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Effect of Vertical Diversification on Sustainable Livelihoods among Fish Farmers in Kakamega County, Kenya

***Daisy Linda Wesonga Mukoya**
ORCiD: https://orcid.org/0000-0001-7055-9887
Department of Economics, Masinde Muliro University of Science and Technology, kenya
Email: daisy.mukoya@gmail.com

Consolata Ngala, PhD
ORCiD: https://orcid.org/0000-0003-3629-4947
Department of Economics, Masinde Muliro University of Science and Technology
Email: cngala@mmust.ac.ke

Edwin Jairus Simiyu, PhD
ORCiD: https://orcid.org/0009-0003-5383-5992
Department of Economics, Masinde Muliro University of Science and Technology, Kenya
Email: ejsimiyu@mmust.ac.ke

***Corresponding Author:** daisy.mukoya@gmail.com

Abstract: This study examined the effect of vertical diversification on sustainable livelihoods among fish farmers. The study employs descriptive and survey research designs to collect data from 350 randomly selected fish farmers across the 12 sub-counties in Kakamega County, Kenya. Findings indicate that vertical diversification, through value addition, processing, and packaging, significantly impacts sustainable livelihoods. The results demonstrate that vertical diversification contributes to income gains, physical asset accumulation and social capital growth. The study concludes that fostering vertical diversification strategies, improving access to financial services and promoting cooperative farming models can significantly enhance the livelihoods of fish farmers. These findings underscore the need for policy interventions to support rural economic diversification. The study further recommends improvement of farmers' access to financial services as well as promotion of cooperative farming for better outcomes.

Keywords: Vertical diversification; sustainable livelihoods; fish farming; value addition; microcredit.

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Introduction

Rural economic diversification, both within agriculture and into non-agricultural activities, has significant potential to reduce poverty, increase coping mechanisms in face of crop failure or price volatility and improve food and livelihood security of rural households, both regionally and globally (International Labour Office, 2019). While approximately 20 to 50 per cent of the rural population in Africa, Asia and Latin America is employed in non-farm work, a large share of the population continues to depend on agriculture for their livelihoods (Wahome et al., 2023). A dynamic agricultural sector should therefore be at the center of rural development strategies, creating better jobs in the sector and, at the same time, enabling the growth of non-farm activities in the rural economy. To secure the potential of economic diversification for poverty reduction and decent work, three main policy priorities are suggested: strengthening family

farms, developing the food product markets, breaking down the barrier of risk for the producer and implementing this in the framework of territorial policies that strengthen rural-urban linkages through the promotion and development of the service functions of small cities and country towns (ILO, 2019).

Fish production has been the fastest-growing food industry in the world for the last 40 years and it is expected to remain so in the near future (Béné et al., 2020). In Africa, small-scale fish farming has continued to grow steadily with millions of poor families relying heavily on fish farming as a livelihood (Gatonye, 2020). Fish farming has great potential of growth in Africa, Kenya and Kakamega County, due to the presence of a wide variety of water sources such as rivers, springs, dams and rainfall (County Government of Kakamega, 2023. In Kakamega County, fish farming households focus on rearing Oreochromis niloticus (Nile tilapia) and Clarias gariepinus (African catfish) (Nguka et al., 2017). Land fragmentation, coupled with the rugged terrain in the county permit farmers to construct only small fishponds, which although cumulatively add up to a large pond area, production in the area is still far below the market demand (Kiiru & Munguti, 2014).

The controversy surrounding the World Bank Report on Poverty 2020/2021 and the economic strategies of other Bretton Woods Institutions indicate inadequate consensus on what can be done to improve the African rural livelihoods (Jayne et al., 2003). FAO (2022) suggested an investigation into what was urgently needed to revive the Kenyan economy and promotion of economic activities that offers the greatest potential for better livelihoods. Barringer and Ireland (2021), Jablonski (2014); Fouracre & Harrison (2022) hypothesized that entrepreneurship proxied by economic activity diversification holds the key to better livelihoods among the small-scale farmers.

