improving household income. The main objective of this study was to assess the interaction between household food security and indigenous crops to improve household food security among farming households. The specific objectives were to examine the factors affecting the consumption of indigenous crops; investigate the factors affecting market channel and food form selection of indigenous crops and analyse the association between socio-economic factors, indigenous crops, and its contribution to household food security. The study was conducted in the KwaZulu Natal province of South Africa across three districts: EThekwini, UMgungundlovu, and Harry Gwala. Data was collected among 260 farmers using simple random sampling.

Descriptive statistics, the Household Food Insecurity Access Scale (HFIAS), binomial logit, multinomial logit, bivariate probit and extended ordered probit regression models were employed to achieve the objectives. The research findings showed more female participation in farming than males. However, female-headed households were more vulnerable to household food insecurity. Farming households had a higher number of older farmers, with ages greater than 65 being prevalent, followed by ages of 35 to 44 years. High unemployment rates and dependency on social grants also characterized households. This was also shown through 34.2% and 36.2% being found to be mildly and moderately food insecure. The research from the study and literature showed that socio-economic factors play a significant role in the consumption and selection of marketing channels for indigenous crops. The study's results also showed that farming experience, farm size and number of males positively influenced food form selection among farming households with a low number of households selecting to sell indigenous crops as processed.

The study revealed that there was an association between socioeconomic factors and household food security. There was also a significant association with indigenous crops perceptions, consumption, marketing potential and household food security. The findings from the study further indicated an increase in the number of farming households consuming indigenous crops. However, although an increase in consumption of these crops increased the likelihood of household food security, the production of these crops is still low.

7.2 Conclusions, Recommendations and Policy Implications

The study provided empirical evidence of the interaction between indigenous crops and household food security among farming households in KwaZulu Natal. The study provided the following conclusions, recommendations and policy implications on each objective;

The first objective was to determine the factors affecting the consumption of indigenous crops. The study concluded that the consumption of indigenous crops increased the likelihood of being food secure. Furthermore, it was concluded that when households have more children, there is a great need to secure nutritional food, and caregivers (mainly female headed households) turn to indigenous crops. Hence, the study recommended a need to train and educate farming households about the potential benefits of growing a wider variety of indigenous crops. The cultivation of varied indigenous crops is likely to increase farmer income and food security. This can be accomplished by assigning indigenous crop-based interventions to community-based workers and extension practitioners. In addition, careful development and implementation of government programs and extension services are required to empower female-headed households, particularly active in farming.

The second objective of the study was to investigate the factors affecting market channel and food form selection of indigenous crops. The study concluded that farming households perceived indigenous crops as not easily marketable and associated them with being largely consumed by young males. Additionally, socio-economic factors play a significant role in the use and selection of marketing channels for indigenous crops. The decision regarding food form was also influenced by various socio-economic factors. Government and other stakeholders should encourage farming households to include indigenous crops in their farming systems when planning for the market by establishing official markets for these crops. Additionally, increasing funding opportunities for research into the potential of processing indigenous crops can increase the range of these products

offered to consumers in formal markets. Consequently, farming households may be inspired to explore the processing of indigenous crops.

The third objective of the study was to analyse the association between socio economic factors, indigenous crops and its contribution to household food security. The study concluded that limited exposure, knowledge, and farming skills towards the production of indigenous crops contributed to the vulnerability of farming households to food insecurity. It was also concluded that increasing access to indigenous crops through formal markets may improve the farming households' food security status. The study recommended in order to encourage more farmers to cultivate indigenous crops, government and policymakers need to include indigenous crops in the food and nutrition security plans.

7.3 Study limitations & Future research

The study results are based on data collected in the KwaZulu-Natal province of South Africa and may not be generalized as a standard view of all farming households nationally and internationally. There is a need to conduct similar studies across all nine provinces of South Africa. Household food security has six dimensions. However, this study focused on food access as part of the elements of food security. Future studies need to also include the nutrition element of food security. There is a need to do further research on the supply chain of indigenous crops.

APPENDICES

Appendix A

Variance Inflation Factor (VIF) Tables

Table 1: Chapter Four Independent variables

Independent variables	Description	VIF	1/VIF
Number of children in household		1.430	0.697
Number of males in a household		1.600	0.627
Number of females in a household		1.700	0.589
Total monthly household income	0= R0 to R500 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= R2501 to R3500 5= R3501 to R4500 6= Greater than R4500	Base 3.650 4.190 3.690 2.280 3.090 3.900	Base 0.274 0.239 0.271 0.439 0.323 0.256
Education Level	0=None 1=Primary 2=Secondary 3=Tertiary	Base 3.720 4.510 3.100	Base 0.269 0.222 0.323
Monthly household food costs	0= R0 to R500 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= Greater than R2500	Base 2.850 2.870 2.200 2.010	Base 0.351 0.348 0.454 0.497
Farming Period	0= Under 4 years 1= 4-10 years	Base 2.870	Base 0.348

