

Contribution of Agro-Pastoral Diversification to the Livelihood Outcomes of Households in South Kerio Basin, Elgeyo Marakwet County, Kenya

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Abstract

This study assessed the nature and effects of agro-pastoral diversification, in particular diversification into horticulture, on the livelihood outcomes in the South Kerio Basin, Elgeyo Marakwet County (EMC), Kenya, a semi-arid region. The study was a cross-sectional survey design with a mixed methods approach in three locations; Keu, Kibargoi and Arror. The study targeted 8,199 households, from which a sample of 383 households was determined using the Yamane (1967) formula. Statistical Package for Social Sciences (SPSS) V22 was used to generate quantitative data in terms of frequencies, percentages and multiple regression analyses. The study established that the average household land size was 3.4 acres, whereby 33 per cent of the land and 30 per cent of annual investments were deployed to horticultural production. A greater proportion of households incorporated horticulture into agricultural production between 2017 and 2019. The majority of households experienced minimum to moderate improvements in food, income security and socio-economic wellbeing as a result of diversifying into horticulture. Diversification into horticultural production significantly influenced livelihood outcomes at the probability level of error less than 0.001. The study concluded that horticultural production was an important livelihood activity for enhancing livelihood outcomes in the basin. The study recommends that the national and county governments promote horticultural livelihoods by reviewing policies and interventions that address agro-pastoral livelihoods and incorporate local socio-economic capabilities while involving households in the intervention process.

Key terms: Agro-pastoral diversification, horticultural production, household, livelihood outcomes, semi-arid region.

INTRODUCTION

The Arid and Semi-Arid Lands (ASAL) of East Africa stretch from Sudan through the northern part of Kenya, Somalia and Ethiopia and occupy approximately 70 per cent of the total land mass (Intergovernmental Panel on Climate Change [IPCC], 2023). The ecological-pastoral-agricultural zones in these ASALs are generally characterised by environmental vulnerability, low agricultural productivity and low livelihood outcomes (Emali, 2023; IPCC, 2023). In Kenya, approximately 84 per cent of the total land mass is classified as ASAL, stretching from the North-West to the North-East part of the country (Nyuma & Churu, 2022; Kalele et al., 2021; Birch, 2018).

It is characterised by low and erratic rainfall (between 0-700mm/year) and high temperatures reaching 40°C in some areas (Birch, 2018; Ministry of Devolution and Planning [MoDP], 2018). It is also characterised by inadequate natural resources and lower-income households (Lutta et al., 2023). In addition to climate-related factors, socio-economic factors such as population growth and migration, land privatisation and agricultural expansion drive many agro-pastoral households in the ASALs to diversify their livelihood sources for survival (Negash, 2021).

The Kerio River basin forms part of the ASAL in North-western Kenya and is defined by the Kerio River. The basin experiences intermittent droughts, which have resulted in increased loss of vegetation, low crop yields and environmental vulnerability, putting more pressure on household livelihoods and capacity to cope. It is also characterised by socio-economic deprivations related to poor infrastructure, loss of communal grazing land and land privatisation, communal conflicts and marginalisation (Ministry of Devolution and Planning [MoDP], 2018). The resultant low livelihood outcomes renders households vulnerable to food insecurity (Davies et al., 2024) and constant dependence on food aid (Mburu et al., 2017). In order to adapt to the changing landscape, households within the Kerio basin continuously diversify their livelihoods from traditional livestock and agricultural practices to new, improved and advanced productions (Ng'ang'a et al., 2020), both of which form important livelihood resources. A number of studies, such as Sewando (2022), Irungu et al. (2021),

and Iiyama et al. (2008), have reported positive effects of diversification into agricultural production on livelihood outcomes. These studies maintain that diversification into agriculture not only improved household livelihood outcomes but also improved innovations in addressing socio-economic and environmental vulnerabilities.

