Implications of avocado farming on income and food diversification among smallholders in Njombe, Tanzania

Simon J. Chamy[1]
Anna A. Temu[2]
Silver J. Hokororo[3]

simonikalembo@gmail.com

[1,2,3]Sokoine University of Agriculture, Tanzania

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ABSTRACT

Avocado has gained popularity as a high-value crop that could improve rural livelihoods in sub-Saharan Africa, yet there is limited field-based evidence on how growing avocado actually changes what farmers earn and what they consume, especially when considering whether concentrating on a single crop makes households less resilient in the face of risks. This study investigates how avocado farming affects income diversification and food consumption among 305 smallholder households surveyed in the Njombe Region, Tanzania, drawing on the Sustainable Livelihoods Framework (SLF) as a theoretical proposition anchored. Data were collected through structured household surveys in a cross-sectional design. Three analytical methods were applied: analysis of variance (ANOVA) for comparing income across three avocado participation intensity groups, a Simpson Income Diversity Index (SIDI) analyzed through fractional logit regression for income diversification determinants, and an ordered logit model for household food consumption measured by the Food Consumption Score (FCS). ANOVA results showed that income differed significantly across the three groups, with farmers who grow avocado more intensively earning considerably more. The fractional logit model indicated that higher avocado involvement reduces income diversification chance (coefficients of -0.620 at $p < 0.01$ for medium intensity and -2.068 at $p < 0.001$ for high intensity), emphasizing a shift toward specialization. Nevertheless, the ordered logit results showed that avocado participation improves food security: none of the high-intensity farmers fell into the 'poor' food consumption category compared with 18.2% of low-intensity farmers ($\chi^2 = 24.76$, $p < 0.001$). Education level, access to financial services, and marital status positively influenced income diversification, while household income and participation intensity were the main factors behind better food consumption. The findings point to a need for policies that balance avocado intensity with livelihood diversification, expand financial access, and integrate nutrition awareness into agricultural extension.

Keywords: Avocado Farming, Food Consumption Score, Fractional Logit, Income Diversity Index, Njombe, Smallholder Livelihoods

I. INTRODUCTION

Avocado is one of the few tropical fruits that has fat-soluble vitamins, an important feature that sets it apart nutritionally from most other fruits and has been linked to reduced cholesterol and lower cardiovascular risk (Duarte et al., 2016). Global production has grown rapidly attributable to both health-conscious driven demand and attractive farm-gate returns. By 2022, worldwide output reached approximately 9 million metric tons, an increase of 4.8% from the previous year, with Mexico accounting for the largest share (Food and Agriculture organization (FAO), 2023). Even so, demand exceeds supply: the market is estimated at US $19.3 billion, whereas the value of production reaches only about US $5.7 billion (FAO, 2023). For countries with suitable agro-climatic conditions, particularly in Africa, this gap represents a real opportunity to expand cultivation and raise farmer incomes.

Within Africa, Kenya, South Africa, and Tanzania lead in avocado production, benefiting from comparatively low labour costs and proximity to European markets (Huang et al., 2023). Tanzania's output is estimated at 190,000 tons per year, supply largely coming from Njombe, Kilimanjaro, Iringa, Arusha, and Mbeya regions (Tumaini et al., 2024). Much of this expansion has been driven by both local entrepreneurship and foreign investment; for instance, Africado Limited has helped link Njombe's smallholders to export channels (Boniphace et al., 2023).

Several studies confirm that avocado farming raises smallholder incomes. In Kenya, Kwizerimana et al. (2023) unveiled higher earnings among avocado producers especially those participating through collective marketing, while Zwane and Ferrer (2024) documented similar advantages in South Africa. Tanzanian evidence from Lushoto and Mwanga also points to improved income and welfare among avocado-growing households compared to those not cultivating the crop (Namwata & Lwelamira, 2010; Charles et al., 2014).

In Njombe Region, however, only about 34% of land seen suitable for avocado is currently planted (United Republic of Tanzania [URT], 2020). Although the region ranks among Tanzania's top avocado-producing areas and

supplies fruit for exportation, research attention has been directed mainly at production constraints and farm-level decision-making (Malekela, 2022; Swai & Ubaldus, 2023). The questions like how avocado cultivation reshapes the composition of household income, particularly whether it increases or decreases the income portfolio, and what this means for food security, has received far less attention. This gap is actually matters because Njombe records one of the country's highest rates of child malnutrition at 53% (Macha et al., 2025), raising the practical question of whether the ongoing avocado flourishing is translating into better nutrition at the household level.

Income diversification is widely regarded as important for rural resilience because it helps farmers cope with production risks, price fluctuations, and weather shocks (World Bank, 2020; Ellis, 2000). As avocado grows in commercial importance in Njombe, it becomes necessary to ask whether deeper involvement in the crop helps or hinders diversification, and that is the essence of this study to inform policies for promoting fair and sustainable involvement in high valued crop systems.

1.2 Research Objective

i. To examine the effect of avocado farming on household income among smallholder farmers in Njombe region.
ii. To assess the effect of avocado farming on household food security in Njombe region.

II. LITERATURE REVIEW

2.1 Theoretical Review

This study is anchored in the Sustainable Livelihoods Framework (SLF) as put forward by Ellis (2000) and used widely in rural development studies. The SLF Proposes that household livelihood outcomes which include income level, income diversity, and food security, are formed by the interlinkages of five capital assets (namely human, natural, physical, financial, and social) with the enabling environment (institutions and policies) in which households operate. When a household distributes a larger share of its natural and human capital to a single enterprise with high-return such as avocado farming, the framework foresees a clear trade-off: total earned income may rise, but the choice of income sources may fall, potentially increasing vulnerability chance to shocks. At the same time, higher income can actually expand food access through market purchases, even if on-farm food production diversity declines. The SLF thus provides a comprehensible lens for examining the two-fold outcomes that is income specialisation and food security improvement, often observed when smallholders intensify avocado production.

