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Sustainable Fishing Practices and the Livelihoods of Fishermen in Rwanda: Evidence from Lakes Muhazi, Ihema, and Cyohoha in the Eastern Province

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Abstract: *This study examined the relationship between sustainable fishing practices and household livelihood outcomes among fishermen on Lakes Muhazi, Ihema, and Cyohoha in Rwanda's Eastern Province for 2020–2026. From 569 members registered with the fishing cooperative on each lake, 235 respondents were selected by proportional stratified random sampling (Muhazi, 38; Ihema, 43; Cyohoha, 154) and surveyed with a structured Likert questionnaire. Analysis used descriptive statistics, Pearson correlation, multiple and simple regression, t-tests, and one-way ANOVA. Reported adoption was very high for most practices (composite means 4.42–4.58) but lower for aquaculture (M = 4.06). Eight of nine practice constructs correlated positively with the Household Livelihood Composite (r = .241–.533, p < .001); aquaculture did not (r = .066). The nine-predictor model explained 46.9% of the variance, with market-value practices the strongest predictor; Ha1, Ha2, Ha3, and Ha5 were supported, and Ha4 was not. Perceived outcomes did not differ significantly across lakes. Lake-level records show combined fish production rising from 8.5 to 19.5 tonnes per month and, with landing-site prices rising from RWF 2,500 to 3,500/kg, gross monthly income per member rising from RWF 73,276 to RWF 119,947 (63.7%) between 2020 and 2026. Ihema ranked first, Muhazi second, and Cyohoha, with the largest membership, a distant third (RWF 51,747 per member in 2026). Conservation compliance appears to support welfare most when combined with collective organisation, training, and post-harvest value addition.*

Keywords: *Sustainable Fishing; Livelihoods; Co-Management; Post-Harvest Value Addition; Fish Prices; Food Security; Rwanda*

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1. Introduction

Small-scale fisheries support food security, employment, and income, and fish is a concentrated source of protein and micronutrients (Béné et al., 2016; FAO, 2022; Hicks et al., 2019). In densely populated Rwanda (National Institute of Statistics of Rwanda [NISR], 2023), lakes supply food and cash income to riparian communities, and national policy prioritises fisheries and aquaculture (Ministry of Agriculture and Animal Resources [MINAGRI], 2018; MINAGRI & Rwanda Agriculture and Animal Resources Development Board [RAB], 2023). National fish production rose from 32,756 tonnes in 2020 to 52,439 tonnes in 2025 (Nyandwi, 2026a), while retail prices for tilapia approached RWF 6,000/kg by 2025–2026 (AllAfrica, 2025; Nyandwi, 2026b).

Sustainable practices can protect stocks and raise returns, but their livelihood benefits depend on compliance costs, institutional legitimacy, and market access (Natugonza et al., 2020; Owusu et al., 2023). Evidence that considers these practices jointly, and that treats livelihood as multidimensional rather than as income alone (Chambers

& Conway, 1992; Scoones, 2015), remains scarce for Rwanda's smaller inland lakes. This study addresses that gap. By linking responsible fishing to household welfare, the study supports SDG 1 (No Poverty), SDG 2 (Zero Hunger, particularly Target 2.3 on small-scale producers' incomes), SDG 3 (Good Health), SDG 4 (Quality Education), SDG 12 (Target 12.3 on post-harvest losses), and SDG 15 (Target 15.1 on inland freshwater ecosystems) (United Nations, 2015).

The general objective was to assess the effect of sustainable fishing practices on the livelihoods of fishermen on Lakes Muhazi, Ihema, and Cyohoha for 2020–2026. The specific objectives were to determine the effects on household livelihood outcomes of (i) gear-regulation compliance, (ii) seasonal-ban compliance, (iii) cooperative and co-management participation, (iv) aquaculture integration, and (v) post-harvest handling and packaging. The corresponding directional hypotheses (Ha1–Ha5) state that each practice is positively associated with household livelihood outcomes.

2. Literature Review

2.1 Theoretical Perspectives

Three theoretical perspectives frame the study. The Sustainable Livelihoods Framework views welfare as the product of natural, physical, financial, human, and social capital (Department for International Development [DFID], 1999; Scoones, 2015), which sustainable practices can strengthen. Common-Pool Resource theory explains compliance as embedded in collective institutions that are legitimate, participatory, and credibly monitored (Cox et al., 2010; Ostrom, 1990, 2009), which is pertinent to transboundary Cyohoha and to Ihema within Akagera National Park. The Blue Economy perspective emphasises value creation along the aquatic value chain while warning that benefits may be unevenly distributed (Bennett et al., 2019; World Bank & United Nations Department of Economic and Social Affairs, 2017).

2.2 Conceptual Framework

Figure 1 summarises the hypothesised relationships: the five practice domains are expected to influence a multidimensional livelihood outcome, conditioned by governance, cooperative, market, and infrastructural factors.

2.3 Empirical Evidence and Research Gap

Intensified enforcement against illegal gear on Lake Victoria did not produce measurable biomass gains, partly because of limited compliance (Nyamweya et al., 2023), and closed-season compliance in Ghana depended on perceived effectiveness, enforcement, and compensation (Owusu et al., 2023). Co-management generally benefits resource users (Evans et al., 2011), especially where leadership and adaptive management are strong (d'Armengol et al., 2018; Gutiérrez et al., 2011). African aquaculture remains constrained by capital and inputs (Brummett et al., 2008), whereas reducing post-harvest losses raises returns without additional fishing effort (Affognon et al., 2015; Kruijssen et al., 2020). Few studies test these practices jointly against a multidimensional livelihood outcome in Rwanda.

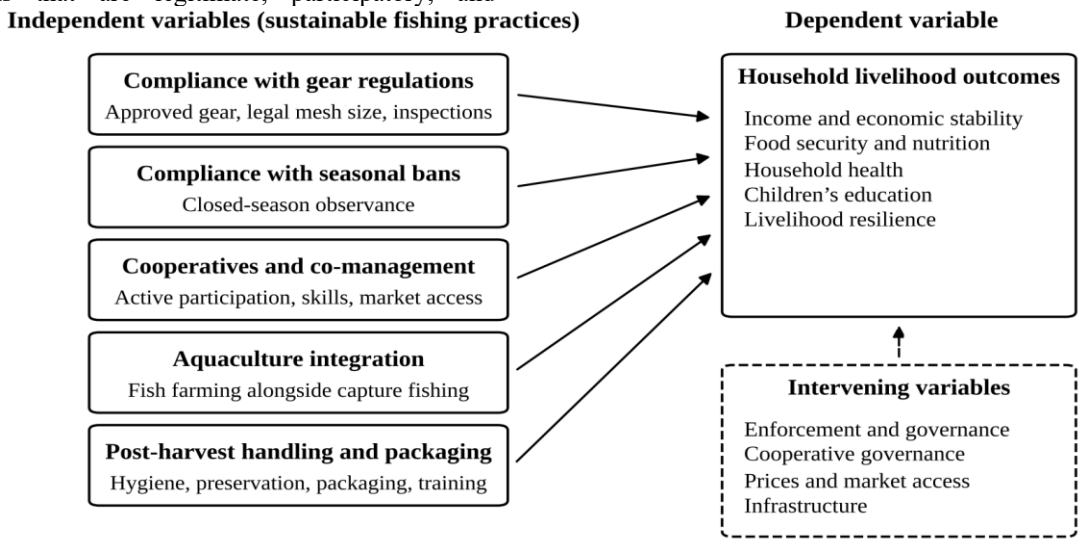


Figure 1: ***Conceptual Framework of Sustainable Fishing Practices and Household Livelihood ::Outcomes Source.*** **Authors' construction based on DFID (1999), Ostrom (1990), and Scoones (2015).**

3. Methodology

3.1 Design, Study Area, and Sampling

A quantitative, cross-sectional explanatory design was adopted, with data collected in 2026 and perception items referring to change since 2020. Data were collected through the three registered fishing cooperatives, one operating on each lake; because each cooperative corresponds to a single lake, all results are reported by lake. The target population comprised the 569 registered members on the three lakes. Yamane's (1967) formula, $n = N / [1 + N(e)^2]$ with $e = .05$, gave 234.88, rounded to 235. Respondents were allocated proportionally and selected randomly within each lake (Table 1). Each stratum was sampled at about 41%, so the pooled sample is self-weighting; Cyohoha contributes 65.5% of respondents.