In the Kerio basin, studies such as Kirui et al. (2022), Chang'ach (2016), Kipkorir and Kareithi (2013), and Iiyama et al. (2008) indicate that diversification into agriculture revolves around the adoption of improved livestock breeds in addition to drought-resistant food and commercial crops, all of which enhance household capacity to reduce socio-economic vulnerability. However, these studies give limited attention to the specific nature and effects of agro-pastoral diversification into horticultural production on the livelihood outcomes among the agro-pastoral communities in the semi-arid regions. South Kerio basin, a semi-arid region, provided a unique opportunity to examine the relationship between agro-pastoral diversification into horticultural production and improved livelihood outcomes. The working hypothesis (H_1) was that agro-pastoral diversification will contribute to improved livelihood outcomes, against the null hypothesis (H_0) that agro-pastoral diversification has no contribution to improved livelihood outcomes.

LITERATURE REVIEW

The livelihoods of agro-pastoral households in the ASALs highly depend on the natural environment and are frequently affected by increased ecological and environmental vulnerabilities (IPCC, 2023; Kirui, 2022; World Food Program [WFP], 2021). However, a shift to agricultural-related livelihoods both on and off the farm could have positive impacts on outcomes. Studies among agro-pastoralists in the East and Horn of Africa [EHOA], such as Negash (2021), report that expansion of cultivation in the Awash semi-arid region of Ethiopia was perceived to be as a result of declining rangeland holdings, increasing population and shortage of water. Morton and Kerven (2013) also indicated diversification into agricultural production as emanating from migrations into areas with substantial rainfall for crop farming. According to Tefera (2013), grazing movements of the *Hamer* pastoralists in Ethiopia to areas inhabited by farming households, as

well as trade interactions, contributed greatly to their growing interest and skill in farming. Doyo et al. (2018) indicated that surplus labour occasioned by decreased livestock due to changing climate and social structures led the Ethiopian *Borana* to diversify into arable farming as a household coping mechanism.

Kenyan agro-pastoral households in arid and semi-arid areas almost entirely depend on rainfall for livelihoods (Food and Agriculture Organisation [FAO], 2022), while diversification towards agricultural livelihoods is attributed to climate change and variability, increased population growth, diminishing land sizes, and government-led development initiatives (Lutta et al., 2023; Doyo et al., 2018). Agro-pastoral households diversify their livelihoods to include agricultural farming in order to strengthen their resilience and cope with the changing natural ecosystem (Kirui, 2022). Maoncha et al. (2022), in a study on factors influencing diversification among agro-pastoralists in Laikipia County, Kenya, indicated that diversification was a response strategy by households against climate variability. Another study by Magembe et al. (2012) on agro-pastoralism in Transmara reports on diversification into agricultural-related livelihoods among the Maasai, Turkana and the Pokots as a communal adaptation strategy due to constant droughts, diminishing herd size and small-scale farming interventions from the government.

Specifically, agro-pastoral diversification into horticultural production has emerged as an important livelihood activity for households. It has created income opportunities for households and enhanced their resilience to unfavourable environmental shocks and risks associated with climate change (Bii, 2021). In the Sudan, *Halfa* agro-pastoral households adapted to irrigation cultivation to cope with persistent low outputs from livestock farming. In Kajiado and Narok Counties, Kenya, *Maasai* households diversified into vegetable farming for subsistence and commercial purposes.

Within the Kerio basin, evidence of diversification into horticultural farming was recorded as early as the 1980s (Liyama et al., 2008). Despite their traditional attachment to livestock, most households living in the basin cultivate horticultural crops along river banks (Davies et al., 2022; Caleb, 2020; MoALF, 2014). In line

with this study, Caleb (2020) indicated that since the pre-colonial periods, households within the Kerio basin used indigenous furrow irrigation systems to supply household food requirements, including during the dry season. Studies by Ostberg and Caretta (2017), Chang'ach (2016), and Kipkorir and Kareithi (2013) indicate that households diversify into farming in response to continued climate variability and risks and the expansion of irrigation cultivation in areas along the banks of the Kerio River.

