***Original Research Article***

**Effects of Resilient Agro-Pastoral Production on Food Security in arid and semi-arid regions of Baringo County- Kenya**

**ABSTRACT**

Arid and Semi-arid zones cover 45.4% of the land surface of the earth, support 36% of the global population in which 90% of them live in developing countries. However, these zones have been characterized by varied levels of food insecurity corresponding to varied levels of environmental variability and related agro-pastoral production. These characteristics have called for improved production of food; or more specifically resilient food production. The objective of this study was to assess the effects of resilient agro-pastoral production on food security. The study was based on a survey research design conducted in three locations of Baringo County, namely: Emining, Salabani and Loboi locations. The population of the proposed study was 3267 households distributed across the three locations. Using Yamane (1967) formula for small population and the table by Krejcie & Morgan, (1970), a sample size of 351 was required. Key data collection method was a structured questionnaire supplemented by Focus group discussion and Key informant guide. Data was analyzed using descriptive statistics and linear regression analysis. Results evidenced that all the indicators of resilient agro-pastoral production had a statistically significant and positive relationship with food security. Surprisingly, some of the agro-pastoral practices had even much greater impact in enhancing food security: Crop spacing (R2=34%), weeding (R2=27%), Fast maturing crops (R2=19%), drought resistant crops (R2=17), and improved livestock breeds (R2=17%) and use of machines (R2=17%), all of which were significant at probability of error less than 0.001. The study concludes that resilient agro pastoral production can improve food security by enhancing the adoptive capacities of agro-pastoralists. The study recommends the need to adopt resilient agro pastoral production system that address environmental shocks to promote food security in arid and semi-arid regions.

**KEYWORDS: Agro-Pastoral Production,** **food security,** **global population,** **semi-arid regions**

**INTRODUCTION**

Sub-Saharan countries depend on agriculture as the primary driver of their economies. It is the leading Gross Domestic Product (GDP) contributor in this region. It also provides livelihoods and subsistence crops for a significant proportion of the African population (Hailu, 2024; Maiga, 2024; UNEP, 2003). Sithole & Olorunfemi (2024), Salifu et al. (2010) and World Bank (2008), observe that most people in sub-Saharan Africa live in rural areas and depend on agriculture for survival and livelihoods. Therefore, agriculture is a fundamental instrument of improving food security, securing livelihoods, and reducing poverty ( Fitawek & Hendriks, 2024; Ochola, 2007; Salifu et al., 2010 ).

Approximately 100 million farmers in Africa live in an agro-pastoral system and over 50% of them are categorized under absolute poverty (Bekele et al., 2021; Mohamed, 2019). The agro-pastoral system of farming is characterized by poor soil conditions and drylands conditions (Lawrence et al., 2023; Salifu et al., 2010). Drylands covers 60% of land surface in East and Horn of Africa (EHOA); where 83% are dryland zones in Kenya, 67% in Ethiopia and 42% in Uganda (FAO, 2021; IPC, 2020; Kinyua, 2004). Available reports indicate that approximately 34% of Kenyans depend on drylands for their livelihoods and socio-economic development (Barrow & Mogaka, 2007; KNBS, 2018).

Right to adequate food has been addressed at various levels and times. Article 25(1) of the United Nations Universal Declaration of Human Rights (UDHR 1948) stated that "everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing...” Further, Article 11 of the International Covenant on Economic Social and Cultural Rights (ICESCR) stated that everyone has the right to be free from hunger. Accordingly, UN and member states are pursuing SDG 2, to address reduction of (or ending) hunger. In addition, the African Charter on Human and Peoples’ Rights implicitly recognizes the right to adequate food. The constitution of Kenya (2010) section 1(c) state that it is the right of every person “to be free from hunger and to have adequate food of acceptable quality.”

