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ADDRESSING FOOD AND NUTRITION SECURITY CHALLENGES AMONG THE FARMING HOUSEHOLDS IN LESOTHO: A CLUSTER ANALYSIS

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ABSTRACT

Food insecurity and malnutrition are a burden to global community and the solutions for addressing these challenges continue to be explored. There are causes, factors and consequences that are important in understanding the nature, extent and severity of food insecurity to inform interventions. The classification of households in accordance with relevant indicators would allow for adapting policy making to respond to specific needs and prioritizing the most vulnerable groups. Organising a targeted population into clusters is a valuable technique that enables a clearer understanding of the food and nutrition security situation. This approach also identifies the most vulnerable and informs the priorities of interventions. This study seeks to explore food and nutrition security clusters within farming households, and their respective demographic and agricultural characteristics. A k-means cluster analysis was employed and yielded three groups: food and nutrition secure, moderately food and nutrition insecure and severely food and nutrition insecure. The findings indicated that the food and nutrition secure households were small-sized (4.18), had higher incomes (LSL5960.00 (USD 380), produced agricultural commodities for commercial purposes and had obtained higher educational levels. They also have access to extension services and credit to purchase agricultural inputs. The moderately food and nutrition insecure group is characterised by a lower monthly income LSL2939 (USD188), with a larger household size (4.65) than the food and nutrition secure group, but less than the severely food and nutrition insecure group. The severely food and nutrition insecure households had the largest household size (5.67), lowest monthly income LSL1411.00 (USD90), produced mainly for own consumption and did not have access to extension services. A cluster analysis identifies key areas, showing the most vulnerable groups within the target group which benefits planning and development of interventions. This approach further indicates the strengths and vulnerabilities of these clusters, which facilitates programs that are specific to the needs.

Key words: Cluster analysis, household food and nutrition security, nutrition-sensitive agriculture

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INTRODUCTION

Food and nutrition security integrate the aspects of food security and nutrition security and highlights their relationship. This term is useful in highlighting the conceptual linkages particularly at the household and individual level [1, 2]. Climate change, political instability, conflict, wars and pandemics are among the challenges that hinder progress in enhancing global food and nutrition security in all its forms [3]. The COVID-19 pandemic and the Russia-Ukraine conflict caused crises in many of the world regions in relation to micro-economic and food security challenges. [4–6]. Food and nutrition security interventions were compromised when resources were diverted to address the COVID-19 pandemic, increasing nutritional vulnerabilities [6].

The importance of addressing the food insecurity and malnutrition challenges is reiterated by the United Nations' food security and nutrition targets in the Millennium Development Goals (MDGs) (2000 - 2015) and Sustainable Development Goals (SDGs) (2015 - 2030). SDG 2 speaks to ending hunger and ensuring access by all people, particularly people experiencing poverty and people in vulnerable situations, including infants, to safe, nutritious and sufficient food by 2030 [7]. The various challenges threaten the achievement of the SDG goals and targets, just as MDG goals and targets were not met [8].

The food and nutrition security concept is a complex and multifaceted phenomenon that needs a multidimensional approach to address it holistically [2,9]. Thus, interventions targeted towards tackling food insecurity and malnutrition will need more than determining the food and nutrition security status. An identification of homogenous groups within the target population and a more detailed description of the food and nutrition security clusters are needed for policy makers to respond accordingly.

A cluster analysis explores naturally occurring groups within a data set [10]. Cluster analysis could be adopted to understand the food and nutrition security groupings within a data set. It further complements the results of the food and nutrition security indicators by subsequently showing the characteristics of the identified groups, using the variables in the data [11,12]. The classification is based on the similarities observed in the households. This approach identifies the areas that need the most attention and sheds light on the different factors influencing the food and nutrition security situation. Cluster analysis has been used to segment and profile citizens according to their food security status, socio-economic variables and perception on the determinants of food security [12,13]. This approach identifies the areas that need the need the most attention and sheds light on the different factors influencing the food and nutrition security situation. This comprehensive depiction can inform

development of relevant plans that are meant to address specific needs within vulnerable populations [12,14].