Against this background, this study offers a comparative analysis of income and food consumption shapes among different participation intensity groups of avocado smallholder farmers in Njombe, Tanzania. By assessing differences and indifferences in income structure and dietary diversity, the study contributes field-based reflections to inform policies that seek to promote reasonable and maintainable participation in high-value horticultural value chains.

2.2 Empirical Review

Avocado production and consumption have expanded rapidly around the world in recent decades, largely driven by growing awareness of its nutritional benefits. As a fruit rich in monounsaturated fats and fat-soluble vitamins, nutrients that are relatively uncommon in other fruits avocado contributes to improved cardiovascular health by helping reduce cholesterol levels (Duarte *et al.*, 2016).

In this context, African countries have emerged as important players in global avocado markets. Nations such as Kenya, South Africa, and Tanzania have progressively increased production volumes, driven by favourable climatic conditions, lower labor costs, and geographic proximity to high-demand export markets, especially in Europe (Huang *et al.*, 2023; World Bank, 2020).

Studies on horticultural and export-oriented crops in Tanzania show that when smallholders see demonstrable successes among peers such as improved incomes or access to markets, they are more likely to adopt similar cropping patterns (Kipkorir et al., 2023). However, while there is abundant evidence that avocado farming enhances cash income, very few studies have systematically examined how avocado cultivation affects income diversity or even food diversity, that is, the composition of income sources and food categories, and not only the volume of income or food.

In the Tanzanian context, and particularly for key producing regions like Njombe, this gap in the literature is important. Existing works have mainly focused on production constraints, household decision-making processes, and adoption barriers (Malekela, 2022; Swai & Ubaldus, 2023). Yet without understanding how avocado farming affects income and food diversification and, by extension, livelihood resilience it is difficult to formulate effective policies that encourage sustainable and equitable growth in the sector. Hence, a comparative analysis of income structure and food setups among different participation intensity groups of avocado smallholder farmers becomes necessary to inform

efforts aimed at promoting diversified livelihoods and maximizing the socio-economic benefits of avocado value chains in Njombe and beyond.

III. METHODOLOGY

3.1 Study Area

Njombe Region is located in the Southern Highlands of Tanzania, between latitudes 8°40′–10°32′ S and longitudes 33°47′–35°45′ E. The region is bordered by Iringa to the north, Morogoro to the east, Mbeya to the west, and Ruvuma to the south; Lake Nyasa and the border with Malawi lie to the northwest. Njombe's cool highland climate, fertile volcanic soils, and relatively dependable rainfall make it well conducive to perennial horticultural crops, with avocado among them. These conditions have driven upward adoption of avocado by smallholder households in most recent years (United Republic of Tanzania (URT), 2020).

Avocado now accounts for roughly 4.8% of the total tonnage of major cash crops in the region (Kingu & Kinyondo, 2024). The combination of commercial significance and the predominance of smallholder producers make Njombe a suitable location for studying how avocado participation affects livelihood making i.e. household income and food consumption.

