Scientific fish farming in Gram Panchayat tanks by Women Self Help Groups in Odisha, India:

Crop outcome survey report 2018–2019 and 2019–2020

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Scientific fish farming in Gram Panchayat tanks by Women Self Help Groups in Odisha, India: Crop outcome survey report 2018–2019 and 2019–2020

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Table of contents

List of abbreviations

AFO	assistant fisheries officer
BMP	better management practice
DAP	diammonium phosphate
FARD	Fisheries & Animal Resources Development Department
GP	Gram Panchayat
ha	hectare
IMC	Indian major carp
INR	Indian Rupees
PR&DW	Panchayati Raj and Drinking Water Department
SIS	small indigenous species
SSP	single superphosphate
t	metric ton
USD	United States Dollar
WCD&MS	Women & Child Development and Mission Shakti Department
WSHGs	Women Self Help Groups

Highlights

Sl. No.	Parameters	2018–2019	2019–2020
1	WSHGs that benefitted under the program	1681	2469
2	WSHGs randomly selected and surveyed	370 (22%)	592 (24%)
3	Districts covered under the survey	30	30
4	Blocks covered under the survey	180	228
5	Average size of Gram Panchayat (GP) tank	0.77 ha	1.02 ha
6	Tanks completely harvested within 12 months of stocking	104 (28%)	141 (24%)
7	Tanks producing carp	370 (100%)	592 (100%)
8	Tanks producing carp and mola	202 (55%)	311 (53%)
9	Tanks producing carp, other small indigenous species (SIS)	33 (9%)	51 (9%)
10	WSHGs that turned a profit	316 (85%)	532 (90%)
11	Average fish production	1725 kg/ha	1956 kg/ha
12	Average cost of production	INR 115,947/ha	INR 123,377/ha
13	Average value of fish produced	INR 243,570/ha	INR 278,333/ha
14	Average profit margin	INR 127,622/ha	INR 153,543/ha

Table 1. Survey results of Women Self-Help Groups (WSHGs).

Sl. No.	Total	2018–2019	2019–2020
1	Total number of WSHG beneficiaries	1681	2469
2	Total area of GP tanks	1411.72 ha	1892.98 ha
3	Total fish produced	2435 t	3703 t
4	Total investment made by WSHGs (cost of production)	INR 16.37 Crore	INR 23.36 Crore
5	Total value of fish harvested	INR 34.39 Crore	INR 52.69 Crore
6	Total profit made by WSHGs	INR 18.02 Crore	INR 29.07 Crore

Table 2. Total crop outcome from the program (extrapolated figures based on survey results).

Figure 1. Potential impact across Odisha if all GP tanks were brought under the program.

Executive summary

Survey details and methodologies

The Odisha-WorldFish project conducted a crop outcome survey during the reporting period (June 2020–February 2021). The purpose was to assess the implementation status of a Government of Odisha flagship program that is implemented by the Fisheries and Animal Resources Development Department (FARD). The program is called "Scientific Fish Farming in Gram Panchayat Tanks by Women Self Help Groups" but is sometimes also called "Input Assistance to Women Self Help Groups for Pisciculture in Gram Panchayat Tanks." It also assessed the achievements of key output and outcome parameters to identify bottlenecks as well as examine the possibilities of replicating good practices.

For this survey, a cross-sectional, multi-layered, interview-based questionnaire was purposively developed covering the program and fish farming attributes. The overall objective of this gender-sensitive survey framework is to understand (a) women-driven community fish farming in public water bodies, (b) adoption of better management practices (BMPs) for WSHGs to carry out scientific fish farming, (c) fish production and marketing details, and (d) the various challenges WSHGs faced during fish farming and the coping strategies they used.

The survey was conducted on WSHGs that participated in the program over first years of implementation in 2018–2019 and 2019–2020. A stratified random sampling method was used for selecting the WSHGs for the survey. This means that proportionate numbers of WSHGs were randomly selected for each year and for each district.

In total, 14 trained enumerators/technical field staff from the Odisha-WorldFish project were engaged in this door-to-door survey under the overall guidance of senior officials from FARD and with the active participation of district- and block-level fisheries and Mission Shakti officers.

Photo credit: Arunkumar Shaw/WorldFish

Peer-to-peer interactions with Pataleswari WSHG members during the survey, Bhawanipatna block of Kalahandi District.

Out of the 4150 WSHGs that participated in the program (1681 in 2018–2019 and 2469 in 2019–2020), 962 were randomly surveyed (370 from 2018–2019 and 592 from 2019–2020). The survey was conducted in 498 Gram Panchayats belonging to 228 blocks that were spread across all 30 districts of Odisha State (Table 3).

Summary results

Number of blocks		Number of GPs		Number of villages	
2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020
180	228	326	498	346	551

Table 3. Coverage of crop outcome survey.

Number of WSHGs that benefitted from the program		Number of WSHGs randomly selected for survey		Number of WSHGs surveyed	
2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020
1681	2469	426	683	370	592

Table 4. Sample size of crop outcome survey.

Average value	2018–2019	2019–2020
Tank size (ha)	0.77	1.02
Water depth (feet)	7.57	7.82
Water retention period (months)	11	11

Table 5. Parameters of GP tanks leased out to the WSHGs.

Adopted management practices	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Preparing/cleaning tank dike	238	64	416	70
Eradicating predatory fish	239	65	417	70
Removing aquatic weeds	327	88	536	91
Applying lime	350	95	574	97
Applying fertilizer	193	52	327	55
Applying fish feed	367	99	589	99
Monitoring water quality	232	63	392	66
Sampling fish monthly	221	60	404	68
Keeping records	314	85	547	92

Table 6. GP tank management practices and BMPs that WSHGs adopted.

Average value	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Completely harvested within 12 months of stocking	104	28	141	24
Partially harvested within 12 months of stocking	266	72	451	76
Tanks producing carp	370	100	592	100
Tanks producing carp and mola	202	55	311	53
Tanks producing carp and other SIS of fish	33	9	51	9
WSHGs that made a profit	316	85	532	90
WSHGs that incurred a loss	54	15	60	10

Table 7. Summary of harvesting details.

Production and harvest details of GP tank	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Average quantity of fish produced (sold + consumed/gifted + leftover)				
Total fish production	1301	1725	1728	1956
Average quantity of harvested fish within 1 year (sold + gifted and/or consumed)				
All types of fish harvested	1015	1392	1268	1457
Carps harvested	950	1287	1185	1364
Mola harvested	102	166	119	148
Other SIS harvested	105	148	249	172
Average quantity of fish sold within 1 year				
All types of fish	952	1281	1197	1369
Carps	907	1215	1137	1306
Mola	85	142	109	133
Other SIS	113	149	232	151
Average quantities of fish consumed in 1 year				
Total fish consumed/gifted	75	123	82	100
Carp gifted and/or consumed	56	94	65	79
Mola gifted and/or consumed	43	67	36	47
Other SIS fish gifted and/or consumed	43	70	51	45
Average quantity of fish left over in GP tanks after 1 year of stocking	296	448	584	635

Table 8. Fish production and use details from GP tanks that WSHGs managed.

Average values	2018–2019		2019–2020	
	INR/WSHG	INR/ha	INR/WSHG	INR/ha
Lease value of GP tank	8084	10,948	10,223	10,789
Seed cost	29,602	40,195	39,747	44,265
Feed cost	42,852	58,531	55,232	58,572
Fish harvesting cost	9014	13,843	9510	10,814
Total cost of production	**84,058**	**115,947**	**113,764**	**123,377**
Value of fish sold from harvested lot	129,841	179,531	164,014	193,597
Value of fish consumed/gifted from harvested lot	9997	17,926	11,155	13,537
Value of leftover fish without harvesting within 12 months	54,214	64,739	85,342	92,776
Value of total fish produced (sold + consumed/gifted + leftover)	180,263	243,570	240,782	278,333
Average margin (sold + consumed/gifted + leftover)	96,205	127,622	125,796	153,543
Average profit of profit-making tanks	117,214	156,983	144,858	174,901
Average loss of loss-making tanks	-26,742	-44,193	-42,905	-35,468

Table 9. Overall economics and profitability of fish farming from GP tanks that WSHGs managed.

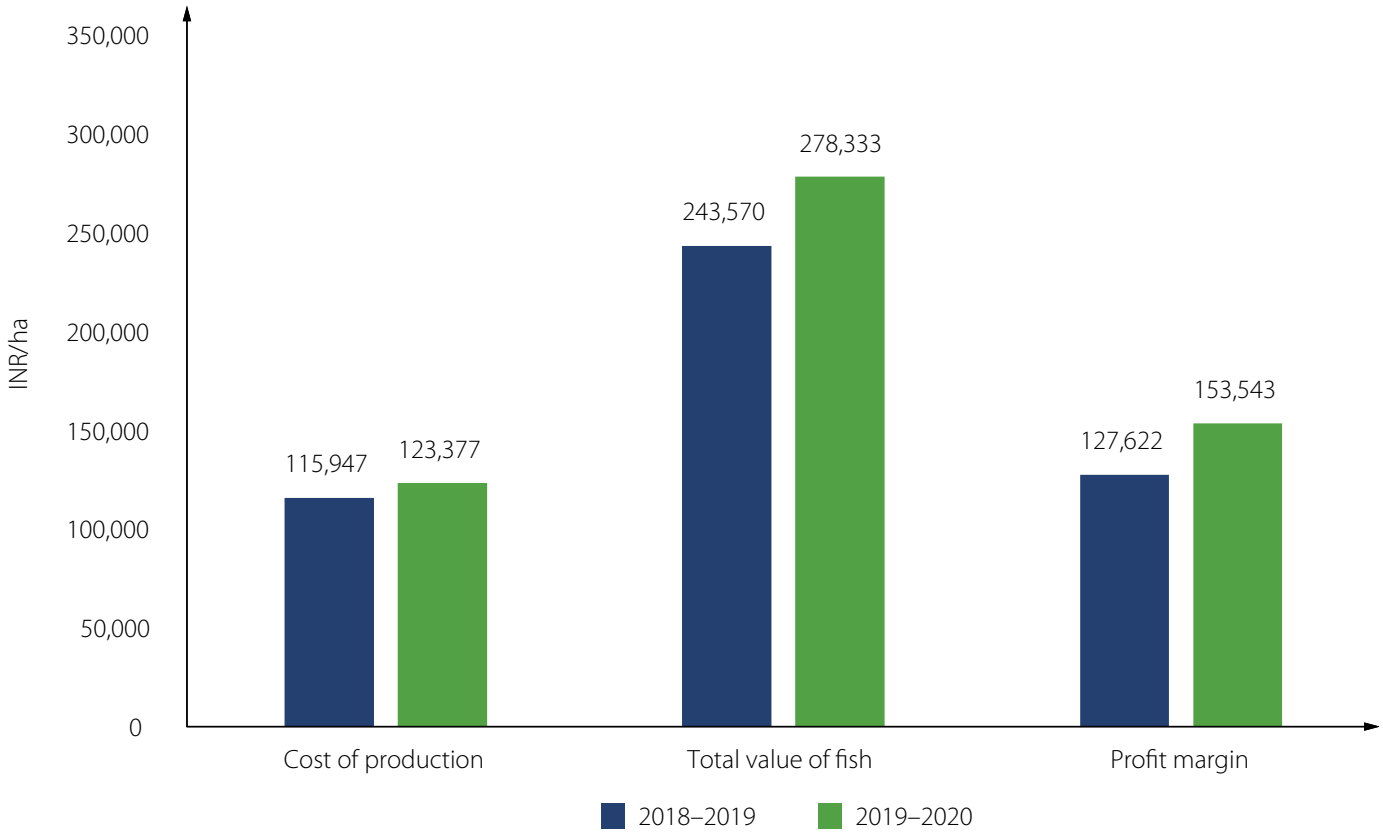

Figure 2. Average cost of production, value of fish and profit margin.

Institutional profile of WHSGs

The number of women in each WSHG ranged from 9 to 22, with an average of 11. On average, the surveyed WSHGs were 8 years old, and 15% of them were dominated by the Scheduled Caste category of beneficiaries.

Besides participating in the scientific fish farming program, nearly half of the surveyed WSHGs were engaged in diversified and gainful self-employment activities to improve their livelihood. On an average, each WSHG spent at least 2 hours every day managing the fish farming activities at their leased GP tank.

Characteristics of community tanks

The water area of the GP tanks allocated to the WSHGs varied greatly (0.10–32.38 ha), while the average size increased from 0.77 ha in 2018–2019 to 1.02 ha in 2019-20. Most of the tanks depend on rainwater (97%) as their primary water source for aquaculture.

The average depth of the tanks is 8 feet (2.43 m). Most of the surveyed tanks in Odisha used for the program are semi-perennial in nature, where water is retained for at least 5 months a year. Considering both years of the survey, nearly 80% of the tanks that were leased out to the WSHGs are perennial and hold water year-round.

Nearly 89% of the tanks are used for versatile community purposes, such as irrigation, bathing and washing. Only 11% are exclusively used for scientific fish farming under the co-management of WSHGs.

View of a GP tank in Odisha.

Knowledge sources on fish farming and capacity building

Nearly 77% of respondents in 2018–2019 and 84% in 2019–2020 said that they have limited knowledge of fish farming.

Over the 2 years that the program was implemented, nearly 96% of the WSHGs attended block-level training sessions on scientific fish farming organized by FARD and Mission Shakti.

A total of 98% of the WSHGs received technical advice and assistance from FARD officials at the farmgate. On average, officials visited the GP tanks five times a year.

Data collection during the crop outcome survey at the Maa Patarani WSHG, Tentulikhunti Block, Nabarangapur District.

Pond management practices and BMP adoption

Approximately 64% of the WSHGs in 2018–2019 and 70% in 2019–2020 prepared or cleared their pond dike at the beginning of fish farming. Over the 2 years of the survey, about 65%–70% of the WSHGs eradicated predatory fish from their tanks, while approximately 90% eliminated aquatic weeds at the beginning of fish farming.

To maintain the proper pH of the water, more than 95% of the WSHGs applied lime to their fish tank at an average rate of more than 300 kg/ha a year.

Plate 1. WSHGs applied lime to their fish tank as part of BMPs.

A total of 52% of the GP tanks in 2018–2019 and 55% in 2019–2020 were fertilized during the pond preparation process to increase the primary productivity of the tank. In 2018–2019, the WSHGs applied fertilizer at an average rate of 1055 kg/ha, which increased sharply in 2019–2020 to 1395 kg/ha. Raw cattle dung was the most popular option followed by inorganic fertilizers like urea, diammonium phosphate (DAP) and single superphosphate (SSP).

A total of 63% of WSHGs in 2018–2019 and 66% in 2019–2020 frequently monitored the water quality of their GP tank as part of BMPs.

Over both survey years, more than 60% of the WSHGs adopted monthly fish sampling as part of BMPs. A total of 60% of the tanks in 2018–2019 and 68% in 2019–2020 were periodically sampled (using a cast net) to check fish growth, health, etc.

More than 80% of the WSHGs maintained daily records on fish farming-related information in a pond record book.

Plate 2. Members of a WSHG working together to remove aquatic weeds from their GP tank.

Fish seed stocking practices

Nearly 60% of the WSHGs preferred single stocking, while the rest (40%) practiced multiple stockings. Under the program, it was suggested to stock advanced yearlings weighing 50–100 g (zero-size fingerlings) to achieve a better survival rate and to shorten the crop duration. Zero-size fingerlings were stocked by 54% of the WSHGs in 2018–2019 and 59% in 2019–2020.

Freshwater aquaculture in GP tanks is dominated by Indian major carps (IMCs) in combination with other exotic varieties. Rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) are the most desirable culturable species, followed by exotic carp, such as grass carp (*Ctenopharyngodon Idella*) and common carp (*Cyprinus carpio*).

For carps, the suggested stocking density for GP tanks is 2700 advanced fingerlings/ha to achieve a target productivity of 2500 kg/ha/crop with an average fish market size of 1 kg under the program. Although different stocking densities of carp seed were reported, the average stocking density remained virtually unchanged, at 6546/ha in 2018–2019 and 6564/ha in 2019–2020. The suggested stocking density for mola (*Amblypharyngodon mola*) was 25 kg/ha. Based on the survey results, the average stocking density for mola seed was 23–25 kg/ha.

Plate 3. Stocking zero-size fingerlings (50–100 g) in GP tanks was recommended for the program (left). WSHGs adopted seed acclimatization as an essential step during stocking (right).

Feed management practices

Interestingly, almost all of the WSHGs (99%) adopted supplementary feeding practices to attain better fish growth.

Approximately 88% relied on local fish feed shops or nearby fish feed dealers to get supplementary fish feed. About 17% of the WSHGs in 2018–2019 and about 12% in 2019–2020 depended on department officers to help buy supplementary fish feed and delivery it to the farm site.

Floating pellets was the most popular feed among the WSHGs, at 74% in 2018–2019 and 77% in 2019–2020. Approximately 20%–22% used floating feed and homemade feed together.

Although the quantities of fish feed that the WSHGs used varied greatly, the average quantity decreased from 1792 kg/ha in 2018–2019 to 1588 kg/ha in 2019–2020.

Plate 4. Members of a WSHG applying commercial pellet feed.

Fish production and use

The survey revealed that about 28% of the GP tanks in 2018–2019 and in 2019–2020 were completely harvested within 12 months of stocking. The majority were partially harvested.

Carp was produced in all of the GP tanks during both years. Mola was produced in 55% of the tanks in 2018–2019 and 53% in 2019–2020. Other small indigenous species (SIS) of fish were produced in about 9% of the tanks during both years.

Regarding the quantities of harvested fish (fish sold + fish consumed/gifted) within first 12 months of stocking and the estimated leftover fish in the tank after the first 12 months, the WSHGs achieved an average fish production in the GP tanks of 1725 kg/ha in 2018–2019, which increased to 1956 kg/ha in 2019–2020. The target fish productivity under the program was 2500 kg/ha/crop.

Of the total amount of fish produced, an average of 1392 kg/ha in 2018–2019 and 1457 kg/ha in 2019–2020 were harvested within 12 months of stocking. Average carp production was 1287 kg/ha in 2018–2019 and 1364 kg/ha in 2019–2020, average mola production was 166 kg/ha in 2018–2019 and 148 kg/ha in 2019–2020, and average production of other SIS fish was 148 kg/ha in 2018–2019 and 172 kg/ha 2019–2020.

On average, 448 kg/ha in 2018–2019 and 635 kg/ha in 2019–2020 were leftover in the GP tanks and harvested after 12 months of stocking.

Of the harvested fish within 12 months of stocking, an average of 1281 kg/ha in 2018–2019 and 1369 kg/ha in 2019–2020 were either sold at farmgate or in the market, while an average of 123 kg/ha in 2018–2019 and 100 kg/ha in 2019–2020 were either given to family and friends and/or consumed in WSHG households themselves.

Economics of fish farming for WSHGs

A total of 85% of the WSHGs made a profit in 2018–2019 and 90% in 2019–2020. The average cost of production (including leasing, seeding, feeding and harvesting) was INR 115,947/ha in 2018–2019 and INR 123,377/ha in 2019–2020. The average value of total fish produced (including sold, gifted, consumed and leftover) was INR 243,570/ha in 2018–2019 and INR 278,333/ha in 2019–2020.

On average, WSHGs generated a profit margin of INR 127,622/ha in 2018–2019 and INR 153,543/ha in 2019–2020 from their GP tanks. Among the tanks that turned a profit, the average margin was INR 156,983/ha in 2018–2019 and INR 174,901/ha in 2019–2020. Among tanks that incurred a loss, the average margin was INR 44,193/ha in 2018–2019 and INR 35,468/ha in 2019–2020.

Willingness of WSHGs to continue fish farming

Almost every (98%–100%) WSHG expressed a willingness to continue fish farming at their GP tank after the program ended. In addition, nearly all (93%–96%) WSHGs expressed a willingness to renew their lease agreement to further continue fish farming at their GP tank beyond period of the program. Almost all (94%–96%) WSHGs also felt that fish farming is an attractive business. The main reasons for participating were the low investment required and the higher profits than they could get from agriculture.

Plate 5. A member of a WSHG harvesting fish from a GP tank (left). Members of the Maa Jyotirmayee WSHG engaged in fish marketing in Bolangir District.

Lessons learned and recommendations for the future

The project has resulted in several benefits for the women in the village community, regardless of their caste, tribe, religion, etc. This will have a long-lasting socioeconomic impact, including improved food and nutritional security, gender equity and environmental sustainability in villages across Odisha. The success of the project is evident from the increasing demand coming from WSHGs all over the state.

The project has directly helped empower women through income generation from fish farming activities. The WSHGs considered fish farming in GP tanks an attractive business because it generated an average farmgate value of INR 180,000–240,000 per WSHG, with an average profit of INR 96,000–125,000 per WSHG as well as an impressive return on investment of 114% in 2018–2019 and 110% in 2019–2020. Since the financial risks from this business are very low (only 10%–14% of WSHGs incurred a loss), new WSHGs that have undertaken this venture have been very successful and are confident that they can continue their business with more interest and aggressiveness. The overall business experience of WSHGs through fish farming has shown that the project has unleashed the entrepreneurship spirit among the women involved.

Nutritional gains were another important outcome. The project made live and fresh fish more available and accessible to the local village community at affordable prices and on a regularly basis. Most of the WSHGs (83%–87%) distributed small quantities of fish, especially mola (75–82 kg per WSHG or about 5%–7% of production), among themselves without any financial gains. This has become an effective tool for tackling malnutrition in the state, because it has led to higher consumption of nutritious fish among the WSHG households.

WSHGs brought positive environmental changes to the GP tanks and their surroundings by cleaning them before beginning fish farming. Most of the tanks were multi-purpose water bodies filled with rainwater. However, most were in derelict condition. About 88%–90% were infested with aquatic plants and weeds, while 64%–70% had dikes/surroundings full of bushes and village wastes, mainly plastic. The WSHGs cleaned the surroundings and removed the plants and weeds, turning the GP tanks into clean and usable water bodies.

The program was reasonably effective and efficient in delivering technical extension support for WSHGs right to their doorstep. The collective efforts of field-level officials from FARD, Mission Shakti and the Odisha-WorldFish project have brought overall positive changes in knowledge, attitude and practices among the WSHGs for profitable and sustainable fish farming in the GP tanks. For 80% of WSHG members, fish farming

was a new venture that they had never tried before. Block-level, hands-on training was given to members on the technical aspects of fish farming. Training also raised awareness about the conditions and entitlements of the activity, and the WSHGs received regular support both at farmgate and over the phone. This made the WSHGs proactive and confident about fish farming practices and marketing their fish at profitable prices.

The results of the crop outcome survey have clearly shown that the program was not only successful in achieving the usual physical and financial target indicators at the government level, but also the outcome indicators, such as increased fish production, consumption, income and women's empowerment.

Other benefits ran parallel to the government intervention through the program, included adopting BMPs in fish farming, the collective efforts of WSHGs and the collaborative institutional efforts from field level to the government decision level. These are some of the building blocks of success. This program can be replicated as a best practice model for promoting community fish production in public waterbodies, including minor irrigation projects across the state.

Photo credit: De Tour Odisha

SIS make up 6%–7% of total fish production in GP tanks managed by WSHGs.

Introduction

With a coastline of 480 km and 640,000 ha of inland freshwater water bodies, Odisha is fourth-largest fish producer among all states in India. The fisheries sector in Odisha witnessed marvelous growth during last decade, and in 2019–2020 the state produced 816,000 t of fish valued at INR 10,000 Crores (USD 1.35 billion). Estimates from the National Family Health Survey – 4 (2015–2016) suggest that 94.4% of people in Odisha consume fish. The per capita annual fish consumption in the state has steadily increased from 7.71 kg in 2000–2001 to 16.24 kg in 2019–2020. Despite its tremendous resource potential, however, Odisha imports a significant quantity of fish every year from neighboring states to meet consumer demand.

Odisha has about 62,000 multi-purpose GP tanks, with a total water area of 54,000 ha. These were built under various government plans and community programs over the past several years for water conservation through rainwater harvesting and for multi-purpose use. The tanks are administered by a decentralized governance system of Gram Panchayats under the Panchayati Raj and Drinking Water Department (PR&DW). The tanks are subject to community access and are used by villagers for versatile purposes, such as household use (washing clothes, cleaning utensils, bathing), religious rituals, animal bathing and drinking, and agricultural farm irrigation. Large sections of the tanks are in poor condition and are either underused for fish production or unused altogether.

Forming self-help groups is an important social development in India and a powerful tool to eradicate poverty and to empower women by helping them undertake agriculture practices, including aquaculture, using microcredit facilities. The Government of Odisha nurtures about 600,000 WSHGs, with approximately 7 million women members, for various socioeconomic activities and women's empowerment at the village level. The Women and Child Development and Mission Shakti Department (WCD&MS) of the Government of Odisha promotes and supports these WSHGs. This enables the WSHGs to access financial assistance, undertake capacity strengthening and create market links to enhance their livelihoods and incomes.

WSHGs in Odisha

7 million women members under **600,000** WSHGs were empowered under the aegis of the Department of Mission Shakti, Govt. of Odisha.

Under the Odisha Fisheries Policy 2015, the goal was to increase fish production from unused and underused GP tanks across the state. Sensing a great opportunity to produce fish in these tanks through WSHGs, an interdepartmental convergence plan was initiated involving FARD, the PR&DW and WCD&MS. To help WSHGs begin fish farming in GP tanks, the PR&DW instituted a favorable policy to lease out the GP tanks to WSHGs on a long-term basis (3–5 years) in all 30 districts of the state during 2018–19.

Later that year, FARD launched its gender-sensitive flagship program called Scientific Fish Farming in Gram Panchayat Tanks by WSHGs, which is also called Input Assistance to WSHGs for Pisciculture in GP Tanks. Under the plan, the goal was to have 2000 WSHGs manage 1500 ha of GP tanks for fish farming. Over the past 3 years, 6242 GP tanks, with a total water area of 5043.52 ha, were leased out to 6235 WSHGs on a long-term basis. These WSHGs were trained and guided through the fish farming process at farmgate to ensure sustainable and profitable fish production through optimal use of these public waterbodies. The program targeted an average fish production of 2500 kg/ha/crop in GP tanks. The objectives and benefits of this gender-sensitive development program are multi-layered. They include implementing BMPs for fish farming, increasing household income, reducing malnutrition by making nutritious fish available in remote villages through the promotion of nutrient-rich SIS (mola) along with economically important IMCs. The overall objective of the program is to socioeconomically empower women in the state.

The Odisha-WorldFish project conducted a crop outcome survey to assess the status of implementation, achievements of key output and outcome indicators, and to identify bottlenecks as well as examine the possibilities for replicating good practices. The survey was done on WSHGs that participated in the program during 2018–2019 and 2019–2020 in all 30 districts of Odisha. The survey was designed to assess the following:

- the level of participation by WSHGs in scientific fish farming in GP tanks
- implementation and adoption level of BMPs
- the extent of fish production and marketing
- fish use and consumption pattern among WSHGs
- enabling and constraining factors the WSHGs faced during fish farming.

The information generated from the study will provide an enhanced understanding of the role of women in aquaculture development and household income. The study will also be useful for policymakers, planners and researchers to formulate gender-sensitive development programs and optimal uses of community water resources for horizontal and vertical expansion of freshwater fish farming.

Fish farming in GP tanks increased household fish consumption for the poor in Odisha.

Survey methodology

Study area and period

The surveys were conducted in all 30 districts of Odisha, covering all physiographic and agro-climatic zones, and different blocks were selected from each district. From each block, WSHGs were then identified at the GP level to participate in this women-focused interdepartmental convergence plan.

The survey was carried out from June 2020 to February 2021 and included WSHG beneficiaries over two successive years: 2018–2019 and 2019–2020. A total of 326 GPs and 346 villages were covered under 180 blocks in 2018–2019, and then 498 GPs and 551 villages under 228 blocks in 2019–2020.

Sampling design and sample size

In 2018–2019, 1681 GP tanks, with a total water area of 1411.72 ha, were brought under scientific fish farming with active participation from 1681 WSHGs. Of these, 25% were randomly selected for the survey, and 22% were actually surveyed. In 2019–2020, 2469 GP tanks, with a total water area of 1892.98 ha, were covered for scientific fish farming with active involvement from 2469 WSHGs. Of these, 28% were randomly selected for the benchmark survey, of which 24% were actually surveyed. In total, 370 WSHGs were interviewed in 2018–2019 and 592 in 2019–2020. Over the 2-year study, some blocks, GPs and villages were repeated to some extent, but the WSHGs were unique. Overall, the study evaluated 962 GP tanks under the community management of 962 WSHGs covering all 30 districts of Odisha.