Lesotho is a small, low-middle-income country landlocked by South Africa. It has a population of about 2.2 million. The nation is faced with widespread poverty rates throughout the country, especially in rural areas [15,16]. Half of Lesotho's population – 50% experiences poverty, while approximately 24% faces extreme poverty, living below the food poverty line. Persistent food insecurity continues to challenge Lesotho, hindering national development efforts and slowing progress toward achieving zero hunger [15].

Agriculture is a significant source of livelihood for 70% of the population residing in rural areas and contributes to 7% of the country's GDP [16,17]. The most significant (75%) total agricultural output comprises livestock and semi-intensive and intensive production of pigs, poultry (free-range), goats and sheep on rangelands in the foothills and highland areas. Sheep and goats dominate the livestock sector and are reared mainly for wool and mohair [16].

Lesotho's agricultural sector suffers from low levels of productivity and commercialisation, which has made the country heavily dependent on food imports to meet domestic consumption needs [17]. Productivity challenges in the sector include limited size of arable land, unfavourable farm structures, outdated farm technologies and farm management practices, limited technical expertise, sub-optimal use of inputs, lack of adequate irrigation and drainage system, a weak rural infrastructure, an undeveloped rural advisory system, and limited access to credit and investment capital. In addition, the country has experienced severe land degradation. Massive soil erosion and loss of scarce agricultural land have resulted in deficient agricultural productivity levels [16,17].

The country is vulnerable to extreme weather events, particularly floods and drought, which affect the productivity of agriculture. The country's development challenges are food insecurity, low agricultural productivity, modifiable disease outbreaks, and poverty. Lesotho is also experiencing a triple burden of malnutrition - high stunting, micronutrient deficiencies, overweight and obesity, across all age groups [15,17].

The government of Lesotho has introduced several interventions that include home and community gardens, nutrition clubs, block farming and commercialisation of agriculture to alleviate food insecurity and agriculture [17, 18, 19]. In the last decade, the agricultural sector has seen a vigorous transition from subsistence to commercial farming, as the high employment rate in the country is forcing citizens to seek other means of making a living. However, commercial farms are still relatively small, some of the farms are self-funded, while others depend on the government and its partners' support [18,19]. Despite these interventions, the prevalence of food

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insecurity and malnutrition is a persistent challenge. Therefore, the linkages between the food and nutrition security and agricultural factors must be further explored to enhance understanding of the food and nutrition security related vulnerabilities within farming households. The Lesotho Food and Nutrition Policy highlights the need for a multi-sectoral approach in addressing food insecurity and malnutrition. Thus, the study seeks to contribute to the approaches for addressing food insecurity and malnutrition by highlighting preliminary strategies that enhance relevance and effectiveness of interventions.

Statistically proven food and nutrition security indicators were employed to classify the surveyed farming households into homogeneous clusters. This will indicate the characteristics of the different clusters and supplement other food and nutrition security assessment methods to give a richer depiction of the unique food and nutrition security situation for the different clusters. The findings are valuable to stakeholders that seek to improve the quality of life of agrarian households. These will contribute to the advancement of policy strategies and inform the development of relevant interventions.

METHODOLOGY

Study area and population

The study focused on farming households in Lesotho who were accessed through extension workers. There are 10 districts in Lesotho, and the sample size was drawn from four districts of Lesotho: Mafeteng, Berea, Thaba-Tseka and Quthing. These four districts each represent one of the four agro-ecological zones in the country: Lowlands, Foothills, Mountains and Senqu River Valley, respectively [20].

The study adopted a quantitative approach and a sample size of two hundred and eighteen (218) respondents were randomly selected from four districts (Mafeteng, Berea, Thaba Tseka, and Quthing). This number was increased by 10% to derive 240 households to compensate for non-responses and reduce the margin of error. However, due to incomplete answers, four responses were excluded during data cleaning, and 236 questionnaires were ultimately used. The list of farmers was obtained from the extension officers in the respective districts. Household members responsible for meal planning and food preparation participated in the study to enhance the accuracy of food and nutrition security data collected. Microsoft excel was employed to facilitate random selection of the participants from the lists.