Peng et al. 2022 observed a tendency for rural households to engage in multiple business occupations, but few attempts have been made to relate economic activity diversification to livelihood outcomes especially to fish farming. The authors further argued that livelihood activity diversity is a paradox of complex interactions with poverty, income distribution, farm productivity, environmental conservation and gender relations that are not straight forward and are counter-intuitive. This has so far led to contradictory practices, study findings and policies. For example, Kenya Vision 2030 advocates for value addition in agriculture for better livelihoods of farmers while Karugia et al (2020) advise Kenyan small-scale farmers to diversify into non-agricultural activities in order to improve their standard of living.

Fish farming in Kakamega County faces challenges of underinvestment and poor management, which often results in low yields. Despite the heavy investment in fish farming by the County government of Kakamega through the Aquaculture Business Development Program (ADBP) and International Fund for Agriculture and Development (IFAD) that gave the plant the go-ahead to export fish through the Lutonyi Fish Factory in Kakamega town, the numbers of potential and upcoming fish farmers is below the expected demand. Karugia et al. (2020) blame the sluggish rise on more concentration on diversified economic activities leaving out the core activity of fish farming.

Production in the county is below expected demand. Despite efforts by several players to revitalize fish farming, the development process is at a snag and is characterized by pond productivity that is low and not rising (Nguka *et al*., 2017). It is against this background that this study sought to establish the effect of vertical diversification on Sustainable livelihoods among fish farmers in Kakamega County.

Literature Review

Vertical Diversification

Vertical diversification is an expansion strategy utilized by economies to join different entities to yield more returns. There are two types of vertical diversification strategies; backward and forward diversification strategies. Backward, vertical diversification strategies can be defined as the designing of raw materials needed to produce the goods. On the other hand, a forward, vertical diversification strategy can be defined as a diversification strategy used by companies to move up the supply chain to finish, distribute and supply the finished products (Mahmudjonovna, 2022). In this study, vertical diversification was explored in terms of strategies that fish farmers employ to push the finished products up the supply chains to reach the consumers and earn them better returns.

Empirical Literature

This section presents the reviewed literature regarding vertical diversification and sustainable livelihood.

The Role of Vertical Diversification

Several empirical studies have been conducted to draw a link between vertical diversification and livelihood of farmers at the global, African and Kenyan levels. One study is that of Trifković's (2016), which delved into the dynamics of vertical coordination within Vietnam's catfish sector. The study demonstrated that vertical coordination among fish farmers did have a significant impact on performance. However, vertically integrated farms had higher revenues and outputs per hectare. Contract farming did not have a significant impact on their performance. While the study offers valuable insights into vertical diversification and performance of the fish farming sector, this research goes further and conceptualizes vertical diversification to consist of Transaction Costs, Economies of Scale and Scope and Technological Innovation. It relies on primary data and focuses on a different context of Kakamega County.

A more recent study was done by Ao et al. (2021) to establish how vertical integration impacted the performance of farmers in China. The study aimed at addressing the persistent issue of low-income growth rates among farmers compared to urban residents in the backdrop of China's economic reforms initiated in 1978. The findings revealed significant associations between the three variables with farmers participating in agricultural operation organizations demonstrating higher total incomes and operation incomes compared to non-participants. Similarly, farmers involved in the entire supply chain from production, processing to retailing activities exhibit greater income levels than those solely engaged in production. Despite providing valuable insights, the study is limited to large-scale farmers in Lin'an, China, limiting the generalizability of findings to other contexts. Additionally, while the study explores the impact of vertical integration on incomes, it overlooks other pertinent factors influencing farmers' livelihoods. Therefore, this study addresses these gaps by focusing on vertical diversification as an independent variable and its effect on sustainable livelihoods among fish farmers in Kakamega County.

In Ghana, Adams et al. (2022) conducted a study on the commercial poultry production sector in Ghana. It aimed at addressing challenges of vertical integration within the region. While the study contributes valuable insights into the determinants of vertical integration in the Ghanaian poultry industry, this study went further to focus on fish farmers in Kakamega County and the effects of vertical integration on sustainable livelihoods.