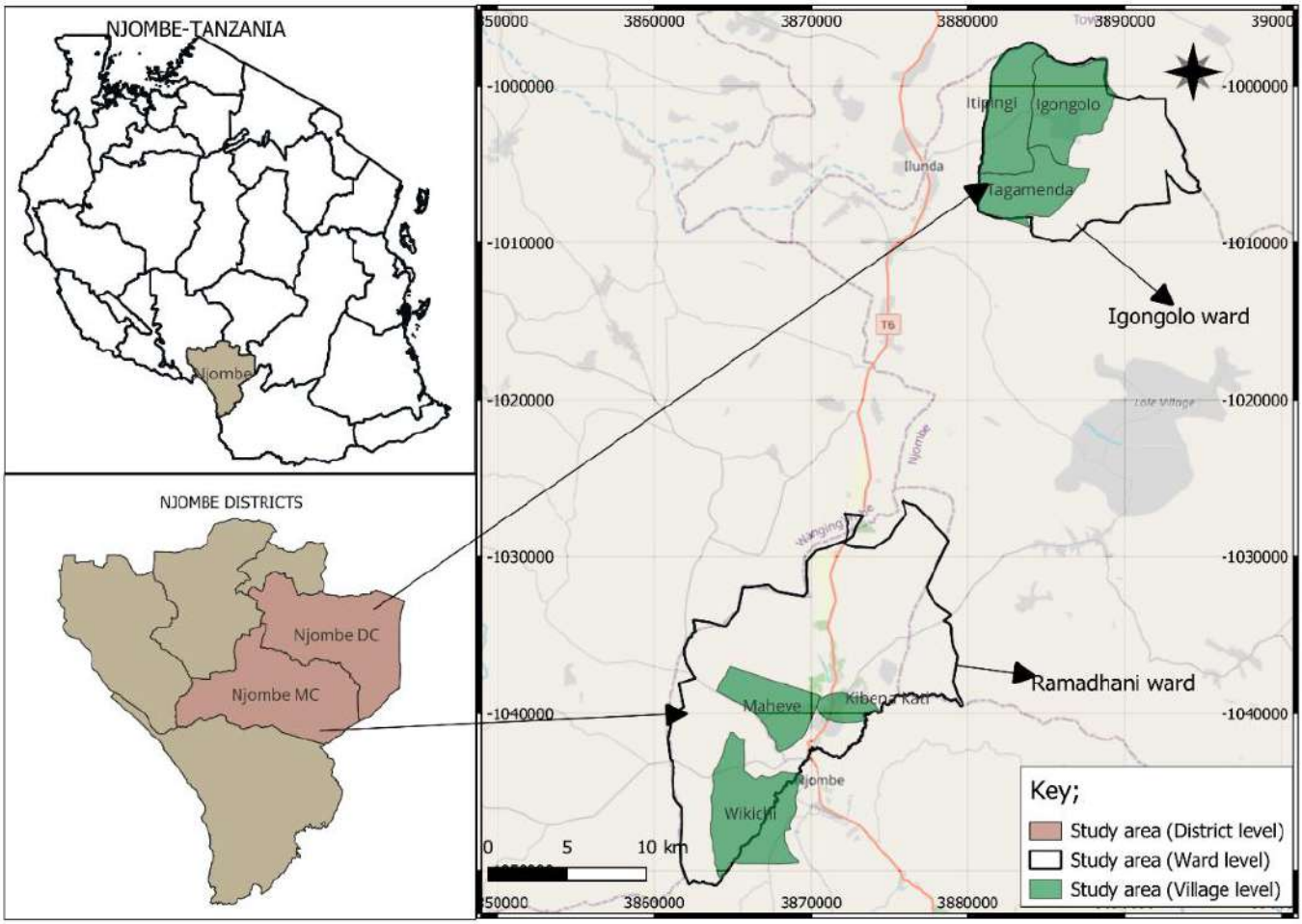

Figure 1
Map of Study Sites

Fieldwork took place in Njombe District Council (DC) and Njombe Township Council (TC). In Njombe TC, the surveyed villages were Wikichi, Maheve, and Kibena Kati in Ramadhani Ward. In Njombe DC, data were collected in Itipingi, Igongolo, and Tagamenda villages within Igongolo Ward, all selected through simple random sampling.

3.2 Research Design and Sampling

A cross-sectional design was adopted, with all data collected at a single point in time through a structured questionnaire (Babbie, 1990). This approach was adopted because of being cost-effective and practical for capturing a snapshot of household livelihood dynamics (Kothari, 2014).

The target population comprised all farming households engaged in avocado production in Njombe District. A multi-stage sampling technique was used. First, Njombe District was purposively chosen because of its prominent role in national avocado production. Second, two wards, Ramadhani (peri-urban) and Igongolo (rural) were purposively selected for their high avocado production volumes and their ability to represent varying settlement types. Third, three villages per ward were randomly drawn. Fourth, individual households were selected by simple random sampling from household lists kept by village offices, ensuring every qualified farming household had an equal chance of being selected.

The sample size was determined using Yamane's (1967) formula. Based on the 2022/2023 National Agricultural Survey, Njombe has approximately 195,146 farming households (N). With a 5% margin of error, the formula yields a required sample of 399 households. Due to workplan and budgetary constraints, the study interviewed 305 respondents, raising the margin of sampling error slightly from 5.0% to approximately 5.7%, which remains within acceptable bounds for socioeconomic field surveys (Krejcie & Morgan, 1970).

3.3 Data Collection

Data were gathered through household surveys and interviews with household heads. The questionnaire covered household resources, agricultural production (including avocado plant densities used to gauge participation intensity), income flows, and food consumption patterns. To improve efficiency and reduce transcription errors, an electronic data collection (digitalized survey) was carried out using the KoboToolbox software installed on tablets.

3.4 Data Analysis

Three analytical approaches were used, each targeting a specific research objective. First, net avocado income was calculated as follows.

$$NR_t = P_t^s * A_t^s - \sum\left(Q^b_{seedlings\ t} * P^b_{seedlings\ t}\right) + \left(Q^b_{pesticide\ t} * P^b_{pesticide\ t}\right) + \left(Q^b_{fertilizer\ t} * P^b_{fertilizer\ t}\right) + \left(MD^h_{labor\ t} * W^h_{labor\ t}\right)$$

Net revenue (*NR*) for farmer *i* at time *t* equals the total sales value of avocado fruit minus the sum of expenses on seedlings, pesticides, fertilizers, and hired labour. One-way ANOVA was then used to test whether mean household income differs across the three participation intensity groups (low, medium, and high).

Second, the Simpson Income Diversity Index (SIDI) was computed for each household. SIDI is ranged between 0 and 1; values closer to 1 indicate greater diversification across income sources. Because SIDI is a fractional variable, a fractional logit model was fitted to identify factors associated with income diversification. The model takes the form:

$$E(\,SIDI_i \mid X_i\,) = \frac{Exp(X_i\beta)}{1+Exp(X_i\beta)}$$

Where the vector *X* includes avocado density, education, household size, land size, access to extension, and access to credit.

Third, household food consumption was measured using the Food Consumption Score (FCS) developed by the World Food Programme (WFP). FCS values were grouped into three ordered categories: poor (FCS ≤ 21), borderline (21 < FCS ≤ 35), and acceptable (FCS > 35). An ordered logit model fitted because the dependent variable is ordinal (Greene, 2012; Long & Freese, 2014):

$$Y_i^* = X_i\beta + \varepsilon_i$$

Where *Y** is the latent (unobserved) food consumption propensity, *X* includes participation intensity, household demographics, farm characteristics, and institutional variables, and ε follows a logistic distribution.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Characteristics of the Sampled Avocado Smallholders

Table 1 summarises the socio-economic and farm-level aspects of the 305 households surveyed. The average household head was about 48 years old (range 27–71), indicating that avocado farming in Njombe is carried out mostly by adults in their economically active years. Heads had spent or completed roughly 11 years of schooling on average, a level that may facilitate uptake of improved production and marketing practices. The typical household had about two working members available for farming labour. About 63% of households were male-headed, while total cultivated land averaged 6.7 acres but ranged widely (1–35 acres), reflecting considerable heterogeneity in farm scale. The average number of avocado trees was 125 (range 7–200), suggesting to a dominance of moderate-scale growers. Nearly 63% of

farmers had formal land tenure, an essential factor that may encourage long-term investment in a perennial crop like avocado. Farming experience in avocado was 6 years on average (range 1–15), suggesting the crop is relatively new in the area. Almost 70% of farmers were growing the main improved variety, and about 66% collected their seedlings from formal sources.