The livelihood outcomes in ASAL areas are characterised by environmental vulnerabilities and low livelihood outcomes, manifested by high poverty levels and low levels of wellbeing. However, studies by Sewando (2022) and Makate et al. (2016) indicated that crop diversification within ASALs significantly enhanced households' crop productivity, income and food security and the ability to cope with environmental vulnerabilities. A study by Irungu et al. (2021) in Laikipia, Kenya, also indicated that households engaging in a variety of farm activities had higher income levels than those who relied only on livestock livelihoods. Studies by Kipkorir and Kareithi (2013) and Liyama et al. (2008) within the Kerio basin reported that diversified livelihood activities and adoption of alternative livelihoods such as irrigated farming and produce marketing considerably contribute to food accessibility and improved livelihood outcomes.

This study was guided by George Homans, Rational choice theory. In applying the theory to this study, agro-pastoral households were viewed as rational actors with scarcity of resources, environmental vulnerabilities and limited household assets. These influenced their calculation of utility, in which diversification into horticultural production was expected as the next best opportunity to achieve food and income security. Therefore, households pursued horticultural livelihoods in order to achieve the desired outcome, particularly their socio-economic wellbeing.

RESEARCH METHODOLOGY

A cross-sectional survey design was utilised and carried out in the South Kerio Basin of the EMC, Kenya. More specifically, the study focused on three locations, namely Keu, Kibargoi and Arror, because of the opportunities to assess agro-pastoral

diversification. The population of the study were all households in the three locations, and based on the 2019 Kenya National Bureau of Statistics Census [KNBS] Census, the overall population for the three (3) locations was 8,199 households with Keu 2,949 households, Kibargoi 2,886 households and Arror 2,364 households. The Yamane (1967) formula below was applied to figure out the sample size at a confidence interval of 95 per cent.

$$\text{Sample Size (n)} = \frac{N}{(1+N(e)^2)}$$

Accordingly, a representative sample of 383 was generated and proportional sampling was used to distribute the determined sample to the three locations, as shown in Table 1.

Table 1: Proportionate Distribution of the Sample Size

Locations	No. of households	Percent (%)	Sample size
Keu	2,949	36	138
Kibargoi	2,886	35	134
Arror	2,364	29	111
Total	8,199	100	383

An interview schedule was employed to gather quantitative data from household respondents. Purposive sampling was employed to pick respondents who were considered knowledgeable in agro-pastoral diversification for the Key informant interviews and focused group discussions. To generate descriptive and inferential statistics, the Statistical Package for Social Sciences (SPSS) program (version 22) was employed to analyse quantitative data. Multiple Regression statistical analysis was employed to analyse the effects of agro-pastoral diversification on livelihood outcomes. The livelihood outcomes were operationalised with three indicators, namely, improved food security, improved income security, and improved socio-economic wellbeing, all of which were assessed in terms of continuous response categories with scales of 1 to 4. The criteria for rejecting the null hypothesis (H_0) or accepting the

working hypothesis (H_1) was the probability of error being less than 0.05. The qualitative data was analysed thematically using an Excel Spreadsheet.

FINDINGS AND DISCUSSION

Household Land Ownership

The security of land rights is an important consideration when addressing agricultural production, related innovation, and progress. In order to understand the nature of agro-pastoral diversification, the study assessed the security of land tenure and land rights within the basin in terms of the ownership of the parcel of land that households were living in or cultivating. The responses were summarised in Table 2. Responses indicated that 49 per cent of the households had formal ownership of the land, 42.3 per cent had no formal allocation, and 8.7 per cent were on community land.

Table 2: Household Land Ownership

Type of land tenure	Frequency	Per cent
Own land	185	49.0
No formal allocation	160	42.3
Communal ownership	33	8.7
Total	378	100.0

The study indicated that most of the communal land within the basin had been subdivided into individual and family land and that households with formal land allocation acquired land rights after family land subdivision and/or through buying. Respondents and a

panel of FGD indicated that land inheritance by male offspring was the most common form of land acquisition. These responses were consistent with the previous MoDP (2018) report, which indicated that 52.5 per cent of the land owners in EMC had land title

deeds while 47.5 per cent did not have any title deeds or any form of registration, particularly within the basin where land has been largely communal. The report also indicated that main form of land ownership was informal and communal land ownerships. The MoALF (2017) reported that at least 63 per cent of households had either title deeds or allotment letters to their land, and 32 per cent owned land but lacked title deeds or any formal document. Ngotho and Kangu (2016) and Tefera (2013) made similar observations where it was established that land in agro-pastoral communities was mostly communally owned.