In Kenya, Mutura et al. (2016) conducted a study to analyze factors driving farmers to adopt horizontal and vertical integration in their farms in Central Kenya. The study revealed that an increase in output levels, turnover of fixed investments influenced the likelihood of vertical integration and horizontally integrated farmers exhibited a willingness to pay more for market information and reported higher profit margins. The study highlighted the role of integrating vertically and horizontally; however, this study goes further to focus on fish farmers and the impact of vertical integration on the sustainability of their livelihoods.

Table 1: Distribution of Target Population and Sampling technique in the Sub-counties

Sub-County	Total Farmers	% of All Farmers	Sample
Lurambi	624	13.87%.	49
Khwisero	370	8.22%	29
Mumias East	455	10.11%	36
Mumias West	412	9.16%	32
Shinyalu	333	7.40%	26
Ikolomani	397	8.82%	31
Butere	342	7.60%	27
Malava	320	7.11%	25
Matungu	306	6.80%	24
Navakholo	301	6.69%	24
Lugari	331	7.36%	26
Likuyani	309	6.87%	25
Total	**4,500**	**100**	**354**

Methodology

Design

Descriptive and survey research designs were used in this study as they allow studies to describe and summarize data, identifying key features, trends or distributions within the study sample as in the case of Kakamega fish farmers.

Population and Sampling

The study was carried out in Kakamega County, Kenya which has 12 sub-counties namely Lurambi, Shinyalu, Ikolomani, Navakholo, Lugari, Butere, Malava, Matungu, Mumias East, Mumias West, Khwisero and Likuyani Sub-counties (Wahome et al. 2023). The population of this study comprised of 4,500 registered fish farmers from 12 sub-counties in Kakamega County (County Government of Kakamega, (2015). Refer to table 1 showing distribution of fish farmers in Kakamega County. Therefore, the 4,500 fish famers were targeted from which 350 were drawn using the Krejcie and Morgan(1970) table.

Cluster sampling was used to group the respondents according to sub-counties and further into wards within the sub-counties. Finally, the farmers were grouped according to their villages. Simple random sampling, using lottery, was used to identify fish farmers to be involved in the study.

Validity and Reliability

After looking at the research objectives, hypotheses and relevant literature, research instrument (a questionnaires) was developed. A panel of experts in the field reviewed each item in the questionnaire to assess its relevance clarity and alignment with the study's objectives and hypotheses. Their evaluations resulted in a CVI score of 0.80, indicating that the questionnaire items were deemed appropriate and relevant for measuring the constructs under study.

To establish the instruments' reliability and clarity of the research instrument, a pilot study was conducted in Vihiga County. Thirty-six participants took part in the pilot study, which was conducted over the course of three weeks. Using two research ethics trained research assistants, the instruments were tested using pilot testing. Cronbach's Alpha test determined the instrument's dependability. The overall Cronbach's Alpha value was 0.79, indicating a good level of reliability for the instrument.

Statistical Treatment of Data

The study employed descriptive and inferential statistical analysis. To analyze the data collected through the questionnaire, descriptive statistics were employed, including the calculation of mean scores and standard deviations for statements related to vertical diversification. Mean scores were interpreted using a five-point scale as follows: 1.00= Strongly Disagree, 2.00= Disagree, 3.00= Neutral, 4.00= Agree and 5.00= Strongly Agree. Inferential statistics, such as correlation and multiple regression analysis were used for hypothesis testing. Multiple regression analysis demonstrated how vertical diversification influences sustainable livelihoods. As demonstrated on Table 2 and 3, the items show relatively high standard deviations in several statements. High standard deviations like these imply that respondents' views are quite dispersed. This can indicate differences in how fish farmers perceived or experienced the impact of vertical diversification practices on their livelihoods.

Ethical Consideration

The study adhered to ethical principles of voluntary participation, confidentiality and anonymity. It also ensured participants' safety and privacy.

Findings and Discussion

This section presents the findings of the study, which are organized into three main components: demographics, descriptive statistics and inferential statistics. The demographic analysis provides an overview of the characteristics of the participants, setting the context for the study. Following this, descriptive statistics are reported to summarize the data, offering insights into the key variables under investigation- Vertical Diversification and Sustainable livelihoods. Finally, inferential statistics are utilized to explore relationships among the variables- Vertical Diversification, and Sustainable livelihoods.