Table 1: Study Population and Sample Allocation by Lake

Lake	District	Governance context	Registered members (*N*)	Sample (*n*)	Share of sample (%)
Muhazi	Rwamagana	Inland lake; district and cooperative management	92	38	16.2
Ihema	Kayonza	Within Akagera National Park	105	43	18.3
Cyohoha	Bugesera	Transboundary lake shared with Burundi	372	154	65.5
Total			**569**	**235**	**100.0**

Note. Sampling fraction = $n \div N \times 100$. *Source.* Primary Data, 2026 (membership registers of the fishing cooperative operating on each lake); sample allocation computed by the authors.

3.2 Survey Instrument and Reliability

A structured questionnaire with five-point Likert items (1 = strongly disagree; 5 = strongly agree) measured nine practice constructs and five livelihood domains; the latter form the Household Livelihood Composite, the dependent variable. Composite scores are item means. Content validity was confirmed by expert review (content validity index = .93). Cronbach's alpha ranged from .744 to .898 for 13 scales; preservation and storage ($\alpha = .619$) fell below .70 and is interpreted cautiously.

2,400 kcal per adult equivalent per day plus an allowance for essential non-food consumption (NISR, 2025b). Because the national EICV7 headcount refers to individuals, whereas the lake-level indicators refer to households, comparisons between the two are indicative only.

Table 2: Definitions of the Lake-Level Indicators

Domain	Indicator	Definition and measurement	Unit
Economic	Production; post-harvest loss	Midpoint of the reported monthly landing range; (landed − marketed) ÷ landed × 100	t/month; %
	Gross monthly income; gross income per member	Midpoint production (kg) × annual landing-site price per kg; gross monthly income ÷ registered members	RWF; RWF/month
	Economic Welfare Index (HEWI)	0.4 × (gross monthly income per member ÷ RWF 300,000 × 100) + 0.3 × % saving regularly + 0.3 × % owning a productive asset	0–100
	Poverty headcount ratio (P0)	Percentage of households whose annual consumption expenditure per adult equivalent is below the EICV7 national poverty line (January 2024 prices); P0 = poor households ÷ all households × 100	% of households
Food security	Meals; acceptable food consumption	Adult meals in previous 24 hours; households with Food Consumption Score > 35	Number; %
	MAHFP; food share; fish consumption	Months of adequate household food provisioning; food share of total expenditure; days per week fish eaten	Months; %; days
Health	Facility visits; appropriate treatment	Visits per household per month; ill members treated by a qualified provider	Visits; %

Domain	Indicator	Definition and measurement	Unit
	CBHI coverage; forgone care	All members insured; ill member untreated because of cost	%
Education	Enrolment; dropout	Children aged 6–18 enrolled; enrolled children leaving during the year	%
	Completion; status	Completion of P6, S6, university; status of children aged 6–24 in 2026	%; *n*

Note. Production, price, and membership values follow lake-level records and estimates; all other indicator values are hypothetical. MAHFP = months of adequate household food provisioning; CBHI = community-based health insurance. *Source.* Authors' indicator framework; Primary Data, 2026; poverty and food-consumption indicators as defined in Foster et al. (1984) and NISR (2025b, 2025c).

3.4 Data Analysis and Ethics

Survey data were analysed with descriptive statistics, Pearson correlation, multiple and simple regression, *t*-tests, and one-way ANOVA (α = .05; one-tailed for directional hypotheses). Mean scores were interpreted as 1.00–1.80 very low, 1.81–2.60 low, 2.61–3.40 moderate, 3.41–4.20 high, and 4.21–5.00 very high. Regression assumptions were met (VIF < 5). Lake-level indicators are summarised by mean, *SD* (*n* = 7 years), coefficient of variation, percentage change, and compound annual growth rate (CAGR). Ethical procedures followed accepted standards for research involving human participants. Access to respondents and to the membership registers was authorised by the leadership of the fishing cooperative on each lake. Before each questionnaire was administered, enumerators explained the purpose of the study, the expected duration of the interview, and how the data would be used, in the language preferred by the respondent, and informed consent was obtained before any question was asked. Participation was voluntary: respondents could decline to answer any question or withdraw at any stage without any consequence for their cooperative membership or access to cooperative services. To protect anonymity and confidentiality, no names or other personal identifiers were recorded on the questionnaires; each respondent was assigned a numeric code, the data were stored securely and accessed only by the research team, and results are reported only in aggregate form, by lake and for the pooled sample, so that no individual respondent can be identified.

4. Results and Discussion

4.1 Adoption of Sustainable Fishing Practices

Table 3: Lake-Level Profile of Sustainable Fishing Practices

Practice construct	Muhazi (rank: 2)	Ihema (rank: 1)	Cyohoha (rank: 3)	Pooled *M*
Compliance, participation, and diversification				
Gear-regulation compliance (Ha1)	4.68	4.78	4.42	4.53
Seasonal-ban compliance (Ha2)	4.60	4.71	4.33	4.44
Cooperative and co-management participation (Ha3)	4.71	4.81	4.47	4.57
Aquaculture integration (Ha4)	4.30	4.45	3.89	4.06
Post-harvest handling and packaging (Ha5)				
Hygienic handling	4.70	4.79	4.46	4.56
Preservation and storage †	4.61	4.72	4.29	4.42
Post-harvest knowledge and training	4.67	4.78	4.38	4.50
Market value and income	4.73	4.82	4.48	4.58
Packaging	4.63	4.74	4.34	4.46
Post-harvest handling and packaging composite	**4.67 (2)**	**4.77 (1)**	**4.39**	**4.50**
Mean of nine practice composites	**4.63 (2)**	**4.73 (1)**	**4.34 (3)**	**4.46**
Mean rank (1 = best)	**2.00**	**1.00**	**3.00**	**—**

Note. Cells show composite means with ranks in parentheses (1 = highest of the three lakes). Lake values are constructed so that their sample-weighted mean (*n* = 38, 43, and 154) reproduces the pooled composite in Tables 4–6. On the interpretation scale in Section 3.4, every value is very high except aquaculture integration at Cyohoha (high). Pooled means from Primary Data, 2026.

Applying the same framework to the practice constructs (Table 3) reproduces the livelihood ranking: Ihema ranks first on all nine practice composites (mean = 4.73), Muhazi second (4.63), and Cyohoha third (4.34). Gear-regulation compliance is highest at Ihema (M = 4.78), where fishing takes place within Akagera National Park, followed by Muhazi (4.68) and Cyohoha (4.42), whose transboundary waters may be harder to monitor. Seasonal-ban compliance follows the same order (4.71, 4.60, and 4.33), and the lower Cyohoha score is consistent with the higher relative cost of forgoing fishing where income per member is lowest. Cooperative and co-management participation is very high on every lake but strongest at Ihema (4.81) and Muhazi (4.71), and weakest at Cyohoha (4.47), where rapid membership growth may dilute active engagement.

Aquaculture integration is the weakest domain across all lakes and the only one where a lake falls below the very high band (Cyohoha, M = 3.89, against 4.45 at Ihema and 4.30 at Muhazi). Post-harvest handling and packaging follow the same gradient (4.77, 4.67, and 4.39), with the largest gap in preservation and storage (4.72 against 4.29), which matches Cyohoha's highest post-harvest loss rate (15% in 2026; Table 8). As in Table 16, the Ihema–Muhazi gap is narrow (0.10 on the nine-composite mean), whereas Cyohoha trails both. Because these lake values are constructed and the survey found no significant lake difference in livelihood outcomes (Table 7), the parallel ranking shows how practices and welfare could align rather than establishing that they do.