Household Land Size

The size of available household land was considered important in terms of the use of the land, options for improvement and viability (Kore, 2019; FAO, 2018). These studies reported diminishing land size generally and among agro-pastoral communities because of increasing population, inheritance and related subdivision, and environmental degradation. In view of these considerations, respondents were requested to indicate the size of land available for household use. Responses indicated that the average land size was 3.4 acres, with a range of 0.5 to 51 acres. Responses (Table 3) also indicated that 52 per cent of the households had between 1 and 3 acres of land, while 80 per cent of the households had less than five acres of land.

Table 3: Household Land Size

Scale	Total land size in acres	Frequency	Per cent
1	Less than 1 acre	17	4.4
2	1 and < 2 acres	83	22.0
3	2 and < 3 acres	97	25.5
4	3 to < 5 acres	105	28
5	5 to 7 acres	57	15.2
6	Above 7 acres	19	5.0
	Total	378	100

These responses support previous reports by EMC (2019) and Seroney (2019), which estimated that the land size in the Kerio basin stood at an average of 1.36ha (3.4 acres). Indeed, Seroney (2019) reported that 51 per cent of households in the Kerio basin had access to less than three acres of land. Accordingly, these results indicated that most households had access to relatively small land sizes.

Allocation of Land to Agro-Pastoral Production

In order to assess diversification, households were requested to indicate portions of their lands allocated

to three components of agro-pastoral production, namely livestock husbandry, cultivation of traditional subsistent crops and horticultural production. Responses (Table 4) indicated that out of an average of 3.4 acres, 1.04 acres were allocated to livestock production, 1.2 acres were allocated to traditional subsistent crops, and 1.1 acres were allocated to horticultural production. More specifically, responses indicated that, on average, 33 per cent of the available land was deployed to horticultural production, a clear indication of agro-pastoral diversification into horticultural production.

Table 4: Land Allocation to Household Agricultural Production

Statistics	Total land size (acres)	Land under livestock production	Land under traditional crop production	Land under horticultural production	Land under other uses
Minimum	.50	.00	.00	.25	.00
Maximum	51.00	45.00	6.00	8.00	4.00
Mode	2.00	.50	1.00	1.00	.00
Mean	3.41	1.04	1.2	1.1	.10

This finding reveals that overall, over two-thirds of the land available to the households was allocated to cultivation of the traditional crops and horticultural production. The small land holdings in the basin also had the potential to encourage the allocation of land for horticultural production based on the fact that seasonal horticultural crops such as vegetables provided households with more flexibility to generate household income. More specifically, households were compelled to convert land into short-term horticultural crops instead of traditional crops, which were harvested once a year. In addition, as livestock decreased, households were compelled to utilise the land for other income-generating activities. As reported by the lead farmer and an extension officer key informants, *'land within the basin consisting of the irrigation scheme was deployed largely for horticulture and other crop production. This land was initially forested land, which was later opened up for cultivation through the development of irrigation schemes and managed by the community.'*

These responses were consistent with reports from previous studies, such as Kipkemei (2020), which indicated that the introduction of cassava and sorghum in the 1920s opened up the basin for the production of other food crops and bananas using traditional irrigation furrows. Ostberg and Caretta

(2017) also reported that land in the Kerio basin was largely used for traditional and horticultural crop production. More specifically, MoALF (2014) indicated that 33 per cent of household land in the basin was allocated to traditional crop production, and 29 per cent was allocated to commercial crop production, which included, to a large extent, horticultural production. A study by Kirua et al. (2022) in the Kerio basin indicated that more than 50 per cent of the households had allocated land (including purchased land) to horticultural (mango) cultivation. Iiyama et al. (2008) also reported that infrastructural developments within the basin had enhanced household access to market opportunities and information, which led to the opening up of more land for horticultural production for commercial purposes.