Although considerable attention has been given to improved production of food, food insecurity continues to be a challenge in the drylands; particularly among the agro-pastoralists and pastoralists communities in SSA, and the EHOA (Gujo et al., 2025; Safari et al., 2022). The increase of environmental variability, particularly the frequency of droughts, has also been accompanied by increase of food insecurity, poverty and socio-economic deprivation. Available reports indicate that whenever there is a drought 13% to 15% of people in dryland zones sink into food insecurity and poverty (KIPPRA, 2020; KNBS, 2018). By 2021, 37% of the people in drylands of Kenya experienced food insecurity; in which 14% (equivalent to 2.1 million) experienced severe food deficiency (IPC, 2021).

Agricultural production is required to keep pace with increasing population and related demand, address the gap between production and demand, and to address food insecurity (Cirelli et al., 2009; FAO, 2014; Lebdi, 2016). Accordingly, consideration has been given to resilient agricultural production (RAP), considered to be necessary in developing countries particularly in dryland regions (Altieri, 2002; Braimoh, 2020; FAO, 2002; Lebdi, 2016; Sawicka, 2019; Uphoff, 2002). Key elements of the resilient agricultural production include mitigation to withstand adverse environmental conditions, enhanced recovery from environmental variability, to promote adaptability to address long term adverse environmental conditions and a transformation to increase productivity (Amede et al., 2023; Pret et al., 2025)

Available reports indicate that resilient agro-pastoral production is a promising solution for addressing food insecurity in Arid and Semi-Arid areas. However, the various strategies that promotes resilient agro-pastoral production in ASAL areas remains largely under explored. Therefore, this study investigated the influence of resilient agro-pastoral production in enhancing food security and presented the necessary measures to address food insecurity. The dryland zones of Baringo County provided an opportunity to assess the potential impact of resilient agro-pastoral production on food security particularly among the agro-pastoralists communities. The findings of this study will shed light on the significance of resilient agro pastoral production in the arid and semi-arid regions of Kenya; particularly with increased frequency and intensity of environmental variability.

**METHODOLOGY**

**Study Site**

**Baringo County- Kenya**

The study was carried-out in three locations of Baringo County in Kenya. Baringo County is one of the 47 Counties in Kenya located in Central Rift Valley Region. The County is divided into six (6) sub-counties (administrative units) namely 1) Eldama Ravine, 2) Mogotio, 3) Baringo South, 4) Baringo Central, 5) Baringo North and 6) Tiaty (East Pokot); each with 4 or 5 Wards with a number of locations. Baringo County borders Turkana and Samburu Counties to the north, Laikipia to the east, Nakuru and Kericho to the south, Uasin-Gishu to the southwest, and Elgeyo-Marakwet and West Pokot to the west. (Baringo County Government, 2023; Pepela, 2019)

Baringo County has typically been classified as arid and semi-arid region. Most parts of the Mogotio Sub-County, Baringo Central, Marigat, Baringo North and Tiaty (East Pokot) are generally low-dryland zones. Rainfall varies from 1,000mm to 1,500mm in the highlands to 350mm to 600mm per annum in the lowlands. Medium and highlands are categorized as 1) Agro-Alphine, 2) High Potential, 3) Medium Potential agro-ecological zones (AEZ) and the low lands are categorized as 4) Semi-Arid, 5) Arid, 6) Very arid based on topography (landform), average rainfall, soil texture, average temperature and adequate moisture for the growth of the agricultural crops. The lowland sub-counties of Mogotio and Marigat, receive relatively low amounts of rainfall (MoALF. 2017; Ochieng, 2017).

Baringo County was chosen in this study because the County is largely arid and semi-arid hence susceptible to environmental variability which affects food production. Further, the rural population in Baringo County mainly depend on livestock rearing and crop farming thus providing an opportunity to understand the factors affecting agro-pastoral production systems (Githu, D.W., et.al 2022). Given these situation, a study in this County is essential in providing lessons on the role of resilient agro-pastoral production in promoting food security. Specifically, the study was carried-out in three ASAL locations, namely 1) Emining location 2) Ilchamus (Salabani) location and Loboi Location. This is presented in 1 below