Sample size

A total of **962** GP tanks under the community management of **962** unique WSHGs covering all **30** districts of Odisha were surveyed in 2 year period.

Survey instrument and analytical methods

For the survey, a cross-sectional, multi-layered, interview-based questionnaire was purposively developed, covering all fish farming attributes. The overall objective of the gender-sensitive survey framework is to understand women-driven community fish farming in public water bodies. Specifically, it focused on BMP adoption among WSHGs, fish production and marketing details, and various challenges WSHGs faced as well as their coping strategies during fish farming. The questionnaire was designed to record information in a standardized format with open- and close-ended explorative questions wherever possible. Both qualitative and quantitative data was collected. Attempts were made to make the language unambiguous, brief, polite and non-technical. The questionnaire was first prepared in English and then translated into Odia (the local dialect) to gain effective results from the survey and to facilitate better understanding among the local inhabitants. The survey questionnaires were pretested to identify ambiguous or irrelevant questions and revised on an iterative basis. Open-ended questions were post-coded during the data cleaning process. Fifteen trained enumerators/technical officials from WorldFish were engaged for the survey with the active participation of FARD.

Proportions of total sample

Out of the total number of WSHGs engaged in scientific fish farming in GP tanks, **22%** were covered in 2018–2019 and **24%** in 2019–2020.

The questionnaire was used to assemble information broadly on the following major categories:

- institutional profile of each WSHG, community tank and its leasing pattern
- pond management practices and BMP adoption

- fish stocking management
- supplementary feeding and health management
- fish production characteristics and marketing aquaculture crops
- fish consumption pattern among WSHGs
- level of community participation and corpus generated by WSHGs
- major challenges WSHGs faced and mitigation strategies

After the data was collected, all information was tabulated remotely using KoBoToolbox,[1] a free online toolkit for collecting and managing data in challenging environments. It is the most frequently used tool in social science research. Basic descriptive statistics combined with qualitative information, various aspects of fish farming and their interpretations were extracted from the collated data and have been presented in this report.

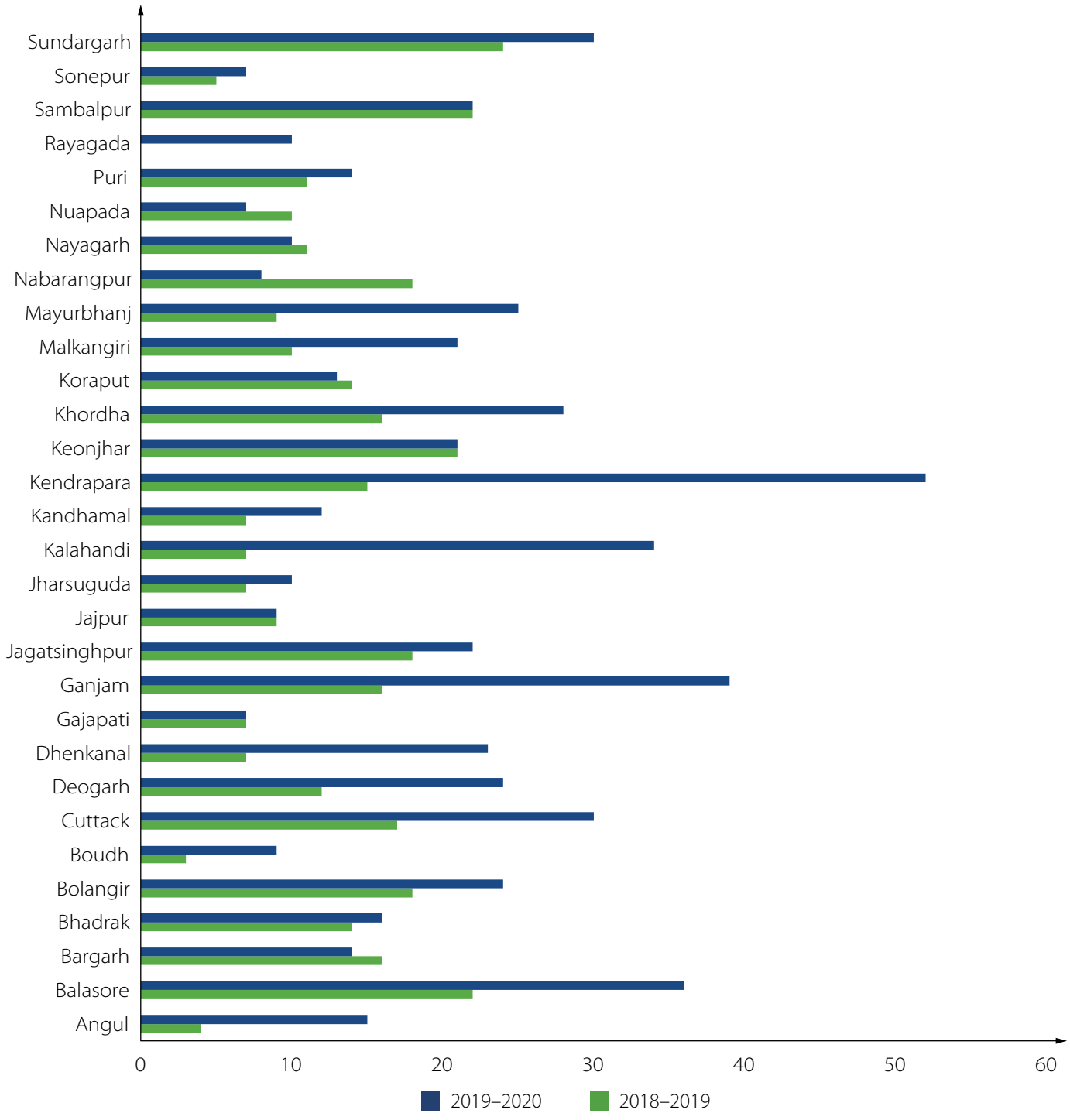

Figure 3. WSHGs surveyed in each district.

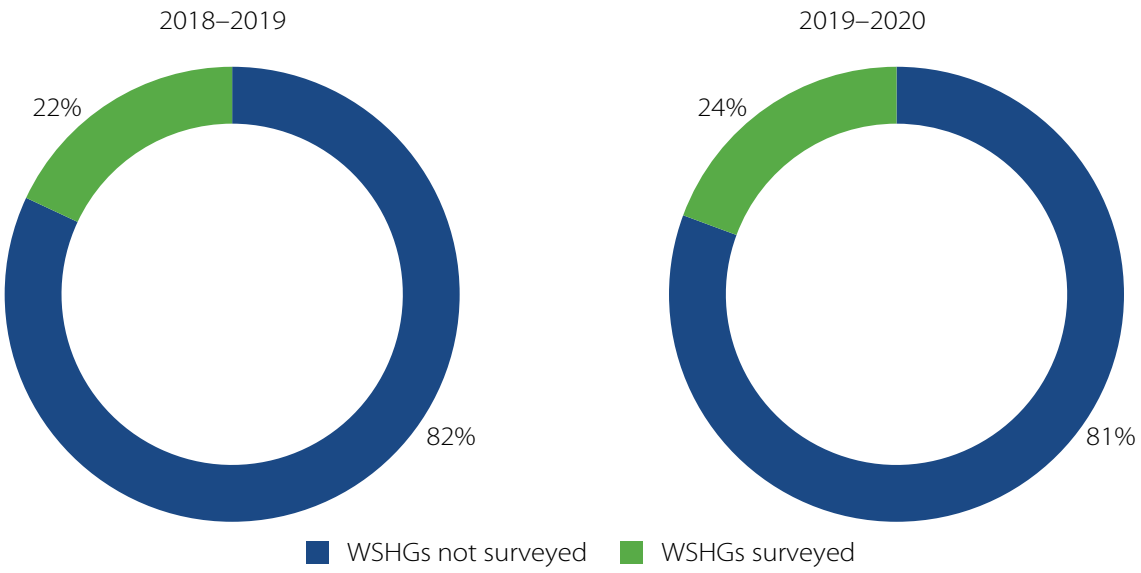

Figure 4. Proportions of total WSHGs surveyed.

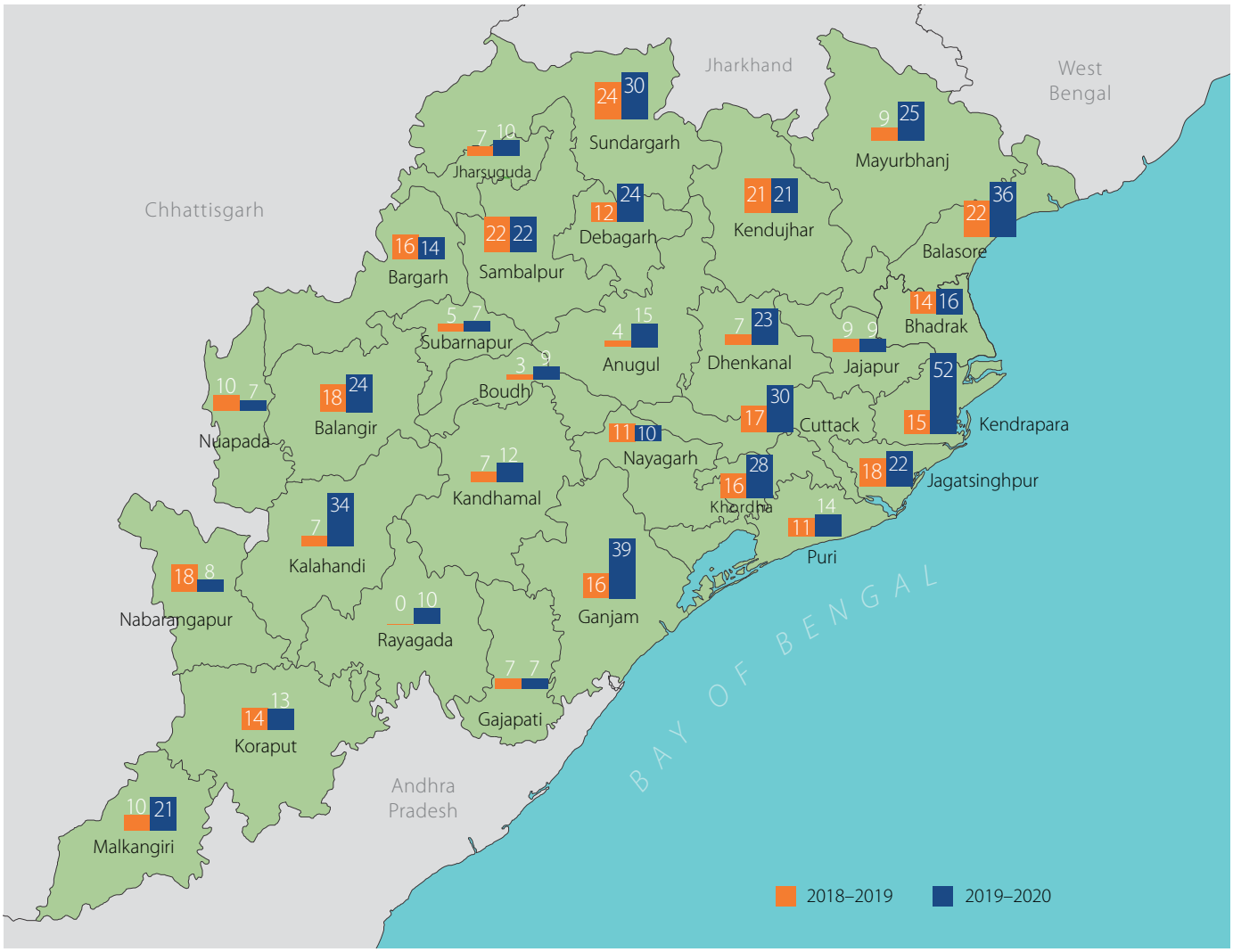

Figure 5. Number of WSHGs surveyed in each district.

Sl. No.	Districts	Number of blocks covered		Number of GPs covered		Number of villages covered		Number of WSHGs in the program		Number of WSHGs selected for survey		Numbers of WSHGs surveyed	
		2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020	2018–2019	2019–2020
1	Angul	1	8	4	12	4	15	31	54	8	14	4	15
2	Balasore	12	12	21	34	22	35	97	227	24	46	22	36
3	Bargarh	9	10	15	12	15	13	56	43	14	16	16	14
4	Bhadrak	3	5	12	9	13	13	74	60	19	16	14	16
5	Bolangir	7	6	11	22	13	22	95	85	24	24	18	24
6	Boudh	3	3	3	7	3	7	5	10	1	5	3	9
7	Cuttack	10	12	16	25	16	29	70	117	18	30	17	30
8	Deogarh	3	3	11	19	12	21	60	96	15	98	12	24
9	Dhenkanal	4	7	6	20	6	21	58	54	15	14	7	23
10	Gajapati	5	4	6	7	6	7	27	16	7	7	7	7
11	Ganjam	11	12	15	28	15	30	62	155	16	39	16	39
12	Jagatsinghpur	8	8	16	21	18	22	70	89	18	22	18	22
13	Jajpur	4	7	7	7	8	9	49	24	12	9	9	9
14	Jharsuguda	4	5	7	8	7	9	23	45	6	10	7	10
15	Kalahandi	4	10	6	32	6	33	78	182	20	47	7	34
16	Kandhamal	7	10	7	12	7	12	20	48	5	12	7	12
17	Kendrapara	7	7	14	45	15	48	43	255	11	52	15	52
18	Keonjhar	9	10	18	14	19	18	86	112	20	21	21	21
19	Khordha	7	10	13	26	14	29	64	114	16	28	16	28
20	Koraput	4	6	13	11	14	13	76	50	19	13	14	13
21	Malkangiri	4	6	6	17	10	20	57	89	14	22	10	21
22	Mayurbhanj	9	15	9	15	9	23	36	97	9	25	9	25
23	Nabarangpur	6	7	15	7	17	8	78	45	20	11	18	8
24	Nayagarh	5	5	9	10	9	10	43	45	11	10	11	10
25	Nuapada	5	3	9	7	9	7	56	39	14	10	10	7
26	Puri	6	9	11	14	11	14	43	59	11	14	11	14
27	Rayagada	0	4	0	9	0	10	19	41	5	10	0	10
28	Sambalpur	9	9	21	21	22	22	86	89	22	22	22	22
29	Sonepur	3	3	4	5	4	6	25	26	6	6	5	7
30	Sundargarh	11	12	21	22	22	25	94	103	26	30	24	30
Total		**180**	**228**	**326**	**498**	**346**	**551**	**1681**	**2469**	**426**	**683**	**370**	**592**

Table 10. District-wise details on WSHG survey sample size.

Results

1. Institutional profile and activities of WSHGs

Age of WSHGs

The average age of the WSHGs was 8 years according to the year of formation (WSHG registration with the concerned authorities). Most WSHGs had been in existence for 1–5 years during both survey years (Table 11, Figure 6). Very few WSHGs were older than 20 years.

Age	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
1–5 years	116	33.14	241	41.99
6–10 years	86	24.57	141	24.56
11–15 years	79	22.57	92	16.03
16–20 years	61	17.43	88	15.33
> 20 years	8	2.29	12	2.09

Note: Age calculated as of February 2021. Data was not available for 20 WSHGs in 2018–2019 and 18 WSHGs in 2019–2020.

Table 11. Age of WSHGs.

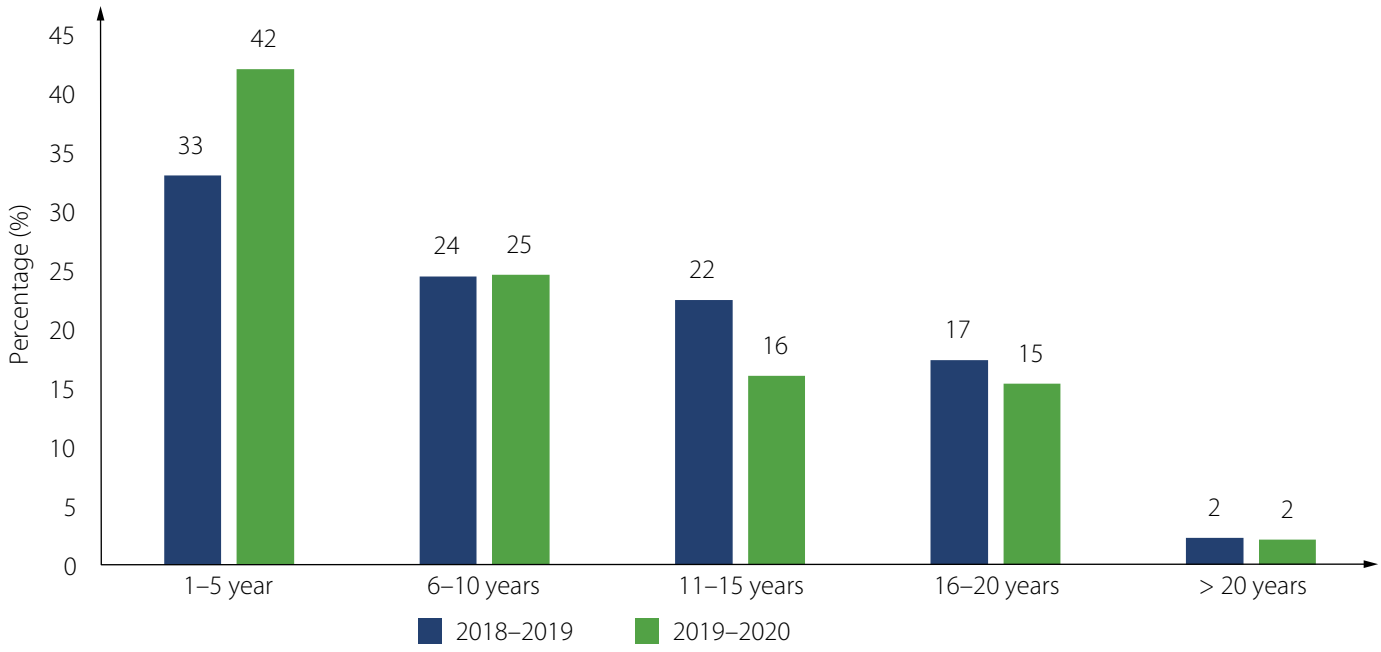

Figure 6. Age of WSHGs.

WSHG membership

The number of women in each WSHG ranged from 9 to 22 across all the WSHGs, with an average of 11. The majority reported having 10 members (Table 12, Figure 7). Only a handful had more than 16.

Membership	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
8–10 members	183	49.46	357	60.30
10–12 members	130	35.14	165	27.87
12–14 members	36	9.73	46	7.77
14–16 members	13	3.51	16	2.70
>16 members	8	2.16	8	1.35

Table 12. WSHG membership.

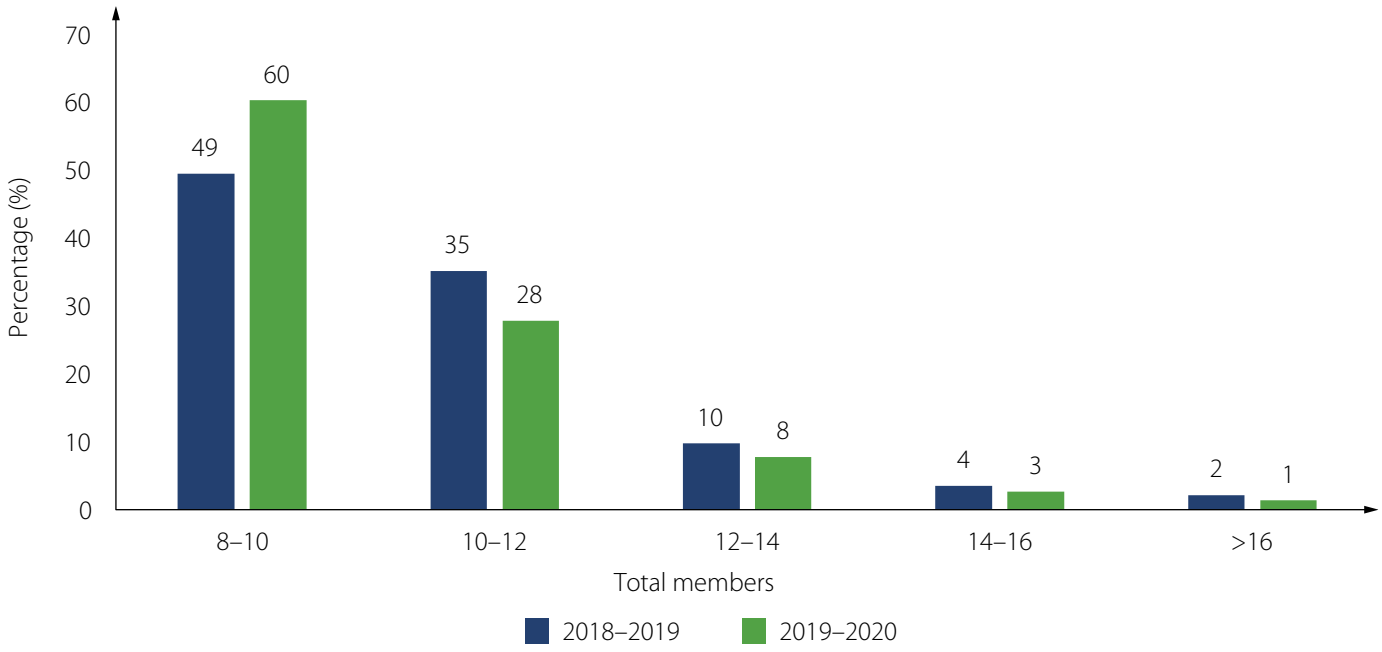

Figure 7. WSHG membership.

Caste of WSHG members

Based on caste stratification, the members of WSHGs in Odisha are classified into three categories—predominantly the General Caste and then the Scheduled Tribes, while the rest belong to the Scheduled Castes. In each survey year, more than half came from the General Caste, about a quarter from the Scheduled Tribes and the rest from the Scheduled Castes (Table 13, Figure 8).

Caste	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Scheduled Castes	759	18.26	1160	17.94
Scheduled Tribes	1074	25.84	1505	23.28
General Caste	2323	55.90	3801	58.78

Table 13. Caste of WSHG members.

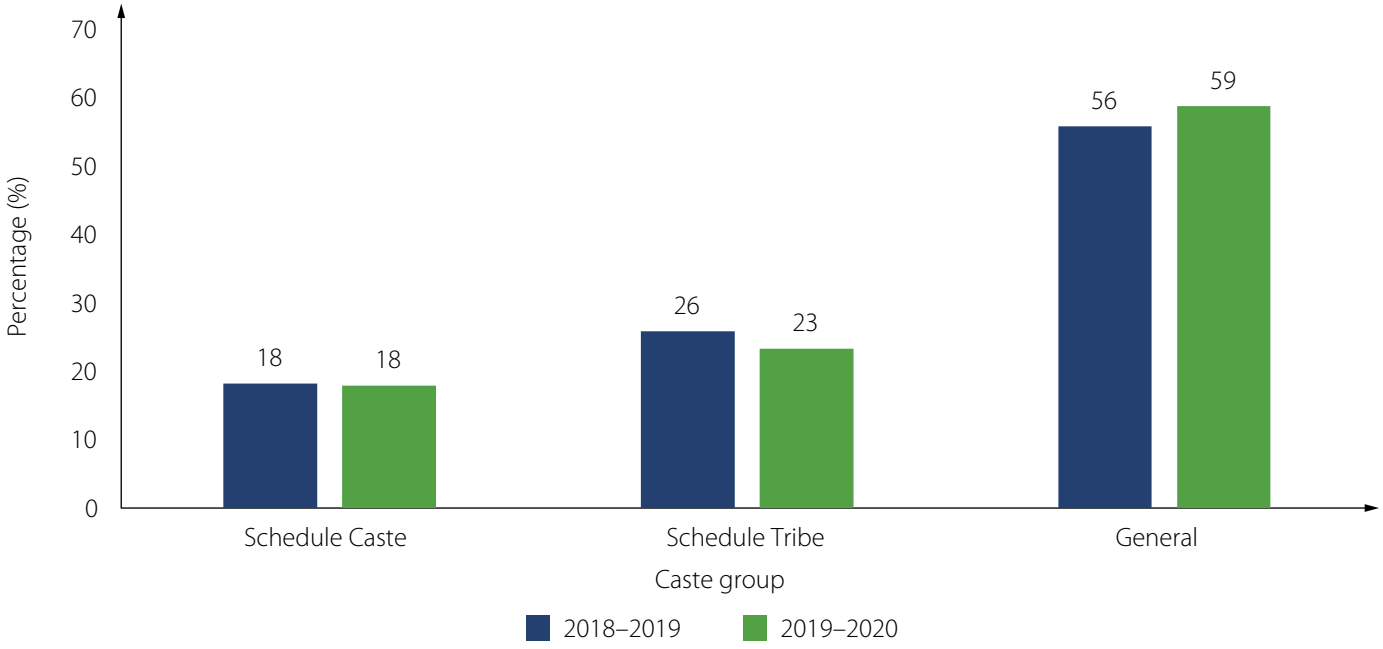

Figure 8. Caste of WSHG members.

Caste majority of WSHGs

Each WSHG can have women from a different caste category. If any caste group represents more than half of the membership, then that caste group makes up the majority of that particular WSHG. Surprisingly, most participants came from the General Caste, in which the largest share of WSHGs had a majority of their membership (Table 14, Figure 9). This is a trend that increased as the survey continued.

Caste majority	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Scheduled Castes	42	11.35	57	15.41
Scheduled Tribes	44	11.89	97	26.22
General Caste	161	43.51	249	67.30
Mixed castes	123	33.24	189	51.08

Table 14. Caste majority of WSHGs.

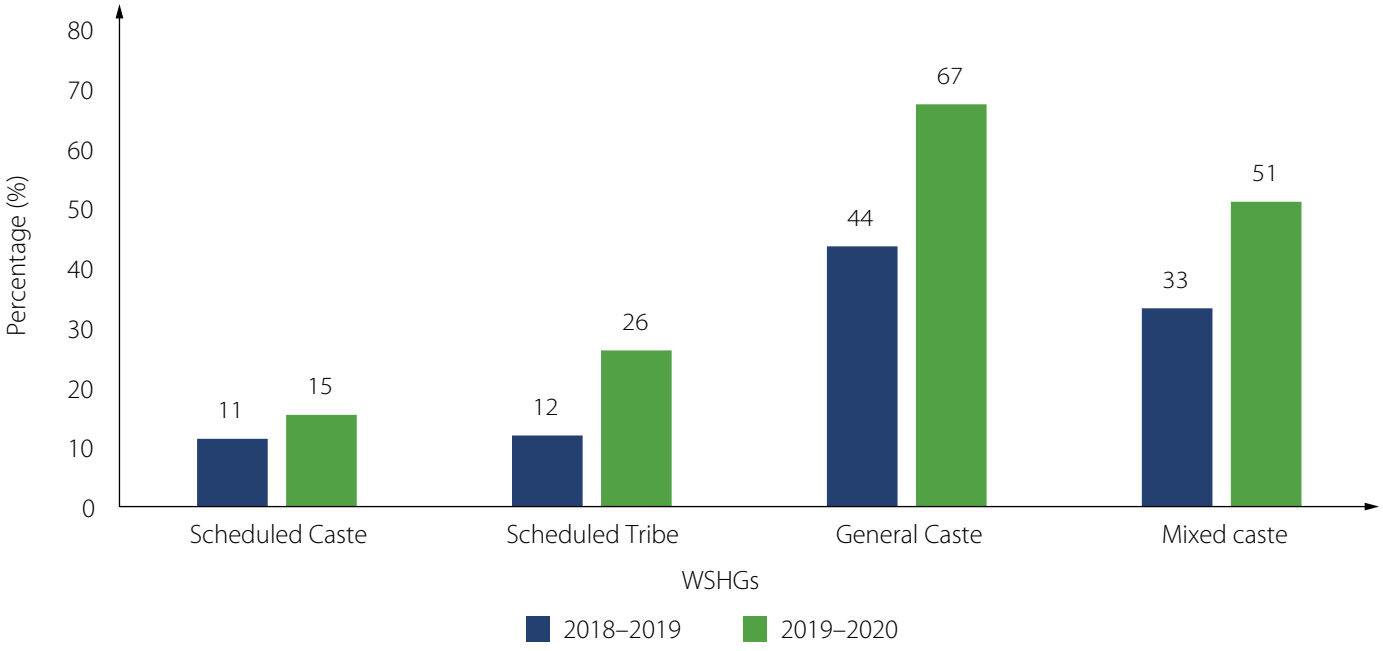

Figure 9. Caste majority of WSHGs.

WSHG activities

Besides participating in the fish farming program, about half of the WSHGs were engaged in diversified and gainful self-employment activities to increase their income (Table 15, Figure 10).