Data collection

Questionnaires were used to collect quantitative data at the respondents' homes or farms. The data collection tool was in Sesotho, the local language. The researcher and trained enumerators administered the questionnaire face-to-face to ensure a thorough understanding of the questions and minimise a low response rate. The

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respondents were asked to provide information on the socio-economic characteristics, agricultural production, food and nutrition security experiences and access to resources (land, credit, extension services, and markets). Standard questionnaires for Household Food Insecurity Access Scale (HFIAS), Household Dietary Diversity Score (HDDS), Minimum Dietary Diversity score for Women (MDD-W) and under-five children's dietary diversity score (CDDS) were used to collect data related to the food and nutrition security of the farming households. The data was used to describe the food security levels and living conditions of the farming households. Ethical clearance was sought from the University of the Free State Research Ethics Committee (UFS-HSD2021/1888/21).

Data analysis

Data were analysed using cluster analysis. This is a technique that classifies variables within a data set into groups. It categorises data on the basis of their similarities [10, 23]. The analysis sought to identify clusters that reflect differences in characteristics in order to describe features of the clusters. The clusters categorise the farming households into homogenous groups, using the food and nutrition security indicators, demographic and agricultural characteristics. The Statistical Package for Social Sciences (SPSS) version 28 was employed to conduct a k-means cluster analysis, resulting in three distinct food and nutrition security groupings, each characterized by unique differentiating factors. This analysis classifies data so that objects within a cluster share similarity while remaining distinct from those in other clusters. To measure the significance of differences between groups, the Pearson chi-square was used to assess differences in categorical variables, while AVOVA was employed to analyse the difference in means.

RESULTS AND DISCUSSION

Attaining household food and nutrition security is defined by a low Household Food Insecurity Access Score (HFIAS) [21], and characterized by a high Household Dietary Diversity Score (HDSS), under-five children's dietary diversity score (CDDS) and Minimum Dietary Diversity score for Women (MDD-W) [22]. Table 7.1 shows that cluster one has the lowest HFIAS (1.04) value and the highest HDDS (10.15), CDDS (3.22) and MDDW (3.85) values indicating that that particular cluster has the most food and nutrition secure households. The households in cluster two show signs of moderate food and nutrition insecurity as they have a slightly higher HFIAS (7.99), and slightly lower dietary diversity values with a HDDS of 9.45, CDDS of 2.59 and MDDW of 2.99. The last cluster has characteristics of severe food and nutrition insecurity. The HFIAS (17.33) is the highest among all clusters, with the lowest HDDS (7.38), CDDS (1.73) and MDDW (2.57). The differences between the clusters are statistically significant with a p-value of 0.00 for mean differences of all food and nutrition security indicators.

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The findings in Table 7.1 further show that the majority (59%) of the farming households are in the food and nutrition secure cluster, 32% are moderately food and nutrition insecure and 9% are severely food and nutrition insecure.

Household characteristics of cluster one (the food and nutrition secure cluster):

- The category has a mean household size of 4.18, which is the lowest among all clusters, and implies that they have less people to feed.
- The average monthly income from all sources is LSL5960.00 (USD380)[1], which is higher than that of all clusters and suggests that they have more economic access to procuring nutritious and varied diets.
- Most of the households in this cluster reside in Berea (30%) and Mafeteng (35%), and these are representative of the Foothills and Lowlands, respectively. It seems that residing in these two areas increases the likelihood for enhanced household food and nutrition security.
- The majority (65.7%) of households use gas for cooking and have the lowest frequency of households that use firewood (17.1%). Gas may afford these households the convenience to cook for short periods of time, compared to those that use fire, and allowing them to prepare diverse foods. Gas is also more expensive and therefore more likely to be used by wealthier households who are also more food secure.
- Marital status for the majority (72.1%) of the respondents is married.
- The cluster has the highest (23.6%) frequency of respondents, who had obtained tertiary education