Table 1

Avocado Smallholder Characteristics

Variable	Obs	Mean	Std. Dev.	Min	Max
Household head age	305	48.121	10.363	27	71
Years of education	305	10.81	3.179	0	17
Household labour force	305	2	1	1	6
Head gender (1=male)	305	.633	.483	0	1
Land cultivated (acres)	305	6.695	7.367	1	35
Number of avocado trees	305	125	59	7	200
Land tenure (1=formal)	305	.633	.483	0	1
Avocado experience (yrs)	305	6	2.893	1	15
Main variety (1=improved)	305	.692	.463	0	1
Seedling source (1=formal)	305	.662	.474	0	1

4.1.2 Participation Intensity in Avocado Farming

Following Parker et al. (2025), participation intensity was classified into three groups: low (5–99 trees per homestead), medium (100–249 trees), and high (250 trees and beyond). Of the 305 households, 29.2% (89 farmers) were classified as low-intensity, 34.1% (104 farmers) as medium-intensity, and 36.7% as high-intensity (112 farmers) (Figure 2). The fact that more than 70% of farmers fell into the medium or high groups suggests that avocado is moving well beyond a just supplementary crop and becoming a dominant commercial activity in the study area.

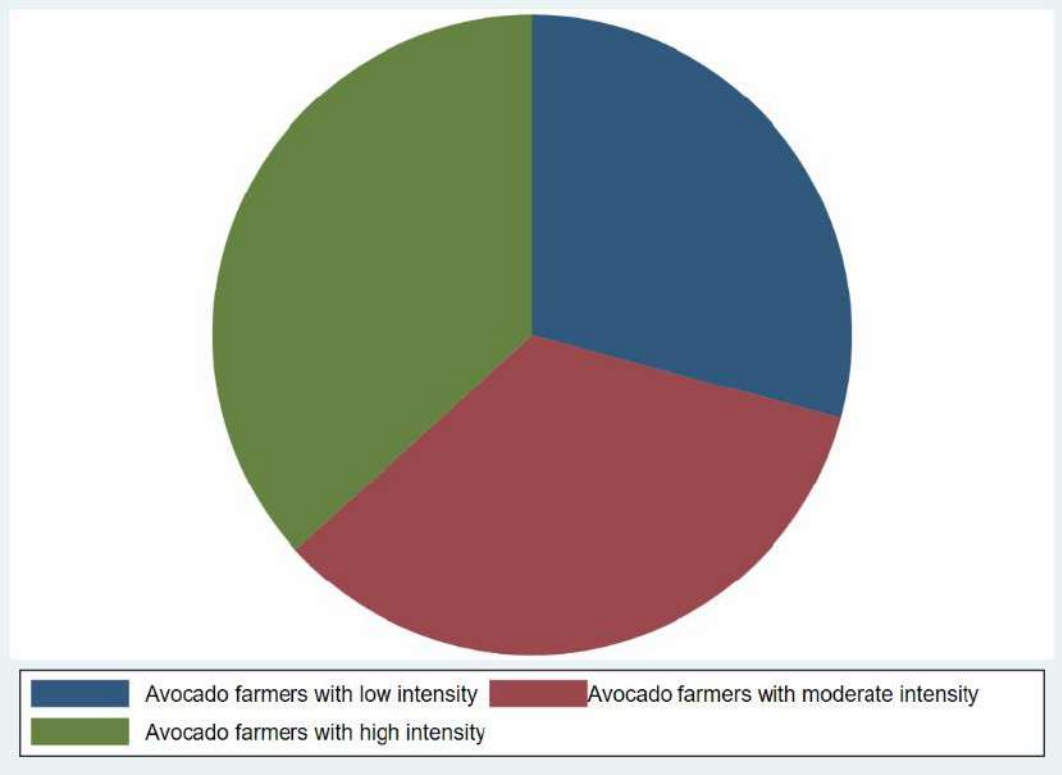

Figure 2

Distribution of Participation Intensity

4.1.3 Income Status of the Surveyed Avocado Farmers

Table 2 shows that avocado is the central income source among the sampled farming households. Net avocado revenue per acre far surpasses what farmers earn from other crops, livestock, or off-farm work, confirming the crop's appeal as a cash earner in Njombe with huge incentive for farmers to participate in higher intensity.

Table 2
Household Income Statistics (TZS)

Variable	Mean	Std. Dev.	Min	Max
Net avocado revenue/yr/acre	2,364,784	13,762,023	0	3,350,600
Other crops revenue/yr/acre	212,269.5	376,108.3	0	4,000,000
Livestock revenue/yr/acre	211,323.5	402,813.8	0	4,000,000
Off-farm income/year	540,786.9	1,103,074	0	8,000,000
Total household income	3,292,707	1,653,051.3	550,000	10,250,700

Total household income averaged TZS 3.29 million per year, but the wide standard deviation suggests large differences in participation levels and access to complementary income sources.

Table 3
ANOVA for Household Income by Participation Intensity

Source	SS	df	MS	F	Prob > F
Between groups	340.663	2	170.332	54.34	0.0000
Within groups	946.651	302	3.135		
Total	1287.314	304	4.235		

One-way ANOVA (Table 3) confirmed that mean incomes vary significantly across the three intensity groups ($F = 54.34$, $p < 0.001$). Bartlett's test rejected the null of equal variances ($\chi^2 = 119.69$, $p < 0.001$), implying that income dispersion widens as participation deepens. Together with Figure 3, which shows a roughly normal log-income distribution, these results clearly show that avocado farming intensity as a key driver of income diversification among Njombe's smallholders.