Investment in Agricultural Production

Diversification into horticulture was also assessed in terms of the investment in the three components of agro-pastoral production. Responses (Table 5) indicated that households in the South Kerio basin had deployed more than 30 per cent of their annual investments to both traditional subsistent crops and horticultural production, and was consistent with the previous indicator of the acres of land deployed to three components of the agricultural production.

Table 5: Percent Annual Investment in Agricultural Production

Statistics	Livestock production	Traditional crops production	Horticultural production
Minimum	0	0	5
Maximum	70	85	80
Mode	20	30	30
Mean	20.56	31.23	34.41

Overall responses indicated that households had greater investments in agricultural production, particularly horticultural production. Indeed, the mean indicated a relatively higher (34.4%) investment in horticultural production, higher than that of livestock and traditional crop production. Investments in horticultural production mainly consisted of investments in the land (including land leasing), irrigation and inputs, including labour. These investments increased crop enterprise output volumes

and returns, thus raising household income and reducing poverty. The income was, in turn, used to expand and promote other agricultural enterprises in the household. However, respondents indicated that the level of returns depended on water efficiency and market access for produce by households. The study established that households with their own land had better and improved land and irrigation investments, probably due to secure land ownership and tenure. It was also established that while leasing land for

horticultural cultivation, households considered the duration of the lease to ensure positive returns to investment on land and irrigation investments. In accordance with these findings, King et al. (2017) indicated that adopting a commercial enterprise increased investment demands in the household. An extension officer key informant indicated that 'a water pump cost between KES 50,000-70,000. Only a few households owned a motorised water-pump'.

Ranking Sources of Household Income

Diversification into horticulture was also assessed by rating the highest source of household income among the three components of agro-pastoral production in the last three years. Responses (Table 6) indicated that horticulture production was ranked as the highest source of household income at 47 per cent, followed by the cultivation of the traditional subsistent crops at 38 per cent and livestock production was ranked the lowest source of household income at 15.7 per cent.

Table 6: Ranking Sources of Household Income

Type of production	Source of income			Total
	1=Lowest	2=Medium	3=High	
Livestock production	58.8(222)	25.5 (100)	15.7 (56)	100 (378)
Traditional crops production	27 (101)	34.8 (132)	38.2 (145)	100 (378)
Horticultural production	19.1 (73)	34.3 (130)	46.6 (175)	100 (378)

The results indicated that horticultural production contributed substantially to the total household income. In addition, the study attributed reduced livestock income to recurring cattle raids from neighbouring communities, the increased population within the basin that reduced open grazing fields, and continuous inbreeding of livestock, which resulted in low-quality animal breeds. This observation was consistent with the report by MoALF (2014), which indicated that the mean income for the households in EMC from crop productions was KES 84,661 as compared to the income of KES 31,437 from livestock productions and which indicated that households generated more income from crop farming. This could explain why households allocated small land sizes for livestock production and more land for crops (including horticultural) cultivation. A study by Ostberg and Caretta (2017) attributed increased

agricultural income to increased commercialisation of cash crops (majorly horticultural) and the introduction of new irrigation canals and soil amendments, especially the use of manure/fertiliser and crop residues.

Main Horticultural Crops

In order to have a greater understanding of horticulture in the South Kerio basin, households were requested to indicate the key household horticultural crop, and responses were tabulated in Table 7. The results indicated that mangoes (40%) were the predominant horticultural crops in the basin, followed by tomato (18%) and kale (15%). Diversification thus increased crop portfolio in a given area to expand production-related activities and spread risks, thereby increasing household options for food and income.