**Table 1: Population of the study Area**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Location** | **Population**  | **Households**  |
| 1 | Emining  | 18,221 | 1875 |
| 2 | Salabani  | 18,191 | 520 |
| 3 | Loboi  | 14,685 | 872 |
|  | **Total**  | 51,097 | 3267 |

Source: KNBS 2019 & Baringo ICDP 2018-2022

**Sampling techniques and sample size**

**Representative Sample**

A sample size is the fraction of the population representing all characteristics of the population members. A representative sample must reflect the size and characteristics of the population. This study targeted a population of 3267 households with a desired probability of confidence i.e. 95% or 99%. (Fisher, 1925; 1954; Yamane, 1967; Krejcie & Morgan, 1970; Cochran, 1963; 1977; Hinkley, 1980; Cohen, 1988). In view of this requirement, the sampling procedure for the sample size was based on the corresponding margin of error (1% or 5%) and probability of precision or confidence (95% or 99%). Most studies in social sciences adopt these criteria. Therefore, this study adopted a probability of precision or confidence of 95% and thus a possibility of error of 0.05%.

Accordingly, the study used Yamane (1967) formula for determination of a sample size in respect to small or finite populations; at 95% probability of confidence and therefore 0.05%

Possibility of error; i.e. 

Use of this formula and the table by Krejcie & Morgan, (1970) resulted to a required sample size of 351. The table by Krejcie & Morgan, also recommends sample sizes for different population levels at 95% confidence level or an inverse of 0.05 probability error.

**Distribution of Required Sample**

Determined sample of 351 was distributed to the three (3) locations in proportion to the population as follows;

**Table 2: Sample Size**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Location** | **Household** | **Percent** | **Required Sample** |
|  | Emining | 1875 | 57% | 200 |
|  | Salabani | 520 | 16% | 56 |
|  | Loboi | 872 | 27% | 95 |
|  | **Total** | **3267** | **100** | **351** |

**Sampling Method**

The study drew respective samples from the study location using systematic sampling method. The registers (lists) of the households in the three (3) locations and the distributed required sample formed the sampling framework for the study. Accordingly, the study secured the registers (lists) of the households in the three locations after which systematic sampling was carried-out based on the register (list) in each Location. Required sample drew every Kth (5 cases) until required sample was obtained in each location and added to 351.

**Research Instruments**

The instruments used to collect data was a structured survey questionnaire supplemented by key informant guide and focus group discussion guide.

**Incorporating Food security Indicator (Dependent Variable)**

It has been noted that the Household Food Insecurity and Access Scale (HFIAS), the Household Hunger Scale (HHS), and the Food Insecurity Experience Scale (FIES) have been used as the indicators of the food insecurity (deficiency). Accordingly, adapted structure of the Food Insecurity Experience Scale (FIES) was incorporated into the questionnaire. Food security was measured on the basis of availability of basic food, required food, preferred food and food with the required nutrition.

**Indicators of Resilient Agro-Pastoral Practices (Independent Variables)**

Resilient agro-pastoral practices was operationalized to include: improved livestock breeds, enhanced irrigation, enhanced soil fertility, management of crop pests, management of crop and animal diseases, use of machines for agro-pastoral production, adoption of innovations in farming, use of pesticides, harrowing, ridging, growing perennial crops, growing fast maturing crops, drought resistant crop varieties, crop spacing, weeding, mulching, growing fodder for livestock consumption, diversification of livestock breeds and effective storage after harvest.

**Reliability and Validity**

Issues of omissions, clarity, reliability and validity was addressed through a number of approaches; 1) adoption of well-established data collection instruments, 2) carrying out a pretest of the draft data collection instruments. A pretest was carried-out among 36 households in in the ASAL location of Lembus- Mogotio. The purpose of the pretest was to address omissions and greater insight on the issues related to food insecurity, clarity of the questions and responses, reliability and validity. The feedback informed few amendments on the questionnaire to improve the wording of the questions to enhance validity and reliability of the instrument. The study used indicators from authorities in the field namely FAO and IPC to ensure that the instruments measure what it purports to measure.