Activity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Only fish farming	185	50.00	286	48.31
Multiple activities	185	50.00	306	51.69

Table 15. WSHG activities.

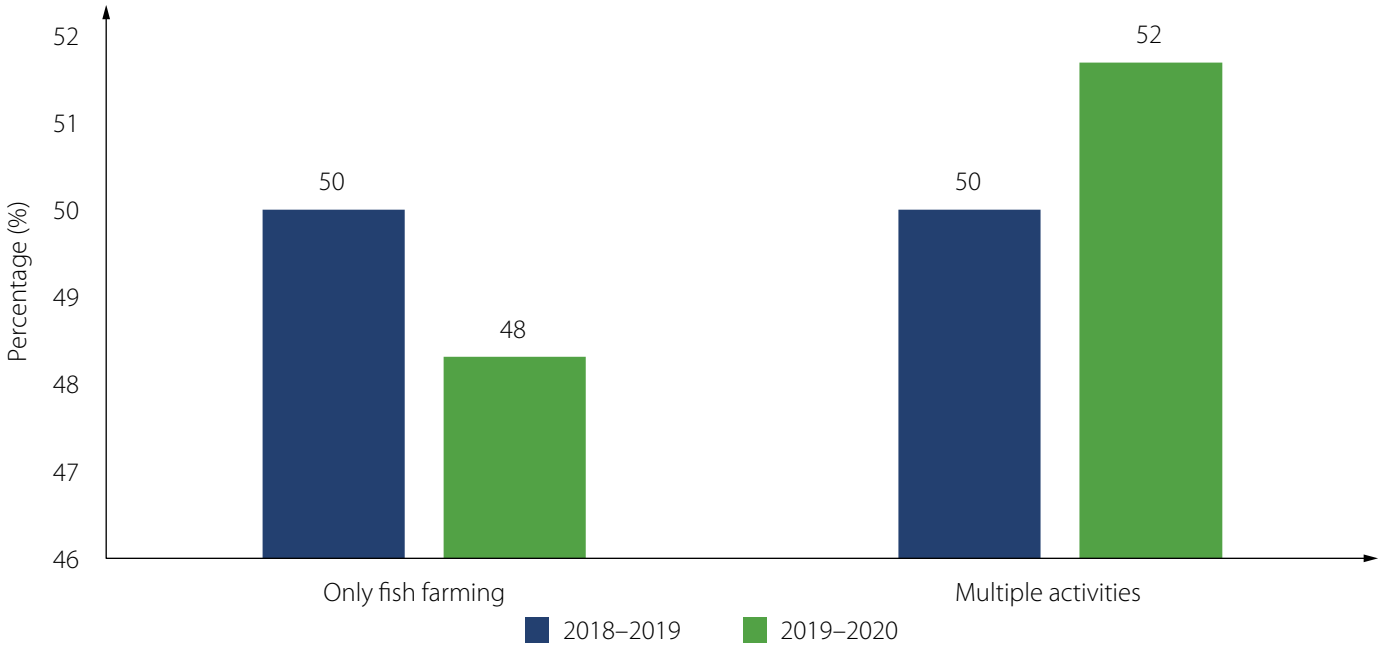

Figure 10. WSHG activities.

Additional WSHG activities

Most of the dynamic WSHGs were involved in private income-generation activities, with only a few involved in government-linked activities (Table 16, Figure 11).

Agriculture activities, such as seasonal vegetable cultivation and agriculture production, were the most preferred options among the majority of WSHGs, followed by different entrepreneurship pursuits performed either collectively or individually. Small-scale entrepreneurship activities are gaining popularity among the women members, including producing incense sticks, preparing candles, making handicrafts, tailoring, handloom, grocery, and fish marketing.

Some WSHGs are engaged in the Mid-Day Meal program in school as well as mushroom cultivation. Several were reported to actively engage in processed and value-added food product preparation, such as bodi, papad, chutney, pickle, puffed rice, confectionery, spice and dried fish.

Government-linked activities included buying paddies, reading electricity meters, taking part in the Public Distribution System, building roads and toilets in villages and supplying uniforms for pre-school students.

Additional activity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Agriculture	74	40.00	125	40.85
Animal husbandry	16	8.65	17	5.56
Entrepreneurship	34	18.38	75	24.51
Floriculture	3	1.62	4	1.31
Fund mobilization	10	5.41	39	12.75
Government contract work	2	1.08	3	0.98
Horticulture	11	5.95	18	5.88
Anganwadi & Mid-Day Meal	11	5.95	14	4.58
Mushroom cultivation	15	8.11	28	9.15
Food product preparation	14	7.57	32	10.46

Note: Respondents chose multiple options.

Table 16. Additional WSHG activities.

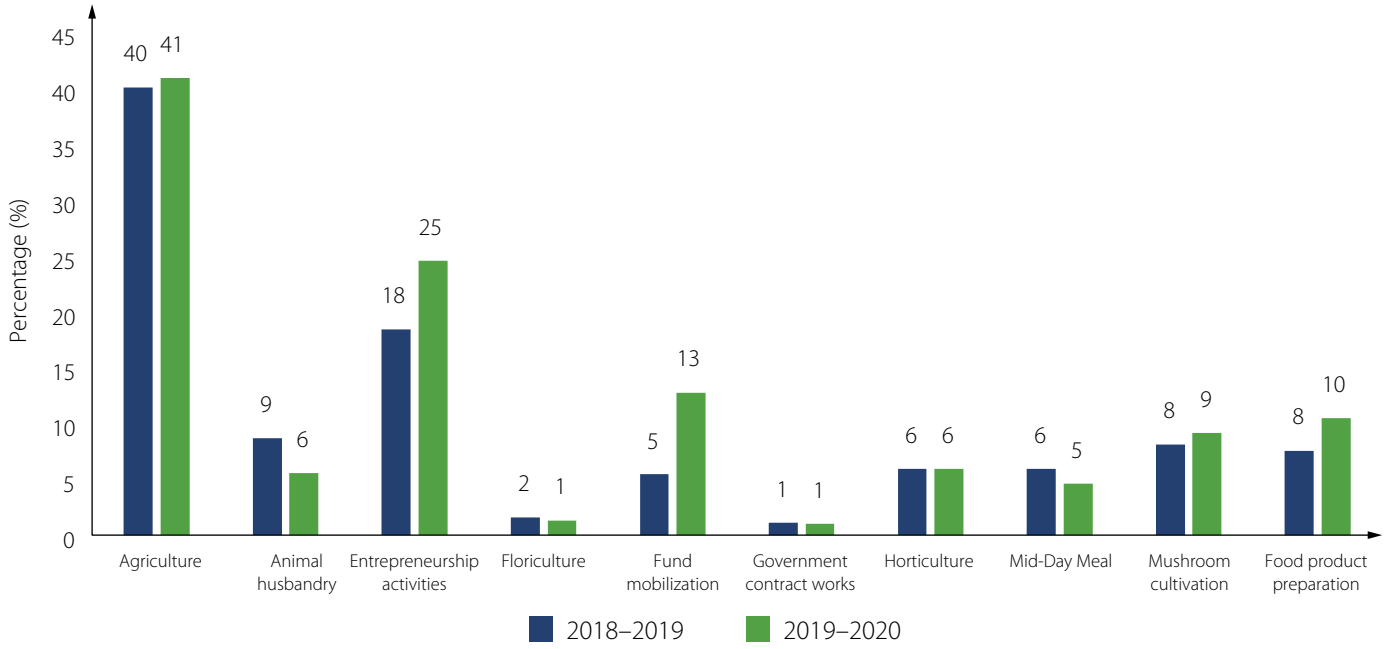

Figure 11. Additional WSHG activities.

Average value	2018–2019	2019–2020
Age of WSHGs	9.70 ± 5.63 (2–34)	8.69 ± 5.66 (1–26)
Total number of WSHG members	11.23 ± 1.80 (9–22)	10.94 ± 1.65 (9–21)
WSHG members of the Scheduled Castes	5.27 ± 4.43 (1–20)	4.96 ± 3.84 (1–20)
WSHG members of the Scheduled Tribes	7.84 ± 3.45 (1–14)	7.23 ± 4.12 (1–17)
WSHG members of the General Caste	8.90 ± 3.77 (1–19)	8.79 ± 3.25 (1–21)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 17. Summary of institutional profile of surveyed WSHGs.

2. Characteristics of Gram Panchayat tanks and leasing pattern

Location of GP tanks

The survey found that almost all of the GP tanks are located in the village where the WSHGs are based (Table 18, Figure 12). Only a small number are located outside the village of the WSHG.

Location	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
In the WSHG village	360	97.30	569	96.11
Outside the WSHG village	10	2.70	23	3.89

Table 18. Location of GP tanks.

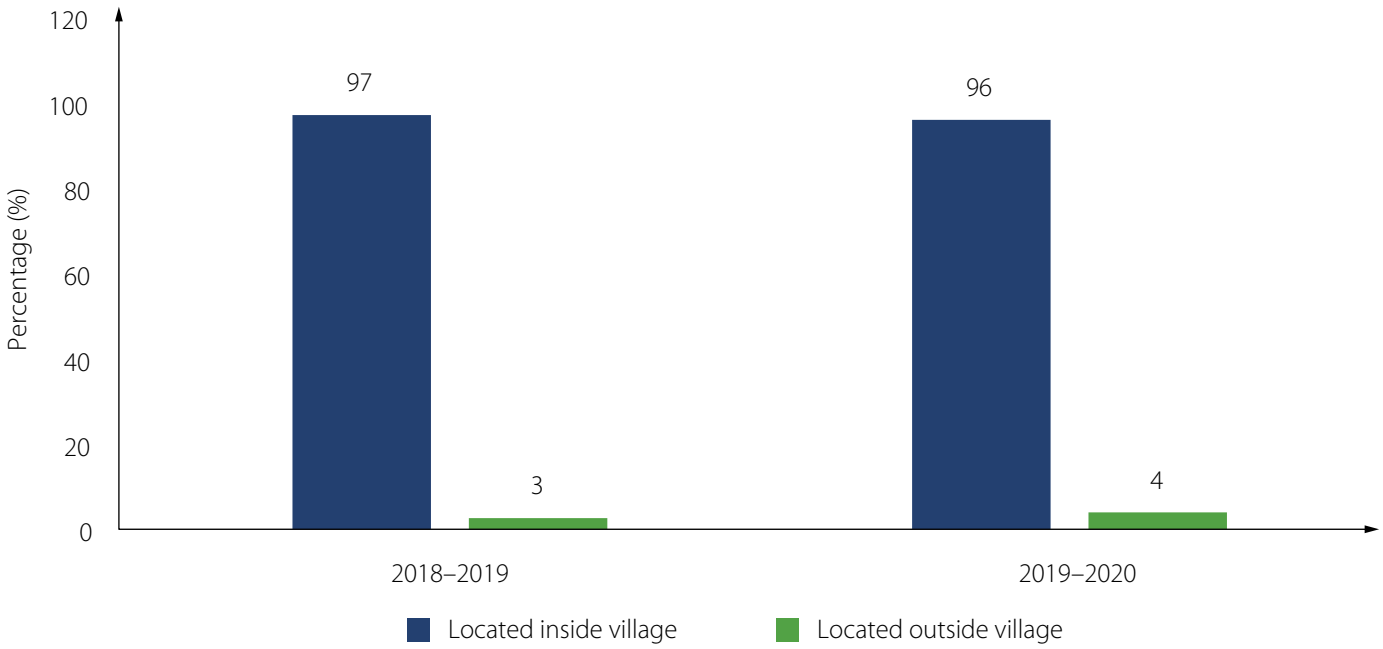

Figure 12. Location of GP tanks.

Distance of WSHGs from GP tanks

The vast majority of respondents said that their GP tank is close by (within 500 m) of their WSHG's location, while about 10% are 0.5–1 km away (Table 19, Figure 13). Only a few are farther than 1 km away.

Distance	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Within 0.5 km	329	88.92	519	87.67
0.5–1 km	36	9.73	62	10.47
> 1 km	5	1.35	11	1.86

Table 19. Distance of WSHGs from GP tanks.

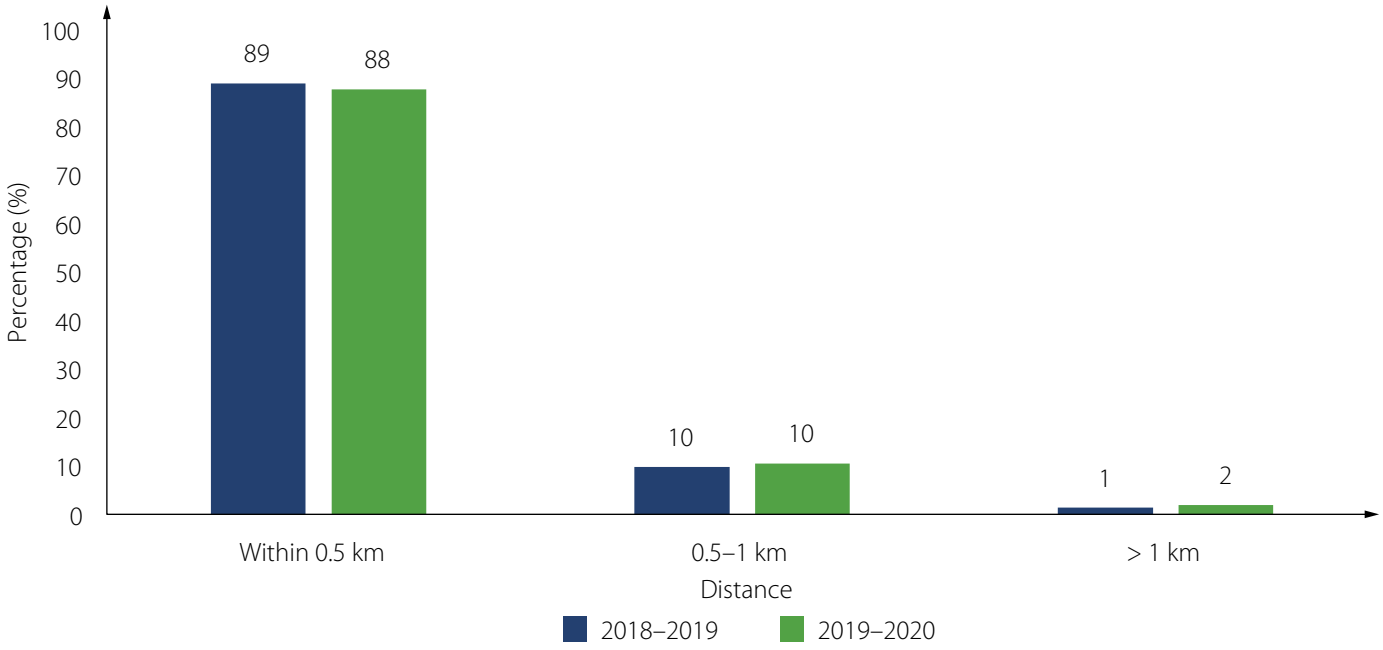

Figure 13. Distance of WSHGs from GP tanks.

Fish farming in GP tanks before lease

In the first year of the survey, over 80% of the GP tanks had not been used for fish farming before they were leased out to the WSHGs. This changed dramatically in the second year, when almost 85% were being used for fish farming. This indicates that WSHGs and local Gram Panchayats were more cautious when leasing out ideal/suitable GP tanks for fish farming (Table 20, Figure 14).

Status	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Fish farming was not present	298	80.54	89	15.03
Fish farming was present	72	19.46	503	84.97

Table 20. Fish farming in GP tanks before lease.

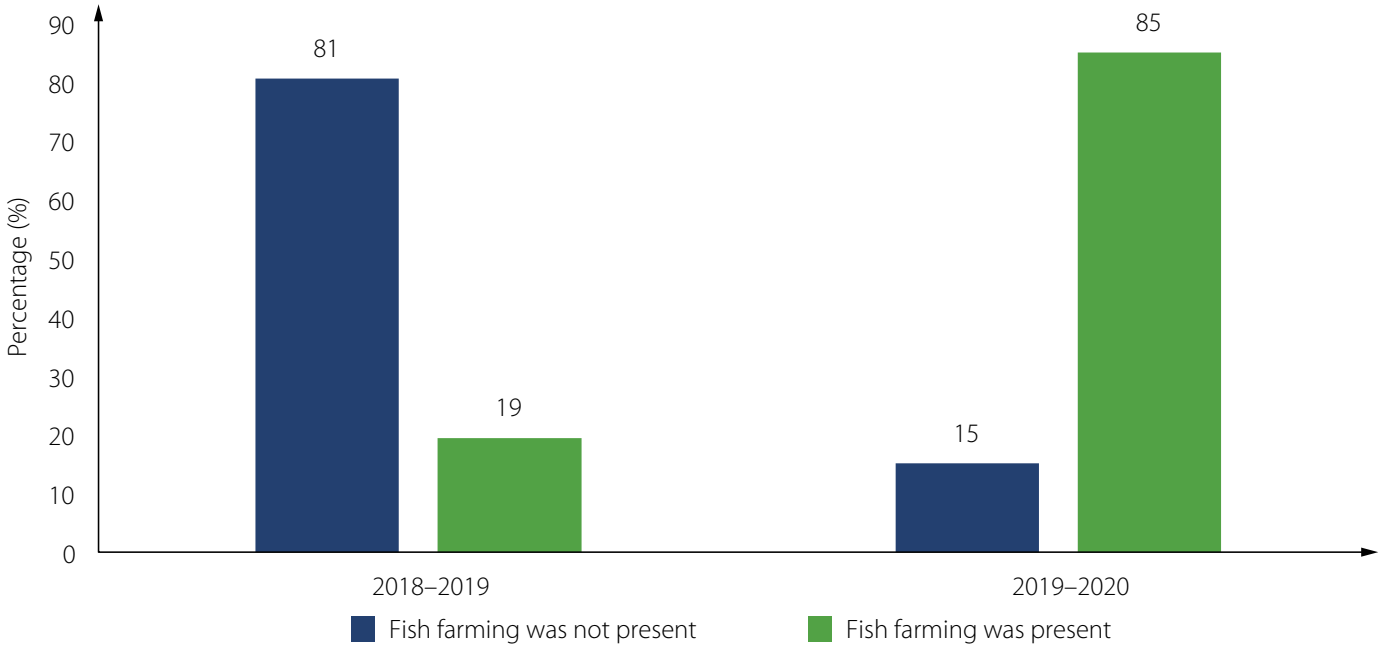

Figure 14. Fish farming in GP tanks before lease.

Size of GP tanks

The water area of the GP tanks allocated to the WSHGs varied greatly, from 0.10 to 32.38 ha, though the average size increased significantly, from 0.77 ha in the first year to 1.02 ha in the second year. The vast majority were less than 2 ha size (Table 21, Figure 15). The proportion that were within 0.40–2 ha was high in each year.

Water area	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< 0.4 ha	76	20.54	114	19.26
0.4–0.5 ha	109	29.46	137	23.14
0.5–1 ha	96	25.95	138	23.31
1–2 ha	56	15.14	130	21.96
2–3 ha	24	6.49	50	8.45
3–4 ha	6	1.62	7	1.18
> 4 ha	3	0.81	16	2.70

Table 21. Size of GP tanks.

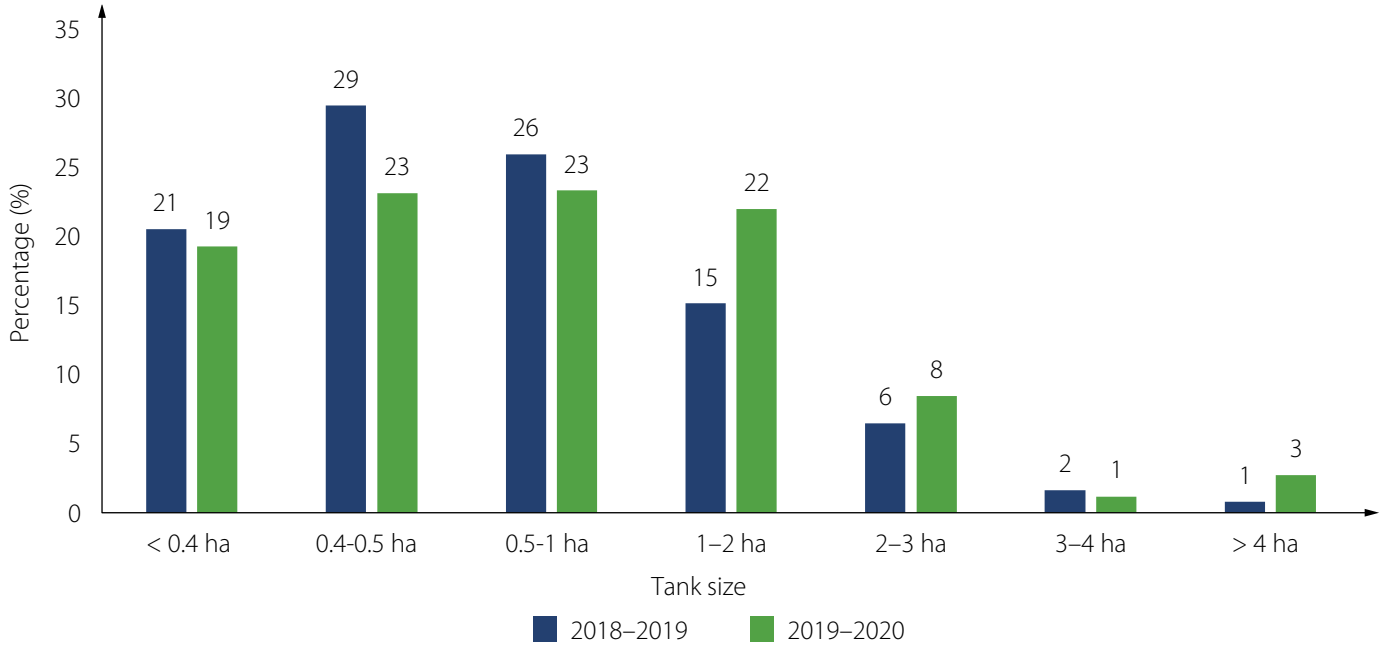

Figure 15. Size of GP tanks.

Water source

Local panchayats build GP tanks to harvest rainwater, especially during the monsoon months, and they store it for multiple purposes of the village community. Most of the tanks depend on rain (97%) as their main source of water. Some depend on multiple sources, such as canals, borewells and ground water seepage, in addition to rainwater. However, water from these sources are mainly drawn during the summer (Table 22, Figure 16).

Source	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Only rainwater	358	96.76	576	97.30
Canal	43	11.62	91	15.37
Ground water seepage	61	16.49	86	14.53
Borewell	20	5.41	32	5.41

Note: Respondents chose multiple options.

Table 22. Water source for GP tanks.

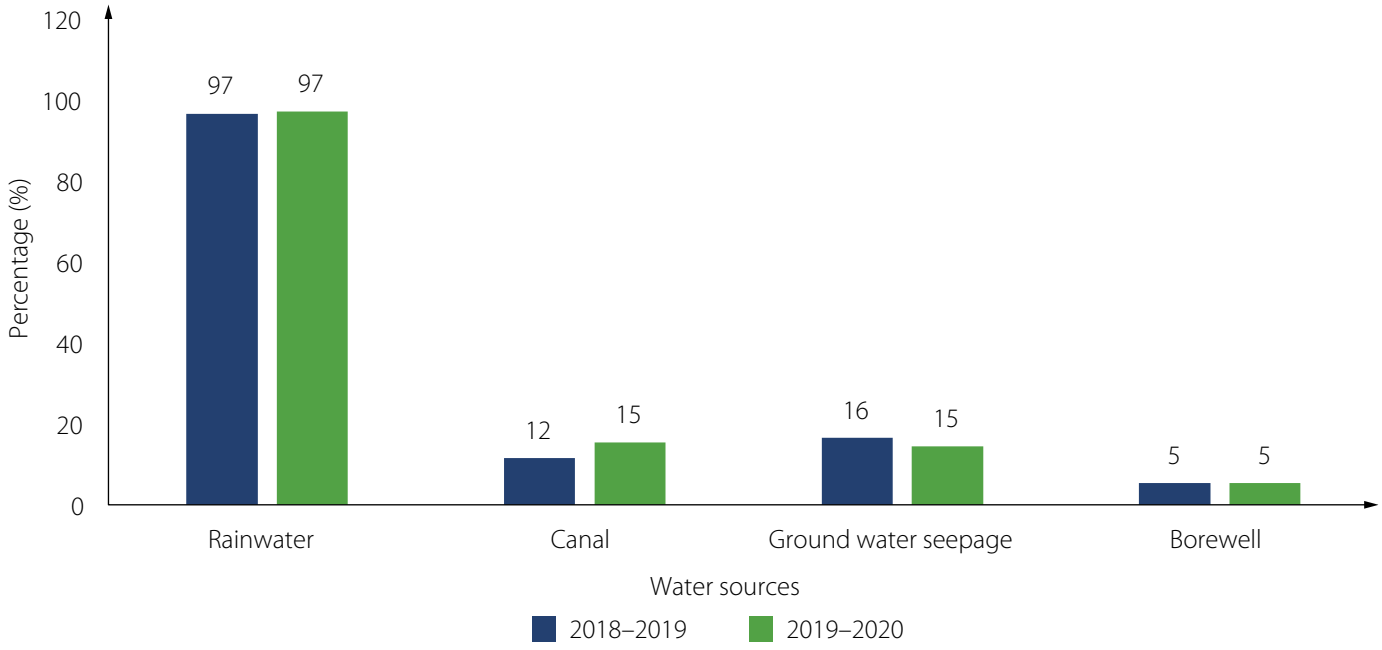

Figure 16. Water source for GP tanks.

Water depth

The average depth of the GP tanks was 8 feet (2.43 m) for both survey years. The water level varied considerably throughout all of Odisha and ranged between 4 and 20 feet (Table 23, Figure 17).

Water depth	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
4–6 feet	168	45.41	229	38.68
6–9 feet	114	30.81	207	34.97
9–12 feet	71	19.19	123	20.78
12–15 feet	16	4.32	28	4.73
>15 feet	1	0.27	5	0.84

Table 23. Water depth of GP tanks.

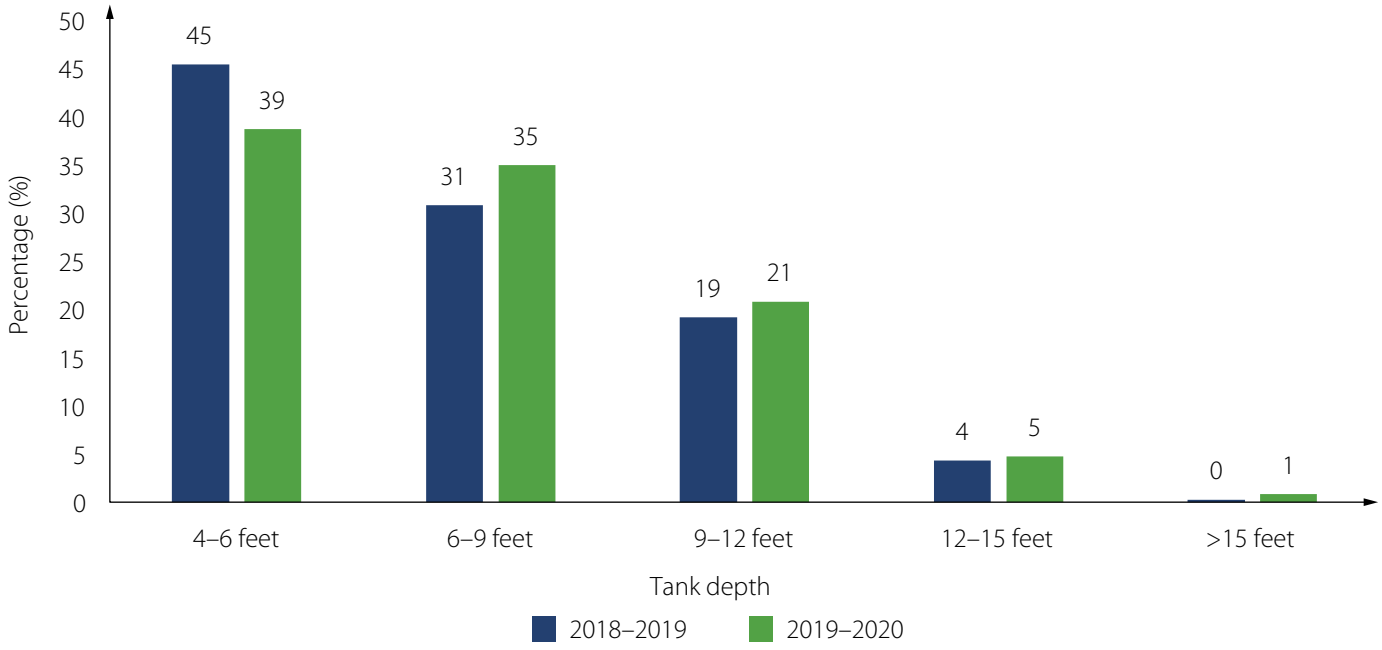

Figure 17. Water depth of GP tanks.