Demographics of the Respondents

The study sought to establish general information regarding the following aspects of the respondents: Gender, Age, marital status, level of education, and household size. The results are on Table 1. Table 1 shows that most of fish farmers (66.5%) were males while females constituted 33.5%. Most (47.1%) of the respondents were between the age bracket of 21-40 while 6.6% were between 1-20 years, 29.4% were between 41-60 and 16.9 % were between 61-80 years. Therefore, most of the farmers were still at their productive age brackets and therefore had

the energy and ability to engage in multiple income generating activities.

Table 1 further reveals that most (54.3%) of the respondents were married. The majority (50.18%) of the respondents had attained secondary level of education. Those who had attained primary level of education were 24.21% while tertiary levels of education constituted 25.61%.

Table 1: Demographic Characteristics of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	233	66.5
	Female	117	33.5
Age (in years)	1-20 years	23	6.6
	21-40 years	165	47.1
	41-60 years	103	29.4
	61-80 years	59	16.9
Marital Status	Single	43	12.3
	Married	190	54.3
	Divorced	31	8.9
	Widowed	86	24.5
Level of Education	Primary	85	24.21
	Secondary	175	50.18
	Tertiary	90	25.61
Household Size	≤ 5	128	36.6
	6-10	182	52.0
	≥11	40	11.4
Farm Size	≤ 1 acres	123	35.1
	1-3 acres	132	37.7
	≥4 acres	95	27.2
Member of Cooperative Society	Yes	180	51.4
	No	170	48.6
Access to Micro-credit	Yes	116	33.14
	No	234	66.86
Ownership of Productive Assets	Yes	190	54.29
	No	160	45.71

The study discovered that most of the respondents (52.0%) were in households consisting of 6 to 10 family members, 36.6% had 5 members and below while 11.4 % had more than 11 members.

The study discovered that 37.7% of the respondents had the farm size of 1 to 3 acres, 35.1% had 1 acre and below while 27.2% had more than 4 acres. Additionally, most of the respondents (51.4%) of were members of the cooperative society while 48.6% were not. Most of the respondents (66.86%) did not have access to microcredit while 33.14% had access. Therefore, most farmers were excluded from credit support from formal financial institutions in the study area. Lastly, most of the respondents (54.29%) possessed productive assets while the minority (45.71%) did not.

Research Question 1: What are trends in Vertical Diversification among fish farmers in Kakamega County?

In the next page, Table 2 indicates trends in vertical diversification among fish farmers in Kakamega County. Scores above 3.0 would be considered positive, those in the range of 3.00 as undecided and those below 3.00 as undecided.

Results show the score of above 3.0 in most of the items, implying agreement with the statements. For instance, value addition to farm produce was perceived to yield greater income gains than costs, with the mean score of 3.07 and a standard deviation of 1.530. This suggests a general agreement among respondents that engaging in value addition is financially beneficial. This finding is consistent with a research conducted by Trifković (2016), which demonstrated that vertically

coordinated farms in Vietnam achieved higher revenues.

On the contrary, the statement regarding packaging, processing and branding products elicited the mean score of 2.66 and standard deviation of 1.458, indicating negative perception among the respondents. This suggests that although some farmers recognize the potential benefits of these practices, there is no clear consensus. The variability in responses may indicate a need for increased education and resources to fully harness the benefits of packaging and branding in this context.

Respondents expressed a positive outlook on the role of value addition in fostering entrepreneurial networks as reflected by the mean score of 3.35 and standard deviation of 1.434. This general agreement underscores the importance of collaboration and resource-sharing among farmers.