**Data analysis**

The study used both quantitative and qualitative approaches to analyze data. Thematic analysis and narrative were used to analyze qualitative data. Quantitative approaches used in this study include frequencies, percentage, measures of central tendency and linear regression model. The linear regression model formula used is Y= b0 + b1X1+ε

Where Y=Dependent Variable (Food Security)

 b0= Constant

 b1= Coefficients

X1= Independent Variable (Resilient Agro- Pastoral Production)

ε=Random error term

**RESULTS AND DISCUSSIONS**

**Food Security**

Respondents rated the availability of food in their household in the last three years on a scale of 1-5 Where 1=Always available and 5=severely limited access. The categories were; basic food, required food, preferred food, and food with required nutrition. The results are presented in the table below.

**Table 3: Availability of Food in the Household**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Food availability  |   1Always available | 2 Mildly Limited availability |  3Moderately limited availability |  4Extensively limited availability |  5Severely limited access (not available) | Total | Mean |
|  1 | Basic food  | 16.5 | 27.6 | 21.9 | 27.6 | 6.4 | 100 (351) | 2.8 |
|  2 | Required food  | 9.4 | 16.2 | 28.5 | 35.9 | 10 | 100 (351) | 3.2 |
|  3 | Preferred food  | 4.5 | 14.5 | 27.9 | 31.9 | 21.2 | 100 (351) | 3.2 |
|  4 | Food with required nutrition  | 2 | 12.3 | 26.5 | 39.3 | 19.9 | 100 (351) | 3.5 |

The mean for availability of basic food was 2.8 depicting that availability of basic food ranged between mildly limited availability to moderately limited availability. This means that about 50% of the respondents had challenges in accessing basic food. In terms of accessing required food, a mean of 3.2 was recorded demonstrating that accessibility of required food ranged between moderately limited availability to extensively limited availability. This data therefore points to a situation where more than 50% of the respondents were severely limited in accessing required food.

In terms of access to preferred food the mean was 3.2 which shows that more than 50% of the respondents did not have access to their preferred food. Further the mean on availability of food with the required nutrition was 3.5 evidencing that more than 50% of the respondents were extremely and severely limited in accessing food with the required nutrition.

**Resilient Agro-Pastoral Practices**

In establishing the effects of resilient agro pastoral practices on food security, the study first assessed the indicators of resilient agro-pastoral practices with the use of descriptive statistics and the results were summarized in the table below.

**Table 4: Resilient Agro-Pastoral Practices**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Agro-pastoral Practices**  | **Not Improved**  | **Occasionally improved**  | **Moderately improved**  | **Routinely/****Always****Improved**  | **Total**  | **Mean** |
| 1 | Livestock breeds | 60.4 | 12.3 | 12.0 | 15.3 | 100 (351) | **2.0** |
| 2 | Use of Irrigation  | 65.7 | 17.0 | 4.6 | 12.6 | 100 (351) | **1.7** |
| 3 | Use of fertilizers  | 25.9 | 22.2 | 4.9 | 47 | 100 (351) | **3.1** |
| 4 | Management of crop diseases | 45 | 36.6 | 4.6 | 13.8 | 100 (351) | **2.0** |
| 5 | Management of animal diseases | 21.6 | 36.9 | 36.6 | 4.9 | 100 (351) | **2.3** |
| 6 | Use of machines  | 48.2 | 21.0 | 10.4 | 20.5 | 100 (351) | **2.1** |
| 7 | Farming methods | 41.9 | 30.1 | 11.3 | 16.8 | 100 (351) | **2.2** |
| 8 | Use of pesticides | 41.7 | 34.4 | 2.9 | 21 | 100 (351) | **2.2** |
| 9 | Storage after harvest | 52.8 | 23.2 | 2.3 | 21.7 | 100 (351) | **2.1** |
| 10 | Diversification of agro pastoral production | 57.8 | 14.8 | 9.3 | 18.1 | 100 (351 | **2.0** |
| 11 | Harrowing | 37.7 | 33.0 | 15.9 | 13.3 | 100 (351 | **2.4** |
| 12 | Ridging | 31.3 | 31.0 | 18.3 | 19.4 | 100 (351 | **2.2** |
| 13 | Growing Perennial crops | 20.9 | 42.9 | 24.6 | 11.6 | 100 (351 | **2.4** |
| 14 | Growing Fast maturing crops | 43.5 | 28.4 | 13.9 | 14.2 | 100 (351 | **2.1** |
| 15 | Growing drought resistant crop varieties  | 53.6 | 23.5 | 2.0 | 20.9 | 100 (351 | **2.1** |
| 16 | Crop spacing | 19.4 | 36.8 | 17.4 | 26.4 | 100 (351 | **2.6** |
| 17 | Weeding | 10.2 | 23.3 | 15.7 | 50.9 | 100 (351 | **3.4** |
| 18 | Mulching | 25.9 | 37.5 | 23.0 | 13.7 | 100 (351 | **2.3** |
| 19 | Growing fodder for livestock | 38.6 | 23.3 | 10.7 | 27.4 | 100 (351 | **2.4** |
|  | **Average** | **39.9** | **27.7** | **12.2** | **20.2** | **100%** | **2.3** |