Table 7: Household Key Horticultural Crop

Type of horticultural crop	Frequency	Per cent
Mangoes	152	40.2
Tomato	69	18.1
Kales	56	14.7
Papaya	39	10.3
Banana	33	8.8
Melon	30	7.8
Total	378	100.0

A Ward administrator key informant indicated that *'mangoes were the first fruit trees to be introduced in the basin followed by citrus. Currently, households were also cultivating vegetables, especially tomatoes and kales, for income generation. Additionally, a mango processing plant had also been opened in Tot where farmers could sell their mangoes'*. These observations were also made by lead farmers' key informants. According to the respondents, mango was a preference for many households due to the economic potential of income generation and poverty reduction. At the same time, it was a good source of shade and enhanced other livelihoods, such as charcoal and firewood production. A household respondent indicated that in the 2022-2023 mango season, he generated KES 300,000 (USD 2,307) from mango production. The study established that the ranking of bananas as a source of income for households was relatively lower due to the fact that bananas were cultivated largely for household consumption despite being among the first crops to be introduced in the Basin (Kipkemei, (2020).

In other studies, Ostberg and Caretta (2017) reported that the expansion of mango production in the Kerio basin started as early as the 1980s, and almost all households in the basin owned a mango tree. The MoDP (2018) report indicated that in 2017-2018, EMC managed to dedicate 827ha to mangoes in the Kerio basin. Similarly, a study by Kirua et al (2022) reported that households in the basin considered mango farming as their primary occupation. The production of vegetables (mainly kales and tomatoes) for sale and household consumption varied widely between households. Knowledge on production and utilisation was usually disseminated by extension officers and from farmer to farmer.

Kales were especially considered high-value crops in terms of food availability and income security in the sense that households profitably produced kales on small household land sizes. Households cultivated tomatoes and kales up to three times in a year in the same field making them the highly produced vegetables within the basin. The study noted that this was partly because vegetables adapted very well under irrigation, with few plots cultivated during the rainy season. This suggested that the availability of

water was important for diversifying into a variety of horticultural vegetables.

The study also established that systematic diversification into horticulture was witnessed between 2014 and 2019. An extension service provider key informant reported that *'initially, households used farrow irrigation but the establishment of the irrigation schemes between 2012-2018 increased household access to water for irrigation resulting to more adoption of horticultural farming'*. Key informants and household respondents also indicated that improvements in irrigation infrastructure, market demand, and the introduction of improved technologies in fruits and vegetables were important factors in this diversification.

Nature of Livelihood Outcomes

The nature of livelihood outcomes was assessed with an adaptation of the IPCC/FAO scale of 1 to 4 on hunger and livelihood vulnerability to examine the adequacy of food, income and socio-economic security as a result of diversification into horticulture. Accordingly, three indicators of livelihood outcomes were assessed based on the experiences of the households in the last three years, namely adequacy of food security, income security and socio-economic security.

Improved Food, Income and Socio-Economic Security

The study considered enhanced food security as a critical indicator of livelihood outcomes. Food security entails food availability, accessibility, utilisation, stability and household purchasing power (FAO, 2018; Laibuni, 2020) and includes nutrition security. Income security was also considered an important livelihood outcome indicator. Income security relates to assured, adequate income to meet household basic standard of living or socio-economic wellbeing (Ortiz, 2018). Accordingly, respondents were requested to indicate their experience in the last three years on a scale of 1 for no improvement to 4 for enhanced/improved food, income and socio-economic security. Results are summarised in Table 8. While 40.2 per cent of the households in the South Kerio basin experienced minimal improvement in food security, 37.3 per cent experienced moderate improvement in food security. Responses also indicated that 47 per cent of the households experienced a minimal improvement in

income security, and 29 per cent experienced a moderate improvement in income security. In addition, 43 per cent of the households experienced moderately improved household socio-economic well-being, while 34 per cent experienced minimally improved household well-being.

Table 8: Experience in the Improvement of Livelihood Outcomes by Households

Scale for improvement		Food security	Income security	Socio-economic wellbeing
1	No improvement	48 12.7%	55 14.7%	52 13.7%
2	Minimal Improvement	152 40.2%	178 47.1%	130 34.3%
3	Moderate improvement	141 37.3%	109 28.9%	163 43.1%
4	Improved food security	37 9.8%	35 9.3%	33 8.8%
Total		378 100%	378 100%	378 100%

The responses on food security were consistent with the MoDP (2018) report, which indicated that 67 per cent of households in the Kerio basin continue to experience varied forms of food inadequacy. MoDP (2018) reported that while 45 per cent of the households have experienced improved food security, 55 per cent continued to experience seasonal food insecurity. Kipyego and Mugalavai (2019) reported that 31 per cent of the households in the basin had minimal improvement in food security, and 32 per cent reported moderate improvement in food security. Seroney (2019) also reported that choices of farm enterprises and related technologies improved food security by 36.2 per cent.