Household characteristics of cluster two (the moderately food and nutrition insecure cluster):

- The households in this cluster have a mean household size of 4.65, which is slightly more than the food and nutrition secure cluster, but less than the severely food and nutrition insecure cluster.
- The household average monthly income is almost half LSL2939 (USD188)[2] of the food and nutrition secure cluster.
- Similar to the food and nutrition secure cluster, the majority of households in this cluster reside in Berea (33.3%) and Mafeteng (30.7%), with these are less than the frequencies in the food and nutrition secure cluster and the frequency of households that reside in Thaba-Tseka (highlands) is higher.

[1] Exchange rate (average) as on March to June 2022 – LSL 1=USD15.67 (https://www.exchangerates.org.uk/USD-ZAR-exchange-rate-history.html)
[2]Exchange rate (average) as on March to June 2022 – LSL 1=USD15.67 (https://www.exchangerates.org.uk/USD-ZAR-exchange-rate-history.html)

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- The majority (60%) of the respondents are married, but a lower proportion than those in the food and nutrition secure cluster, but higher than those in the severely food and nutrition insecure cluster.
- More respondents had obtained secondary (37.4%), high school (17.3%) and tertiary education (9.3%) than in the severely food insecure cluster.

Household characteristics of cluster three (the severely food and nutrition insecure cluster):

- The mean household size is 5.67 and is the highest among all clusters, which suggests that they have more people to feed, which can be a challenge when there are limited resources to acquire food.
- The household monthly average income is LSL1411.00 (USD90)[3] and is the lowest.
- The majority (42%) reside in Thaba-Tseka (highlands). The region is described by remote areas, limited access to facilities, high food prices and low affordability of nutritious foods [24].
- Most (81%) of the households in this cluster use firewood as fuel for cooking. The collection of firewood requires ample time and labour, which makes it inconvenient for food preparation. The cost of cooking fuels requires the economic ability of the households, so it is related to household income [25].
- The cluster has the highest frequency of respondents who are widowed (38.1%) and the lowest of those who are married (57.1%).
- The majority (57.1%) of households in this cluster have only obtained primary education, and has the highest (9.5%) frequency of those who have not been to school.

The findings on the three clusters are consistent with previous study findings. In Nigeria, food insecure households were characterized by low education level, large household size and low average income [26–28]. A study found that food secure households were characterized by higher education level, smaller household size and higher income in Cape Town Metropole (South Africa) [12]. In Northern Cape Province of South Africa, food insecurity was more prevalent among low-income households [29]. Household food security was influenced by education status and this was attributed to low education levels being associated to low income jobs, impeding the ability to procure healthy and nutritious food in Bantul, Indonesia [30], and Ghana [31].

In relation to agricultural characteristics, the food and nutrition secure group has more (83.6%) commercial farming households than the moderately food and

[3]Exchange rate (average) as on March to June 2022 – LSL 1=USD15.67 (https://www.exchangerates.org.uk/USD-ZAR-exchange-rate-history.html)

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nutrition insecure (74.7%) and severely food and nutrition insecure (38.1%). The differences among clusters are statistically significant. The frequency of subsistence farmers is higher (61.9%) in the severely food and nutrition insecure cluster, compared to the moderately food and nutrition insecure (25.3%) and food secure clusters (16.4%). The findings suggest that agricultural production that is meant for selling in the market, is associated with an enhanced food and nutrition security status at household level. In Tanzania, selling agricultural produce significantly improved income and food security [32]. Households that sold their agricultural produce in Kwazulu Natal (South Africa) had an increased likelihood of being food secure [33]. The findings of a study carried out in Kenya, Tanzania and Uganda, revealed that food secure farming households devoted their land to farming and were market-oriented [34].