Results indicate that 67.6% of the households had not enhanced their agro pastoral practices and 20.2% had adopted some enhanced agro-pastoral practices. This was also consistent with the overall mean of 2.3 which indicates that majority of the households had never or rarely practiced enhanced agro-pastoral practices. Specifically, in terms of improvement of livestock breeds, just 15.3% of the households indicated that they always improve their livestock breeds. A majority of them have not improved their livestock breeds (72.7%), the overall mean on improvement of livestock breeds was at 2.0 evidencing that this practice was rare in the study area. Improvement of the local breeds has the potential of improving livestock production. This can be realized if dry land pasture production can be enhanced as well as establishment of livestock improvement centers.

Irrigation practices helps in supplementing rain fed agriculture, in this study a majority of the respondents do not practice irrigation regularly 82.7%) whereas only 12.6% of the respondents indicated that irrigation was a regular practice. Similarly, the overall mean on use of irrigation as an agro pastoral practice was at 1.7 which shows that this was not regularly practiced by the respondents. According to 47% of the respondents, use of fertilizers is a regular practice on their farms. Whereas another 48.1% do not use fertilizers on their farms. The overall mean on use of fertilizers in the study area was at 3.1 indicating that the use of fertilizers was averagely utilized by the respondents. Fertilizers have a potential of improving crop production. This therefore means that farmers that use the recommended amount of fertilizers, produce more compared to those that do not use fertilizers.

In terms of management of crop diseases, majority of the respondents did not practice it regularly (81.6%). Only 13.8% of the respondents indicated that they regularly managed crop diseases. The mean on management of crop diseases was at 2.0 which shows that it was not a regular practice by the respondents. In the management of animal diseases, most of the respondents did not regularly practice management of animal diseases (58.5) whereas only 4.9% of the respondents regularly managed animal diseases. The mean on management of animal diseases was at 2.3 painting a situation in which the practice was not often done. If crop diseases are not managed, then it will lower the crop yields hence contributing to food insecurity.

Results indicate that 20.5% of the respondents use machineries for agro pastoral production. In terms of those who did not use machines, the percentage stands at 69.2%. The overall mean on use of machines is at 2.1 which evidence that most of the respondents do not use machines on their farms. When farmers use machines, they can cover more land within a short period of time as opposed to farmers who have not mechanized their farming practices.

According to 21% of the respondents, application of pesticides is a common practice in their farms. Most of the respondents (76.1%) however indicated that they do not use pesticides on their farms. If crops are protected from pests, it is expected that the production would increase. The overall mean on use of pesticides as an agro pastoral practice stands at 2.2 evidencing that this is not a regular practice. Effective storage of harvested crops was regularly done by just 21.7% of the respondents, whereas 76% did not properly store their agricultural production. The average mean on effective storage after harvest is at 2.1 which clearly shows that farmers are having difficulties in properly storing their agricultural produce. A farmer could have a bumper harvest but incur post-harvest losses because of reasons such as: attack by pests, products being rained on, exposure to too much sunlight or even theft due to poor storage.