In addition, the responses on income security were consistent with existing reports by Kiptoo et al. (2023) and Chepwambok et al. (2021), which indicated that nearly a quarter of the households had experienced improved income security in recent years. The income generated contributed to greater improvement in socio-economic security by allowing households to purchase food and health-supporting goods and services. Bargarora et al. (2020) reported that the Kerio Valley Development Authority (KVDA) had opened up and supported seed nursery projects in the basin and had also constructed dams and water pans. Indeed, household respondents, key informants, and focus group discussants indicated that diversification into horticulture could potentially improve their household

income base by providing employment for more days as horticultural activities were labour-intensive. A respondent indicated that *'After retiring, I leased three acres of land with access to water where I cultivated papaya, besides mango and tomato farming. I generate about KES 100,000 from mango production and harvests 1,000 kgs of papaya per week. I used the income earned to buy land, start an agro-vet shop, and upgrade the water pump, build a modern house and educate my children up to university level. I also participate in community welfare activities such as fundraising'*.

The study established that despite declining livestock numbers and livelihoods, the range of assets, housing conditions, medical services, education and social networks had improved the socio-economic well-being of households in the basin, as indicated by 34 per cent and 43 per cent minimal to moderate improvement, respectively. From the study, improved socio-economic well-being was associated with new income from agricultural production, self-employment, new business start-ups, and irrigation investments. According to respondents and focused group discussants, increased production of crops increased food for household consumption and subsequent increase in income security through the acquisition of more assets such as land, farm inputs and farm investments. Respondents reported *using horticultural produce income to buy land*. A respondent, 39, reported that *"I rented out new land from my*

neighbours. Currently, I am using the land to cultivate maize and beans. The maize and beans provides food for my household and the surplus is sold to earn income. I plan to use this income to rent out another piece of land, which I will use for horticulture cultivation." Respondents also reported that the ability to own and access more land for farming, improved livestock, and mango orchards enhanced their socio-economic well-being. For instance, the ability to access more land increased food security in the household and good health. This strengthened their human capital base for the production of additional income.

The MoDP (2018) report indicated that by 2018, some households in the basin had increased their household socio-economic wellbeing by an average of 33 per cent. It also reported an increased enrollment rate in schools and a reduction in food insecurity within the basin. The KNBS (2019) also indicated that poverty in the Kerio basin was reduced by 13.1 from 57.3 per cent to 44.2 per cent. Chepwambok et al. (2021) indicated that nearly a quarter of farming households in the basin had experienced an improved ability to meet healthcare services. Part of the indicators included reduced morbidity and mortality rates, which had been reduced by nearly 30 per cent in the last three years. According to the Enhancing Nutrition Services to Improve Maternal and Child Health (ENRICH 2021),

while the national stunting rate stood at 26 per cent in 2021, the stunting rate stood at 35 per cent in the Kerio basin, which was an improvement of 25 per cent from 60 per cent in 2018. Similar observations made in KNBS (2021) reported that enrolment in schools had increased by 15 per cent in early childhood education, 17 per cent in transition to secondary education, and 9 per cent in transition to tertiary education.

Effects of Agro-Pastoral Diversification on the Livelihood Outcomes

An assessment of the effects of the diversification of agro-pastoral production, specifically diversification into horticulture, on improved livelihood outcomes was carried out against the hypothesis that diversification of agro-pastoral production improved livelihood outcomes. In this respect, diversification of agro-pastoral production was the independent variable, while improved food and income security and socio-economic well-being were the dependent variables. The regression coefficients in Table 9 indicated that agro-pastoral diversification influenced 31 per cent of the improved food security of the households in the South Kerio basin with the likelihood of less than 0.000 that such a conclusion would be wrong, and a probability level of error <0.001; much lower than the study criteria of 0.05.