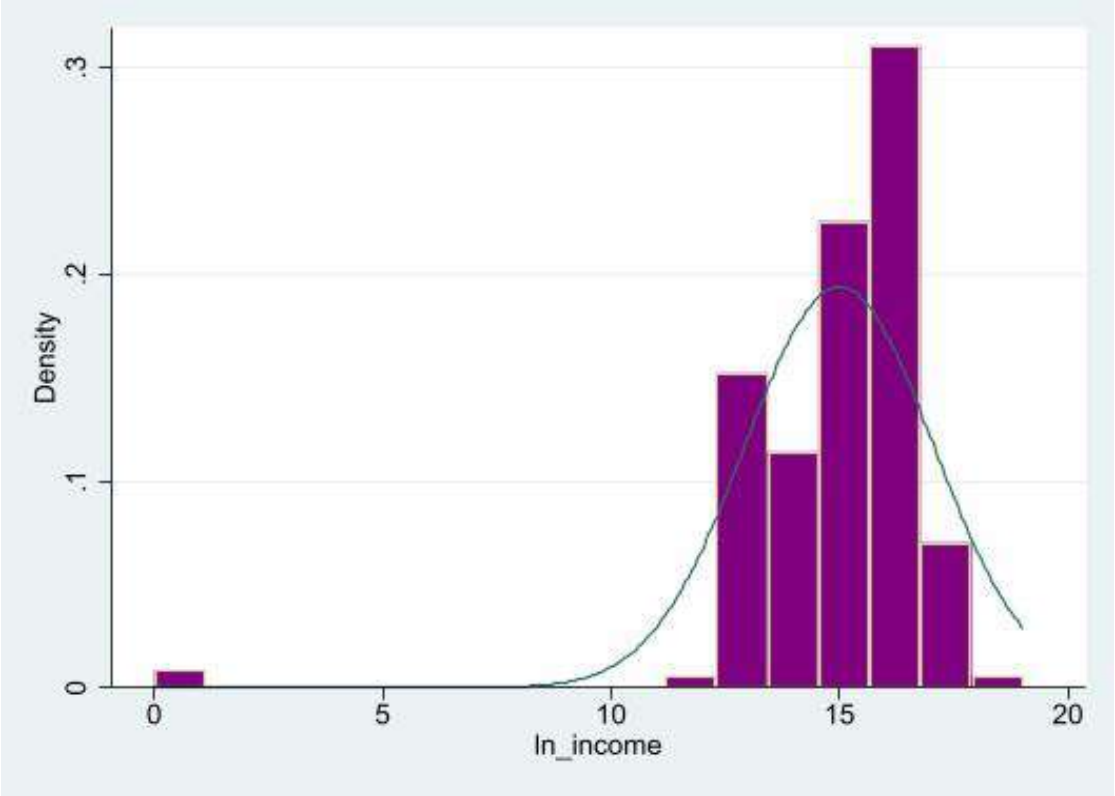

Figure 3
Distribution of Income among Surveyed Farming Households

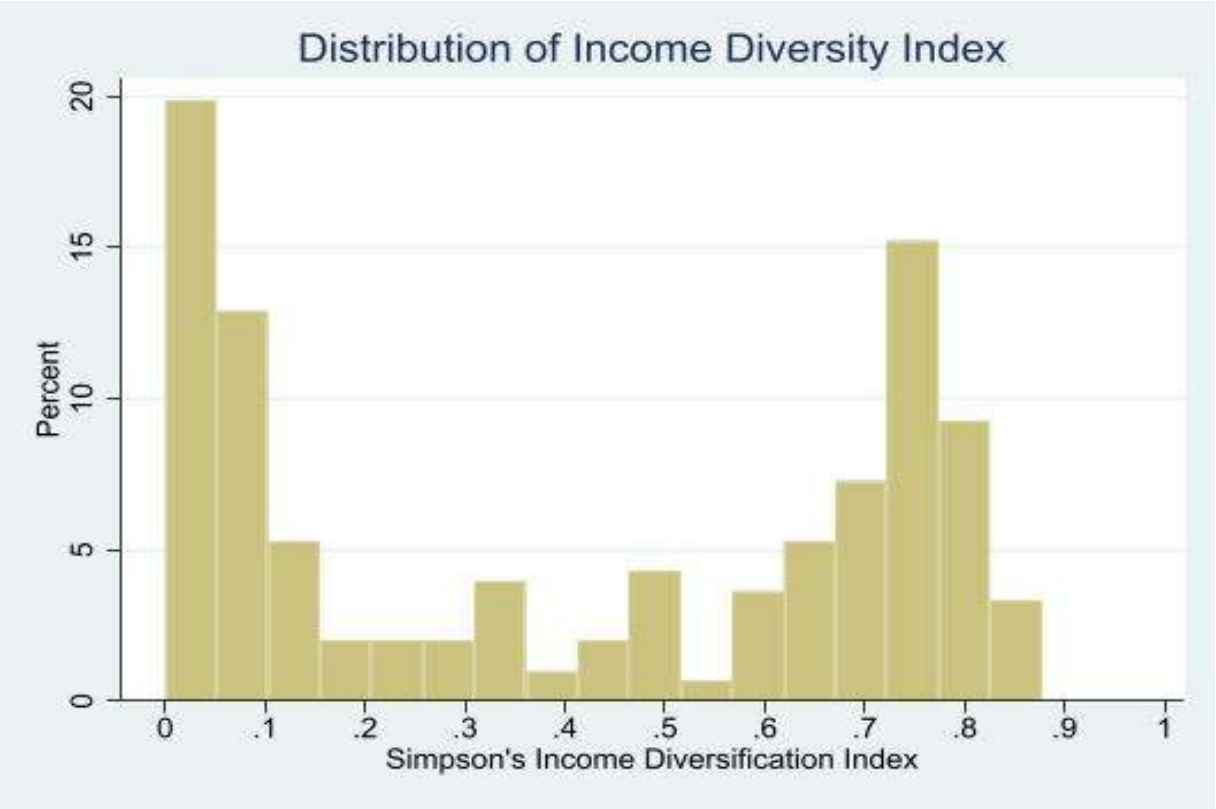

Figure 4
Distribution of Simpson Income Diversity Index

Figure 4 reveals two groups of households, one at the low end of the SIDI (indicating income specialisation) and another at higher values (indicating diversified income portfolios). This shape supports the use of a fractional logit model and reflects the varying livelihood strategies adopted in response to differing levels of avocado farming involvement.