Water retention

Most of the GP tanks hold water year-round (Table 24, Figure 18), while the average water retention period was 11 months. Interestingly, almost all of the tanks held water for 10–12 months. This gives ample opportunity for WSHGs to carryout fish farming year-round with multiple stockings and multiple harvests to optimize the cash flow of their business.

Period	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
12 months	291	78.65	477	80.57
11 months	21	5.68	41	6.93
10 months	45	12.16	56	9.46
9 months	9	2.43	11	1.86
8 months	2	0.54	5	0.84
7 months	1	0.27	1	0.17
6 months	1	0.27	1	0.17

Table 24. Water retention of GP tanks.

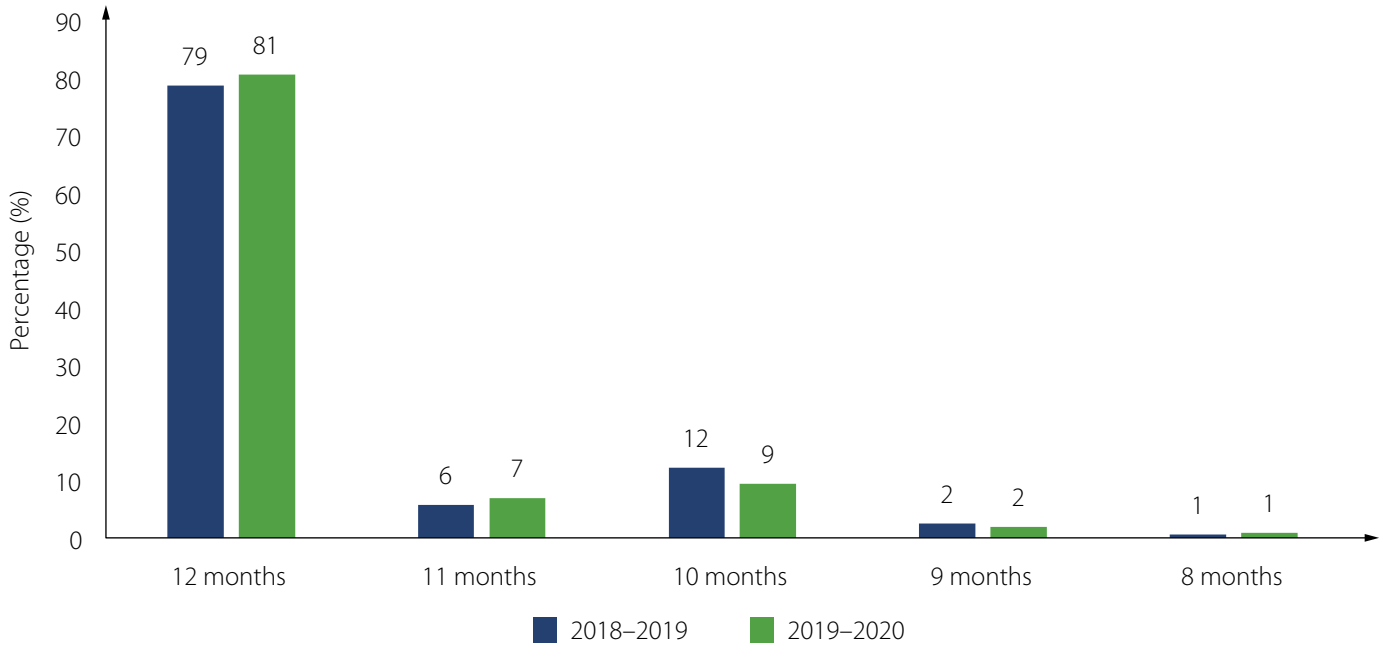

Figure 18. Water retention of GP tanks.

Length of lease

Most of the GP tanks were leased out long term to WSHGs. Leases lasted 3 years or more for almost all of the tanks (Table 25, Figure 19). About three-quarters of them were leased out for 3 years.

Period	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
1 year	13	3.51	17	2.87
3 years	277	74.86	464	78.38
4 years	2	0.54	1	0.17
5 years	78	21.08	108	18.24
10 years	0	0.00	2	0.34

Table 25. Length of lease.

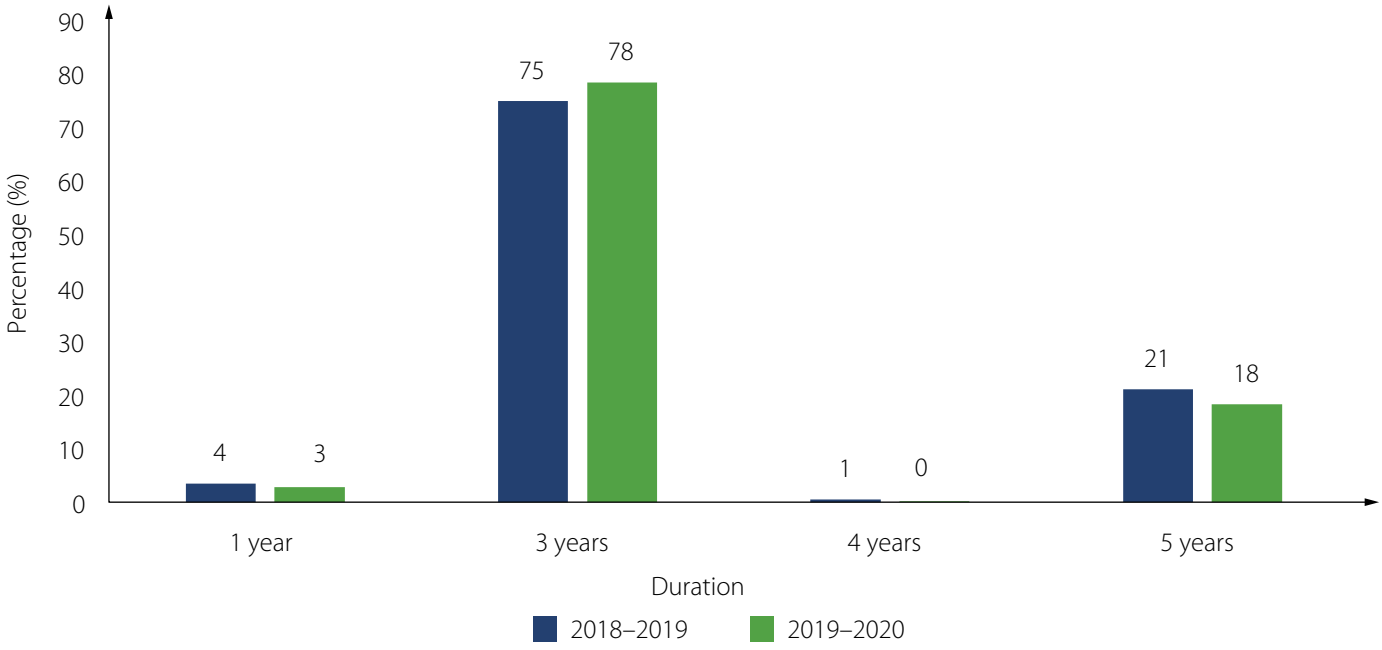

Figure 19. Length of lease.

Primary use of GP tanks

The vast majority of the GP tanks leased out were used for versatile community purposes, such as irrigation, bathing, washing, daily household chores, animal bathing and drinking, as well as religious rituals (Table 26, Figure 20). Only 11% were used exclusively used for fish farming by WSHGs.

Use	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Exclusively fish farming	40	10.81	66	11.15
Multipurpose community use besides fish farming	330	89.19	526	88.85

Table 26. Primary use of GP tanks.

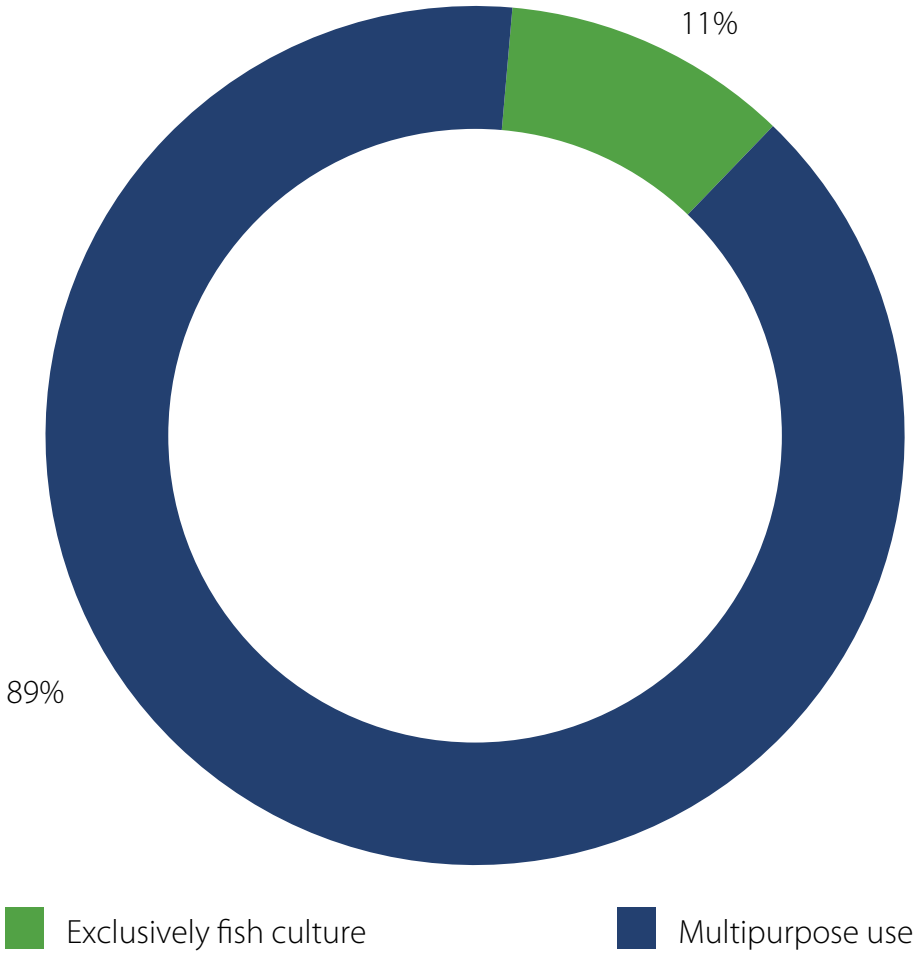

Figure 20. Primary use of GP tanks.

Average value	2018–2019	2019–2020
Tank size (ha)	0.77 ± 0.83 (0.13–7.28)	1.02 ± 1.82 (0.10–32.38)
Water depth (feet)	7.57 ± 2.55 (4–20)	7.82 ± 2.72 (4–20)
Water retention (months)	11.60 ± 0.90 (6–12)	11.64 ± 0.87 (5–12)
Lease duration (years)	3.36 ± 0.93 (1–5)	3.33 ± 0.96 (1–10)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 27. Characteristics and leasing pattern of GP tanks.

Photo credit: De Tour Odisha

Smiles tell many stories of achievement.

3. WSHG mobilization and technical awareness

Previous fish farming experience

Over three-quarters of the WSHGs had no previous experience in fish farming (Table 28, Figure 21). Among those that did, most only had less than 5 years of experience, while only a handful had more.

Experience	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
None	286	77.30	497	83.95
1–5 years	60	16.22	81	13.68
5–10 years	19	5.14	10	1.69
> 10 years	5	1.35	4	0.68

Table 28. Previous fish farming experience.

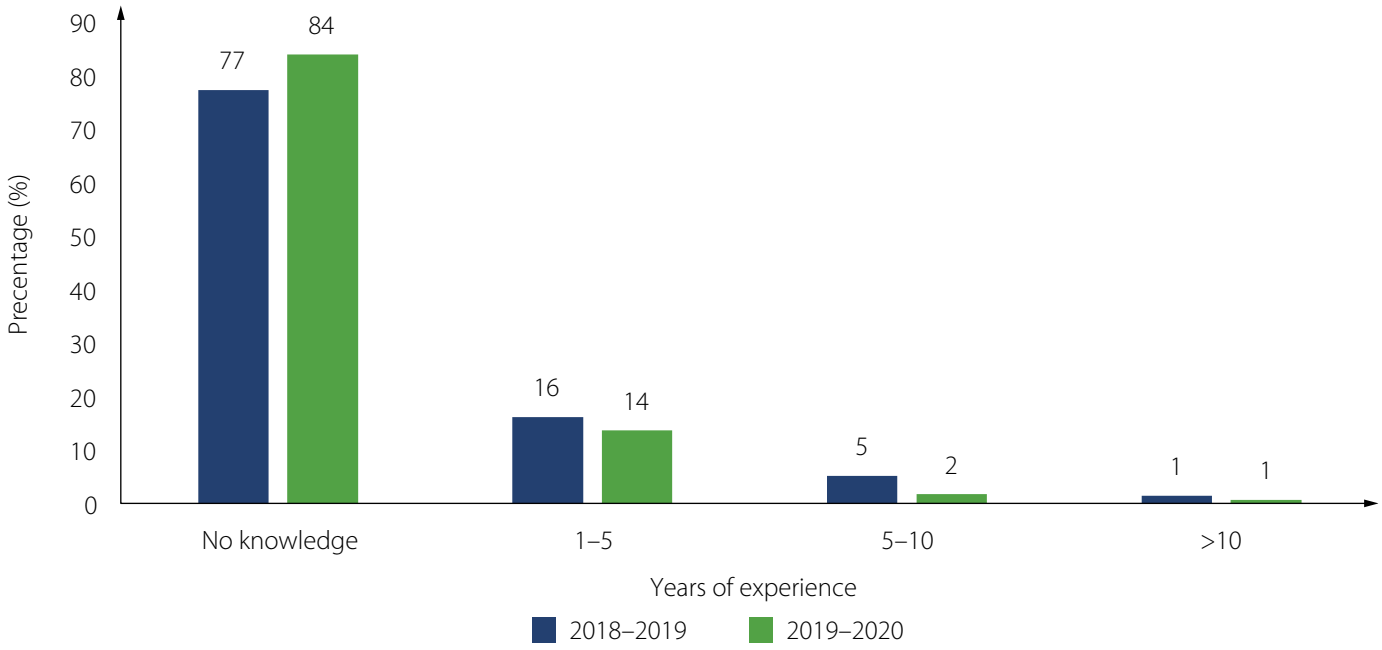

Figure 21. Previous fish farming experience.

Participation in training

Block-level training on fish farming techniques was mandatory for all beneficiary WSHGs. These training sessions were jointly organized by FARD and Mission Shakti across the state. Almost all of the WSHGs participated in the training (Table 29, Figure 22).

Attendance	2018–2019		2019-2020	
	WSHGs	%	WSHGs	%
Yes	358	96.76	567	95.78
No	12	3.24	25	4.22

Table 29. Participation in training.

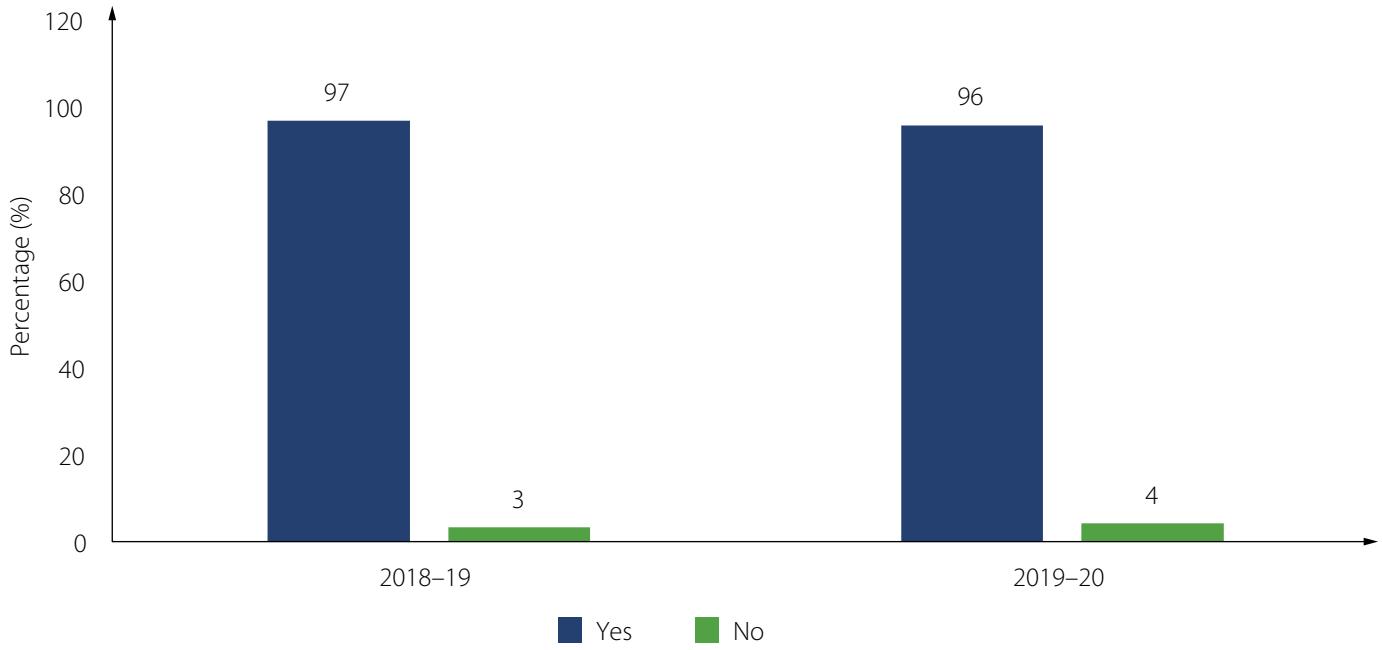

Figure 22. Participation in training.

Timing of training

Ideally, WSHGs should attend training before stocking so that they can learn about BMPs for fish farming. In the first year, most of the WSHGs completed the training during the pre-stocking period; however, most did so after stocking in the second year (Table 30, Figure 23).

Timing	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Before stocking	297	82.96	161	28.40
After stocking	61	17.04	406	71.60

Table 30. Timing of training.

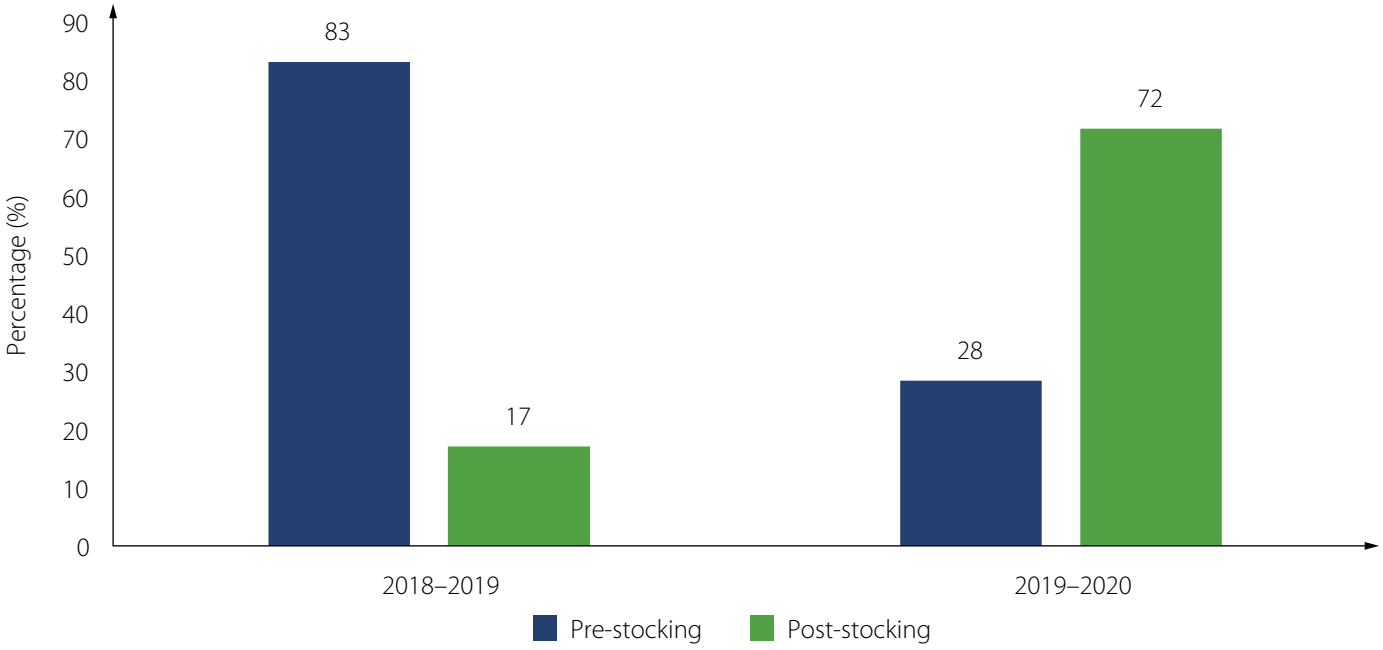

Figure 23. Timing of training.

Attendance at training

On an average, 3 members of each WSHG participated in the training. The vast majority of the WSHGs sent 2–5 members (Table 31, Figure 24).

Attendance	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
2–5 members	323	90.22	496	87.48
5–10 members	15	4.19	42	7.41
10–15 members	14	3.91	28	4.94
> 15 members	6	1.68	1	0.18

Table 31. Attendance at training.

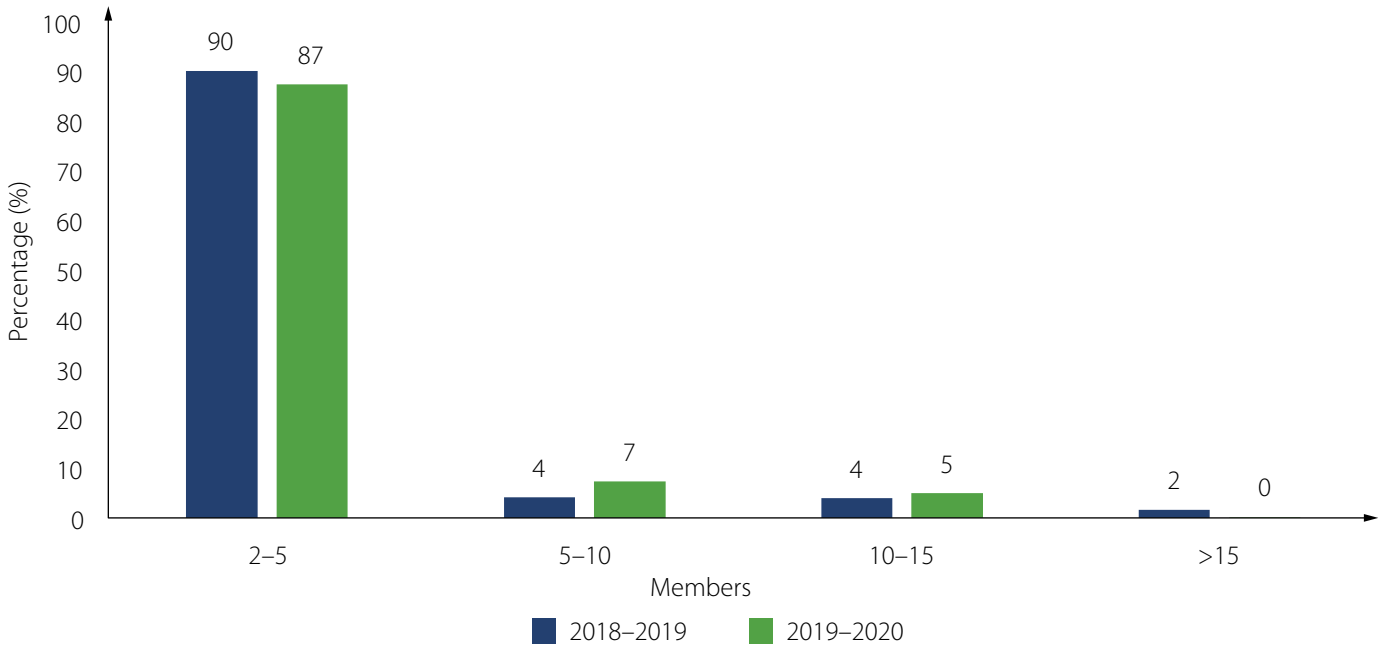

Figure 24. Attendance at training.

Other types of training

In addition to block-level training on fish farming, only 9%–10% of the WSHGs attended technical training conducted by other agencies, such as government departments, private companies and nongovernmental organization (Table 32, Figure 25).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	34	9.19	59	9.97
No	336	90.81	533	90.03

Table 32. Participation in other types of training.

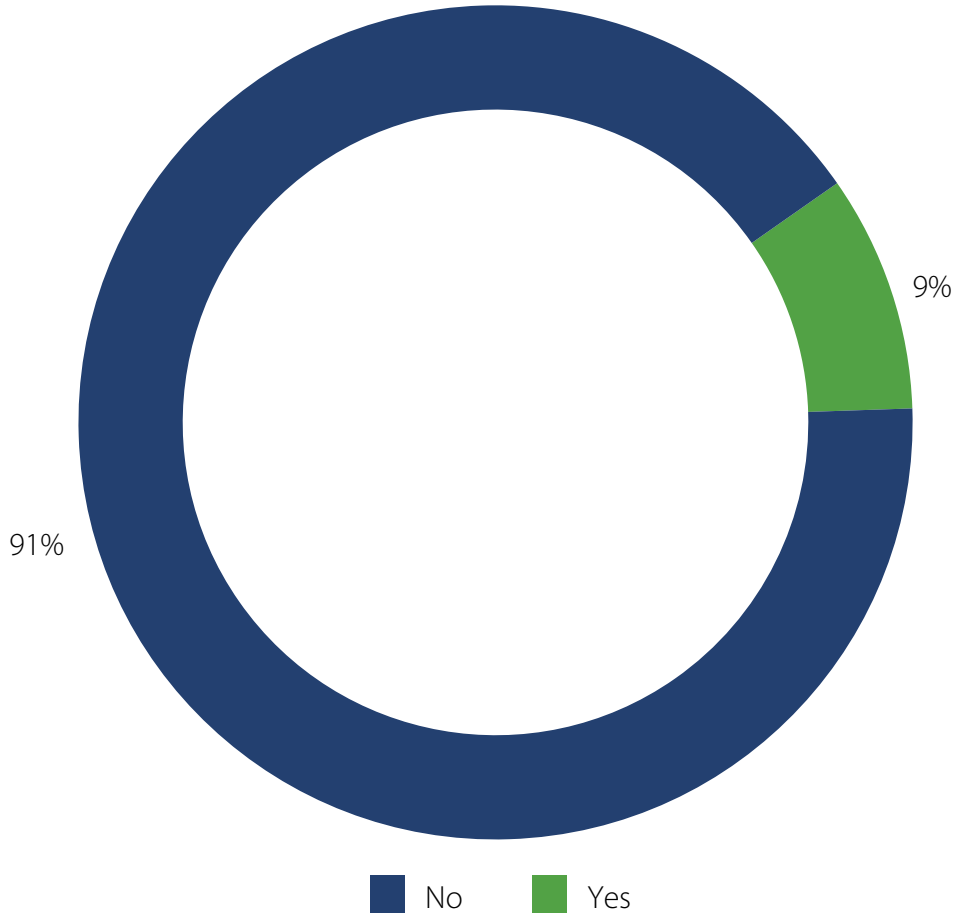

Figure 25. Participation in other types of training.

On-farm technical services

Almost all of the WSHGs reported receiving farmgate technical services and guidance from officials of FARD and the Odisha-WorldFish project (Table 33, Figure 26).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	366	98.92	577	97.47
No	4	1.08	15	2.53

Table 33. WSHGs that received on-farm technical services.