Diversification of agro pastoral production entails keeping different types of livestock and growing a variety of crops. However, only 18.3% of the respondents indicated that they keep different varieties of livestock and grow different types of crops. The majority (72.6) have not diversified their agro pastoral production as much. The mean on diversification of agro-pastoral production is at 2.0 evidencing that this practice was not common. It is expected that if farmers diversify their livestock, productivity and profitability will increase. Just 13.3% of the respondents indicated that they regularly practised harrowing. While a majority (70.3%) of the respondents indicated that they hardly harrowed their farms before planting. The mean on harrowing is at 2.4 proving that the practise was not common among the respondents.

Results indicate that 19.4% of the respondents regularly practised ridging whereas most of the respondents (62.3%) reported that they don’t practice ridging. Further the mean on ridging as an agro pastoral practice was at 2.2 showing that a majority of the respondents did not practice it. According to Gan et al. (2013), ridging saves soil moisture within the root zone, improving the probability of crop survival during extended periods of dry spells and meteorological drought. According to this study, 11.6% of the respondents indicated that they have planted perennial crops. Whereas the majority 63.8% of the respondents indicated that they do not grow perennial crops. The overall mean on growing perennial crops was 2.4 evidencing that it was not practised by most of the respondents. Since perennial crops do not need to be replanted every year, they require less labour thus saving on cost.

Fast maturing crops are fast growing hence they get ready for harvest over short period of time. In this study, 71.9% of the respondents indicated that they do not plant fast maturing crops despite its potential in ensuring availability of food in the household. The respondents who regularly grew fast maturing crops were at 14.2%, depicting a situation which majority do not grow fast maturing crops. Further, the overall mean on planting fast maturing crop was at 2.1 evidencing that majority do not grow fast maturing crop varieties. When farmers plant fast maturing crops, they get more frequent harvest therefore improving food security in the household.

Drought resistant crop varieties are drought tolerant and can survive in drought prone areas. Results show that 77.1% of the respondents indicated that they do not grow drought resistant crops varieties. Whereas 20.9% indicated that they regularly grew drought resistant crop varieties. The mean was 2.1 evidencing that most farmers do not plant drought resistant crop varieties. Drought resistant crop varieties have a potential of ensuring availability of food in the households. Especially, with the study area being arid and semi-arid areas, drought resistant crops increase the chances of harvest by farmers hence improving food security in the households.

Crop spacing is practised by 26.4% of the respondents, whereas 56.2% do not put crop spacing to practice. The overall mean on crop spacing was 2.6 showing that most of the respondents did not space their crops. Crop spacing allows the leaves space so they can get sunlight. It also allows plants to spread their roots and access the necessary nutrients and water from the soil. Results indicate that 50.9% remove weeds as a regular practice. In terms of those who did not regularly practice weeding, the figure stood at 33.5% and the overall mean was 3.4. The figures evidence that the practice of weeding was above average. The high practice can be attributed to the negative effects of weeds whereby they consume nutrients, water and sunlight which ultimately reduces the crop yields.

Results evidenced that 13.7% of the respondents regularly practised mulching in their farms. This could be attributed to the role of mulching in preserving moisture in the soil. It’s therefore a practice that has the potential to improve productivity especially in arid and semi-arid areas. The figure of those who did not practice mulching was at 63.4% and the overall mean was 2.3. Therefore, despite mulching being a good agro pastoral practice, majority of the respondents did not practice it. Growing of fodder for livestock consumption was regularly practiced by 27.1% of the respondents. Growing of fodder plays a crucial role in providing feeds for the livestock, it also supplements the naturally available fodder like grass hence play a crucial role in meeting the year-round feed requirements of livestock.