4.1.4 Determinants of Income Diversification

Table 4 shows the fractional logit results where the model fits well (Pseudo $R^2 = 0.523$, Wald $\chi^2 = 191.62$, $p < 0.001$). The key finding is a clear negative relation between avocado intensity and income diversification. It is evident that medium-intensity farmers had a coefficient of -0.620 ($p < 0.01$) and high-intensity farmers -2.068 ($p < 0.001$), indicating that as households commit more land and labour to avocado, they draw resources away from other income-generating activities. In practical terms, moving from low to high intensity is linked with roughly a 68% fall in the SIDI value. This finding is consistent with the SLF proposition that reallocation of livelihood assets toward a single high-return activity narrows the income base for other enterprises, a pattern also documented for cash crops in Ethiopia (Hirvonen & Hoddinott, 2017) and cocoa in Ghana. In Zambia specifically, Nkonde et al. (2021) reported a 30–40% reduction in income diversification among smallholders who commercialised high-value vegetables.

Table 4
Fractional Logit Results for Income Diversification (SIDI)

Variable	Coefficient (Std. Err.)
Participation intensity (Medium)	-0.620** (0.008)
Participation intensity (High)	-2.068*** (0.001)
Years spent in education	0.035* (0.009)
Gender (1 = male)	0.231 (0.023)
Household size	0.108 (0.011)
Main variety (1 = hybrid)	0.512 (0.020)
Marital status (1 = married)	0.195* (0.003)
Access to financial services (by borrowing)	0.09** (0.010)
Constant	-0.508 (0.023)

Pseudo $R^2 = 0.523$; Wald $\chi^2(8) = 191.62$; Prob > $\chi^2 = 0.0000$
****, **, and * denote significance at 1%, 5%, and 10% levels, respectively.*

Holding other things unchanged, years of education had a positive effect (0.035, $p < 0.10$), suggesting that better-educated farmers are more capable of managing several income streams at once conforming to findings by Asfaw et al. (2019) and Bezu and Barrett (2012). Access to financial services and borrowing was also positively significant (0.09, $p < 0.05$), implying that credit and savings help farmers invest in complementary activities without having to abandon ongoing enterprises (Adjognon et al., 2016). Married farming household heads showed higher diversification (0.195, $p < 0.10$), likely because spousal labour pooling allows different household members to engage in multiple economic activities (Doss et al., 2017).

4.1.5 Avocado Participation Intensity and Household Food Diversity

Table 5 cross-tabulates food consumption categories against participation intensity. The Pearson χ^2 of 24.76 ($p < 0.001$) confirms a strong association between the two. Among low-intensity avocado farmers, 2.25% of them fell into the 'poor' category, 16.85% were in 'borderline,' and 80.9% actually achieved 'acceptable' food consumption. Medium-intensity farmers had a higher share in the 'poor' category (8.65%) compared to other intensity groups possibly reflecting households still in the transition phase of establishing productive avocado systems. while 62.5% reached 'acceptable.' Notably, not a single high-intensity farmer fell into the 'poor' category, although the proportion classified as 'acceptable' was 59.82%, with 40.18% in 'borderline.' The complete absence of poor food consumption at the highest intensity level is a noteworthy result, suggesting that avocado income enables households to clear the minimum food security threshold even if on-farm food production diversity has narrowed.

Table 5

Avocado Farmers by Participation Intensity and Food Consumption Category

FCS Category (21–35)	Low	Medium	High	Total
Poor	2 (2.25%)	9 (8.65%)	0 (0.00%)	11 (3.61%)
Borderline	15 (16.85%)	30 (28.85%)	45 (40.18%)	90 (29.51%)
Acceptable	72 (80.90%)	65 (62.50%)	67 (59.82%)	204 (66.89%)
Total	89 (100%)	104 (100%)	112 (100%)	305 (100%)

Pearson $\chi^2 = 24.76$, Prob = 0.0001

The ordered logit model (Table 6) confirms these descriptive patterns while controlling for covariates (Pseudo $R^2 = 0.532$, $\chi^2 = 142.46$, $p < 0.001$). Both medium and high intensity coefficients are negative (-1.001 and -0.158, respectively), which in the ordered logit framework means they reduce the probability of being in a lower food consumption category, effectively pushing households toward better food security. Household income is positively associated with food security (0.218, $p < 0.01$), confirming the SLF prediction that the income pathway mediates the link between commercialisation and nutrition (Ruel et al., 2018). Household size had a negative effect (-0.089, $p < 0.10$), reflecting the consumption pressure of feeding more mouths with a given budget (Headey & Ecker, 2013). Male-headed households had lower food security than female-headed ones (-0.306, $p < 0.05$), possibly because women tend to allocate a larger share of income to food (Doss et al., 2017; Quisumbing et al., 2021). Younger household heads also fared worse (-0.103, $p < 0.01$), likely due to fewer accumulated assets and weaker market networks.