Table 4: Household Livelihood Outcomes

Statement	Strongly disagree		Disagree		Neutral		Agree		Strongly agree		*M*	*SD*
	n	%	*n*	%	*n*	%	*n*	%	*n*	%		
Income and economic stability												
Household income has increased since adopting sustainable fishing practices.	2	0.9	0	0.0	8	3.4	53	22.6	172	73.2	4.67	0.63
Household income is more stable than before 2020.	5	2.1	2	0.9	10	4.3	67	28.5	151	64.3	4.52	0.80
The household saves money regularly from fishing activities.	0	0.0	3	1.3	14	6.0	67	28.5	151	64.3	4.56	0.67
The household has invested in productive assets.	3	1.3	6	2.6	15	6.4	65	27.7	146	62.1	4.47	0.83
Composite (α = .811; very high)											**4.55**	**0.59**
Food security and nutrition												
The household has enough food throughout the year.	1	0.4	4	1.7	13	5.5	29	12.3	188	80.0	4.70	0.69
Household fish consumption has improved.	4	1.7	2	0.9	10	4.3	48	20.4	171	72.8	4.62	0.76
The family rarely skips meals because of food shortages.	5	2.1	2	0.9	10	4.3	53	22.6	165	70.2	4.58	0.80
Composite (α = .744; very high)											**4.63**	**0.61**
Household health												
The household can afford healthcare expenses.	1	0.4	2	0.9	10	4.3	65	27.7	157	66.8	4.60	0.66
Household nutrition has improved over the last three years.	5	2.1	2	0.9	9	3.8	74	31.5	145	61.7	4.50	0.80
Household members access medical services promptly when needed.	4	1.7	4	1.7	21	8.9	63	26.8	143	60.9	4.43	0.86
Composite (α = .764; very high)											**4.51**	**0.64**
Children's education												
All school-age children in the household attend school regularly.	7	3.0	0	0.0	9	3.8	68	28.9	151	64.3	4.51	0.83
Fishing income enables me to pay school expenses.	7	3.0	3	1.3	15	6.4	66	28.1	144	61.3	4.43	0.90

Statement	Strongly disagree		Disagree		Neutral		Agree		Strongly agree		*M*	*SD*
	n	%	*n*	%	*n*	%	*n*	%	*n*	%		
Children's school attendance has improved since 2020.	6	2.6	7	3.0	12	5.1	65	27.7	145	61.7	4.43	0.91
Composite (α = .772; very high)											**4.46**	**0.73**
Livelihood resilience												
The household has diversified income sources beyond fishing.	11	4.7	1	0.4	7	3.0	55	23.4	161	68.5	4.51	0.95
The household is better able to cope with economic shocks.	3	1.3	4	1.7	15	6.4	65	27.7	148	63.0	4.49	0.80
The household's overall standard of living has improved since 2020.	3	1.3	7	3.0	22	9.4	56	23.8	147	62.6	4.43	0.88
Composite (α = .811; very high)											**4.48**	**0.75**

Note. Valid *n* = 235 for every item; see note to Table 4. *Source.* Primary Data, 2026.

All livelihood domains were rated very high (Table 4), led by food security (M = 4.63; 92.3% reported enough food throughout the year), followed by income (4.55), health (4.51), resilience (4.48), and education (4.46). Perceived: income growth (M = 4.67) exceeded asset investment (M = 4.47). Combined agreement ranged from 78.5% (aquaculture) to 92.8% (income and food security) across constructs, indicating a ceiling effect.

4.2 Relationships between Practices and Livelihood Outcomes

Eight constructs were positively correlated with livelihood outcomes ($p < .001$), most strongly market-value practices (r = .533), packaging (r = .464), training (r = .422), and cooperative participation (r = .412); aquaculture was not (r = .066, p = .313). In the joint model (Table 5), market-value practices (B = 0.234), cooperative participation (B = 0.133), gear compliance (B = 0.114), and training (B = 0.093) remained significant, and the model explained 46.9% of the variance.

Table 5: Multiple Regression of the Household Livelihood Composite on Practice Constructs

Predictor	*B*	*SE*	*t*	*p*
(Constant)	1.276	0.272	4.684	< .001
Gear-regulation compliance	0.114	0.039	2.942	.004
Seasonal-ban compliance	0.060	0.039	1.537	.126
Cooperative participation	0.133	0.044	3.006	.003
Aquaculture integration	−0.052	0.025	−2.030	.043
Hygienic handling	−0.003	0.044	−0.074	.941
Preservation and storage	0.045	0.037	1.206	.229
Packaging	0.089	0.051	1.745	.082
Post-harvest knowledge and training	0.093	0.037	2.522	.012
Market value and income	0.234	0.041	5.716	< .001

Note. n = 235. R^2 = .469; adjusted R^2 = .448; $F(9, 225)$ = 22.086; $p < .001$. *Source.* Primary Data, 2026.

Table 6: Results of Hypothesis Tests

Hypothesis	Predictor	*r*	*b*	R^2	*t*	*p* (one-tailed)	Decision
Ha1	Gear-regulation compliance	.327	0.221	.107	5.279	< .001	Supported
Ha2	Seasonal-ban compliance	.398	0.253	.158	6.623	< .001	Supported
Ha3	Cooperative participation	.412	0.320	.170	6.900	< .001	Supported
Ha4	Aquaculture integration	.066	0.032	.004	1.011	.157	Not supported

Hypothesis	Predictor	*r*	*b*	R^2	*t*	*p* (one-tailed)	Decision
Ha5	Post-harvest handling and packaging	.599	0.630	.359	11.433	< .001	Supported

Note. $n = 235$; $df = 233$. Simple linear regressions with the Household Livelihood Composite as the dependent variable. *Source.* Primary Data, 2026.

Ha1, Ha2, Ha3, and Ha5 were supported, and Ha4 was not (Table 6). Perceived livelihood outcomes did not differ significantly across the three lakes, by age, or by gender (Table 7); licensed fishermen reported significantly better post-harvest handling ($p = .007$).

Table 7: Comparisons of Mean Scores across Lakes and Respondent Groups

Grouping variable	Groups (*n*; *M*)	Outcome	Test	Statistic	*p*
Lake	Muhazi (38); Ihema (43); Cyohoha (154)	HLC	ANOVA	$F = 2.214$	.112
Age group	Age categories	HLC	ANOVA	$F = 2.207$	.069
Education level	Education categories	SFP	ANOVA	$F = 1.457$	.227
Cooperative membership	Members (205; 4.56); non-members (30; 4.33)	HLC	*t*-test	$t = 1.950$	.059
Gender	Male (168; 4.53); female (67; 4.51)	HLC	*t*-test	$t = 0.282$	.779
Fishing licence	Licensed (198; 4.54); unlicensed (37; 4.28)	PHH	*t*-test	$t = 2.822$	.007

Note. HLC = Household Livelihood Composite; SFP = Sustainable Fishing Practices score; PHH = post-harvest handling composite. $F(2, 232)$ for lake. *Source.* Primary Data, 2026.

4.3 Lake-Level Indicators, 2020–2026

This section reports the lake-level indicators described in Section 3.3. Production, price, and membership figures follow lake-level records and estimates compiled by the fishing cooperative on each lake (Primary Data, 2026); the remaining welfare indicators are hypothetical and illustrate plausible magnitudes and lake differences rather than empirical findings. Each table presents annual values for 2020–2026 with the relative change over the period, and the corresponding figure is placed immediately below it.

Table 8: Fish Production and Post-Harvest Losses by Lake, 2020–2026

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Panel A. Monthly fish production, midpoint (t/month)								
Muhazi	2.50	3.25	4.00	4.50	5.00	5.50	6.50	+160.0
Ihema	4.50	5.00	5.50	6.00	6.50	7.00	7.50	+66.7
Cyohoha	1.50	2.50	3.50	4.00	4.50	5.00	5.50	+266.7
Total (t/month)	**8.50**	**10.75**	**13.00**	**14.50**	**16.00**	**17.50**	**19.50**	**+129.4**
Total (t/year)	102	129	156	174	192	210	234	+129.4
Annual change, total (%)	—	+26.5	+20.9	+11.5	+10.3	+9.4	+11.4	—
Panel B. Reported monthly production range (t/month)								
Muhazi	2–3	3–3.5	3.5–4.5	4–5	4.5–5.5	5–6	6–7	—
Ihema	4–5	4.5–5.5	5–6	5.5–6.5	6–7	6.5–7.5	7–8	—
Cyohoha	1–2	2–3	3–4	3.5–4.5	4–5	4.5–5.5	5–6	—
Panel C. Post-harvest loss (% of landings)								
Muhazi	21	19	17	15	13	11	10	−52.4
Ihema	19	17	15	13	11	10	9	−52.6
Cyohoha	26	25	23	21	19	17	15	−42.3
Pooled	**20.8**	**19.5**	**17.8**	**15.8**	**13.9**	**12.3**	**11.0**	**−47.1**

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Total losses (t/year)	21.2	25.1	27.7	27.5	26.6	25.9	25.8	+21.7

Note. Totals and statistics use range midpoints; annual total = monthly midpoint × 12. Pooled loss = total losses ÷ total landings × 100. Change 2020–26 = relative change between 2020 and 2026. Production ranks in 2026: Ihema 1, Muhazi 2, Cyohoha 3. *Source.* Primary Data, 2026 (lake-level production estimates); *Source.* Primary Data, 2026.