Table 2: Descriptive statistics for Vertical Diversification

SN	Item in the Questionnaire	Mean	Std. Dev.
1	Value addition to farm produce has more income gains than costs.	3.07	1.530
2	Packaging, processing and branding increases livelihood outcomes	2.66	1.458
3	Value addition increases Entrepreneurial Network	3.35	1.434
4	Value addition increases Risk-sharing and asset accumulation	3.22	1.332
5	Value addition increases Access to Extension Services	3.05	1.165
6	Value addition increases access to infrastructural facilities	3.11	1.061
7	Value addition increases Social Capital gains	3.24	1.029
8	Acquiring or upgrading of Technological Resources for fish farming	3.36	1.074

Moreover, the perception that value addition increases risk-sharing and asset accumulation was supported by the mean score of 3.22 and standard deviation of 1.332, indicating agreement. This reflects the insights from Mutura et al. (2016), who discussed the advantages of vertical integration in promoting market participation and profit margins. The ability to share risks and accumulate assets is crucial for enhancing the financial resilience of fish farmers.

The study revealed agreement with the notion that value addition enhances access to extension services, with the mean score of 3.05 and standard deviation of 1.165.This is an important finding as access to extension services has been shown to significantly improve agricultural productivity. For instance, Ao et al. (2021) reported the vital role of extension services in facilitating effective farming practices. Therefore, enhancing access to these services could optimize the benefits of vertical diversification among fish farmers.

Furthermore, the results indicated agreement that value addition increases access to infrastructural facilities, evidenced by the mean score of 3.11 and standard deviation of 1.061. This finding resonates with the research of Adams et al. (2022), which underscored the importance of adequate infrastructure in supporting agricultural activities and facilitating market access. Therefore, improving infrastructure could provide substantial benefits to fish farmers in Kakamega County.

Respondents also recognized the effectiveness of value addition toward social capital gains, reflected in the mean score of 3.24 and standard deviation of 1.029. This supports the findings of Trifković (2016), who reported that vertical integration fosters relationships and networks within farming communities. Strengthening social capital can enhance collaboration among farmers, ultimately benefiting their collective livelihoods.

Lastly, the perception on acquiring or upgrading technological resources for fish farming received a strong agreement, with the mean score of 3.36 and a standard deviation of 1.074. This aligns with the work of Ao et al. (2021), which reported the critical role of technological advancements in improving income and productivity.

Research Question 2: What are trends in the sustainability of livelihoods among fish farmers in Kakamega County?

This research question sought to the sustainability of livelihoods among fish farmers in Kakamega County. Table 3 (Next page) presents descriptive findings for sustainable livelihoods. As to whether social capital gains had improved their performance, the findings show agreement, with the mean of 3.99 and a standard deviation of 0.875. This high score suggests high agreement among respondents regarding the positive impact of social capital on their operational effectiveness. Similarly, Chambers and Conway (1991) reported that sustainable rural livelihoods are intrinsically linked to the capacity for

positive transformation and improved standards of living.

With regards to physical asset accumulation enhancing the societal wellbeing, the respondents demonstrated the mean of 3.67 and a standard deviation of 1.038. This finding aligns with the Department for International Development (2019), which describes sustainable livelihoods as encompassing the necessary assets to cope with and recover from environmental stresses and shocks. By accumulating physical assets, fish farmers can bolster their resilience against vulnerabilities and improve their overall living standards.

Likewise, Table 2 shows agreement that income gain had contributed to accessibility, affordability and availability of goods and services, with a mean of 3.38 and standard deviation of 1.186. This observation is consistent with the work of Peng et al. (2022), which reported rural livelihood diversification as a means to create a diverse portfolio of activities that enhance living standards.

Table 3: Sustainability of Livelihoods

SN	Questionnaire Item	Mean	Std. Dev
1	Social capital gains have improved our performance	3.99	0.875
2	Physical Asset accumulation has enhanced the societal well being	3.67	1.038
3	Income improves accessibility, affordability and availability of goods and services	3.38	1.186
4	Social capital gain has led to community empowerment and reduced conflicts	3.89	0.978
5	Income gains has enhanced our capacities	3.24	1.228

Table 4: Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Vertical Diversification	.117	348	.000	.958	348	.000
Structural Diversification	.256	348	.000	.852	348	.000
Portfolio Diversification	.145	348	.000	.909	348	.000
Entrepreneurial Determinant	.165	348	.000	.923	348	.000
Sustainable Livelihood	.156	348	.000	.945	348	.000

a. Lilliefors Significance Correction

Whether social capital gains had led to community empowerment and reduced conflicts, respondents agreed with the mean score of 3.89 and standard deviation of 0.978. They were also in agreement that income gains had enhanced their capacities with the mean of 3.24 and standard deviation of 1.228. This finding is particularly relevant in light of the sustainable livelihood framework proposed by Fouracre and Harrison (2021), which shows the importance of social networks in reducing vulnerability and fostering community cohesion.