The differences among clusters, in relation to the probability of being a beneficiary of an agriculture program, are statistically insignificant (p-value=0.13). It is becoming increasingly appreciated that agricultural interventions must not only focus on increased production, but be developed to also yield nutrition outcomes, which is termed as the nutrition-sensitivity of agriculture [35, 36]. Since nutrition-sensitive agricultural programs are still limited, this could explain the insignificant differences between the clusters.

The differences among the clusters, in relation to access to extension services, were statistically significant (p-value=0.004). The severely food and nutrition insecure cluster have the most (81%) households, who did not have access to extension services than the moderately food and nutrition insecure (74%) and the food and nutrition secure cluster having the least (54.3%) frequency of households, who did not have access to extension services. Thus, the food secure cluster has the highest frequency of households that had access to extension services and similar findings were established in South Africa [37] and Kenya [38]. Extension services are meant to educate farmers to increase their agricultural production and food security. It exposes farmers to new knowledge and technologies that improve agriculture yields and also combat production challenges [38]. In most developing countries, including Lesotho, agriculture is rain-fed, and this makes it vulnerable to drought and erratic weather occurrences [16,17]. Therefore, access to extension services can be associated with higher food production and enhanced food security, as farmers who have been capacitated, are likely to have higher yields.

Although the differences relating to the nutrition education received by the surveyed households are not significant (p-value=0.512), the food and nutrition secure cluster had the highest (32.9%) frequency of households, who had received nutrition education, compared to the moderately food and nutrition insecure (25.3%) and the severely food and nutrition insecure (28.6%). There are significant differences (p-

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value=0.006) in the awareness of the respondents on the problems associated with limited consumption of fresh fruits and vegetables. The food and nutrition secure cluster is more aware (56.8%) than the moderately food and nutrition insecure (56.0%) and the severely food and nutrition insecure (28.6%). Although the difference is not significant, the households that are more informed about practices and behaviors that improve nutrition, are likely to have an improved food and nutrition security status [39]. A study in Iran found that food and nutrition education and awareness are key to tackling food insecurity as it changes perceptions and improves nutrition behaviors and practices [40].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The surveyed households were clustered into three groups using food and nutrition security indicators. The groups were food and nutrition secure, moderately food and nutrition insecure and severely food and nutrition insecure. The food and nutrition secure cluster is characterised by a small household size, higher monthly household income, farming for commercial purposes, as well as respondents who are married and have higher education status. They also have access to extension services. They mostly live in Berea and Mafeteng.

The moderately food and nutrition insecure cluster has the second lowest household size, compared to the other two clusters and lower income, compared to the food and nutrition secure cluster. The households also have a lower average income and education level than the food and nutrition secure cluster, yet higher than the severely food and nutrition insecure cluster.

Households that experience severe food and nutrition insecurity have the largest household size, with the lowest monthly income and the majority of respondents have acquired primary education only. Their main source of fuel for cooking is firewood. They mainly farm for subsistence purposes and have limited access to extension workers. Majority of the farming households in this cluster reside in the highlands (Thaba-Tseka).

As depicted by the food and nutrition security clusters, there are different characteristics for the different groups. The interventions that seek to tackle food insecurity and malnutrition at household level may benefit from considering the identified areas and specified vulnerabilities. In addressing food insecurity and malnutrition, it is recommended that the target population be categorised into clusters that are informed by the food and nutrition security indicators. These will highlight areas that must be prioritized, and subsequently, relevant interventions should be designed for the specific needs of each cluster.

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Availability of data

Data will be made available upon reasonable request.