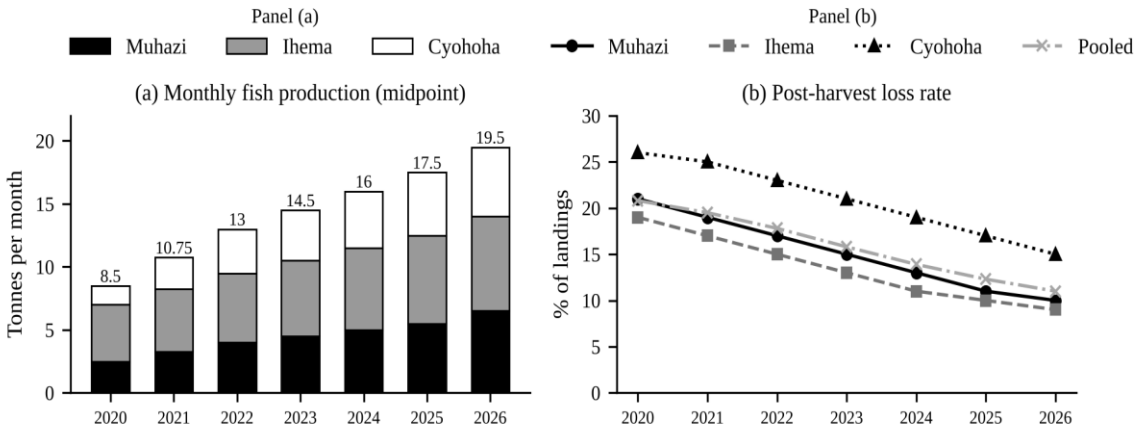


Figure 2: Fish Production and Post-Harvest Losses by Lake, 2020–2026

Note. Panel (a) shows stacked midpoint production by lake, with the three-lake total above each bar. *Source.* Table 8.

Combined production rises from 8.5 to 19.5 tonnes per month (102 to 234 tonnes per year; +129.4%) (Table 8; Figure 2). Ihema remains the largest producer in every year (7.5 t/month in 2026), followed by Muhazi (6.5) and Cyohoha (5.5), but growth is fastest at Cyohoha (CAGR 24.18%) and slowest at Ihema (8.89%), so the production gap narrows. Post-harvest loss rates fall on every lake and the pooled rate declines from 20.8% to 11.0%; because landings more than double, physical losses rise only modestly, from 21.2 to 25.8 tonnes per year. Cyohoha maintains the highest loss rate (15% in 2026).

Table 9: Fish Prices, Gross Fishing Income, Membership, and Income per Member by Lake, 2020–2026

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Panel A. Average landing-site price (RWF/kg)								
All lakes	2,500	2,667	2,833	3,000	3,167	3,333	3,500	+40.0
Panel B. Gross monthly fishing income (RWF million)								
Muhazi	6.25	8.67	11.33	13.50	15.84	18.33	22.75	+264.0
Ihema	11.25	13.34	15.58	18.00	20.59	23.33	26.25	+133.3
Cyohoha	3.75	6.67	9.92	12.00	14.25	16.66	19.25	+413.3
Total (per month)	**21.25**	**28.67**	**36.83**	**43.50**	**50.67**	**58.33**	**68.25**	**+221.2**
Total (per year)	255.0	344.0	441.9	522.0	608.1	699.9	819.0	+221.2
Panel C. Registered members (number)								
Muhazi	50	56	62	70	78	85	92	+84.0
Ihema	60	67	75	83	90	98	105	+75.0
Cyohoha	180	210	245	280	315	345	372	+106.7
Total	**290**	**333**	**382**	**433**	**483**	**528**	**569**	**+96.2**
Panel D. Average gross monthly income per member (RWF)								
Muhazi	125,000	154,781	182,774	192,857	203,013	215,665	247,283	+97.8
Ihema	187,500	199,030	207,753	216,867	228,728	238,071	250,000	+33.3
Cyohoha	20,833	31,750	40,471	42,857	45,243	48,304	51,747	+148.4

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Pooled	**73,276**	**86,097**	**96,411**	**100,462**	**104,911**	**110,469**	**119,947**	**+63.7**

Note. Gross monthly income = midpoint monthly production (kg) × annual landing-site price per kg; post-harvest losses and operating costs are not deducted. Prices are rounded up for display. Average gross income per member = gross monthly income ÷ registered members; pooled = total gross income ÷ total members. Shares of cumulative 2020–2026 income: Ihema 41.7%, Muhazi 31.4%, Cyohoha 26.8%. *Source.* Primary Data, 2026 (membership registers and lake-level production); price trends cross-checked against CASA (2023), AllAfrica (2025), and Nyandwi (2026a).

Combined gross income rises from RWF 21.25 million to RWF 68.25 million per month (RWF 255.0 to 819.0 million per year; +221.2%), driven both by larger volumes (+129.4%) and by a 40% rise in the landing-site price, from RWF 2,500 to 3,500/kg (Table 9; Figure 3). Ihema earns the most in every year (RWF 26.25 million per month in 2026), followed by Muhazi (RWF 22.75 million) and Cyohoha (RWF 19.25 million). Cyohoha's income grows fastest (+413.3%), yet it generates only 26.8% of cumulative 2020–2026 income, against 41.7% for Ihema and 31.4% for Muhazi, although it holds 65.4% of registered members in 2026.

Table 10: Household Economic Welfare Indicators by Lake, 2020–2026

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Panel A. Economic Welfare Index (HEWI, 0–100)								
Muhazi	41.6	46.4	51.7	56.6	61.6	66.9	74.4	+78.8
Ihema	51.7	54.1	57.1	61.9	67.1	71.9	76.8	+48.5
Cyohoha	19.0	21.0	23.4	26.4	29.7	33.7	37.2	+95.8
Pooled	**28.6**	**31.2**	**34.1**	**37.8**	**41.7**	**46.1**	**50.5**	**+76.6**
Panel B. Households saving regularly (%)								
Muhazi	38	40	43	50	57	64	70	+84.2
Ihema	41	43	46	53	60	67	73	+78.0
Cyohoha	24	25	27	32	38	45	51	+112.5
Panel C. Households owning a productive asset (%)								
Muhazi	45	46	48	53	58	63	68	+51.1
Ihema	48	49	52	57	62	67	72	+50.0
Cyohoha	30	31	33	37	41	46	50	+66.7
Panel D. Poverty headcount ratio, P0 (% of households below the EICV7 national poverty line)								
Muhazi	42.0	41.0	43.0	38.0	33.0	28.0	24.0	−42.9
Ihema	39.0	38.0	40.0	35.0	30.0	25.0	21.0	−46.2
Cyohoha	61.0	60.0	62.0	57.0	52.0	46.0	40.0	−34.4
Pooled	**53.9**	**52.9**	**54.9**	**49.9**	**44.9**	**39.2**	**33.9**	**−37.1**

Note. Pooled values are weighted by sampled households (38, 43, 154). HEWI uses gross income per member from Table 9. Poverty headcount ratio (P0) = households whose annual consumption expenditure per adult is below the EICV7 national poverty line (January 2024 prices) ÷ all households × 100 (see Section 3.3). *Source.* Primary Data, 2026 (income); other

values are hypothetical ; poverty line as defined in NISR (2025b).