With the region being largely arid and semi-arid, growing and storing of fodder can play a significant role in ensuring supply of fodder even in dry seasons. Fodder production has been found to improve food security (Ayuko et al., 2023). A similar study by ul Haq et al. (2023) indicate that sufficient and quality fodder has the potential to improve livestock production. Despite growing of fodder being beneficial in improving production, most of the respondents (61.9%) did not practice it. This is further evidenced by the overall mean of 2.4 depicting a situation that the practice of growing fodder was uncommon in the study area.

**Effects of Resilient Agro-pastoral Production on Food Security**

The main objective of this study was to assess the relationship between resilient agro-pastoral production and food security, particularly the effects of resilient agro-pastoral practices on food security. In view of this objective, the study examined the effects of resilient agro-pastoral practices on food security. Resilient agro-pastoral practices were assessed in a Likert scale of 1 to 5, where 1 reflected not improved, 2 occasionally improved, 3 moderately improved, 4 routinely improved, and 5 always improved.

Similarly, food security was assessed with a Likert scale of 1 to 5; where 1 reflected always available, 2) mildly limited, 3 occasionally limited, 4. Extensively limited and 5 severely limited (starvation and death). In view of the fact that both sets of the indicators were assessed with Likert scales, appropriate procedure to assess the effects of enhanced agro-pastoral practices on food security would be regression analysis.

The prediction (hypothesis) was resilient agro-pastoral practices would have significant effects on food production and food security; against the null prediction (hypothesis) that resilient agro-pastoral practices would not have significant effects on food production and food security. The criteria to reject the null hypothesis were two 1) the coefficient of effects greater than 3%, and 2) the probability of error less than 0.05, and which therefore maintained 95% level of confidence.

Regression procedure (method) was used to analyse the effects of resilient agro-pastoral practice on food production and food security; and to evaluate the hypothesis that resilient agro-pastoral practices had significant effects on food production and food security. Regression method used was particularly relevant because it provides estimate of five (5) key parameters 1) B coefficient reflected the specific effects of the agro-pastoral practice on indicators of food security, 2) R reflected the nature of the effects (relation), 3) R2 (square) reflected the percentage of the effects of the agro-pastoral practice on the indicators of food security, 4) F reflected the ratio o within and between variances, and 5) P reflected the probability of error of these estimates; whether or not they would have occurred by chance .

The results of the regression analyses were summarized in the table below.

**Table 5: Effects of Resilient Agro pastoral Practices on Indicators of Food Security**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Constant** | **B Coefficient** | **R** | **R 2** | **F** | **P** **Value** |
| 1 | Crop spacing | 1.191 | 0.433 | 0.584 | 0.341 | 177.386 | 0.000 |
| 2 | Weeding | 1.118 | 0.362 | 0.519 | 0.269 | 125.818 | 0.000 |
| 3 | Enhanced diversification of agro pastoral production | 1.729 | 0.296 | 0.465 | 0.216 | 94.247 | 0.000 |
| 4 | Drought resistant crop varieties  | 1.794 | 0.254 | 0.416 | 0.173 | 71.696 | 0.000 |
| 5 | Growing Fast maturing crops | 1.672 | 0.312 | 0.431 | 0.185 | 77.846 | 0.000 |
| 6 | Improved livestock breeds | 1.816 | 0.269 | 0.409 | 0.168 | 68.226 | 0.000 |
| 7 | Use machines for agro-pastoral production | 1.705 | 0.272 | 0.408 | 0.167 | 67.023 | 0.000 |
| 8 | Improved farming methods  | 1.790 | 0.249 | 0.358 | 0.128 | 50.584 | 0.000 |
| 9 | Management of animal diseases | 3.172 | 0.374 | 0.335 | 0.112 | 43.554 | 0.000 |
| 10 | Improved storage facility  | 1.893 | 0.213 | 0.326 | 0.106 | 40.248 | 0.000 |
| 11 | Use of Pesticides | 1.882 | 0.204 | 0.323 | 0.104 | 39.788 | 0.000 |
| 12 | Certified seeds | 1.608 | 0.185 | 0.316 | 0.100 | 38.151 | 0.000 |
| 13 | Growing Perennial crops | 1.806 | 0.221 | 0.266 | 0.071 | 26.110 | 0.000 |
| 14 | Ridging | 1.940 | 0.179 | 0.245 | 0.060 | 21.894 | 0.000 |
| 15 | Mulching | 1.879 | 0.197 | 0.234 | 0.055 | 19.790 | 0.000 |
| 16 | Enhanced Irrigation  | 2.645 | 0.187 | 0.226 | 0.051 | 18.473 | 0.000 |
| 17 | Use of fertilizer  | 2.657 | 0.187 | 0.224 | 0.050 | 17.978 | 0.000 |
| 18 | Management of crop diseases | 2.004 | 0.165 | 0.216 | 0.046 | 16.771 | 0.000 |
| 19 | Improved fodder for livestock  | 2.084 | 0.100 | 0.159 | 0.025 | 8.959 | 0.003 |