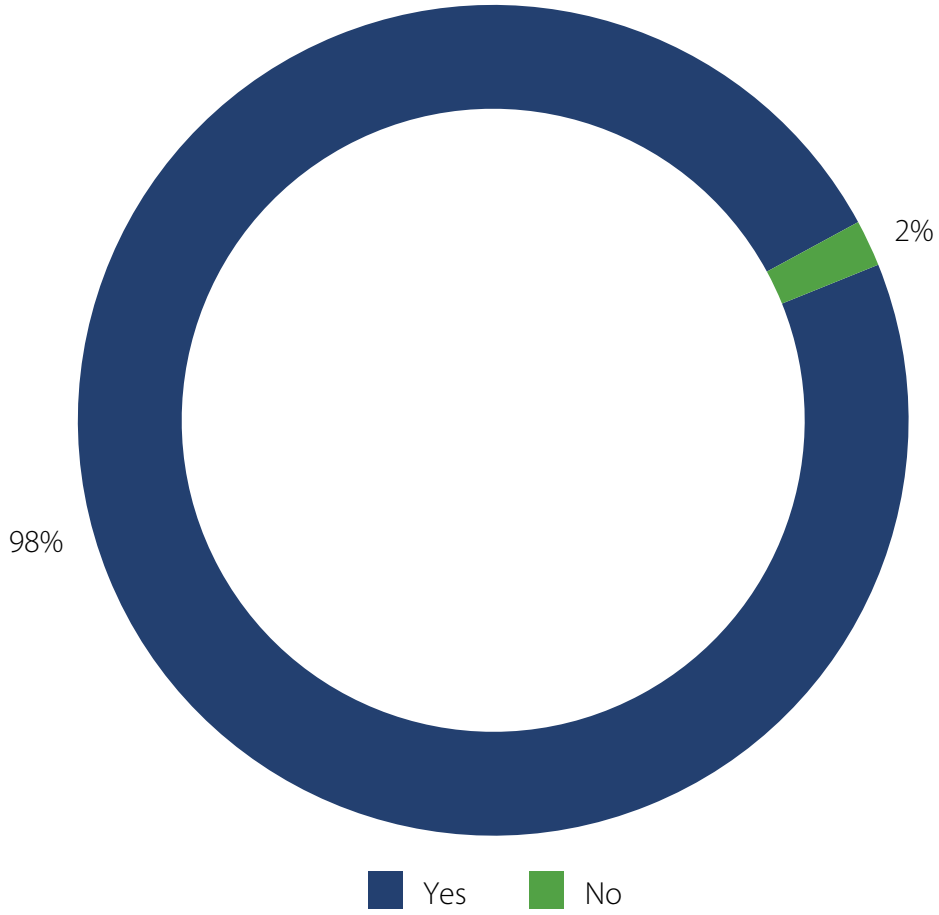

Figure 26. WSHGs that received on-farm technical services.

Frequency of farm visits from officials

The WSHGs reported that officials from FARD and the Odisha-WorldFish project visited their GP tanks an average of six times during their crop period. Most of the WSHGs reported receiving more than four visits during their crop period in each survey year (Table 34, Figure 27).

Visits per crop period	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< 4 times	51	13.93	96	16.64
4–6 times	226	61.75	325	56.33
7–10 times	75	20.49	121	20.97
> 10 times	14	3.83	35	6.07

Table 34. Frequency of farm visits from officials.

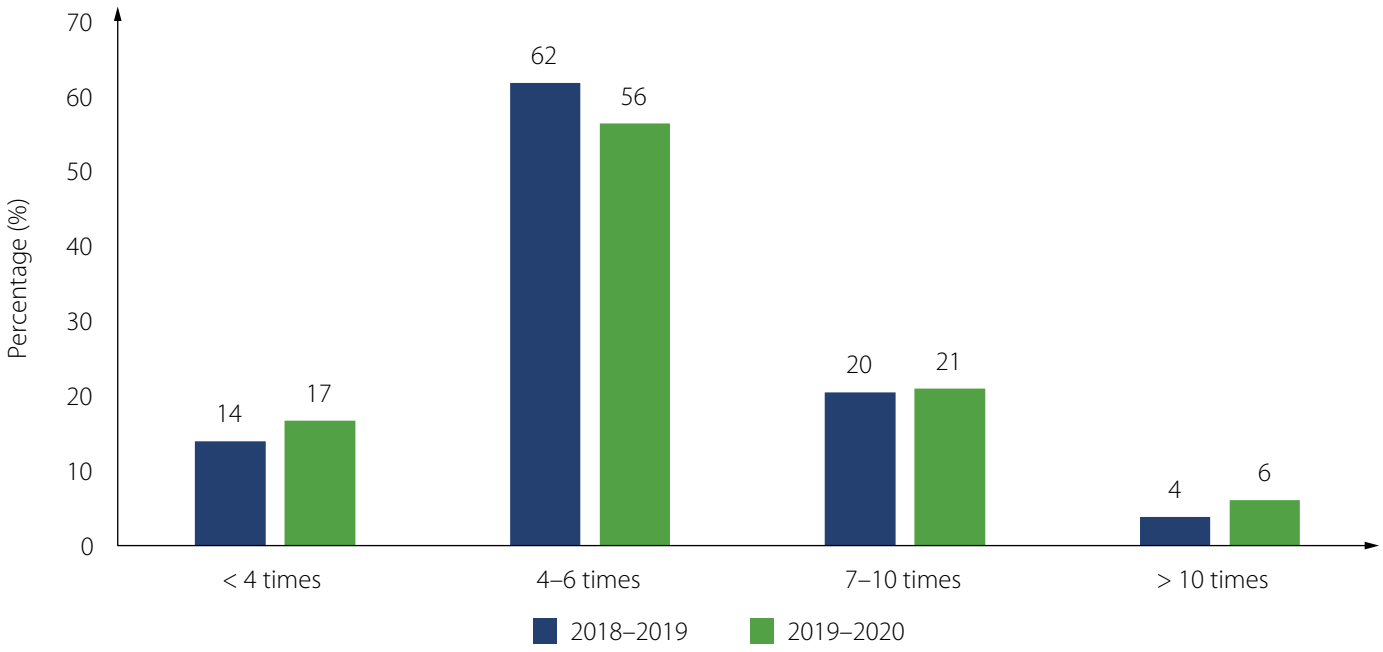

Figure 27. Frequency of farm visits from officials.

Other sources of knowledge on fish farming

In addition to learning about fish farming through training and farm services from FARD, WSHG members frequently depend on various other sources, like leaflets, books, radio, TV and the internet to learn more (Table 35, Figure 28). Leaflets that FARD distributed were the most popular source of knowledge among farmers. Many WSHGs also depended on print and electronic media, such as newspapers, internet, TV and radio, for fish farming knowledge in the first survey year, but only about a third did so in the second.

Other source	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Leaflets	257	69.46	449	75.84
Books	144	38.92	252	42.57
Print and electronic media	217	58.65	195	32.94

Note: Respondents chose multiple options.

Table 35. Other sources of knowledge on fish farming.

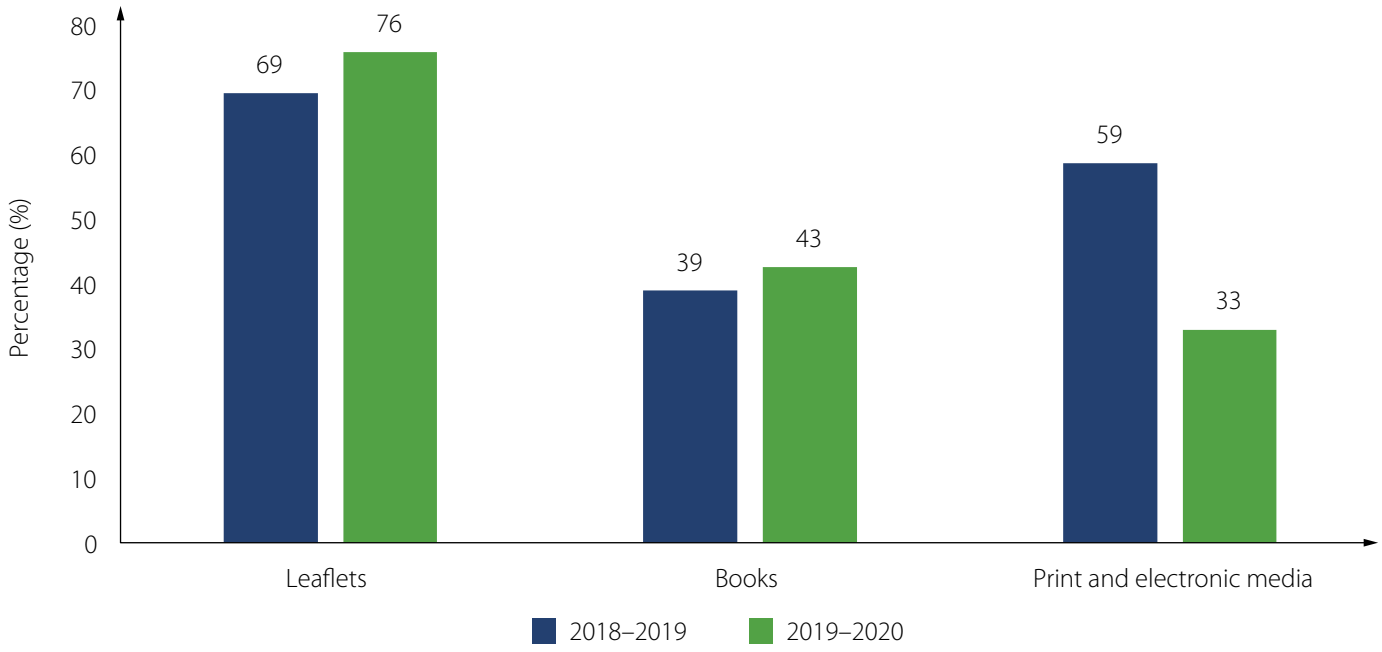

Figure 28. Other sources of knowledge on fish farming.

Average time spent on fish farming activities

On average, WSHGs spent 2 hours per day on fish farming activities in their GP tanks. Only 7% spent more than 4 hours per day (Table 36, Figure 29).

Average time	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< 1 hour/day	61	16.49	76	12.84
1–2 hours/day	232	62.70	400	67.57
2–4 hours/day	52	14.05	76	12.84
> 4 hours/day	25	6.76	40	6.76

Table 36. Average time spent on fish farming activities.

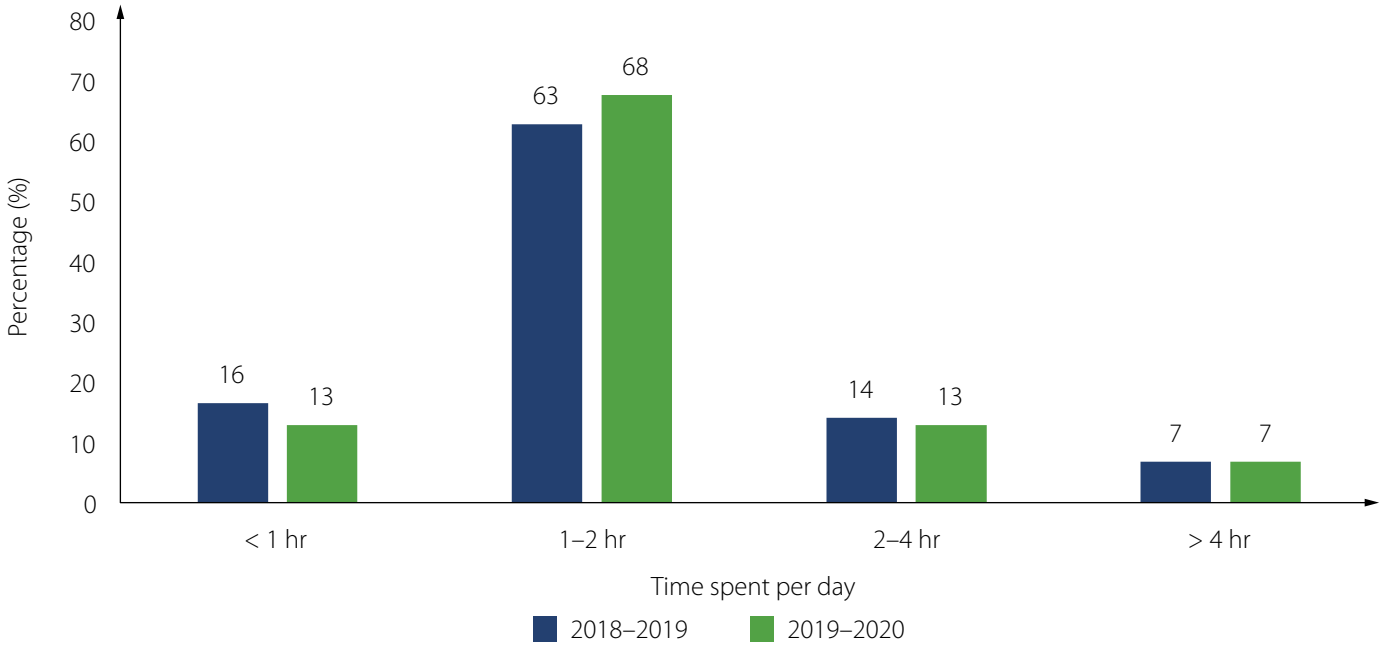

Figure 29. Average time spent on fish farming activities.

Average value	2018–2019	2019–2020
WSHG members attended block-level training (numbers)	2.91 ± 2.62 (2–17)	3.19 ± 2.97 (2–16)
Daily time spent on fish farming (hours)	1.84 ± 1.38 (0.5–8)	1.77 ± 1.35 (0.10–7)
Frequency of visit from officials of FARD and the Odisha-WorldFish project to GP tanks during the crop period (numbers)	5.57 ± 2.43 (1–18)	5.78 ± 2.91 (1–20)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 37. Information on knowledge sources for fish farming and community mobilization.

A member of a WSHG monitoring plankton levels.

4. GP tank management practices and BMP adoption among WSHGs

Tank dike preparation

The majority of the WSHGs in each survey year prepared their tank dike at the beginning of fish farming, with about a 6% increase year over year. The remaining WSHGs did not prepare their dike for various reasons (Table 38, Figure 30).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	238	64.32	416	70.27
No	132	35.68	176	29.73

Table 38. Tank dike preparation.

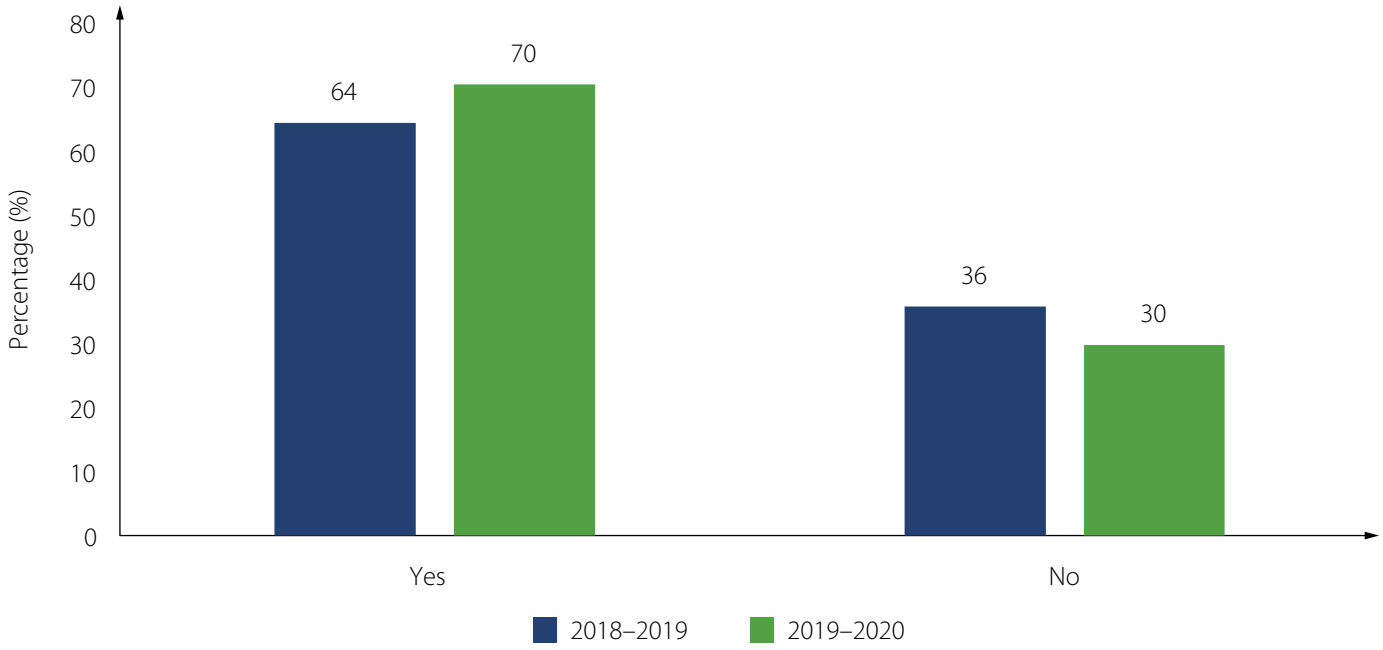

Figure 30. Tank dike preparation.

Methods of tank dike preparation

Preparing the tank dike includes removing weeds, tightening the soil and tidying up the surroundings (Table 39, Figure 31), and WSHGs used various methods to prepare their tank dike.

The majority depended exclusively on hired manual laborers in both survey years. Among the rest of the WSHGs, most used a mix of manual labor from within their membership and hired laborers in the first year, but most used mechanical methods in the second year.

Method	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Manual labor of WSHG members along with hired labor	45	18.91	39	9.38
Hired manual labor only	158	66.39	291	69.95
Mechanical methods	35	14.71	86	20.67

Table 39. Methods of tank dike preparation.

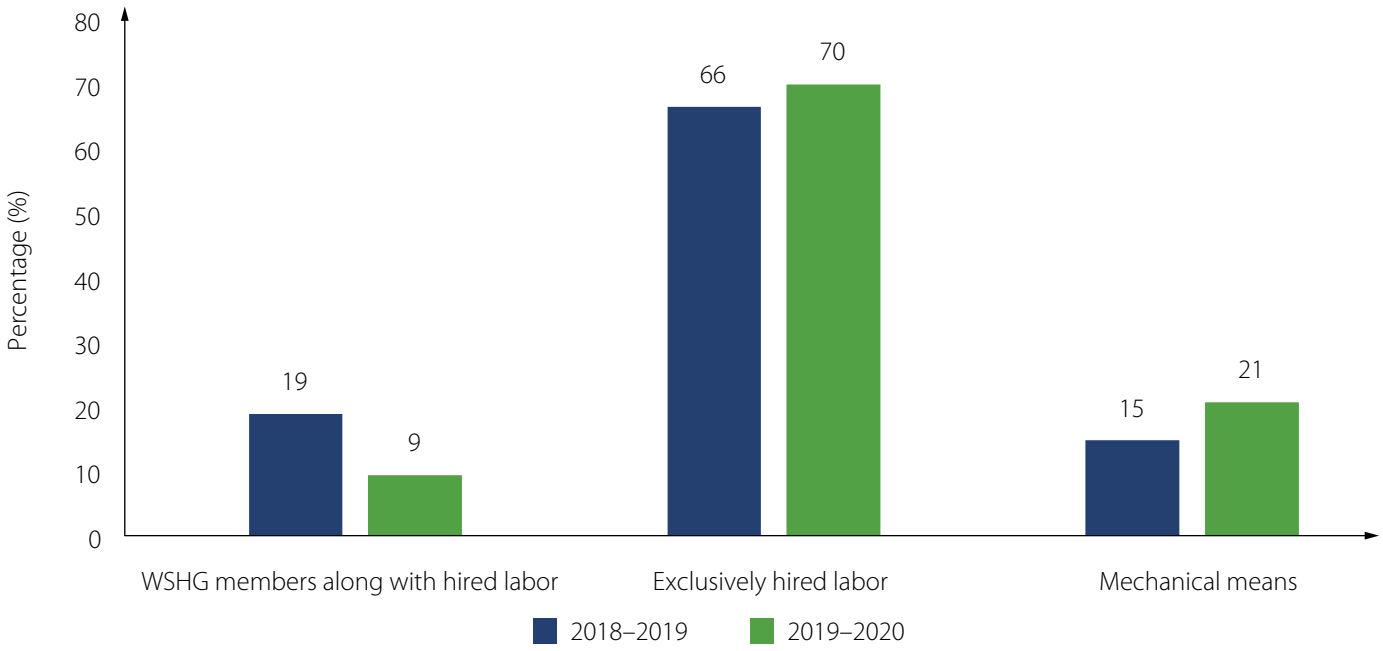

Figure 31. Methods of tank dike preparation.

Reasons for not preparing the tank dike

Among the WSHGs that did not prepare their tank dike, most said that it was because the tank was in good condition, while only a few cited high labor costs as a reason why they did not clean and shape their tank dike (Table 40, Figure 32). A handful of WSHGs did not know about the benefits of tank dike preparation before starting fish farming.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Dike was prepared earlier and in good condition	116	87.88	157	89.20
High labor cost	4	3.03	6	3.41
Not aware about dike preparation	12	9.09	13	7.39

Table 40. Reasons for not preparing the tank dike.

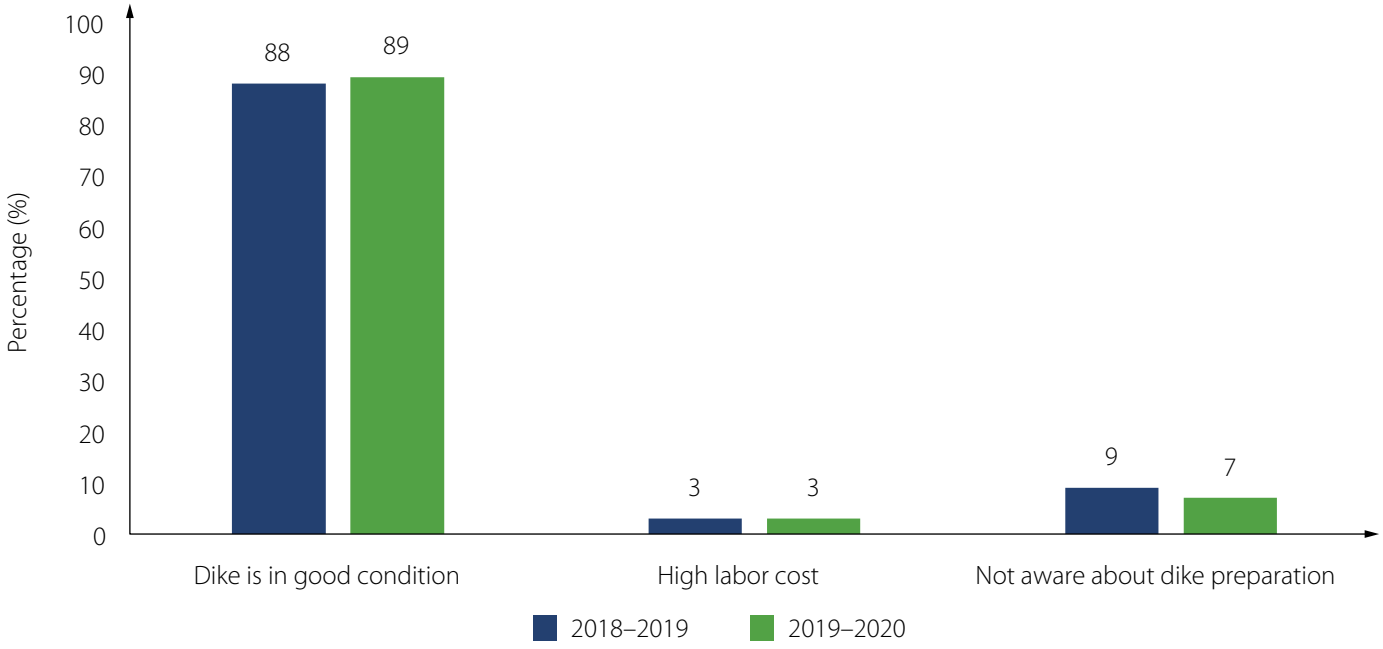

Figure 32. Reasons for not preparing the tank dike.

Eradicating predatory fishes

Sizable proportions of WSHGs eradicated predatory fish from their GP tank as part of BMPs (Table 41, Figure 33). The rate increased slightly from the first year to the second.

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	239	64.59	417	70.44
No	131	35.41	175	29.56

Table 41. Eradicating predatory fish.

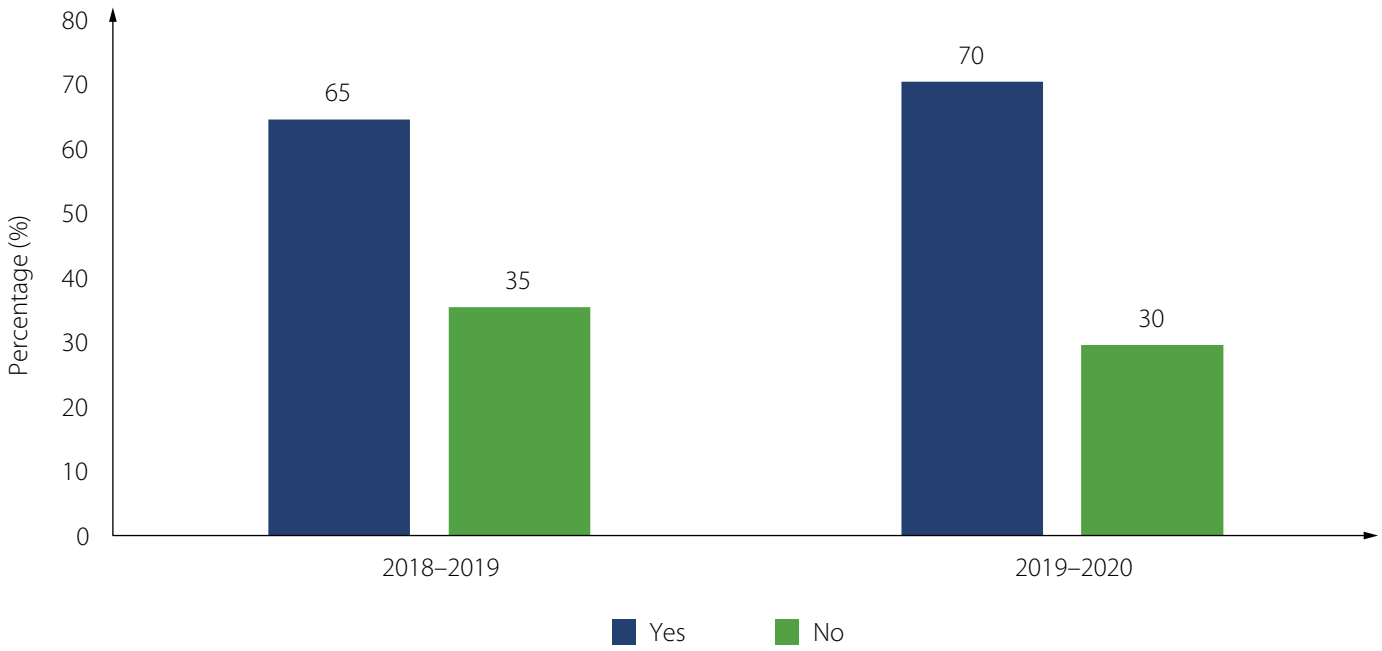

Figure 33. Eradicating predatory fish.

Methods used to eradicate predatory fish

In both survey years, the vast majority of the WSHGs used repeated netting to eradicate predatory fish from their GP tanks (Table 42, Figure 34). The rest used dewatering and drying, or applied a combination of mahua oil cake and bleaching powder.

Method	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Repeated netting	193	80.75	346	82.97
Pond dewatering and drying	35	14.64	54	12.95
Applying mahua oil cake and bleaching powder	11	4.60	17	4.08

Table 42. Methods used to eradicate predatory fish.