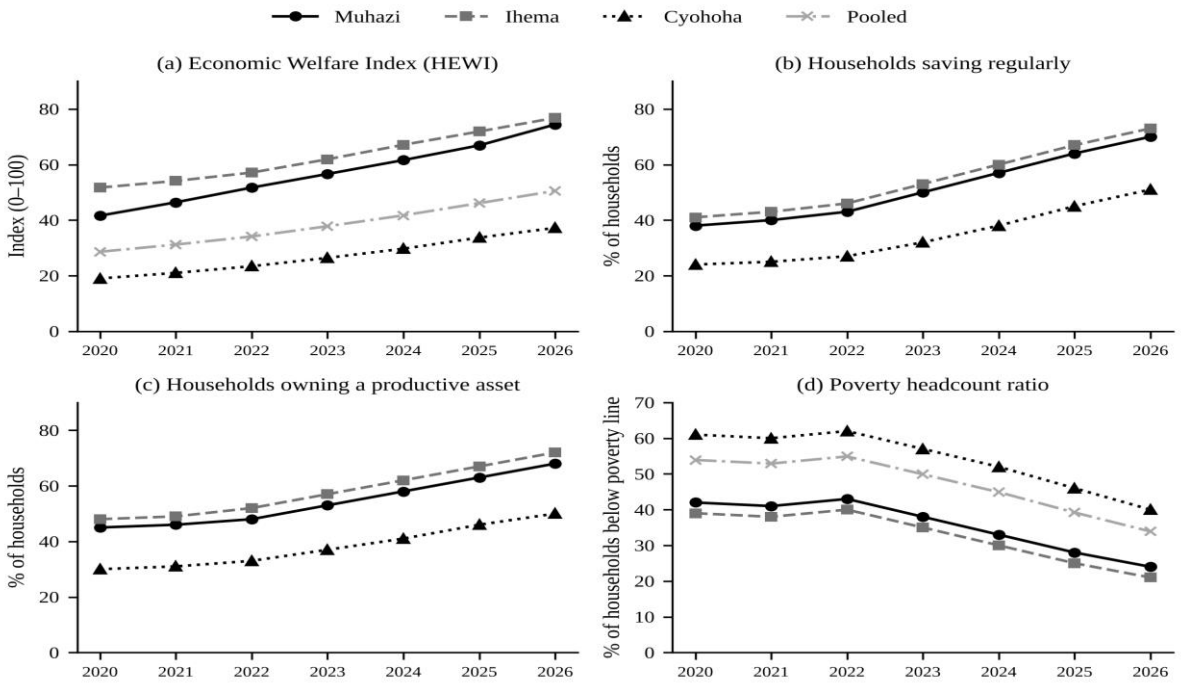


Figure3: Household Economic Welfare Indicators by Lake, 2020–2026

Source. Table 10 : Primary Data, 2026.

The pooled HEWI rises from 28.6 to 50.5 (Table 10; Figure 4). Ihema (76.8 in 2026) and Muhazi (74.4) remain well ahead of Cyohoha (37.2), whose index is held down by low income per member. The poverty headcount ratio falls on all lakes, from a pooled 53.9% to 33.9% of households, but 40% of Cyohoha households remain below the national poverty line in 2026, well above the EICV7 national poverty headcount ratio of 27.4% of the population reported for 2024 (NISR, 2025b).

Table 11: Food Consumption, Availability, Affordability, and Fish Consumption by Lake, 2020–2026

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Panel A. Meals per household per day								
Muhazi	2.2	2.2	2.2	2.4	2.5	2.6	2.7	+22.7
Ihema	2.3	2.3	2.3	2.5	2.6	2.7	2.8	+21.7
Cyohoha	1.9	1.9	1.9	2.0	2.1	2.2	2.4	+26.3
Pooled	**2.0**	**2.0**	**2.0**	**2.2**	**2.3**	**2.4**	**2.5**	**+25.0**
Panel B. Households with acceptable food consumption (FCS > 35) (%)								
Muhazi	58.0	60.0	57.0	64.0	70.0	75.0	79.0	+36.2
Ihema	62.0	64.0	61.0	68.0	73.0	78.0	82.0	+32.3
Cyohoha	41.0	43.0	40.0	47.0	53.0	58.0	63.0	+53.7
Pooled	**47.6**	**49.6**	**46.6**	**53.6**	**59.4**	**64.4**	**69.1**	**+45.2**
Panel C. Months of adequate household food provisioning (0–12)								
Muhazi	9.1	9.2	9.0	9.6	10.1	10.5	10.8	+18.7
Ihema	9.4	9.5	9.3	9.9	10.4	10.8	11.1	+18.1

Indicator/lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Cyohoha	7.6	7.7	7.4	8.0	8.5	9.0	9.5	+25.0
Panel D. Food share of household expenditure (%)								
Muhazi	63	62	66	61	58	56	54	−14.3
Ihema	61	60	64	59	56	54	52	−14.8
Cyohoha	70	69	73	69	66	64	61	−12.9
Panel E. Days per week fish consumed								
Muhazi	2.4	2.5	2.5	2.8	3.1	3.3	3.6	+50.0
Ihema	2.6	2.7	2.7	3.0	3.3	3.5	3.8	+46.2
Cyohoha	2.0	2.0	2.1	2.3	2.5	2.8	3.0	+50.0

Note. Acceptable food consumption = Food Consumption Score > 35. A lower food share indicates greater affordability. Pooled values weighted by sampled households; indicator definitions as used in NISR (2025c). Source. Primary Data, 2026.

Pooled meals per day rise from 2.0 to 2.5 and acceptable food consumption from 47.6% to 69.1% (Table 11; Figure 5). Consumption adequacy dips in 2022 while meal frequency stagnates. Availability, affordability, and fish consumption also improve: months of adequate provisioning rise on every lake, and the food share of expenditure falls after 2022, but Cyohoha trails on every indicator. For comparison, 83% of Rwandan households were food secure in 2024, and food insecurity in the Eastern Province was 14% (NISR, 2025c).

Table 12: Health Access, Treatment, Insurance Coverage, and Forgone Care by Lake, 2020–2026

Indicator / lake	2020	2021	2022	2023	2024	2025	2026	Change 2020–26 (%)
Panel A. Health-facility visits per household per month								
Muhazi	0.62	0.58	0.66	0.74	0.80	0.85	0.88	+41.9
Ihema	0.65	0.60	0.69	0.77	0.83	0.88	0.92	+41.5
Cyohoha	0.48	0.45	0.50	0.56	0.62	0.68	0.73	+52.1
Pooled	**0.53**	**0.50**	**0.56**	**0.63**	**0.69**	**0.74**	**0.79**	**+49.1**
Panel B. Ill members appropriately treated (%)								
Muhazi	64.0	66.0	69.0	73.0	77.0	80.0	83.0	+29.7
Ihema	67.0	69.0	72.0	76.0	79.0	82.0	85.0	+26.9
Cyohoha	49.0	51.0	54.0	59.0	63.0	67.0	71.0	+44.9
Pooled	**54.7**	**56.7**	**59.7**	**64.4**	**68.2**	**71.8**	**75.5**	**+38.0**
Panel C. Households fully covered by CBHI (%)								
Muhazi	78.0	80.0	82.0	85.0	88.0	90.0	92.0	+17.9
Ihema	80.0	82.0	84.0	87.0	89.0	91.0	93.0	+16.3
Cyohoha	66.0	68.0	71.0	75.0	79.0	82.0	85.0	+28.8
Pooled	**70.5**	**72.5**	**75.2**	**78.8**	**82.3**	**84.9**	**87.6**	**+24.3**
Panel D. Households forgoing care because of cost (%)								
Muhazi	28.0	27.0	26.0	22.0	19.0	16.0	14.0	−50.0
Ihema	26.0	25.0	24.0	20.0	17.0	14.0	12.0	−53.8
Cyohoha	41.0	40.0	40.0	35.0	31.0	28.0	25.0	−39.0
Pooled	**36.2**	**35.2**	**34.8**	**30.2**	**26.5**	**23.5**	**20.8**	**−42.5**

Note. CBHI = community-based health insurance (*Mutuelle de santé*). Pooled values weighted by sampled households. *Source. Primary Data, 2026*.