From the foregoing results, it will be noted that the effects coefficients were greater than 3% for virtually all the 19 indicators of resilient agro-pastoral practices on food production and therefore food security; and the probability of error for those coefficients were less than 0.05. More specifically, R2s(squares)for virtually all the 19 indicators of resilient agro-pastoral practices were greater than 3% and the probability of error for those coefficients were less than 0.05. In view of these observations and results, the null prediction (hypothesis) was rejected and the working hypothesis was accepted that resilient agro-pastoral practices would have significant effects on food production and security. This was the case in virtually all the 19 agro- pastoral practices.

Surprisingly, some of the agro-pastoral practices had even much greater impact. Crop spacing (R2=34%), weeding (R2=27%), Fast maturing crops (R2=19%), drought resistant crops (R2=17), and improved livestock breeds (R2=17%), use of machine (R2=17%), all of which were significant at probability of error less than 0.001. Others had modest impact such as improved farming methods (R2=13%), management of animal diseases (R2=11%), improved storage (R2=11%), use of pesticides (R2=10.4%) and Certified seeds (R2=10%); all of which were also significant at probability of error less than 0.001. Other agro-pastoral practices included growing perennial crops (7.1%), ridging (6%), mulching (5.5%), enhanced irrigation (5.5%); use of fertilizers (5.1%); management of crop diseases (4.6%) and growing of fodder (2.5%); all of which were also significant at probability of error less than 0.001.

Overall, the results evidence that resilient agro pastoral production has a significant and positive impact on food security. A related study by Tofu et al*.* (2023) in a research of agro-pastoral Communities in Ethiopia presented that in dry land zones that are affected by environmental variability, the adoptive capacity of agro-pastoralists has a potential to improve productivity and food security. Similarly, Scott et al. (2024) evidenced that food security can be enhanced among agro-pastoralist communities if their socio-economic capacity to overcome environmental shocks can be enhanced.

**CONCLUSION**

The study conclude that despite the effort that has been made to enhance availability of food, more than 50% of the households in the study area are not food secure. Results also evidenced that 67.6% of the households had not adopted resilient agro pastoral practices. This study established that all the indicators of resilient agro-pastoral production had a statistically significant and positive relationship with food security; these include fast maturing crops, drought resistant crops, improved livestock breeds, Crop spacing , weeding, use of machines, improved farming methods, management of animal diseases, improved storage , use of pesticides, growing Certified seeds, growing perennial crops, ridging , mulching , enhanced irrigation, use of fertilizers, management of crop diseases and growing of fodder; all of which were significant at probability of error less than 0.001. The study therefore recommends that agro-pastoralists in ASAL areas should adopt resilient agro-pastoral production practices to improve food security. Governments should also enact policies that supports adoption of resilient agro-pastoral production.

Consent

As per international standards or university standards, respondents’ written consent has been collected and preserved by the author(s).

Disclaimer (Artificial intelligence)- This is an original research article thus AI was not used for this study. Therefore we will go with option 1

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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