	2= 10-20 years 3= Greater than 20 years	2.530 2.740	0.396 0.365
Indigenous crop marketing potential	0= Yes 1=No	Base 1.080	Base 0.926
Mean VIF	**2.800**		

Table 2: Chapter Five Independent Variables

Independent Variable	Description	VIF	1/VIF
Number of males in household		1.590	0.631
Number of females in household		1.650	0.606
Number of children in household		1.240	0.809
Number of formally employed members		1.410	0.710
Number of casually employed members		1.420	0.706
Number of unemployed members		1.220	0.820
Total Household Income	0= R0 to R500 1= R501 to R1000 2= R1001 to R1500 3= R1501 to R2500 4= R2501 to R3500 5= R3501 to R4500 6= Greater than R4500	Base 3.060 3.630 3.110 2.000 2.600 3.330	Base 0.327 0.276 0.322 0.501 0.385 0.300
Education Level	0=None 1= Primary 2= Secondary	Base 3.710 4.640	Base 0.269 0.215

	3= Tertiary	3.130	0.320
Farming Period	0= Less than 4 years	Base	Base
	1= 4 to 10 years	2.810	0.356
	2= 10 to 20 years	2.820	0.354
	3= Greater than 20 years	2.860	0.349
Farm Size	0= Small	Base	Base
	1= Medium	1.480	0.675
	2=Large	1.750	0.571
	3= Very Large	1.170	0.853
Crop Use	0= Food	Base	Base
	1= Market	1.330	0.751
	2= Hobby	1.150	0.873
	3= Food+ Market	1.200	0.836
Indigenous Crop marketing Potential	0= Yes	Base	Base
	1= No	1.120	0.894
Mean VIF	2.260		

Table 3: Chapter Six Independent Variables

Independent Variables	Description	VIF	1/VIF
Indigenous crop access	0 = Cultivation from own garden	Base	Base
	1 = Cultivation from cultivated lands from other farmers/gardens	2.300	0.434
	2 = Collection from wild velds or forests	1.970	0.509

Indigenous crop consumption	0 = Yes 1 = No	Base 1.390	Base 0.719
Farming period	0 = Under 4 years 1 = 4 to 10 years, 2 = 10 to 20 years 3 = Greater than 20 years.	Base 3.200 2.790 2.840	Base 0.312 0.358 0.352
Indigenous crops' perception	0 = old women 1 = old men 2 = young women 3 = young men 4 = everyone	Base 1.890 - 1.600 1.830	Base 0.528 - 0.625 0.546
Required farm assistance	0 = Seeds 1 = Garden tools 2 = Fencing 3 = Shielding net 4 = Soil analysis	Base 1.610 1.460 1.220 1.100	Base 0.621 0.687 0.819 0.905
Indigenous crops' perceived marketing potential	0 = Yes 1 = No	Base 1.200	Base 0.831
Indigenous crops are a suitable marketing channel	0 = Local market 1 = Informal market 2 = Formal market 3 = All markets	Base 1.880 1.580 1.500	Base 0.533 0.635 0.666
Mean VIF	**1.84**		

Appendix B: Ethical Clearance Letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

22 June 2023

Nomfundo Shelembe (210505559)
School Of Agri Earth & Env Sc
Pietermaritzburg Campus

Dear N Shelembe,

Protocol reference number: HSSREC/00005365/2023
Project title: Assessment of the contribution of indigenous and traditional crops to household food security in rural South Africa.
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 27 February 2023 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted FULL APPROVAL.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 22 June 2024.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Appendix C: Informed Consent and Questionnaire

Dear Participant

My name is Nomfundo Shelembe. I am a PhD candidate studying at the University of KwaZulu Natal, Pietermaritzburg campus. The title of my research is the "Assessment of the contribution of indigenous crops towards household food security in South Africa". This research aims to compare the access to and consumption of indigenous crops and exotic crops, identify the challenges in the production of indigenous crops and cross examine the relationship between economic, social sustainability and food security in the context of indigenous crops. I am interested in interviewing you so as to share your experiences and observations on the subject matter. Please note that:

- The information that you provide will be used for scholarly research only.
- Your participation is entirely voluntary. You have a choice to participate, not to participate or stop participating in the research. You will not be penalized for taking such an action.
- Your views in this interview will be presented anonymously. Neither your name nor identity will be disclosed in any form in the study.
- The written record associated with the interview will be held in a password protected file accessible only to myself and my supervisors. After a period of 5 years, in line with the rules of the university, it will be disposed by shredding and burning.