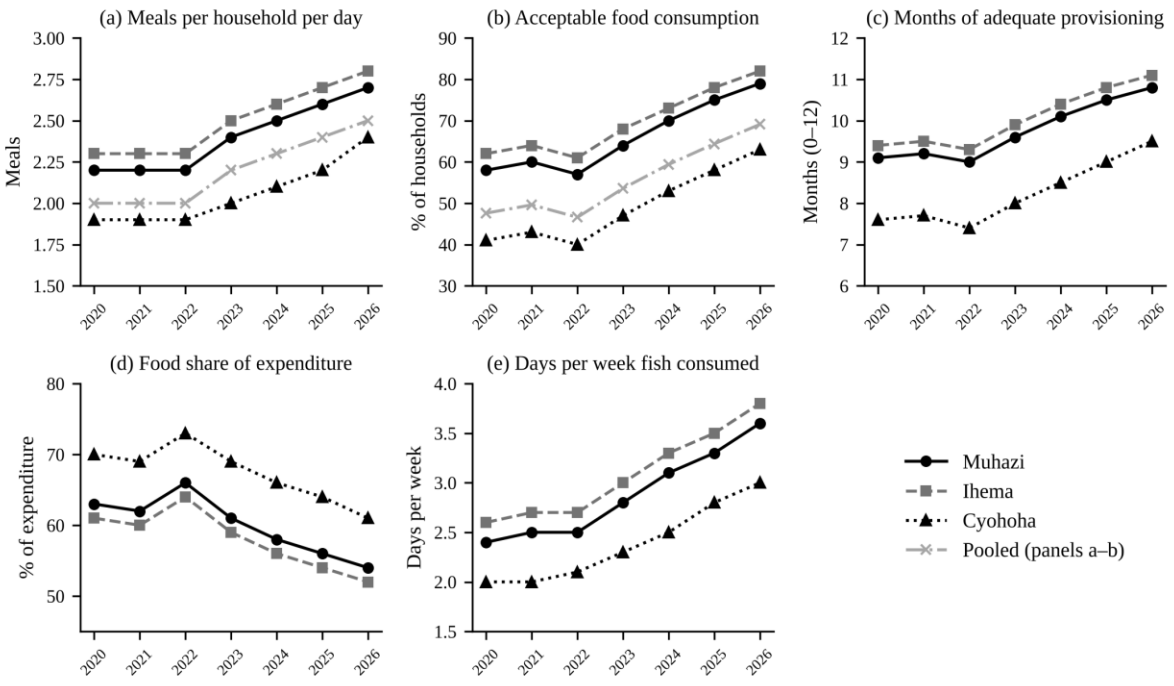


Figure 4: Food Security Indicators by Lake, 2020–2026

Note. In panel (d), a declining line indicates improving affordability. *Source.* Table 11: Primary Data, 2026.)

Facility visits rise after 2021 while appropriate treatment rises (54.7% to 75.5%), CBHI coverage rises (70.5% to 87.6%), and forgone care falls (36.2% to 20.8%), indicating better access rather than more illness (Table 12; Figure 6).

Table 13: School Enrolment and Dropout among Children Aged 6–18 by Lake, 2020–2026

Indicator / lake	2020	2021	2022	2023	2024	2025	2026	Change in rate 2020–26 (%)
Panel A. Children aged 6–18 enrolled,* n *(%)								
Muhazi	87 (86.1)	84 (82.4)	87 (85.3)	91 (88.3)	93 (90.3)	96 (92.3)	97 (93.3)	+8.4
Ihema	97 (86.6)	94 (83.2)	98 (86.0)	101 (88.6)	105 (91.3)	108 (93.1)	109 (94.0)	+8.5
Cyohoha	318 (76.1)	298 (71.0)	317 (74.9)	336 (79.1)	350 (82.0)	365 (85.1)	375 (87.0)	+14.3
All lakes	**502 (79.6)**	**476 (75.0)**	**502 (78.6)**	**528 (82.2)**	**548 (85.0)**	**569 (87.7)**	**581 (89.2)**	**+12.2**
Panel B. Enrolled children who dropped out during the year,* n *(%)								
Muhazi	7 (8.0)	8 (9.5)	6 (6.9)	6 (6.6)	5 (5.4)	4 (4.2)	3 (3.1)	−61.3
Ihema	7 (7.2)	8 (8.5)	7 (7.1)	6 (5.9)	5 (4.8)	4 (3.7)	3 (2.8)	−61.1
Cyohoha	39 (12.3)	42 (14.1)	38 (12.0)	35 (10.4)	31 (8.9)	28 (7.7)	24 (6.4)	−48.0
All lakes	**53 (10.6)**	**58 (12.2)**	**51 (10.2)**	**47 (8.9)**	**41 (7.5)**	**36 (6.3)**	**30 (5.2)**	**−51.1**

Note. Enrolment % = enrolled ÷ children aged 6–18 in sampled households; dropout % = dropouts ÷ enrolled. All-lakes rates are computed from summed counts. Change = relative change in the rate between 2020 and 2026. *Source.* Primary Data, 2026.

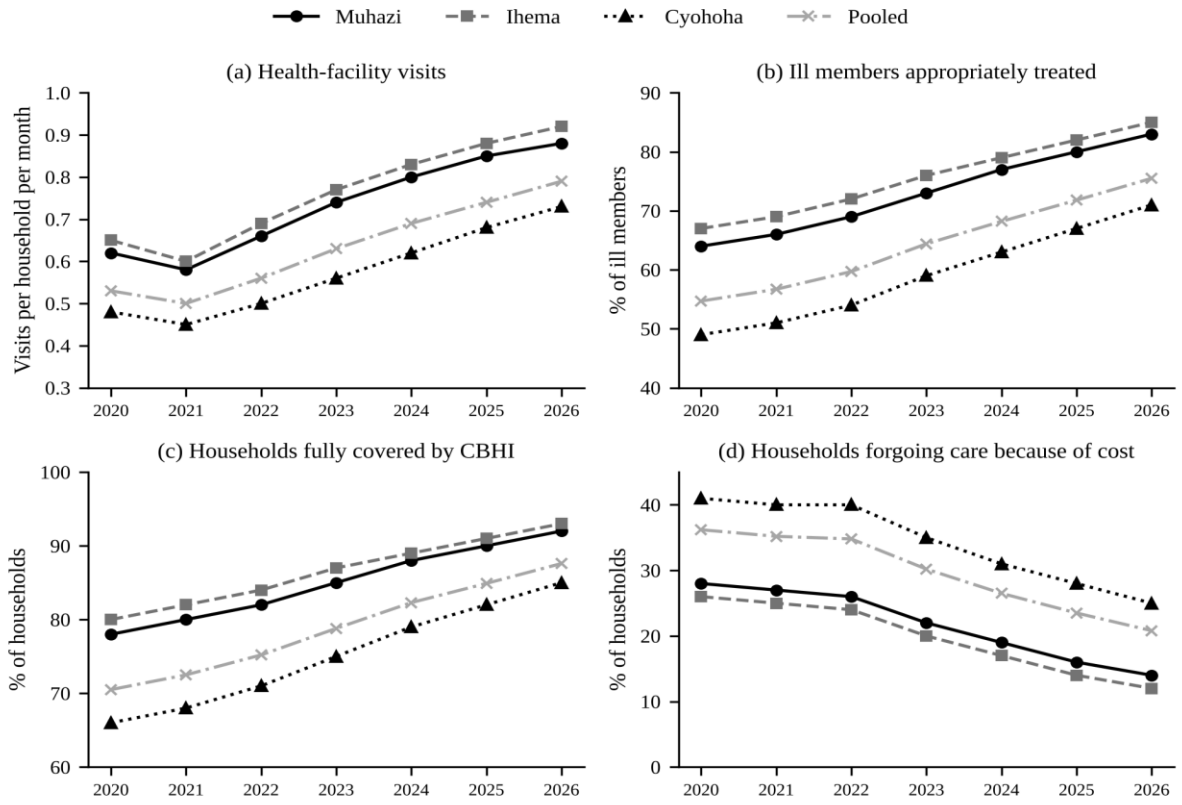


Figure 5: Health Indicators by Lake, 2020–2026

Source. **Table 12:** ***Source.*** **Primary Data, 2026.**

Table 14: Educational Completion (2020–2026) and Educational Status (2026) by Lake