Table 9: Effect of Agro-Pastoral Diversification on Improved Food Security

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	17.576	6	2.929	3.320	.000
Residual	39.599	45	.882		
Total	57.175	51			

R = 0.554; R Square = 0.307

In view of these results, the study rejected the null hypothesis (H₀) and accepted the working hypothesis (H₁) that agro-pastoral diversification influenced household food security. The study indicated that diversifying into horticultural cultivation was associated with a variety of fruits and vegetable crops, which contributed greatly to household food and nutrition requirements. In addition, these were sold to generate income to purchase other food requirements

that were not available in the household, thus ensuring household food security.

Similarly, as indicated in Table 10, agro-pastoral diversification influenced 56 per cent of the improved income security in the households and was significant at the probability level of error less than 0.001, which was much lower than the study criteria of 0.05.

Table 10: Effect of Agro-pastoral Diversification on Improved Income Security

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	32.162	6	5.360	9.346	.000
Residual	25.741	45	.574		
Total	57.903	51			

R = 0.745; R Square = 0.555

Based on the regression coefficients, $R = 0.745$; R Square = 0.555, the study rejected the null hypothesis (H_0) and accepted the working hypothesis (H_1) that agro-pastoral diversification influenced improved income security at the households with the likelihood of less than 0.000 that such conclusion would have occurred by chance. Accordingly, the study concluded that 56 per cent of the improved income security for households was influenced by agro-pastoral diversification. It was reported that diversification increased crop portfolio in the household, where a variety of fruits and vegetables were cultivated in addition to food crops. This ensured a continuous

supply of output and generation of revenue since crops matured at different times. It also improved the household income base by providing casual employment for household members, as horticultural activities were labour-intensive.

In addition, outcome on the effects of agro-pastoral diversification on the socio-economic wellbeing as shown in Table 11 indicated that agro-pastoral diversification influenced 39 percent of the improved socio-economic wellbeing of the households and was significant at the probability level of error less than 0.001; much lower than the study criteria of 0.05.

Table 11: Effects of Agro-Pastoral Diversification on Socio-Economic Wellbeing

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	25.175	6	4.196	4.818	.001
Residual	39.081	45	.871		
Total	64.256	51			

R= 0.626; R Square = 0.392,

Similarly, the regression coefficients, $R = 0.626$; R Square = 0.392, indicated that 39 per cent of the change in household socio-economic wellbeing was influenced by diversification into horticulture. In view of these observations, the study rejected the null hypothesis (H_0) and accepted the working hypothesis (H_1) that agro-pastoral diversification influenced improved socio-economic wellbeing of the households with the likelihood of less than 0.000 that such a conclusion would have occurred by chance. This concurred with the study findings, which indicated that diversification into horticultural production increased household livelihood options, which enhanced their income for household use and for acquisition of assets such as land and housing, thus contributing to poverty reduction and improving the socio-economic wellbeing.

Conclusion: In conclusion, a vast majority of households had diversified their livelihood options to include horticultural production. The small land-holding played a significant role in influencing household decisions on land use for horticultural production due to the seasonality of horticultural crops, which provided households with more flexibility for enhanced income. More specifically, households were compelled to convert the land into short-term horticultural crops, which they harvested up to three times a year. Diversification into horticultural production thus increased crop portfolio in a given area to expand production-related activities and spread risks, thereby increasing household options for food and income. Additionally, this resulted in varied levels of outcomes at the household level in relation to household income, food and nutrition security and socio-economic wellbeing, thus making it an important livelihood activity in the basin.

CONCLUSION AND RECOMMENDATIONS

Recommendations: The study recommends the need for development partners, National and County governments to partner and integrate with local communities in order to review policies that include ways of working with the community to identify locally available resources, how to integrate the resources in the development process and promote them for enhanced adoption of horticultural livelihoods. There is also the need to strengthen extension service delivery within the basin through public-private partnerships in farmer capacity building, identification of strategies and interventions that enhance access to households and financial support for irrigation and infrastructural development to enhance the use of technologies and practices related to horticultural production and marketing.

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