If you agree to participate, please sign the declaration attached to this statement . I can be contacted at: School of Agriculture, University of KwaZulu-Natal, Pietermaritzburg Campus, Scottsville. Contact details; Email: 210505559@stu.ukzn.ac.za and cell number [redacted]. My supervisor and co-supervisor are Dr M. Ngidi & Prof T. Mabhaudhi who are located at the School of Agriculture, Pietermaritzburg Campus of the University of KwaZulu-Natal. Contact details: Email: ngidim@ukzn.ac.za & mabhaudhi@ukzn.ac.za. The Humanities and Social Sciences Research Ethics Committee contact details are as follows: University of KwaZulu-Natal, Research Office, Email: HSSREC@ukzn.ac.za, Phone number +27312603587. Thank you for your contribution to this research.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Part 1: Household Demographics

1. Respondent's location?

   _____

2. Name of respondent:

   _____

3. Gender of household head: Male ☐ Female ☐
4. Age of household head: _____ years
5. Marital status of household head: Single ☐ Married ☐ Widowed ☐
6. Number of household members: _____
7. Households consists of: Males_____, Females_____ and children <12 _____
8. What is the employment status of the household head? _____
9. What is the household head's monthly income?

   R0 to R500 ☐
   R501 to R1000 ☐
   R1001 to R1500 ☐
   R1501 to R2500 ☐
   Greater than R2500 ☐

10. How many individuals are formally employed in the household? _____
11. How many individuals are casually employed in the household? _____
12. How many individuals are unemployed in the household? _____
13. Total estimated monthly household income

    R0 to R500 ☐
    R501 to R1000 ☐
    R1001 to R1500 ☐
    R1501 to R2500 ☐

Greater than R2500 ☐

14. What is the educational level of the household head?

None ☐ Primary ☐ Secondary ☐ Tertiary ☐

15. Average time the household visits the clinic per month? _____

16. Indicate the primary expenses of the household and their cost per month.

Item	Estimated cost (Rands)	Give one key word to indicate the reason
Food		
Travelling		
School fees		
Support for others		

Part 2: Household Production

17. Do you practice farming? Yes ☐ No ☐

18. How long have you been farming:

Under 4 years ☐ 4-10 years ☐ 10-20 years ☐ >20 years ☐

19. What is the size of your farm:

Small ☐ Medium ☐ Large ☐ Very large ☐

20. Select the type of farming do you do and why

List	**List the commodities**	**Use (food; market; hobby)**
1. Crops		
2. Animal		
3. Forest		
4. Other		

21. Do you buy vegetables in supermarkets? Yes ☐ No ☐

22. List the five vegetables you purchase regularly in order of priority

List of vegetables	Score (5 highest; 1 lowest)	Reason (one word)

23. List five kinds of support you need for your farming activities

Item	Score (5 highest; 1 lowest)	Reason (one word)

Part 3: Indigenous crops nutrition, consumption and use

24. What is an indigenous crop? (Or list three key words)

1	
2	
3	

25. Do you consume indigenous crops? Yes ☐ No ☐

26. If No, why not?

27. If Yes, give three main reason why you consume them.

1	
2	
3	

28. How do you access indigenous crops?

Cultivation	
Collection from the cultivated lands	
Collection from the wild veld or forest	
Not applicable (if No to consumption)	

29. Why do you consume indigenous crops? (Please mark with an X)

Reason	**Mark**	**Rank in order of priority (5, highest; 1, lowest)**
Nutritional value		
Lack of food		
Readily available		
Tradition		
Other reasons Sate:		

30. List three main factors that affect the production of indigenous crops in your opinion and mark whether these factors affect availability and access indigenous crops

Factors	**Availability**	**Access**	**Other**

31. In your view, who are the people who should be consuming indigenous crops?

Category	**Mark (X)**
Old women	

Old men	
Young women	
Young men	
Everyone	

32. Do you think that indigenous crops can be easily marketed? Yes ☐ No ☐

33. If No, why not?

_____
_____
_____

34. If yes, why?

_____
_____
_____

35. How do you think indigenous crops could be marketed?

Strategy	**Score (5 highest; 1 lowest)**	**Reason (one word)**
Fresh		
Processed		
Where?		
Local markets		
Informal markets		
Formal markets		

Part 4: Household Food Insecurity Access Scale

Example:

In the past four weeks, did you worry that your household would not have enough food?

0 = No (skip to Q2) 1 = Yes

Occurrence Questions

1. In the past four weeks, did you worry that your household would not have enough food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
2. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
3. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
4. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	

5. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
6. In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
7. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	
8. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	

9. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? • If yes, how often did this happen? • 1 = Rarely (once or twice in the past four weeks) • 2 = Sometimes (three to ten times in the past four weeks) • 3 = Often (more than ten times in the past four weeks).	