Table 6

Ordered Logit Results for Household Food Consumption (FCS)

Variable	Coefficient (Std. Err.)
Participation (moderate)	-1.001** (0.006)
Participation (high)	-0.158*** (0.012)
Household income	0.218** (0.001)
Household size	-0.089* (0.022)
Years of education	0.041 (0.050)
Marital status (1 = married)	0.218 (0.076)
Gender (1 = male)	-0.306* (0.014)
Access to finance (1 = borrowed)	-0.323 (0.101)
Land tenure (1 = formal)	0.213 (0.031)
Age group (1 = youth)	-0.103** (0.005)

*Pseudo $R^2 = 0.532$; $\chi^2 = 142.462$; Prob > $\chi^2 = 0.000$. ***p<.01, **p<.05, *p<.1*

4.2 Discussion

4.2.1 Income Effects of Avocado Participation

Avocado farming substantially boosts household incomes for smallholder farmers in Njombe, Tanzania, with ANOVA results ($F = 54.34$, $p < 0.001$) confirming marked differences across participation intensity groups, high-intensity farmers consistently outperform their low-intensity peers. This pattern aligns with regional evidence, such as Kenyan studies where collective marketing raised avocado farmers' incomes by 47%, scaling with production volume (Kwizerimana et al., 2023), and findings in Rwanda were potatoes and coffee outperforming staples like maize or rice in profitability and comparative advantage across Rwandan provinces (Jenkins et al., 2017). Superior gross margins (3–5 times those of maize or beans), access to premium export markets through firms like Africado, and perennial yields that stabilize cash flows underpin these gains (Boniphace et al., 2023; Huang et al., 2023; World Bank, 2020).

However, such benefits are conditional, depending on reliable market linkages, extension support, credit, and management skills (Bezu & Barrett, 2012). Substantial income variance within groups underscores uneven access, signalling a need for targeted analysis of barriers facing less successful farmers.

4.2.2 Diversification Trade-offs

Fractional logit analysis reveals a clear downside: medium (-0.620) and high-intensity (-2.068) avocado engagement significantly reduces income diversification, as households redirect limited land, labor, and capital toward the most profitable option (Zwane & Ferrer, 2024). Comparable dynamics appear in Ethiopia's teff systems, Ghana's cocoa farms, and northern Tanzania's high-value vegetables, where commercialization cuts diversity by 30–40% (Hirvonen & Hoddinott, 2017; Koppmair et al., 2017).

This specialization yields short-term advantages in scale and expertise but heightens exposure to shocks, including COVID-19 disruptions in Kenya's export vegetable sector and broader risks from price volatility or pests (Kwizerimana et al. 2023). A "managed specialization" approach pairing avocados with livestock, off-farm work, or secondary crops, offers a balanced path to resilience (Bezu & Barrett, 2012). In Njombe, policies promoting complementary activities could protect gains without undermining avocado's momentum.

4.2.3 Food Security and Nutrition Outcomes

Despite narrower income streams, avocado intensity enhances food security, as ordered logit results show, with zero poor consumption scores among high-intensity farmers. This reflects income's primacy over on-farm diversity in driving nutrition, enabling market purchases of diverse foods like fruits, proteins, and fortified items (Huang et al., 2023; Zwane & Ferrer, 2024). Evidence from Kenya's vegetable contracts (18–25% diet score gains) and Vietnam's aquaculture mirrors this pathway, reinforced by Njombe's accessible markets (Ruel et al., 2018; Malekela, 2022; FAO, 2023).

Qualifying factors include vulnerability to shocks eroding purchasing power, potential intra-household inequities, and inflation pressures on net buyers (Asfaw et al., 2019).

4.2.4 Key Controls and Policy Insights

Model controls reveal structural influences: larger households face diluted per-capita food access (-0.089, $p < 0.10$), female heads surpass males (-0.306, $p < 0.05$) through child-prioritizing allocations, and older farmers benefit from accumulated assets (-0.103, $p < 0.01$). Youth exclusion from high-value opportunities calls for intergenerational interventions (Adjognon et al., 2016; Ellis, 2000).

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study examined how avocado farming shapes income diversification, and food consumption among 305 smallholder households in Njombe, Tanzania. Three findings grounded in the Sustainable Livelihoods Framework (SLF) stand out. First, avocado farming substantially raises household income, with statistically significant differences across participation intensity groups. Second, higher avocado involvement leads to income specialisation, as reflected in large negative fractional logit coefficients; education and financial access partly counteract this narrowing. Third, despite less diversified income, households that farm avocado more intensively eat better: high-intensity farmers recorded no cases of poor food consumption, compared with 18.2% among low-intensity farmers, an effect that operates mainly through the income–food access pathway. For Njombe, avocado has clearly moved from a supplementary crop to a livelihood pillar, offering tangible poverty-reduction and nutrition benefits while simultaneously raising questions about household resilience should the avocado market face disruption.

5.2 Recommendations

Several policy actions follow from these findings. Specifically agricultural extension and market support programmes should continue to promote avocado production while actively encouraging farmers to maintain at least two or three complementary income sources, moving away from single-crop promotion toward integrated livelihood planning. Given the strong positive link between financial access and income diversification, expanding rural financial services, through agricultural cooperative savings and credit schemes (SACCOS), mobile money, avocado-tailored seasonal credit, and index-based insurance should be a priority, accompanied by financial literacy training.

The positive role of education further highlights the need for investment in rural secondary schooling and farmer training that goes beyond agronomic skills to include financial management, market analysis, and risk assessment. Because avocado income improves food security but does not guarantee nutritional quality, extension programmes and public–private partnerships (for example, out-grower schemes run by companies like Africado) should incorporate nutrition education components. Finally, avocado promotion should be embedded within broader regional food security and agricultural transformation strategies, with coordinated platforms that bring together government, private-sector actors, non-governmental organisations, and farmer cooperatives to align crop-pattern planning with nutritional objectives.

REFERENCES

Adjognon, S. G., Liverpool-Tasie, L. S. O., & Reardon, T. (2016). Agricultural input credit in sub-Saharan Africa: Telling myths from facts. *Food Policy, 83*, 93–105. https://doi.org/10.1016/j.foodpol.2016.09.014

Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from sub-Saharan Africa. *World Development, 117*, 278–295.

Babbie, E. R. (1990). *Survey research methods* (2nd ed.). Wadsworth Publishing Company.