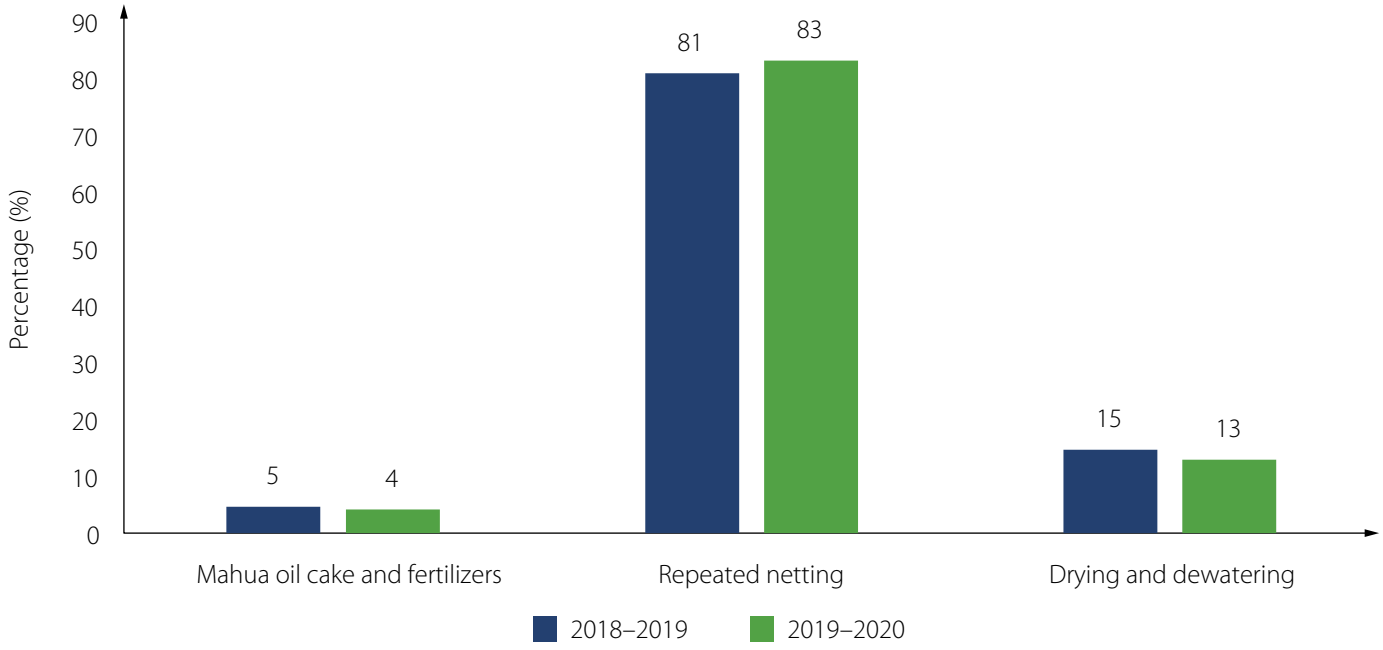

Figure 34. Methods used to eradicate predatory fish.

Reasons for not eradicating predatory fish

A large tank area and greater water depth sometimes inhibit WSHGs from adopting proper BMPs. Among the WSHGs that did not get rid of predatory fish from their GP tanks, about a third cited this reason in each survey year (Table 43, Figure 35). Well under half believed that there were no predatory fish in their GP tank, so they did not think they had to get rid of them. About a quarter were not aware that predatory fish have to be removed. Aquatic macrophytes infestation was the other reason given among a small portion of WSHGs.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Large tank area and deep water	48	36.64	56	32.00
Presumed that there were no predatory fish in the tank	45	34.35	73	41.71
Did not know	35	26.72	41	23.43
Covered with aquatic vegetation	3	2.29	5	2.86

Table 43. Reasons for not eradicating predatory fish.

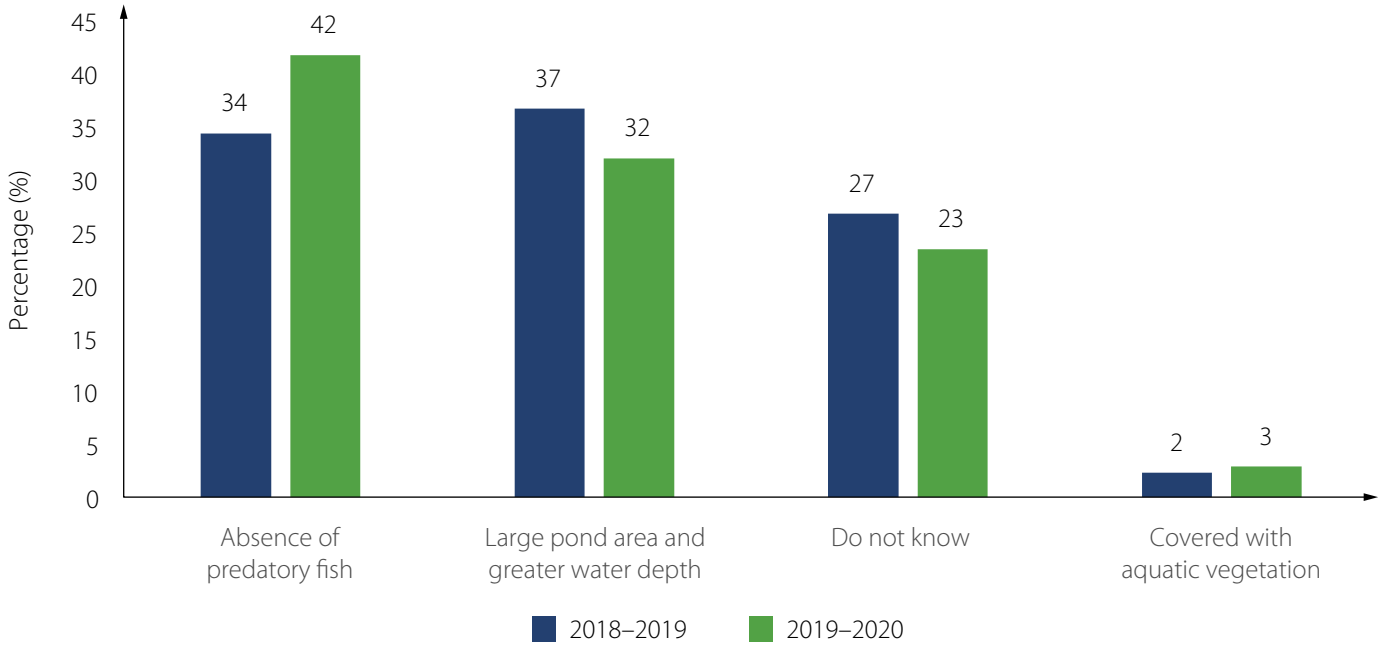

Figure 35. Reasons for not eradicating predatory fish.

Removing aquatic weed plants

The vast majority of WSHGs removed aquatic weeds and macrophytes from their GP tank as part of BMPs, and this practice is gaining importance among them with time (Table 44, Figure 36).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	327	88.38	536	90.54
No	43	11.62	56	9.46

Table 44. Removing aquatic weeds.

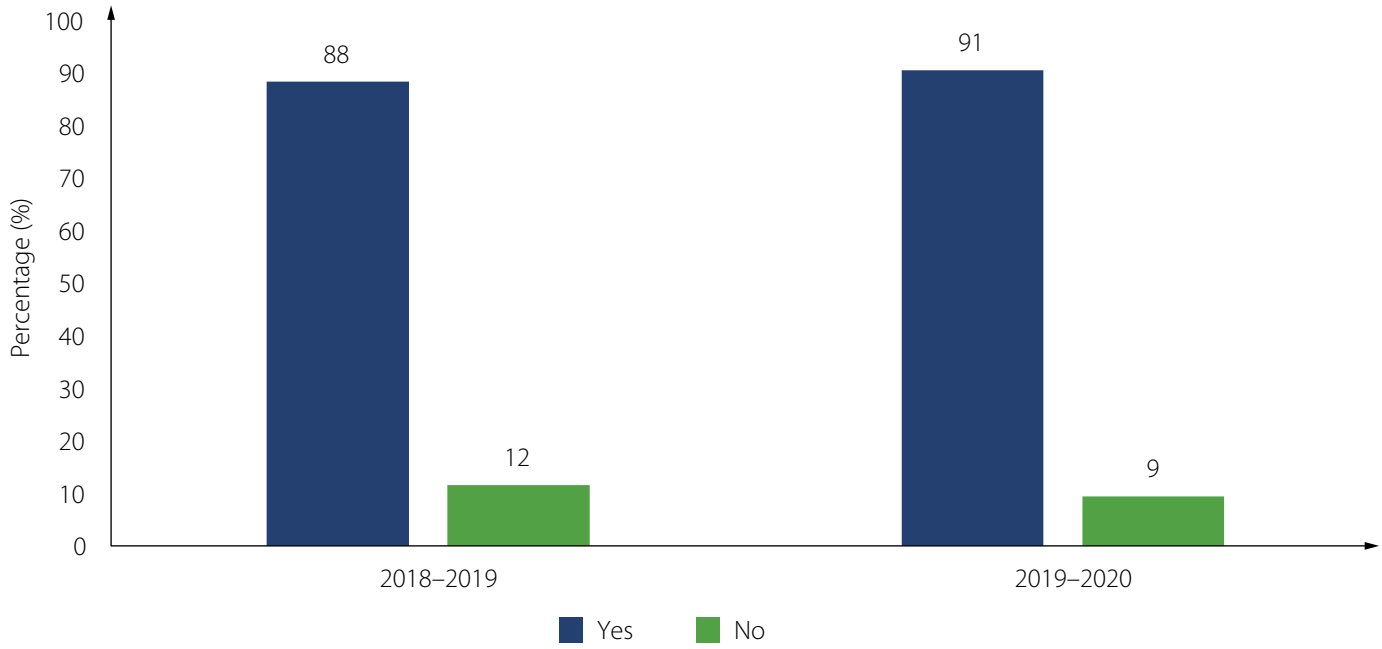

Figure 36. Removing aquatic weeds.

Methods used to remove aquatic weeds

In the first survey year, more than half of the members of WSHGs removed aquatic weeds manually, but only a quarter did so in the second (Table 45, Figure 37). In contrast, nearly two-thirds used hired labor to remove the weeds in the second year. Very few WSHGs used repeated netting, and even fewer used chemicals to get rid of the weeds.

Method	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Manually through WSHG members	181	55.35	133	24.81
Manually through hired labor	116	35.47	328	61.19
Repeated netting	23	7.03	40	7.46
Mechanical means	3	0.92	4	0.75
Chemical application	4	1.22	31	5.78

Table 45. Methods used to remove aquatic weeds.

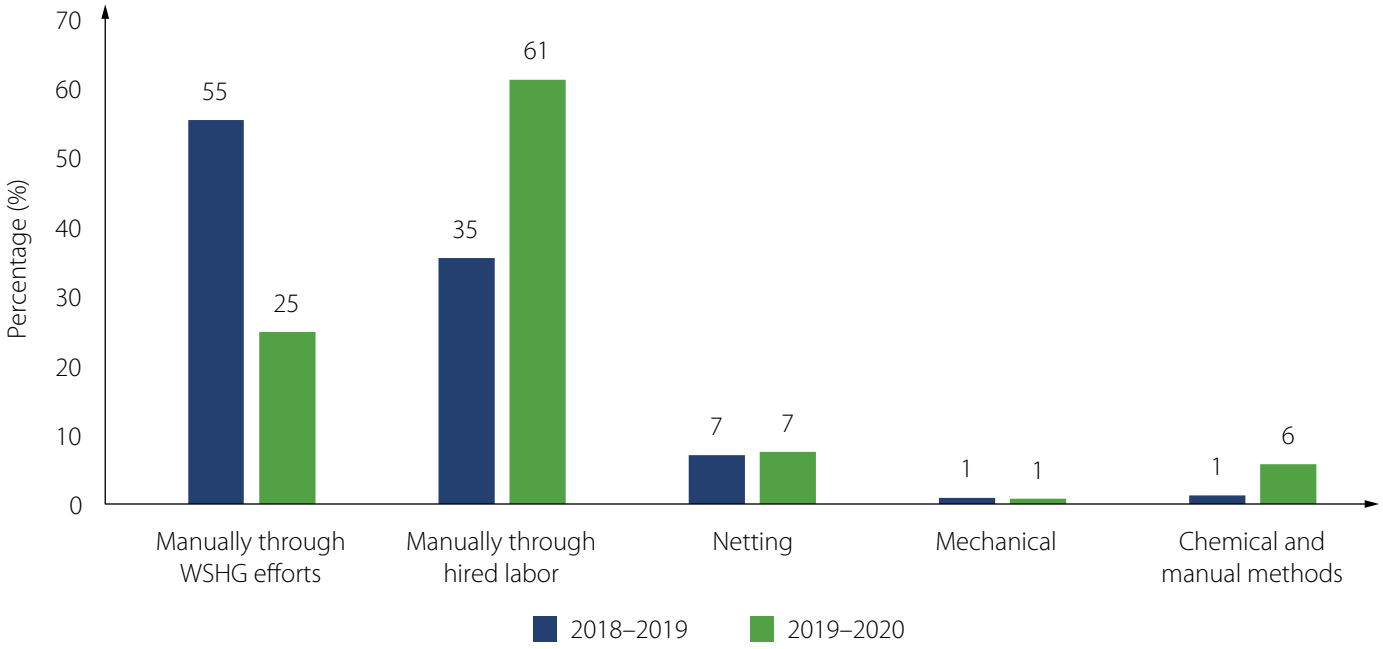

Figure 37. Methods used to remove aquatic weeds.

Reasons for not removing aquatic weeds

Among WSHGs that did not remove aquatic weed plants, the vast majority said that their GP tank did not have any aquatic weeds (Table 46, Figure 38). High cost of labor was the other reason given.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
No aquatic weeds in GP tank	40	93.02	47	83.93
High labor cost	3	6.98	9	16.07

Table 46. Reasons for not removing aquatic weeds.

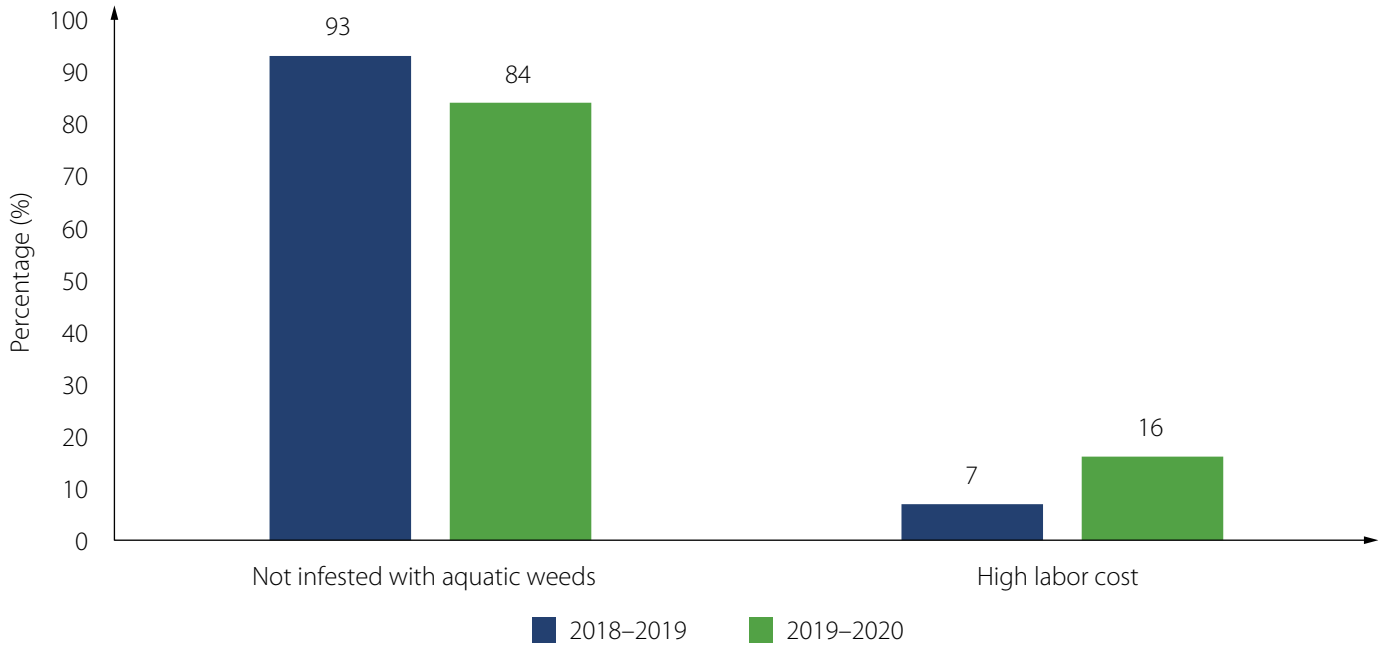

Figure 38. Reasons for not removing aquatic weeds.

Lime application

To maintain the ideal pH of the water (7.5 to 8.5), almost all of the WSHGs applied lime in each survey year (Table 47, Figure 39).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	350	94.59	574	96.96
No	20	5.41	18	3.04

Table 47. Lime application.

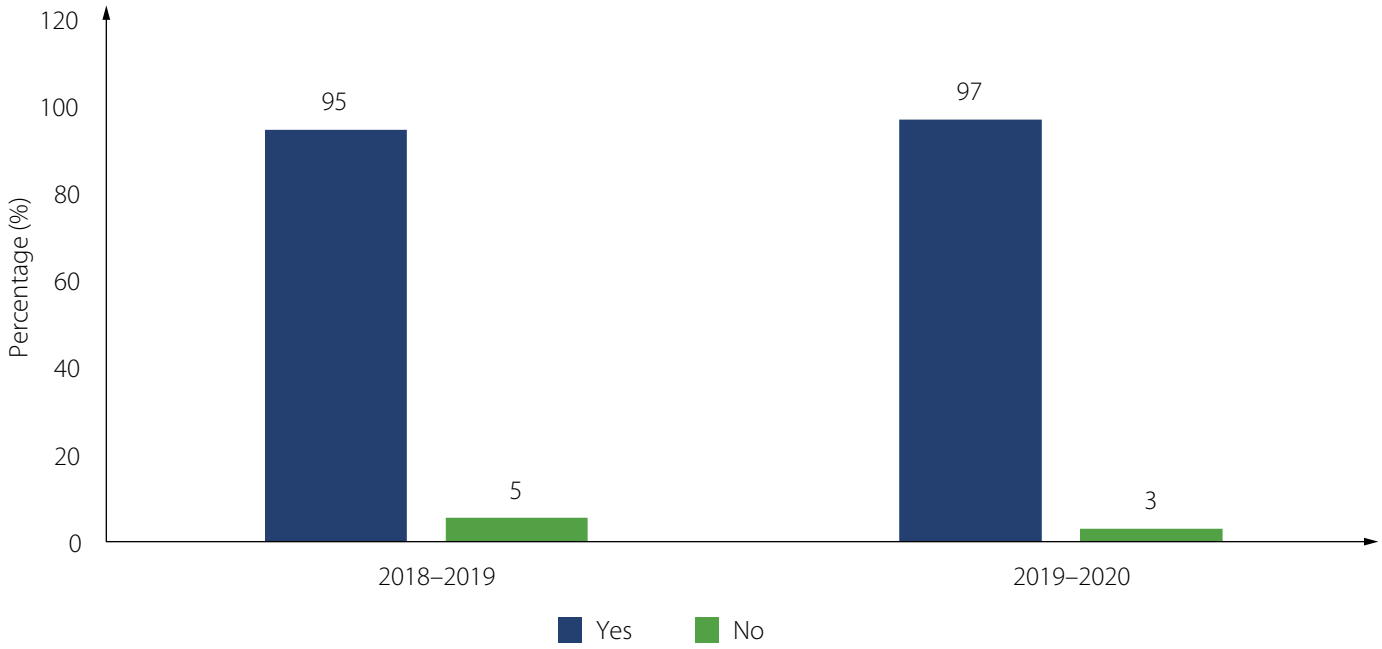

Figure 39. Lime application.

Average quantity of lime used

WSHGs applied varying doses of lime, ranging from 200 kg/ha to more than 1000 (Table 48, Figure 40).

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 200 kg/ha	134	38.29	231	40.24
200–300 kg/ha	63	18.00	109	18.99
300–600 kg/ha	101	28.86	168	29.27
600–1000 kg/ha	39	11.14	53	9.23
> 1000 kg/ha	13	3.71	13	2.26

Table 48. Average quantity of lime used.

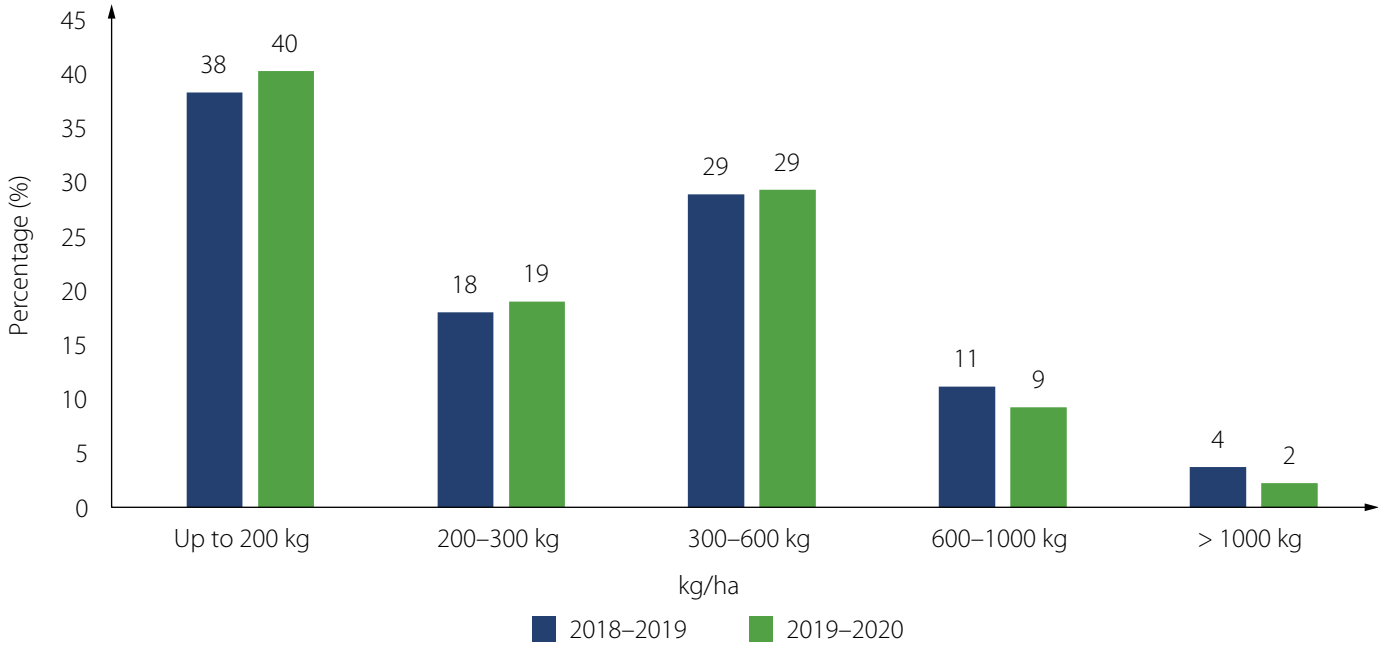

Figure 40. Average quantity of lime used.

Reasons for not applying lime

Among the WSHGs that did not apply lime, half said that they did not know it was necessary. Others cited a lack of availability during the pond preparation phase (Table 49, Figure 41). Since the GP tanks are primarily used for community access, some WSHGs said that the villagers opposed using lime.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Not aware	8	40.00	4	22.22
Lime not available	2	10.00	5	27.78
Villagers opposed	10	50.00	9	50.00

Table 49. Reasons for not applying lime.

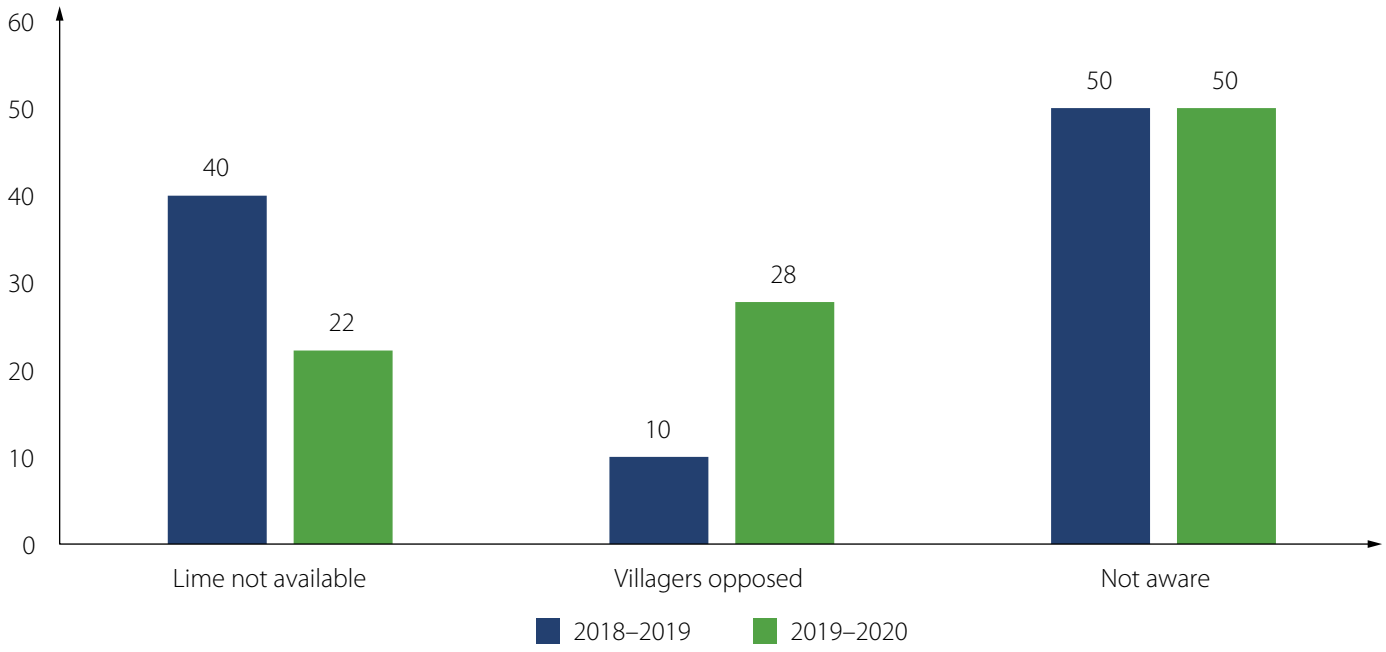

Figure 41. Reasons for not applying lime.

Fertilizer application

To increase primary productivity, slightly more than half of the WSHGs in both survey years applied fertilizer to their GP tank during pond preparation (Table 50, Figure 42). A little less than half did not practice pond fertilization for various reasons. The average rate of fertilization was 1055 kg/ha in the first survey year and 1395 kg/ha in the second.

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	193	52.16	327	55.24
No	177	47.84	265	44.76

Table 50. Fertilizer application.

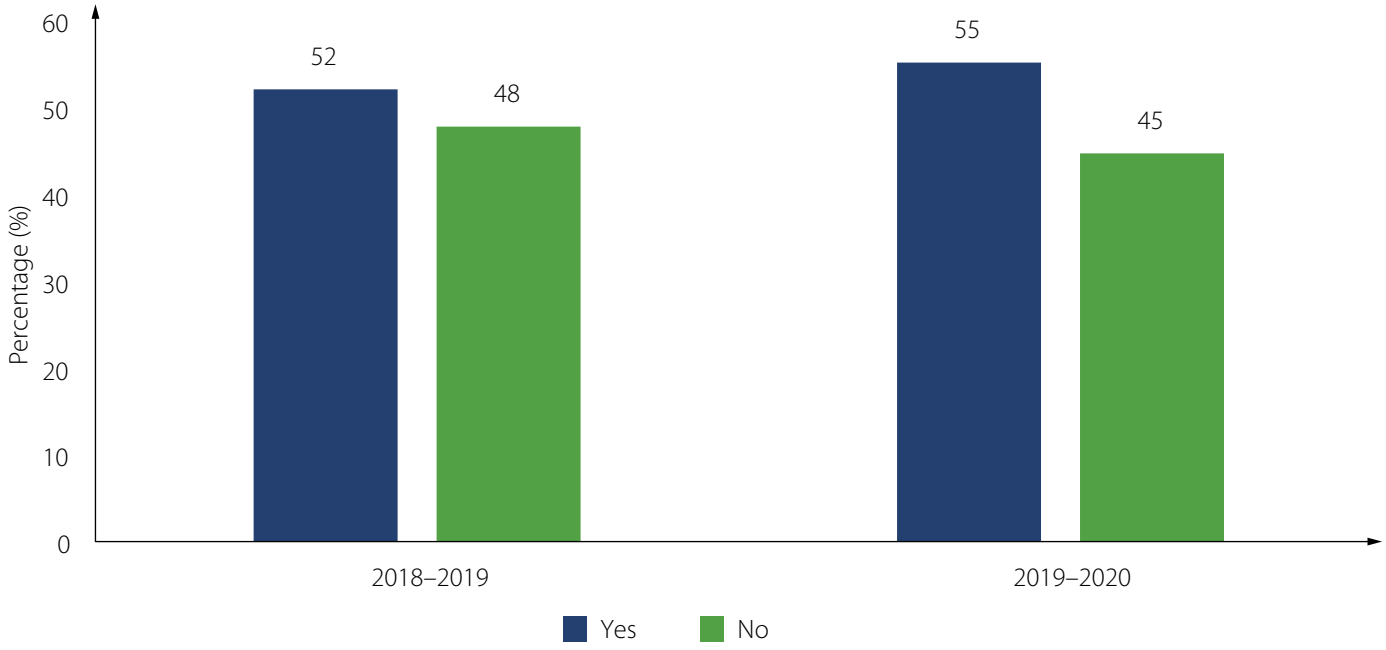

Figure 42. Fertilizer application.