Normality Tests

In Table 4, Kolmogorov-Smirnov output tested the normality of distribution of data. At 95% confidence level, for any data to be considered normal, the P values should be greater or equal to 0.05 (P≥0.05). In Table 4, all the variables had the p-values of 0.00. However, large samples greater than 50 can violate this assumption, hence the data was considered normal since the population in this study was 350 individuals (Pallant, 2011).

Test for Multi-collinearity

When two or more independent variables in a correlation model are highly correlated, indicated by the Pearson Correlation values greater than 0.5, multi-collinearity occurs. As a rule of thumb, one should notice multi-collinearity if the correlation coefficient (r) is above 0.9.

Structural diversification and portfolio diversification are missing. Why so?

The correlation test between vertical diversification and structural diversification yielded the Pearson Correlation of 0.813 while that between vertical diversification and portfolio diversification yielded the Pearson Correlation of .570. These findings show that the assumption of multi-collinearity was not violated and therefore, data could be subjected to regression analysis.

Homoscedasticity Test

Homoscedasticity was tested though the use of a scatterplot. The scatter plot in Figure 1 indicates that Vertical Diversification is homoscedastic and linearly related to sustainable livelihoods among fish

farmers in Kakamega County. This is supported by the possibility of fitting goodness of fit line in the scatter plot. The slope of the line is 0.53X while the intercept constant is 3.51 based on the sum of scores for the variables. The points are concentrated towards the fit line, indicating presence of homoscedasticity. This further shows that the assumption has not been violated and hence the data can be subjected to regression analysis.