Bezu, S., & Barrett, C. (2012). Employment dynamics in the rural nonfarm sector in Ethiopia: Do the poor have time on their side? *The Journal of Development Studies, 48*(9), 1223–1240. https://doi.org/10.1080/00220388.2012.671476

Boniphace, J., Kadigi, R. M., & Kangile, J. R. (2023). Effects of avocado farming on livelihoods and biodiversity: Perspectives of smallholder farmers in Hai and Rungwe Districts, Tanzania. *Open Journal of Social Sciences, 11*(11), 474–505.

Charles, R., Munishi, P., & Nzunda, E. (2014). Agroforestry as a resilient strategy in mitigating climate change in Mwanga District, Kilimanjaro, Tanzania. *Global Journal of Biology, Agriculture and Health Sciences, 3*(2), 11–17.

Doss, C., Meinzen-Dick, R., Quisumbing, A., & Theis, S. (2017). Women in agriculture: Four myths. *Global Food Security, 16*, 69–74.

Duarte, P. F., Chaves, M. A., Borges, C. D., & Mendonça, C. R. B. (2016). Avocado: Characteristics, health benefits and uses. *Ciência Rural, 46*(4), 747–754.

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.

Food and Agriculture Organization of the United Nations. (2023). *The state of food security and nutrition in the world 2023*. FAO.

Headey, D., & Ecker, O. (2013). Rethinking the measurement of food security: From first principles to best practice. *Food Security, 5*, 327–343.

Hirvonen, K., & Hoddinott, J. (2017). Agricultural production and children's diets: Evidence from rural Ethiopia. *Agricultural Economics, 48*(4), 469–480.

Huang, K., Guan, Z., Blare, T., & Hammami, A. M. (2023). Global avocado boom. *Choices, 38*(4), 1–10.

Jenkins, G. P., Miklyaev, M., Ujeneza, N., Afra, S., Matanhire, B., Basikiti, P., & Nsenkyire, A. (2017). *Comparative economic advantage of crop production in Rwanda* (Development Discussion Paper No. 2017-19). Cambridge Resources International. https://cri-world.com/publications/qed*dp*3006

Kingu, E. J., & Kinyondo, G. (2024). Evaluation of avocado production and export as a source of prosperity to smallholder farmers: A case of Wanging'ombe District Mdandu Division, Tanzania. *African Journal of Empirical Research, 5*(3), 748–757. https://doi.org/10.51867/ajernet.5.3.64

Kipkorir, P., Ngeno, V., & Chumo, C. (2023). Impact of agricultural commercialization on household food insecurity in Kenya. *African Journal of Education, Science and Technology (AJEST), 7*(3), 187–206. https://ajest.org/index.php/ajest/article/view/434

Koppmair, S., Kassie, M., & Qaim, M. (2017). Farm production, market access and dietary diversity in Malawi. *Public Health Nutrition, 20*(2), 325–335.

Kothari, C. R. (2014). *Research methodology: Methods and techniques* (3rd ed.). New Age International.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610.

Kwizerimana, S., Mugwe, J., & Nigat, B. (2023). Impact of collective marketing participation on farmers' income: Evidence from smallholder avocado farmers of Murang'a County, Kenya. *Social Sciences & Humanities Open, 8*(1), 100614.

Macha, D. E., Chegere, M. J., & Munuo, A. (2025). Gendered pathways to nutrition in Tanzania: The interplay of household dynamics, food affordability and adaptive strategies (PASHFARM Policy Brief No. 9). African Economic Research Consortium (AERC). https://publication.aercafricalibrary.org/items/dcff5838-03b4-44b7-b9eb-b6ab9f9e7fa3

Malekela, A. A. (2022). Value chain challenges: Experiences from avocado farmers and traders in Njombe Town, Tanzania. *East African Journal of Education and Social Sciences, 3*(2), 17–25.

Namwata, B., & Lwelamira, J. M. O. B. (2010). Adoption of improved agricultural technologies for Irish potatoes (Solanum tuberosum) among farmers in Mbeya Rural District, Tanzania: A case of Ilingu Ward. *Journal of Animal & Plant Sciences, 8*, 927–935.

Nkonde, C., Audain, K., Kiwanuka-Lubinda, R. N., & Marinda, P. (2021). Effect of agricultural diversification on dietary diversity in rural households with children under 5 years of age in Zambia. *Food Science & Nutrition, 9*(11), 6274–6285. https://doi.org/10.1002/fsn3.2587

Parker, L., Bourgoin, C., Martinez-Valle, A., & Läderach, P. (2019). Vulnerability of the agricultural sector to climate change: The development of a pan-tropical climate risk vulnerability assessment to inform sub-national decision making. *PLOS ONE, 14*(3), e0213641. https://doi.org/10.1371/journal.pone.0213641

Quisumbing, A. R., Sproule, K., Martinez, E. M., & Malapit, H. (2021). Do tradeoffs among dimensions of women's empowerment and nutrition outcomes exist? *Food Policy, 100*, 102001.

Ruel, M. T., Quisumbing, A. R., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security, 17*, 128–153.

Swai, L., & Ubaldus, T. (2023). Avocado households farmers decision making in Southern Highlands of Tanzania: A case of Njombe Urban. *European Journal of Theoretical and Applied Sciences, 1*(5), 1363–1371.

Tumaini, S., Ghahula, R., & Macha, S. (2024). The impact of transportation on the avocado market in Tanzania. *ESI Preprints, 20*(22), 1–1.

United Republic of Tanzania. (2020). *Njombe Region socio-economic profile, 2018*. Ministry of Finance and Planning.

World Bank. (2020). *World development report 2020: Trading for development in the age of global value chains*. World Bank.

Yamane, T. (1967). *Mathematical formulae for sample size determination* (2nd ed.). Harper & Row.

Zwane, S., & Ferrer, S. R. D. (2024). Competitiveness analysis of the South African avocado industry. *Agrekon, 63*(4), 277–302.