Types of fertilizer used

Among the WSHGs that used fertilizer, the two most popular options were raw cattle dung and inorganic fertilizers, such as urea, diammonium phosphate (DAP) and single superphosphate (SSP) (Table 51, Figure 43). Inorganic fertilizers were often applied in combination with pond soil to attain better productivity.

Fertilizer	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Raw cattle dung	116	31.35	173	29.22
Poultry manure	2	0.54	4	0.68
Urea, DAP and SSP	89	24.05	221	37.33
In combination with sediment	17	4.59	49	8.28
Oil cake, rice bran, etc.	6	1.62	8	1.35

Note: Respondents chose multiple options.

Table 51. Types of fertilizer used.

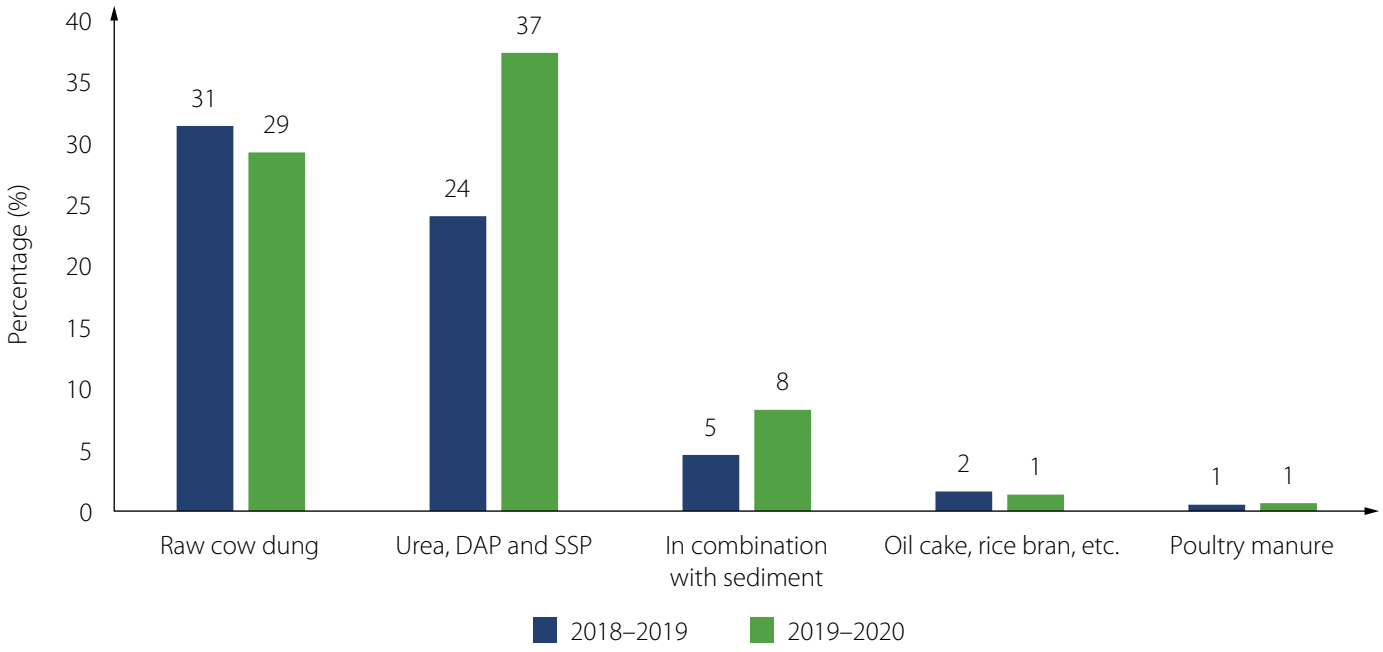

Figure 43. Types of fertilizer used.

Average quantity of fertilizer used

About two-thirds of the WSHGs used less than 500 kg/ha of fertilizer per crop (Table 52, Figure 44). Rates for the rest ranged from 500–1000 kg/ha to more than 1000.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	128	66.32	217	66.36
500–1000 kg/ha	21	10.88	29	8.87
1000–2000 kg/ha	12	6.22	16	4.89
2000–5000 kg/ha	21	10.88	38	11.62
> 5000 kg/ha	11	5.70	27	8.26

Table 52. Average quantity of fertilizer used.

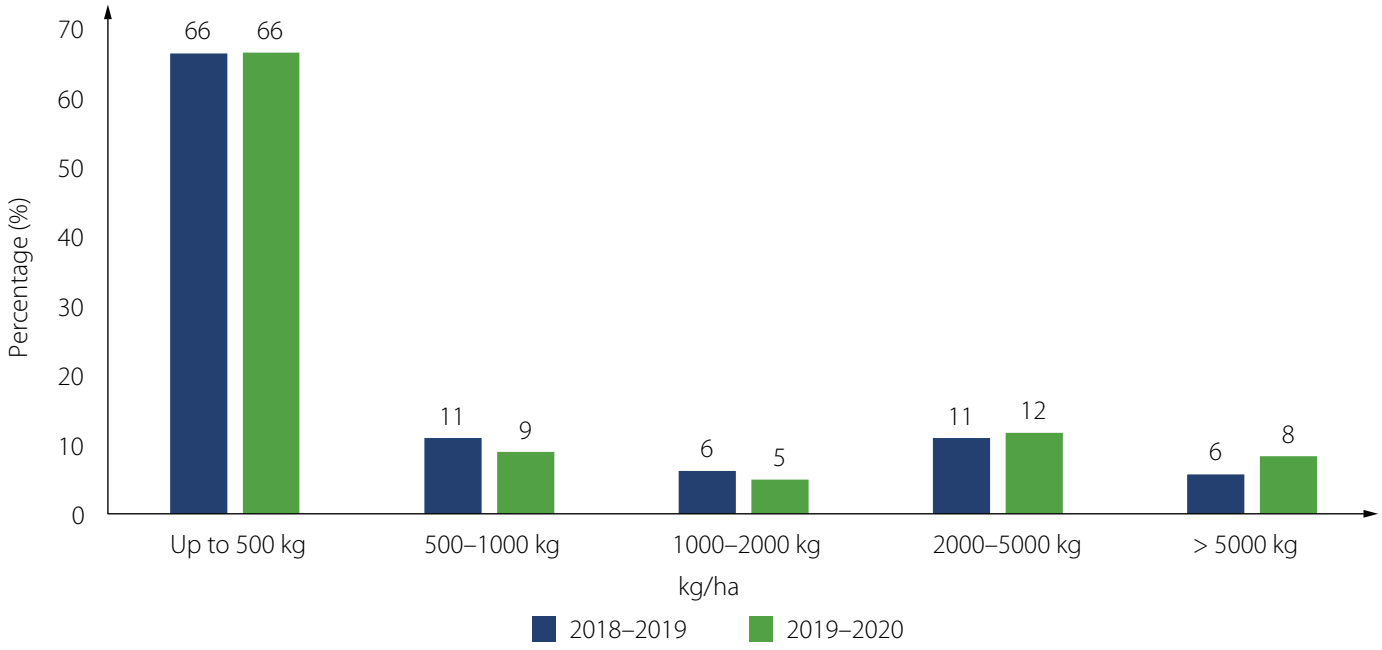

Figure 44. Average quantity of fertilizer used.

Reasons for not applying fertilizer

Among the WSHGs that did not use fertilizer, the majority said that they are often restricted from applying cattle dung and inorganic fertilizers because the villagers use the pond for multiple household purposes (Table 53, Figure 45). A handful of WSHGs did not know about the benefits of fertilization, while a few said that their GP tank was already overfertilized with lot of algal bloom.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Restricted by villagers	138	77.97	177	66.79
Not aware of fertilization	22	12.43	49	18.49
Fish tank already fertilized and full of algal bloom	17	9.60	39	14.72

Table 53. Reasons for not applying fertilizer.

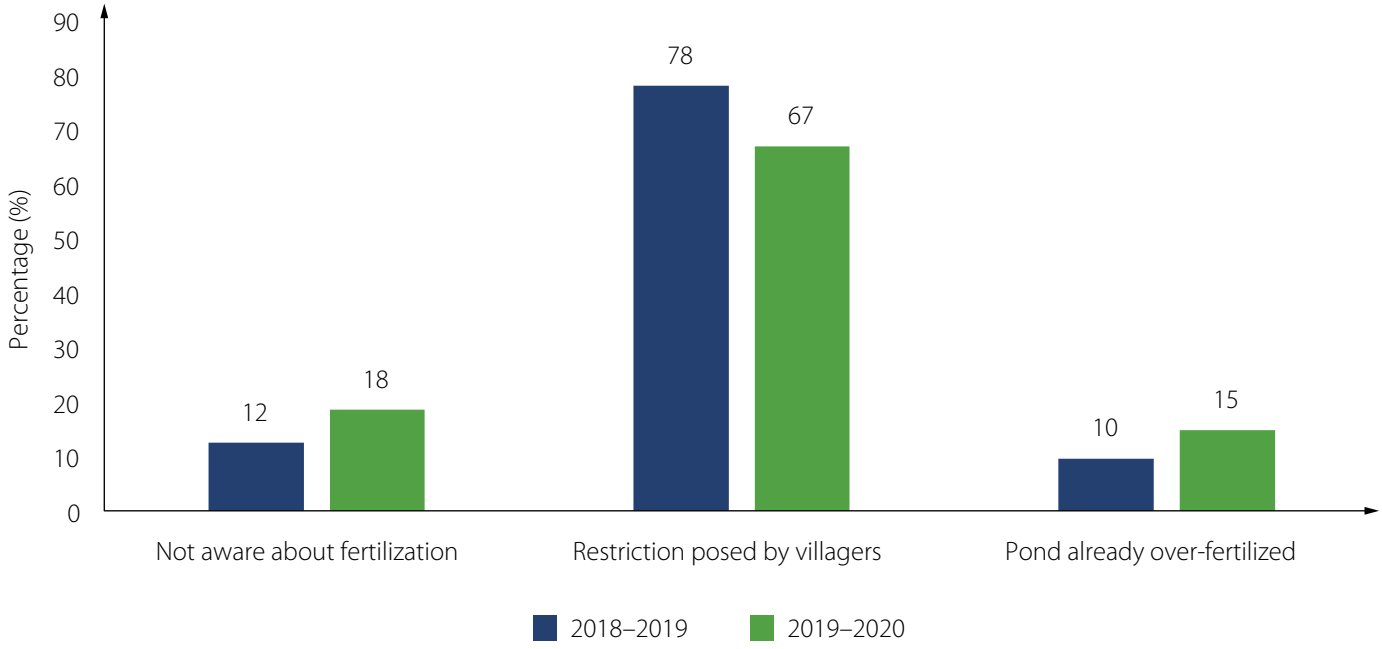

Figure 45. Reasons for not applying fertilizer.

Average value	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Use of lime	219 ± 233 (10–2000)	346 ± 307 (23–1977)	293 ± 615 (5–10,000)	320 ± 265 (2.47–1977)
Use of fertilizer	588 ± 1137 (1.5–8000)	1055 ± 1833 (1.24–10,872)	1232 ± 2678 (1–25,000)	1395 ± 2872 (1–19,768)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 54. Quantity of lime and fertilizer applied during the entire cropping period.

WSHG members preparing farm-made feed.

5. Fish seed stocking management

Size of fish seed stocked

Under the activity, it is suggested to stock advanced yearlings weighing 50–100 g (zero-size fingerlings) for a better survival rate and to shorten the crop duration (Table 55, Figure 46). In both survey years, more than half of the WSHGs stocked zero-size fingerlings, while most of the rest stocked fingerlings under 50 g. Only a handful of WSHGs stocked fry in both years.

Size	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Zero-size advanced yearlings 50–100 g	200	54.05	349	58.95
Fingerlings under 50 g	157	42.43	225	38.01
Fry	13	3.51	18	3.04

Table 55. Size of fish seed stocked.

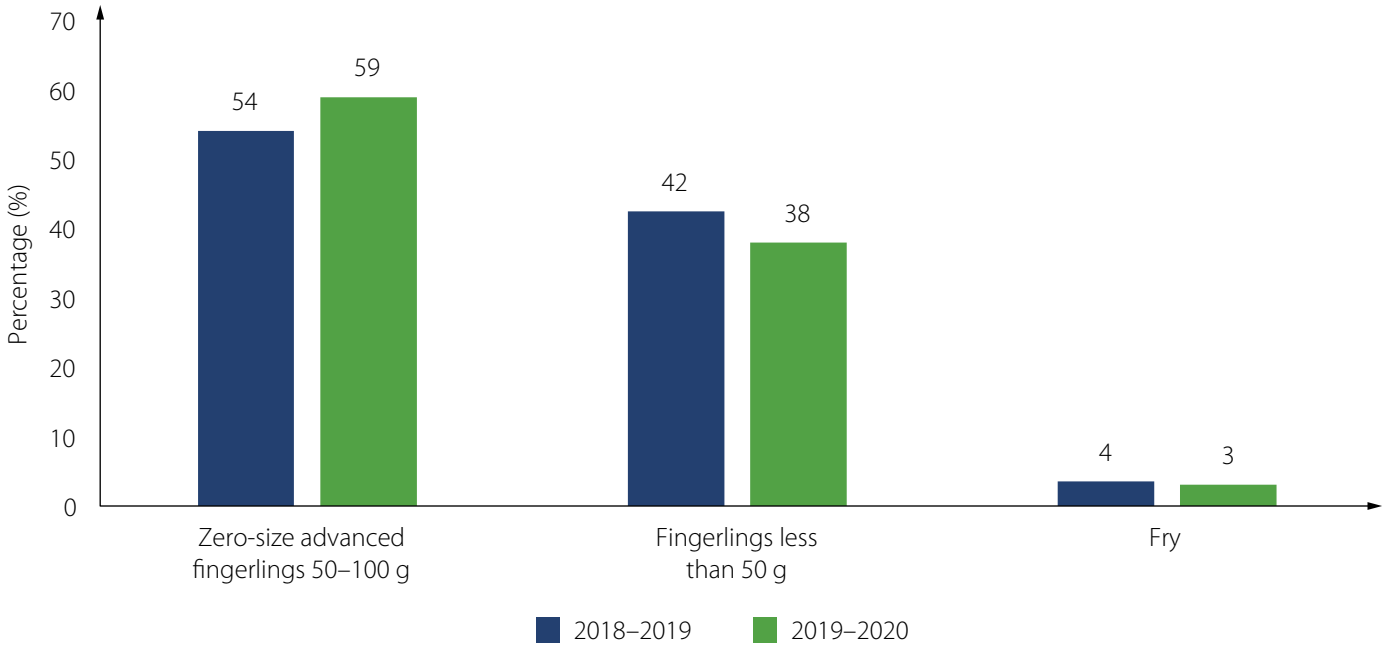

Figure 46. Size of fish seed stocked.

Average weight of fish seed

The average weight of the stocked fish seed was 44 g in the first year and 47 g in the second (Table 56, Figure 47). Most of the WSHGs stocked their tanks with fish seed weighing between 10 and 100 g.

Average weight	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 10 g	61	16.49	91	15.37
10–50 g	175	47.30	250	42.23
50–100 g	133	35.95	249	42.06
> 100 g	1	0.27	2	0.34

Table 56. Average weight of fish seed.

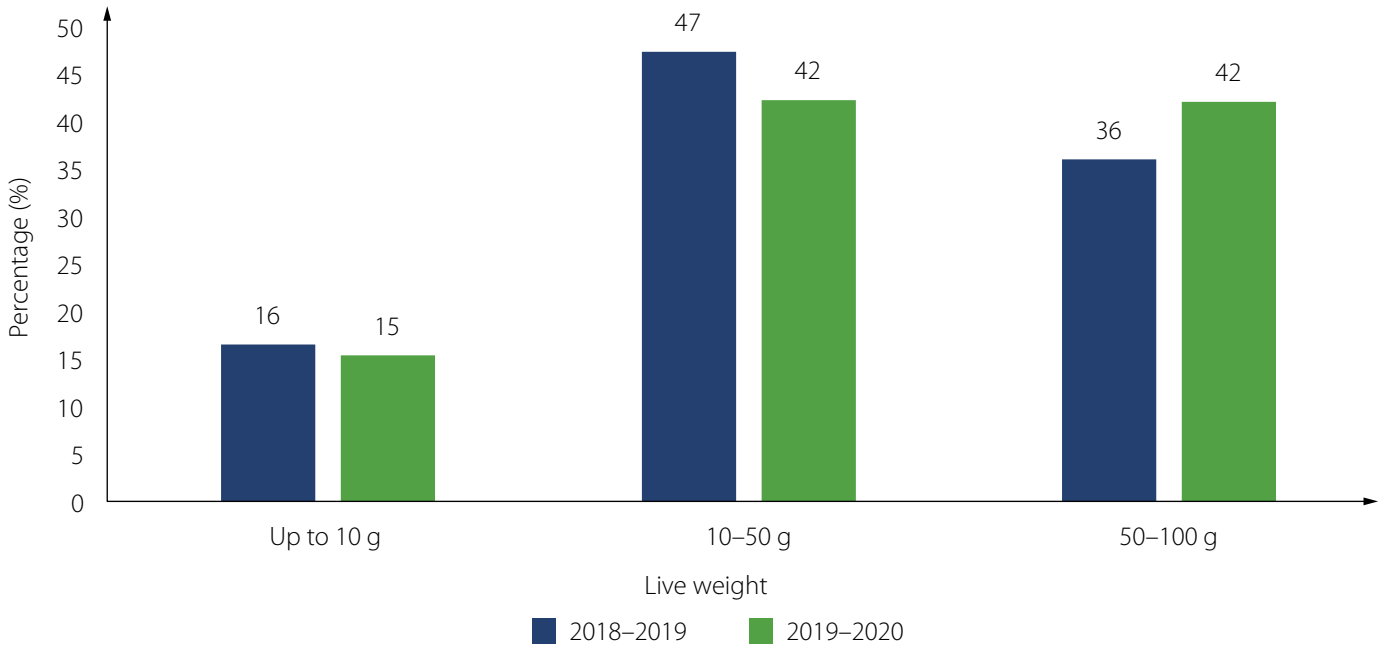

Figure 47. Average weight of fish seed.

Stocking frequency

The majority of the WSHGs stocked fish seed once each survey year, while the rest stocked them multiple times (Table 57, Figure 48).

Frequency	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Single	222	60.00	354	59.80
Multiple	148	40.00	238	40.20

Table 57. Stocking frequency.

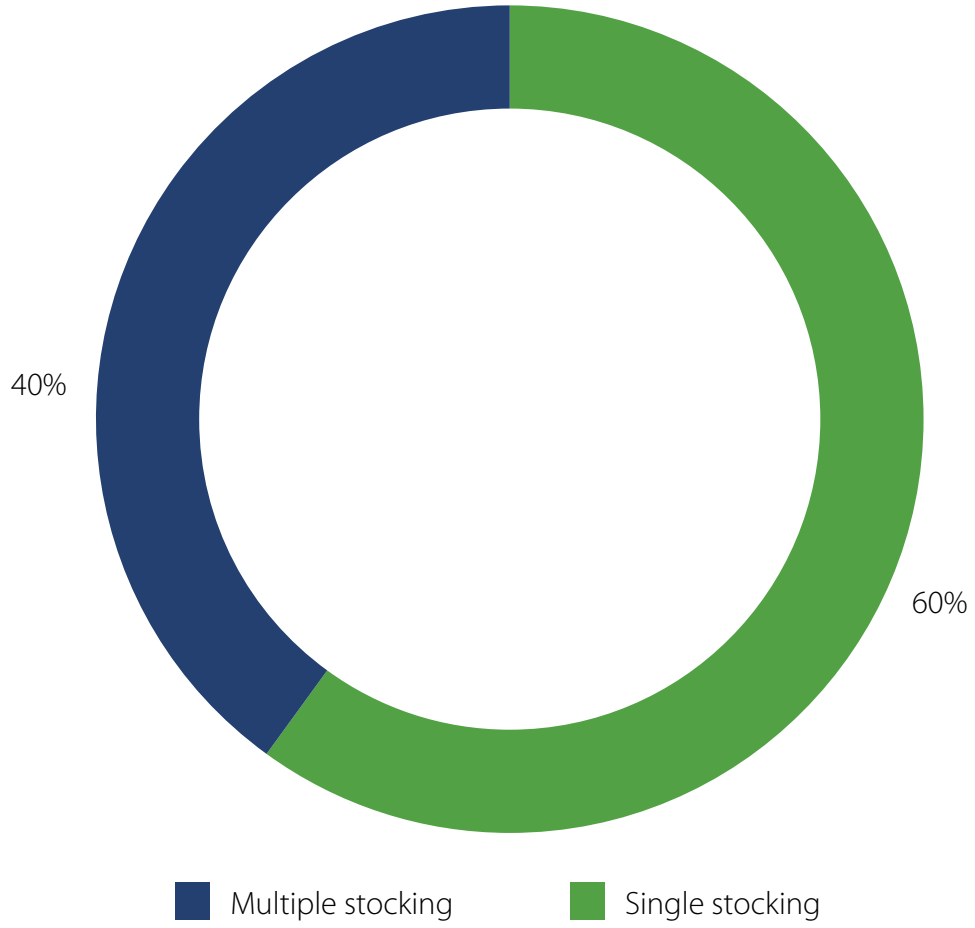

Figure 48. Stocking frequency.

Frequency of multiple stocking

Among the WSHGs that followed multiple stockings, the vast majority stocked fish seed twice in each survey year (Table 58, Figure 49).

Frequency	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Two times	124	83.78	188	78.99
Three times	22	14.86	40	16.81
> Three times	2	1.35	10	4.20

Table 58. Frequency of multiple stocking.

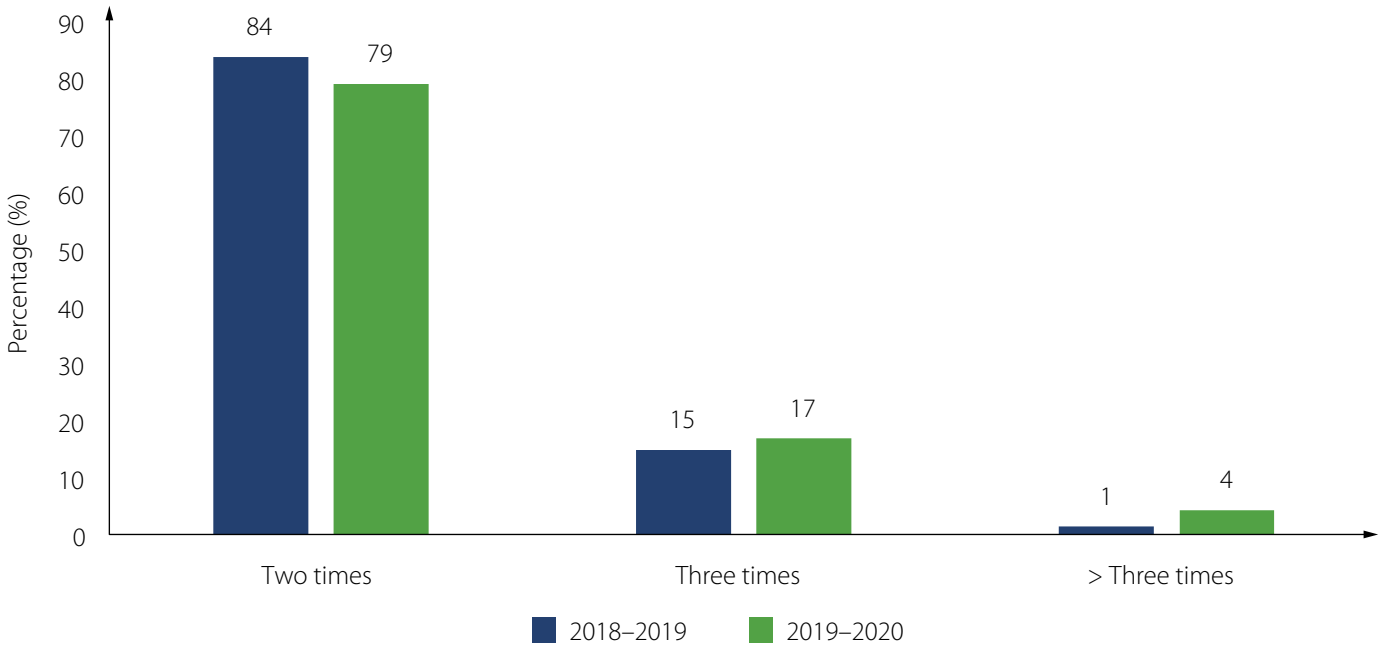

Figure 49. Frequency of multiple stocking.

Stocking density

Under the activity, WSHGs were advised to stock 2700 advanced fingerlings per ha of their GP tank (Table 59, Figure 50). When asked whether they followed this advice, most said that they did, while the rest either said they did not follow it or were completely unaware of it.

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	244	65.95	417	70.44
Did not know	82	22.16	103	17.40
No	44	11.89	72	12.16

Table 59. Stocking according to the advised seed numbers.

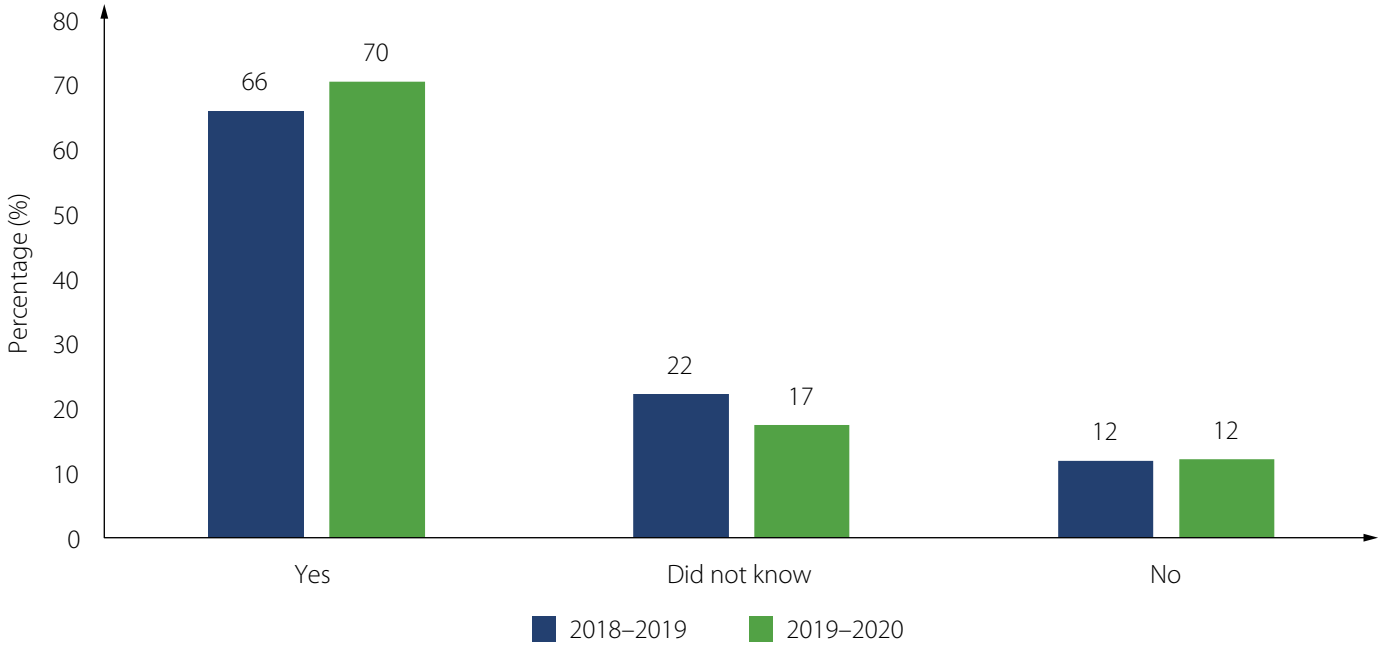

Figure 50. Stocking according to the advised seed numbers.

Species composition

Fish farming in GP tanks is dominated by IMCs in combination with other exotic carp varieties. Rohu, catla and mrigal are the most widely cultured species followed by exotic carp, like grass carp and common carp. In each survey year, about two-thirds of the WSHGs stocked only IMC fingerlings, while the rest either stocked IMCs and exotic carp fingerlings (composite fish farming) or mola along with IMCs (Table 60, Figure 51).