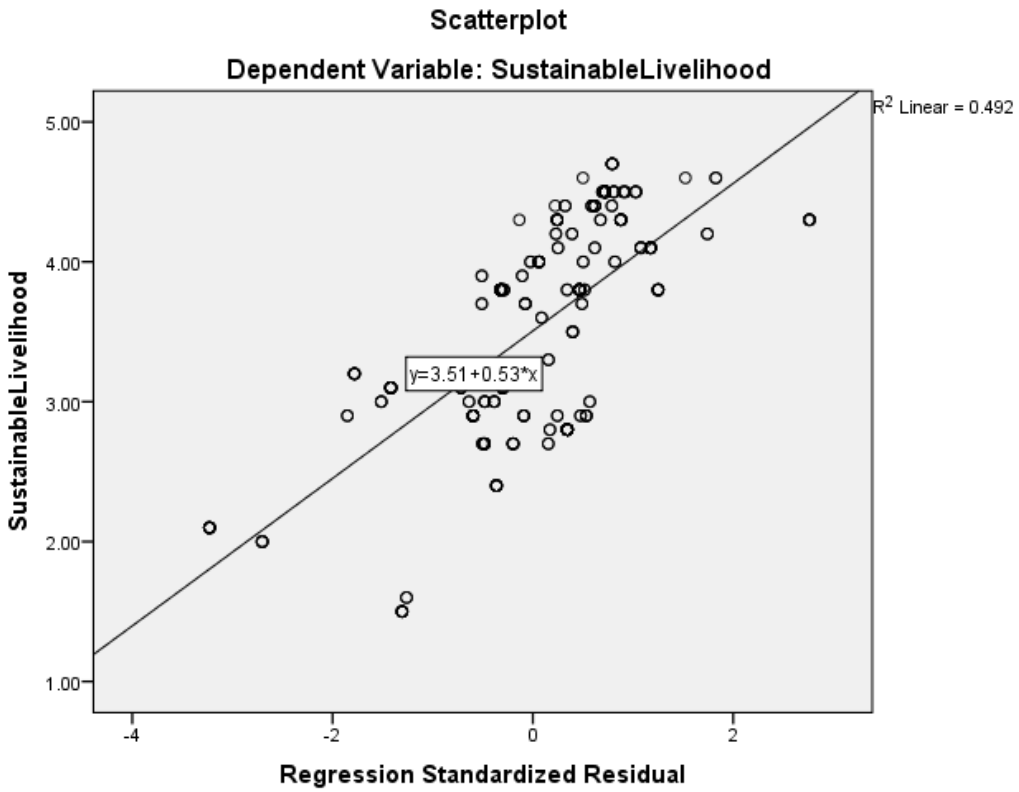

Figure 1. Scatterplot diagram

Table 6: Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.576[a]	.332	.330	.61179	.332	173.034	1	348	.000

a. Predictors: (Constant), Vertical Diversification

Research Question 3: What is the effect of Vertical Diversification on Sustainable Livelihoods among fish farmers in Kakamega County?

This research question called for testing of the following null hypothesis: Vertical Diversification has no significant effect on Sustainable Livelihood among fish farmers in Kakamega County.

In Table 6, the value of R-square is 0.332. This implies that 33.2% variation of sustainable livelihoods was explained by Vertical Diversification. This result implies a moderate relationship, where vertical diversification significantly influences sustainable livelihoods. The finding suggests that while vertical diversification strategies like value addition, processing, and branding contribute positively to livelihood sustainability, other unexamined variables are also at play in shaping these outcomes. This finding directly addresses the research question by demonstrating that vertical diversification has a notable effect on the livelihoods of fish farmers. Trifković's (2016) research on Vietnam's catfish sector similarly found that vertical integration, such as contract farming, had a measurable impact on the performance and income of farmers. However, Trifković noted that

fully integrated farms saw more significant returns than those participating solely in contract farming, which highlights the potential added value of full vertical integration. In the African context, Adams et al. (2022) found that Ghanaian poultry farmers who adopted vertically integrated practices, such as milling and hatching beyond egg production, achieved higher levels of income stability and operational resilience.

From the findings in Table 7, at the 0.05 level of significance, the ANOVA test indicates that in this model the independent variable, namely Vertical diversification, is important in predicting enhanced livelihoods of fish farmers in Kakamega County as indicated by the significance value of 0.001, which is less than the critical value.

Table 7: **ANOVA Test**

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	64.765	1	64.765	173.034	.001[b]
	Residual	130.252	348	.374		
	Total	195.017	349			

a. Dependent Variable: Sustainable Livelihood

b. Predictors: (Constant), Vertical Diversification

Table 8: Coefficients of the Model

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	1.925	.124		15.488	.000
	Vertical Diversification	.498	.038	.576	13.154	.000

a. Dependent Variable: Sustainable Livelihood

From Table 8, vertical diversification has a significant influence on livelihoods (t-statistic=13.154, p-value=0.001< 0.05). Therefore, at 5% level of significance, the null hypothesis was rejected, indicating that Vertical diversification significantly influenced Sustainable livelihoods among fish farmers in Kakamega County. Letting Y be Sustainable livelihood of fish farmers, X_1 be Vertical diversification, using the regression coefficients in Table 8. Sustainable Livelihoods=1.925 + .498VD. Thus, for every unit increase in vertical diversification there was a corresponding increase on sustainable livelihoods of fish farmers in Kakamega County by 0.498.

Conclusions and Recommendations

This study concludes that vertical diversification has a significant and positive impact on sustainable livelihood. Specifically, higher levels of engagement in vertical diversification practices are associated with improved livelihood outcomes. Thus, the study concludes that promoting vertical diversification can enhance the sustainability and resilience of fish farming livelihoods in Kakamega County.

Recommendations

The study recommends that fish farmers should be encouraged to adopt value-added practices (e.g., packaging and processing) to enhance product value and income stability. Local cooperatives should support resource sharing, market negotiations and knowledge exchange among farmers. Government and Non-Government Organizations should strengthen cooperatives and provide training to fish farmers. Finally, policymakers should offer subsidies or grants to incentivize vertical diversification while private sector partnerships should facilitate access to financing and training. These steps can drive sustainable livelihoods for fish farmers in Kakamega County.

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