Level/status	Period	Muhazi	Ihema	Cyohoha	All lakes
Panel A. Completion by level and period, completed/eligible (%)					
Primary (P6)	2020–2022	20/25 (80.0)	23/28 (82.1)	68/103 (66.0)	111/156 (71.2)
	2023–2026	29/33 (87.9)	35/38 (92.1)	108/138 (78.3)	172/209 (82.3)
	2020–2026	**49/58 (84.5)**	**58/66 (87.9)**	**176/241 (73.0)**	**283/365 (77.5)**
Secondary (S6)	2020–2022	9/18 (50.0)	11/20 (55.0)	24/72 (33.3)	44/110 (40.0)
	2023–2026	14/23 (60.9)	17/26 (65.4)	42/96 (43.8)	73/145 (50.3)
	2020–2026	**23/41 (56.1)**	**28/46 (60.9)**	**66/168 (39.3)**	**117/255 (45.9)**
University	2020–2022	1/13 (7.7)	2/15 (13.3)	2/52 (3.8)	5/80 (6.2)
	2023–2026	3/17 (17.6)	4/19 (21.1)	5/70 (7.1)	12/106 (11.3)
	2020–2026	**4/30 (13.3)**	**6/34 (17.6)**	**7/122 (5.7)**	**17/186 (9.1)**
Panel B. Educational status of children aged 6–24 in 2026, **n** ***(%)***					
Currently enrolled		108 (77.1)	126 (79.7)	412 (69.8)	646 (72.7)
Completed a level and exited		14 (10.0)	16 (10.1)	46 (7.8)	76 (8.6)
Dropped out		15 (10.7)	14 (8.9)	118 (20.0)	147 (16.6)
Never enrolled		3 (2.1)	2 (1.3)	14 (2.4)	19 (2.1)
Total		**140 (100.0)**	**158 (100.0)**	**590 (100.0)**	**888 (100.0)**

Note. In Panel A, eligible = children reaching the official completion age for the level during the period; cells show completed/eligible with the completion rate in parentheses. In Panel B, categories are mutually exclusive. All-lakes values are computed from summed counts. *Source.* Primary Data, 2026.

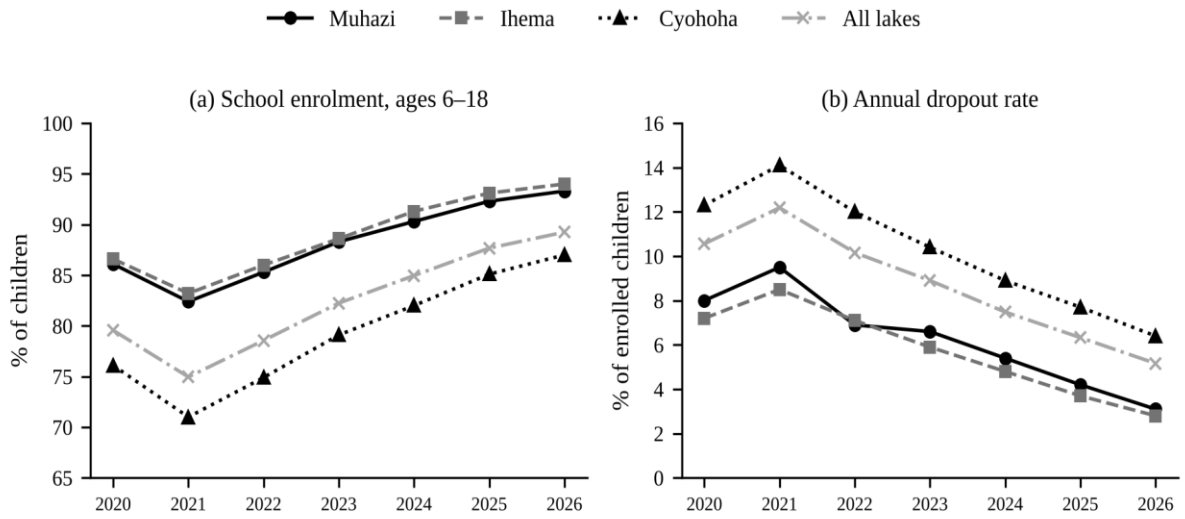


Figure 6: School Enrolment and Dropout Rates by Lake, 2020–2026

Source. Table 13: Primary Data, 2026.

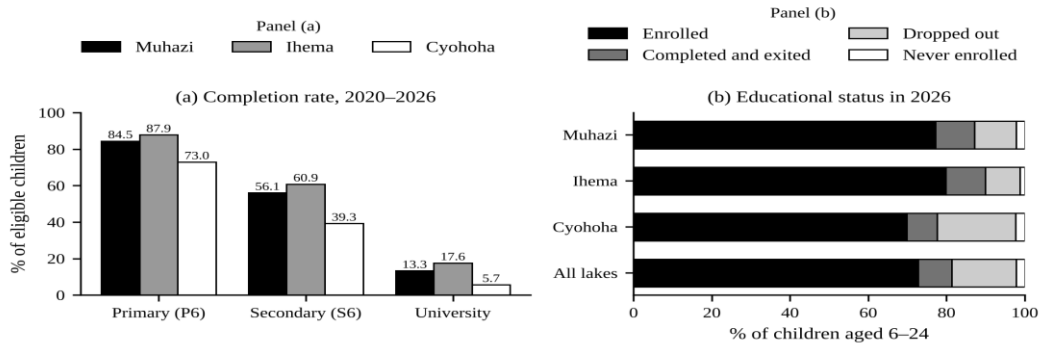


Figure 8: Completion Rates by Level (2020–2026) and Educational Status (2026) by Lake

Source. Table 14 (*Source.* Primary Data, 2026)

Enrolment falls in 2021 and then rises to 93.3% at Muhazi, 94.0% at Ihema, and 87.0% at Cyohoha in 2026, while dropout across all lakes declines from 12.2% (2021) to 5.2% (Table 13; Figure 7). Completion declines steeply from primary to secondary to university on every lake, and Cyohoha records the lowest rates at each level (Table 14; Figure 8). In 2026, 20.0% of Cyohoha children aged 6–24 had dropped out, about double the share at Muhazi (10.7%) and Ihema (8.9%). For reference, national net attendance rates in 2024 were 92.8% in primary and 33.7% in secondary school (NISR, 2025a).

4.4 Comparative Analysis of the Three Lakes

Table 15: Variability and Growth of Economic, Food-Security, Health, and Education Indicators by Lake, 2020–2026

Indicator/lake	Mean	*SD*	*CV* (%)	Absolute change 2020–26	CAGR (%)
Fish production (t/month, midpoint)					
Muhazi	4.46	1.36	30.4	+4.00	+17.26
Ihema	6.00	1.08	18.0	+3.00	+8.89
Cyohoha	3.79	1.41	37.2	+4.00	+24.18
Gross monthly income (RWF million)					
Muhazi	13.81	5.69	41.2	+16.50	+24.03
Ihema	18.33	5.41	29.5	+15.00	+15.17
Cyohoha	11.79	5.48	46.5	+15.50	+31.34
Gross income per member (RWF/month)					

Indicator/lake	Mean	*SD*	*CV* (%)	Absolute change 2020–26	CAGR (%)
Muhazi	188,768	40,051	21.2	+122,283	+12.04
Ihema	218,279	22,128	10.1	+62,500	+4.91
Cyohoha	40,172	10,631	26.5	+30,914	+16.37
HEWI (0–100)					
Muhazi	57.0	11.5	20.2	+32.8	+10.18
Ihema	63.0	9.4	14.9	+25.1	+6.83
Cyohoha	27.2	6.7	24.6	+18.2	+11.87
Meals per household per day					
Muhazi	2.40	0.21	8.7	+0.50	+3.47
Ihema	2.50	0.21	8.3	+0.50	+3.33
Cyohoha	2.06	0.19	9.2	+0.50	+3.97
Acceptable food consumption (%)					
Muhazi	66.1	8.7	13.1	+21.0	+5.29
Ihema	69.7	8.2	11.7	+20.0	+4.77
Cyohoha	49.3	8.9	18.1	+22.0	+7.42
Health-facility visits per month					
Muhazi	0.73	0.12	15.9	+0.26	+6.01
Ihema	0.76	0.12	15.8	+0.27	+5.96
Cyohoha	0.57	0.11	18.5	+0.25	+7.24
Ill members appropriately treated (%)					
Muhazi	73.1	7.2	9.8	+19.0	+4.43
Ihema	75.7	6.7	8.9	+18.0	+4.05
Cyohoha	59.1	8.3	14.0	+22.0	+6.38
School enrolment, ages 6–18 (%)					
Muhazi	88.3	4.0	4.5	+7.1	+1.33
Ihema	89.0	4.0	4.5	+7.4	+1.37
Cyohoha	79.3	5.8	7.3	+10.9	+2.26
Annual dropout rate (%)					
Muhazi	6.2	2.2	35.6	−5.0	−14.73
Ihema	5.7	2.1	36.3	−4.5	−14.84
Cyohoha	10.2	2.7	26.8	−5.9	−10.27