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Table 1: Cluster analysis for food and nutrition security indicators

	Cluster 1 (Food and nutrition secure)	Cluster 2 (Moderately food and nutrition insecure)	Cluster 3 (Severely food insecure)		
N	***140 (59%)***	***75 (32%)***	***21 (9%)***	**F Statistic**	
Food Security Indicators (means)	***Mean (Std dev)***	***Mean (Std dev)***	***Mean (Std dev)***		
HFIAS	*1.04 (1.41)*	*7.99 (2.27)*	*17.33 (3.31)*	*803.03**	
HDDS	*10.15 (1.40)*	*9.45 (1.95)*	*7.38 (1.86)*	*27.24**	
CDDS	*3.22 (1.06)*	*2.59 (1.27)*	*1.73 (0.47)*	*8.56**	
MDDW	*3.85 (1.44)*	*2.99 (1.19)*	*2.57 (1.27)*	*14.43**	
Demographics					
Number of people per household	*4.18 (1.95)*	*4.65 (1.86)*	*5.67 (1.39)*	*6.30**	
Monthly income	*5960 (5594)*	*2939 (2622)*	*1411 (912)*	*12.34**	
Education level				**Likelihood**	**Chi-Square**
Never been to school	*2 (1.4)*	*2 (2.7)*	*2 (9.5)*		
Primary Level (Grade R to 8)	*38 (27.1)*	*27 (36.0)*	*12 (57.1)*		
Secondary Level (Grade 9 to 12)	*40 (28.6)*	*28 (37.4)*	*4 (19.0)*	*23.24**	*21.66**
High School Level (Matriculated)	*27 (19.3)*	*12 (17.3)*	*3 (14.3)*		
Tertiary Qualification	*33 (23.6)*	*6 (9.3)*	*0 (0.1)*		
Districts					
Berea	*42 (30.0)*	*25 (33.3)*	*1 (4.8)*		
Mafeteng	*49 (35.0)*	*23 (30.7)*	*5 (23.8)*	*13.71**	*12.56**
Quthing	*22 (15.7)*	*10 (13.3)*	*6 (28.6)*		
Thaba Tseka	*27 (19.3)*	*17 (22.7)*	*9 (42)*		
Employment Status					
Employed	*18 (12.9)*	*6 (8.0)*	*0 (0.0)*		
Self Employed	*74 (52.9)*	*41 (54.7)*	*11 (52.4)*		
Pensioner	*13 (9.33)*	*6 (8.0)*	*2 (9.5)*	*10.1*	*7.6*
Business Entrepreneur	*5 (3.6)*	*1 (1.3)*	*0 (0.0)*		
Unemployed	*30 (21.4)*	*21 (28.0)*	*8 (38.1)*		
Marital Status					
Married	*101 (72.1)*	*45 (60.0)*	*12 (57.1)*	*12.3***	*12.1***

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Divorced	*5 (3.6)*	*7 (9.3)*	*0 (0.0)*		
Widowed	*20 (14.3)*	*16 (21.3)*	*8 (38.1)*		
Single	*14 (10.0)*	*7 (9.3)*	*1 (4.8)*		
Agricultural characteristics				**Likelihood**	**Chi-Square**
Type of Farming					
Subsistence	*23 (16.4)*	*19 (25.3)*	*13 (61.9)*	*18.32**	*21.38**
Commercial	*117 (83.6)*	*56 (74.7)*	*8 (38.1)*		
Agricultural Program beneficiary					
Yes	*35 (25.0)*	*10 (13.3)*	*4 (19.0)*	*4.08*	*4.29*
No	*105 (75.0)*	*65 (86.7)*	*17 (81.0)*		
Access to resources					
Access to extension services					
Yes	*64 (45.7)*	*20 (26.0)*	*17 (19.0)*	*11.50**	*11.09***
No	*76 (54.3)*	*55 (74.0)*	*4 (81.0)*		
Access to credit					
Yes	*26 (18.8)*	*9 (12.3)*	*3 (14.3)*		
No	*114 (81.2)*	*66 (87.7)*	*18 (85.7)*	*1.55*	*1.60*
Farm Land Ownership					
Owned	*127 (90.7)*	*71 (94.7)*	*18 (85.7)*	*2.51*	*2.78*
Rented	*11 (7.9)*	*3 (4.0)*	*2 (9.5)*		
Communal	*2 (1.4)*	*1 (1.3)*	*1 (4.8)*		

Levels of significance. 0.05, 0.01** 0.001****

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