Note. Mean, *SD*, and coefficient of variation (*CV*) across seven annual values; annual values and relative changes are reported in Tables 8–13. For percentage indicators, absolute change is in percentage points. CAGR = compound annual growth rate over six intervals. *Source.* Primary Data, 2026 (production, income, and membership);

Relative growth differs sharply across lakes (Tables 8, 9, and 15): Cyohoha records the fastest production growth (+266.7%), gross income (+413.3%), and income per member (+148.4%), whereas Ihema, starting from the highest base, grows slowest (+66.7%, +133.3%, and +33.3%). Levels nevertheless remain far apart: Cyohoha's mean income per member (RWF 40,172) is less than a fifth of Ihema's (RWF 218,279). Cyohoha also shows the largest relative gains in food security, treatment, and enrolment (Table 15), indicating partial convergence in social outcomes while economic gaps persist.

Table 16: Comparative Performance of the Three Lakes on Key Indicators, 2026

Indicator (2026 unless stated)	Muhazi (rank:2)	Ihema (rank:1)	Cyohoha (rank:3)	Performance
Fish production (t/month)	6.5	7.5	5.5	Higher
Production per member (t/year)	0.85	0.86	0.18	Higher
Post-harvest loss (%) †	10	9	15	Lower
Gross monthly income (RWF million)	22.75	26.25	19.25	Higher
Gross income per member (RWF '000/month)	247.3	250.0	51.7	Higher
HEWI (0–100)	74.4	76.8	37.2	Higher
Poverty headcount ratio, P0 (% of households) †	24	21	40	Lower
Meals per day	2.7	2.8	2.4	Higher
Acceptable food consumption (%)	79	82	63	Higher

Indicator (2026 unless stated)	Muhazi (rank:2)	Ihema (rank:1)	Cyohoha (rank:3)	Performance
Food share of expenditure (%) †	54	52	61	Lower
Ill members appropriately treated (%)	83	85	71	Higher
Households forgoing care due to cost (%) †	14	12	25	Lower
School enrolment, ages 6–18 (%)	93.3	94.0	87.0	Higher
Annual dropout rate (%) †	3.1	2.8	6.4	Lower
Primary completion, 2020–26 (%)	84.5	87.9	73.0	Higher
Secondary completion, 2020–26 (%)	56.1	60.9	39.3	Higher
University graduation, 2020–26 (%)	13.3	17.6	5.7	Higher
Mean rank (1 = best)	**2.00**	**1.00**	**3.00**	

Note. Ranks are shown in parentheses (1 = best and 3 = weakest performance among the three lakes). † Indicator for which a lower value indicates better performance; these indicators are ranked in ascending order (lowest value = rank 1).

Ihema ranks first on every indicator, Muhazi second, and Cyohoha third (Table 16). The Ihema–Muhazi gap is narrow, whereas Cyohoha's 2026 values for food consumption and treatment are below the levels the other lakes had already reached by 2023.

Table 17: Correlations between Gross Income per Member and Selected Welfare Indicators

Indicator correlated with income per member	*r* (levels)	*p*	*r* (annual changes)	*p*
Meals per day	.853	< .001	−.366	.135
Acceptable food consumption (%)	.871	< .001	−.361	.141
Food availability (MAHFP)	.875	< .001	−.405	.095
Food share of expenditure (%)	−.839	< .001	.301	.225
Ill members appropriately treated (%)	.868	< .001	−.554	.017
Households forgoing care due to cost (%)	−.888	< .001	.486	.041
School enrolment (%)	.824	< .001	−.364	.137
Annual dropout rate (%)	−.819	< .001	.180	.475
Post-harvest loss (%)	−.822	< .001	.246	.326
HEWI (contains income by construction)	.973	< .001	.618	.006

Note. Levels: 21 lake-year values; changes: 18 year-on-year differences; two-tailed tests. *Source.* Primary Data, 2026 (income per member);

In levels, income per member correlates strongly with every indicator ($|r|$ = .819–.973), but such correlations are inflated by common trends and persistent lake differences (Table 17). In annual changes, most associations are weak and non-significant; apart from HEWI, the only significant ones are for treatment (r = −.554, p = .017) and forgone care (r = .486, p = .041), whose signs run opposite to expectation because income gains were concentrated in 2021–2022, when several social indicators dipped. Because the welfare indicators are constructed, these coefficients describe the internal structure of the constructed data rather than causal relationships.

4.5 Discussion of results

The survey shows that sustainable practices are positively associated with livelihoods, but unequally. Practices closest to value realisation matter most: market-value practices were the strongest predictor, and the post-harvest composite explained more than a third of the variance. This supports the Blue Economy argument that welfare can be raised along the value chain without additional extraction (World Bank & United Nations Department of Economic and Social Affairs, 2017) and evidence that reducing losses increases the value of existing catches (Affognon et al., 2015; Kruijssen et al., 2020).

Cooperative participation was a significant net predictor, consistent with Common-Pool Resource theory and co-management evidence (Evans et al., 2011; Ostrom, 1990), whereas nominal membership made no significant difference, underlining the importance of active engagement (d'Armengol et al., 2018). Gear compliance remained significant in the joint model, but seasonal-ban compliance did not, suggesting that closures yield benefits largely through channels captured by other predictors while imposing short-term income costs. This accords with evidence that closures are accepted when their effects are credible and losses are mitigated (Owusu et al., 2023), and that enforcement does not necessarily produce rapid stock recovery (Nyamweya et al., 2023). Aquaculture showed no

positive association, reflecting low and uneven adoption and the capital and input constraints documented for African aquaculture (Brummett et al., 2008). Perceived livelihood outcomes did not differ significantly across lakes, whereas the lake-level indicators show large gaps for Cyohoha. The divergence may reflect ceiling effects in the survey. Landing-site prices of RWF 2,500–3,500/kg remained below documented urban producer and wholesale prices, so gross income estimates are conservative; moreover, the rapidly growing membership on Lake Cyohoha spread its production gains thinly, leaving income per member at about one-fifth of the level on Lakes Ihema and Muhazi. The evidence supports linking compliance to tangible economic benefits, with priority for lagging sites such as Cyohoha.

5. Conclusions and Recommendations

5.1 Conclusions

Sustainable fishing practices are positively associated with the livelihoods of fishermen on Lakes Muhazi, Ihema, and Cyohoha. Four of five hypotheses were supported, and market-value practices, cooperative participation, gear compliance, and training contributed independently to livelihood outcomes, whereas aquaculture did not. Lake-level records and estimates indicate that combined production more than doubled and gross income per member rose by about 64% between 2020 and 2026, with Ihema ranking first, Muhazi second, and Cyohoha third; without targeted support, the large membership on Lake Cyohoha will continue to dilute its gains.

5.2 Recommendations

Based on the findings, the following recommendations were made:

1. Invest in post-harvest infrastructure and market linkages (ice, cold storage, hygienic landing facilities, packaging, market information), given the strongest association of post-harvest practices with livelihoods (Ha5).
2. Strengthening cooperative governance and active participation through transparent management, inclusive leadership, and collective marketing (Ha3).
3. Make compliance affordable through cooperative credit for legal gear and savings or income support during closed seasons (Ha1, Ha2).
4. 4, Reorient aquaculture support towards viability, addressing finance, fingerlings, feed, extension, and markets (Ha4; MINAGRI & RAB, 2023).
5. Establish lake-level monitoring of landings, losses, prices, and incomes, and prioritise Lake Cyohoha, including coordination with main stakeholders in fishery industry.

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