Preferred stocking combination	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
IMCs	243	65.68	370	62.50
Composite (IMCs and exotics)	61	16.49	161	27.20
IMCs and mola	66	17.84	61	10.30

Table 60. Species composition.

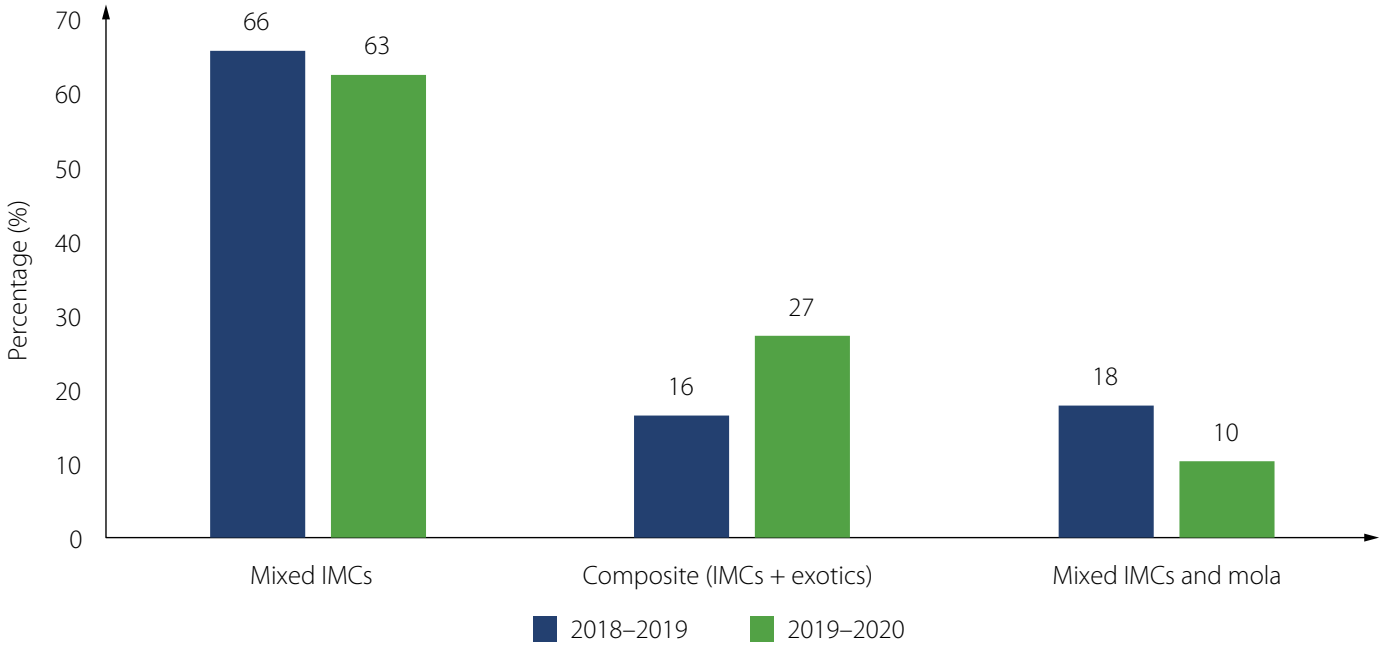

Figure 51. Species composition.

Average stocking density of carp seed

For carps, the BMP for stocking density in GP tanks is 2700 advanced fingerlings/ha. Although the WSHGs reported using different stocking densities, the average was 6546/ha in the first year and 6564/ha in the second. The most common ranges were 2500–3000/ha and 3000–6000/ha. The lowest stocking density was 2500, while the highest was more than 20,000/ha (Table 61, Figure 52).

Density	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 2500/ha	39	10.54	56	9.46
2500–3000/ha	119	32.16	198	33.45
3000–6000/ha	110	29.73	195	32.94
6000–10,000/ha	64	17.30	88	14.86
10,000–20,000/ha	26	7.03	22	3.72
> 20,000/ha	12	3.24	33	5.57

Table 61. Average stocking density of carp seed.

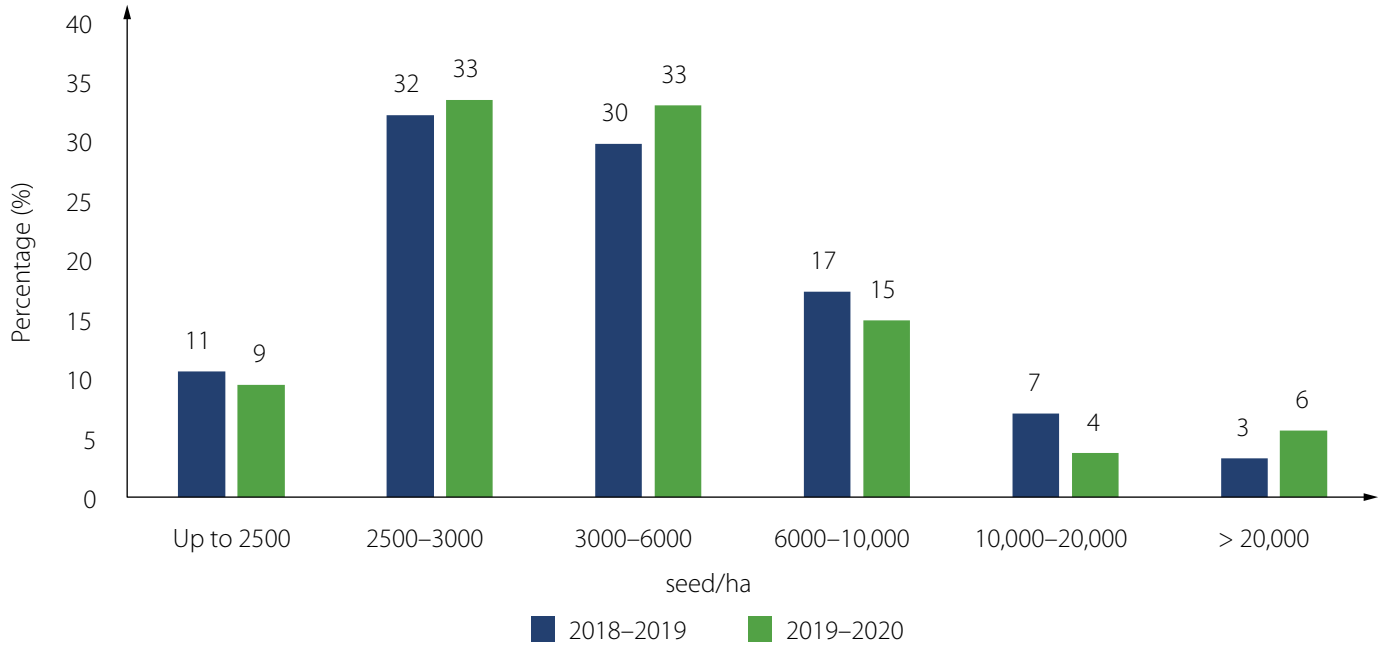

Figure 52. Average stocking density of carp seed.

Average stocking density of mola seed

The suggested stocking density for mola was 25 kg/ha. Most WSHGs followed this guideline, with an average of 23–25 kg/ha (Table 62, Figure 53). The majority stocked mola seed between 20 and 40 kg/ha. Only a handful stocked more than 40 kg/ha.

Density	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 10 kg/ha	3	4.55	10	16.39
10–20 kg/ha	14	21.21	9	14.75
20–40 kg/ha	47	71.21	40	65.57
> 40 kg/ha	2	3.03	2	3.28

Table 62. Average stocking density of mola seed.

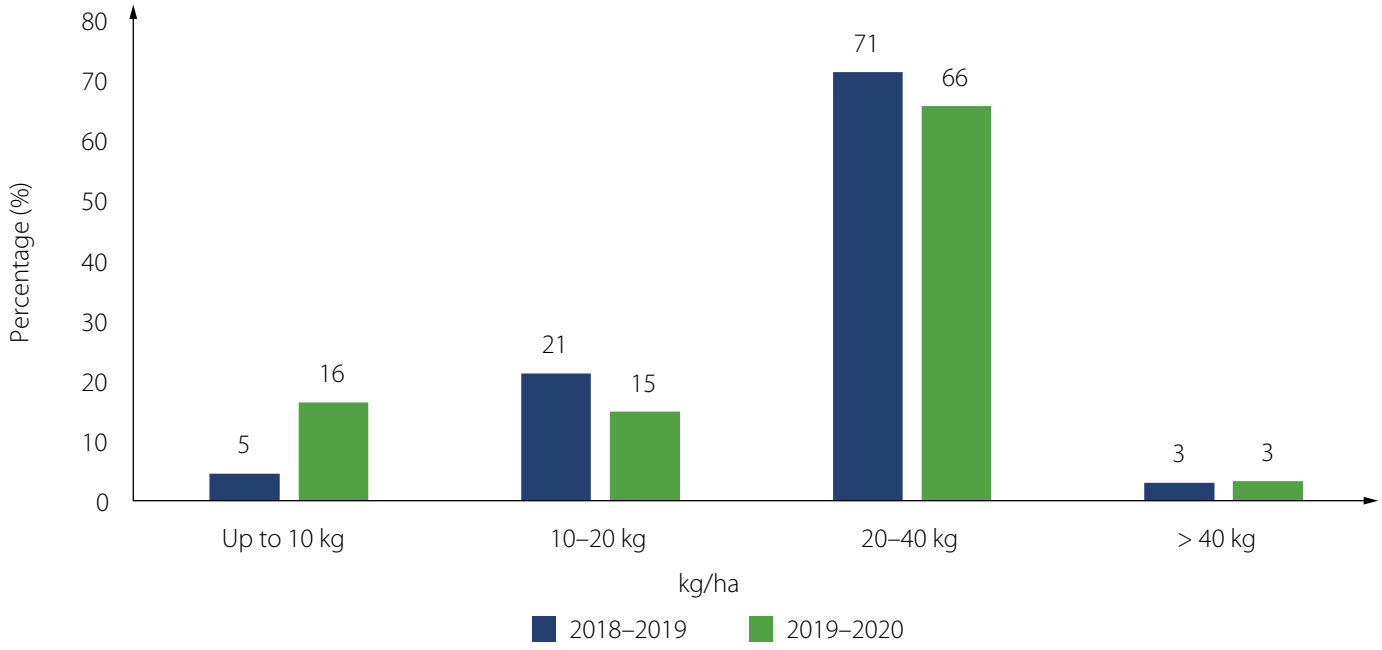

Figure 53. Average stocking density of mola seed.

Sources of carp seed

Although WSHGs in Odisha depend on multiple sources for fish seed, about half bought it from private hatcheries/nurseries during the program period (Table 63, Figure 54). The rest got their carp seed from government hatcheries or fish seed traders, while a handful used others sources.

Source	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Government hatchery	123	33.24	161	27.20
Private nursery	184	49.73	298	50.34
Seed trader	113	30.54	198	33.45
Other sources	9	2.43	4	0.68

Note: Respondents chose multiple options.

Table 63. Sources of carp seed.

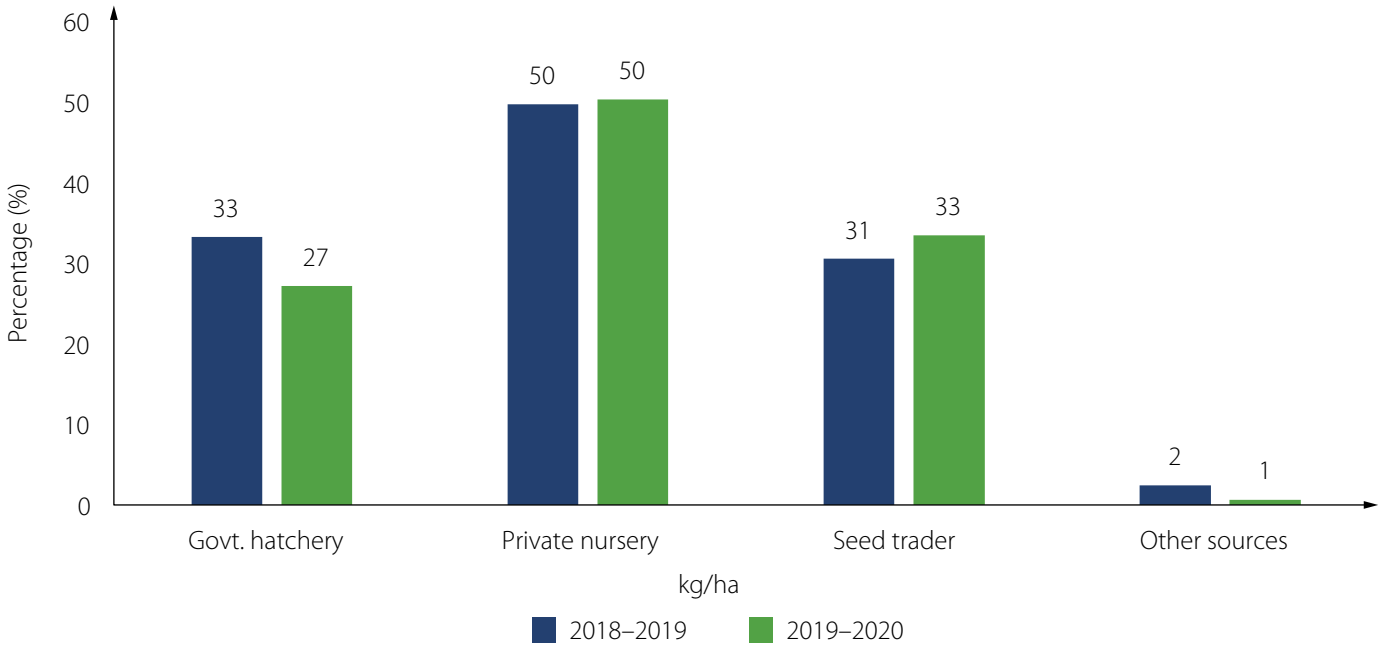

Figure 54. Sources of carp seed.

Sources of mola seed

Most of the WSHGs that stocked mola in their GP tanks got their seed from private sources, such as farmers or seed growers (Table 64, Figure 55). A handful sourced their seed from local ponds, where mola is naturally established.

Source	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Private sources (farmers/seed growers)	59	89.39	40	65.57
Natural stock from local ponds	7	10.61	21	34.43

Table 64. Sources of mola seed.

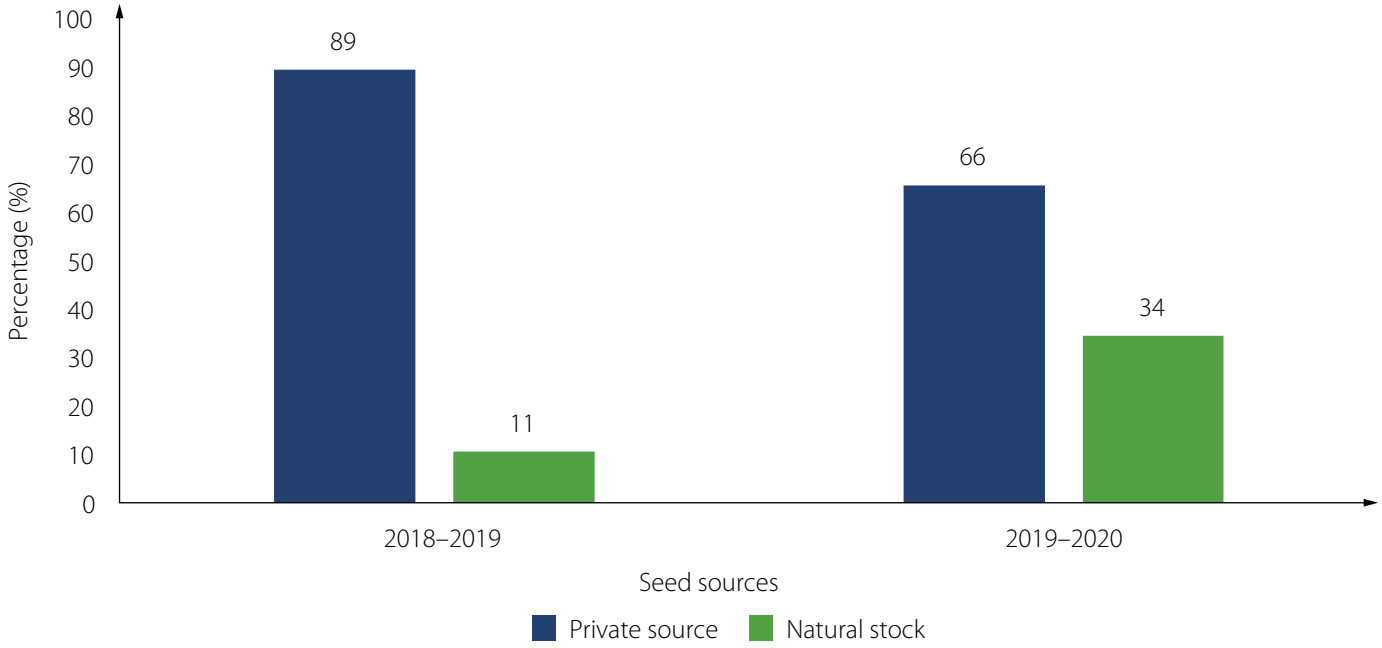

Figure 55. Sources of mola seed.

Average value	2018–2019	2019–2020
Weight of carp seed (g)	44 ± 27 (2–250)	47.07 ± 25.65 (2–180)
Carp seed stocking density (per ha)	6546 ± 15184 (741–263,796)	6564 ± 10984 (26.69–153,202)
Carp seed stocking density (per WSHG)	4472 ± 9946 (300–158,000)	5195 ± 8368 (110–75,000)
Mola seed stocking density (kg/ha)	25.20 ± 12.91 (4.94–98.84)	23.32 ± 11.49 (1–69.19)
Mola seed stocking density (kg/WSHG)	17.44 ± 11.47 (4–54)	16.80 ± 13.10 (2–75)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 65. Information on stocking density.

Counting during fish stocking helps WSHGs get better yields.

6. Feed management

Use of feed

Interestingly, almost all of the WSHGs adopted supplementary feeding practices to attain better fish growth (Table 66, Figure 56).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	367	99.19	589	99.49
No	3	0.81	3	0.51

Table 66. Use of feed.

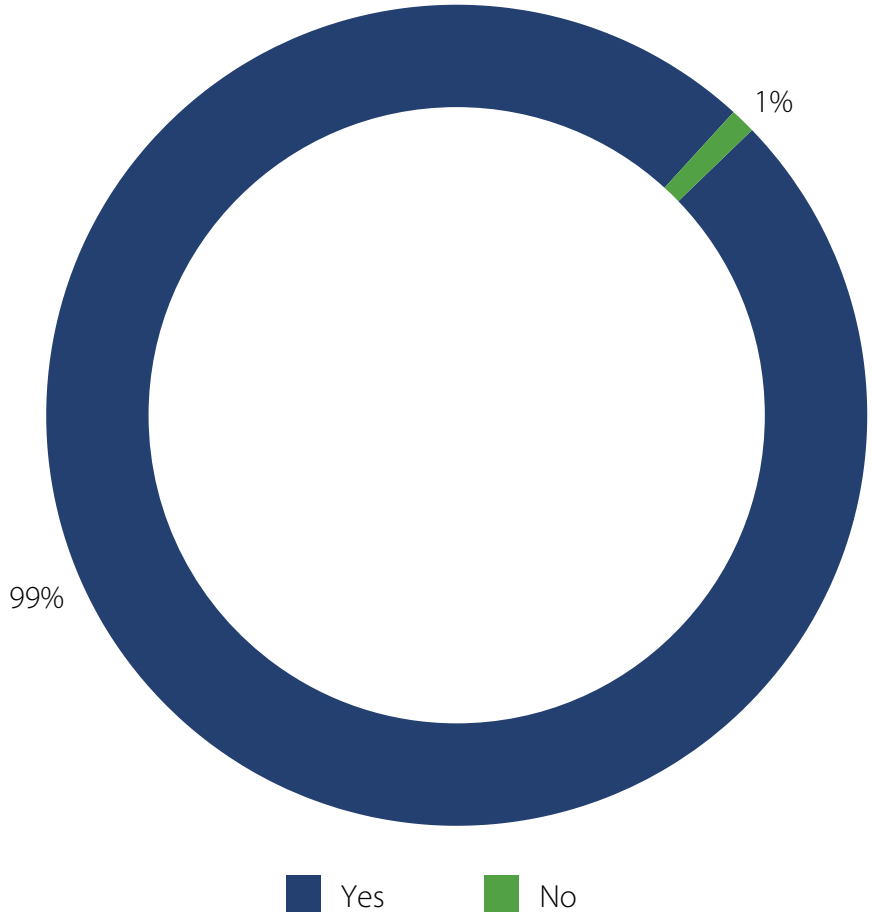

Figure 56. Use of feed.

Sources of fish feed

Although WSHGs across Odisha depend on multiple sources for fish feed, the vast majority in the program relied on local shops or nearby fish feed dealers to get supplementary feed (Table 67, Figure 57). Others used homemade feed with locally available ingredients or bought their feed with the help of FARD, or both.

Source	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Homemade feed	93	25.14	127	21.45
Local shop and dealer	326	88.11	523	88.34
Facilitated by FARD	62	16.76	71	11.99

Note: Respondents chose multiple options.

Table 67. Sources of fish feed.

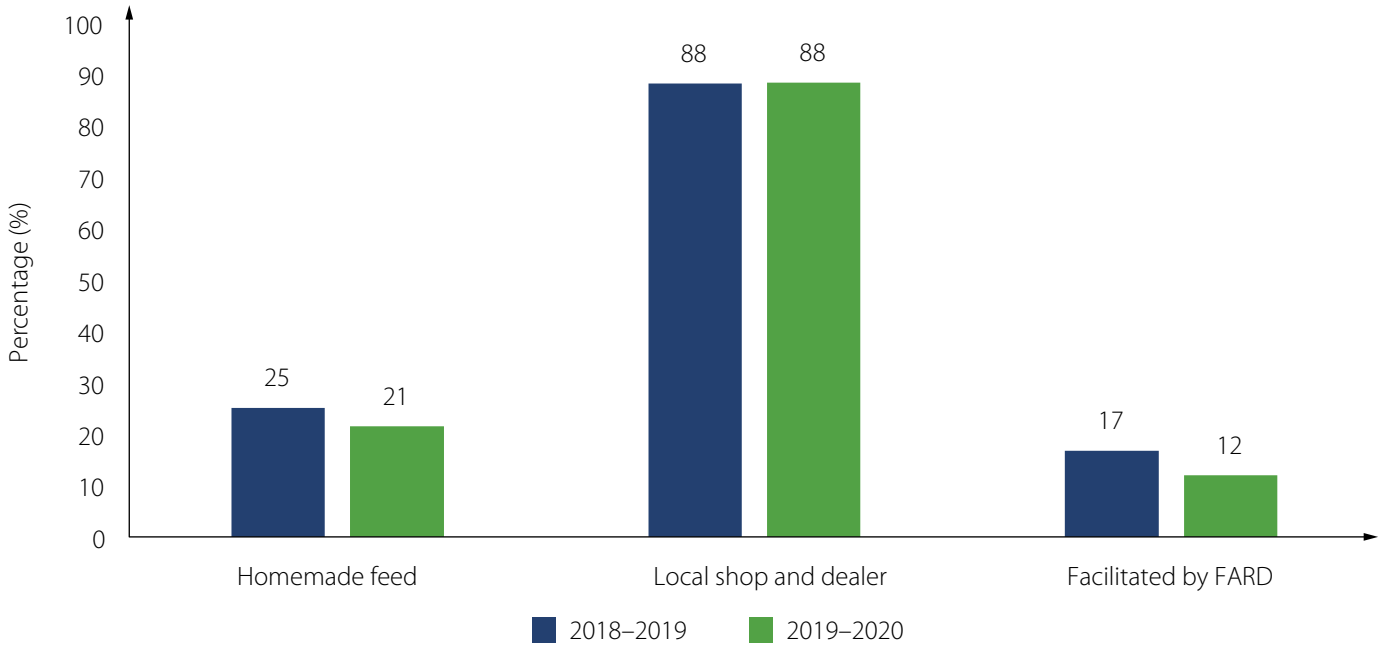

Figure 57. Sources of fish feed.

Types of fish feed used

WSHGs used three types of fish feeds: floating pellets, sinking pellets and homemade feed (Table 68, Figure 58). Among the three, floating pellets was by far the most popular. About a fifth of the WSHGs used a combination of floating and homemade fish feed, while a negligible portion preferred sinking pellet feed.

Type	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Floating pellet only	274	74.05	453	76.52
Floating pellet and homemade	80	21.62	116	19.59
Homemade only	12	3.24	8	1.35
Sinking pellet and floating pellet	-	-	8	1.35
Homemade and sinking pellet	4	1.08	3	0.51
Homemade, sinking pellet and floating pellet	-	-	2	0.34
Sinking pellet only	-	-	2	0.34

Table 68. Types of fish feed used.

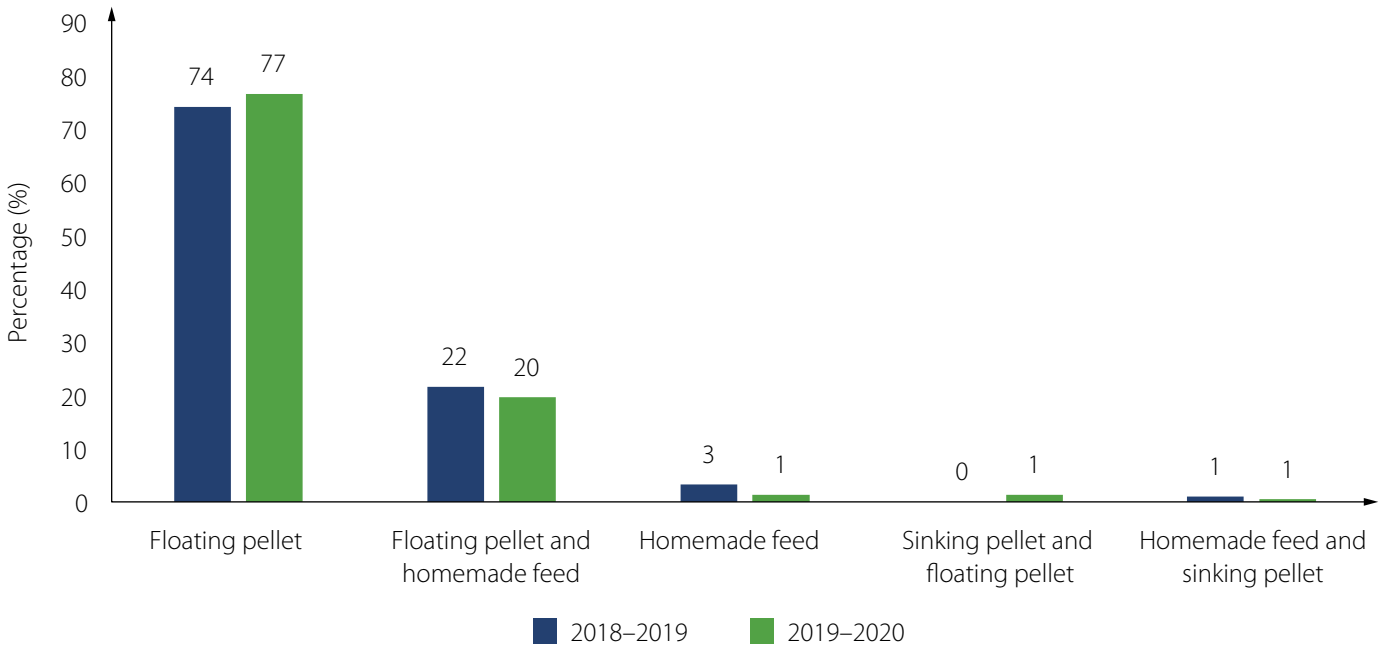

Figure 58. Types of fish feed used.

Average quantity of feed used

Although the amount of fish feed that WSHGs used varied greatly, the average dropped from 1792 kg/ha in the first survey year to 1588 kg/ha in the second (Table 69, Figure 59). Most WSHGs used between 500 and 3000 kg/ha.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	40	10.81	60	10.14
500–1000 kg/ha	59	15.95	130	21.96
1000–2000 kg/ha	125	33.78	209	35.30
2000–3000 kg/ha	82	22.16	162	27.36
> 3000 kg/ha	22	5.95	28	4.73

Note: Total feed considers homemade, sinking pellet and floating pellet feed.

Table 69. Average quantity of feed used.

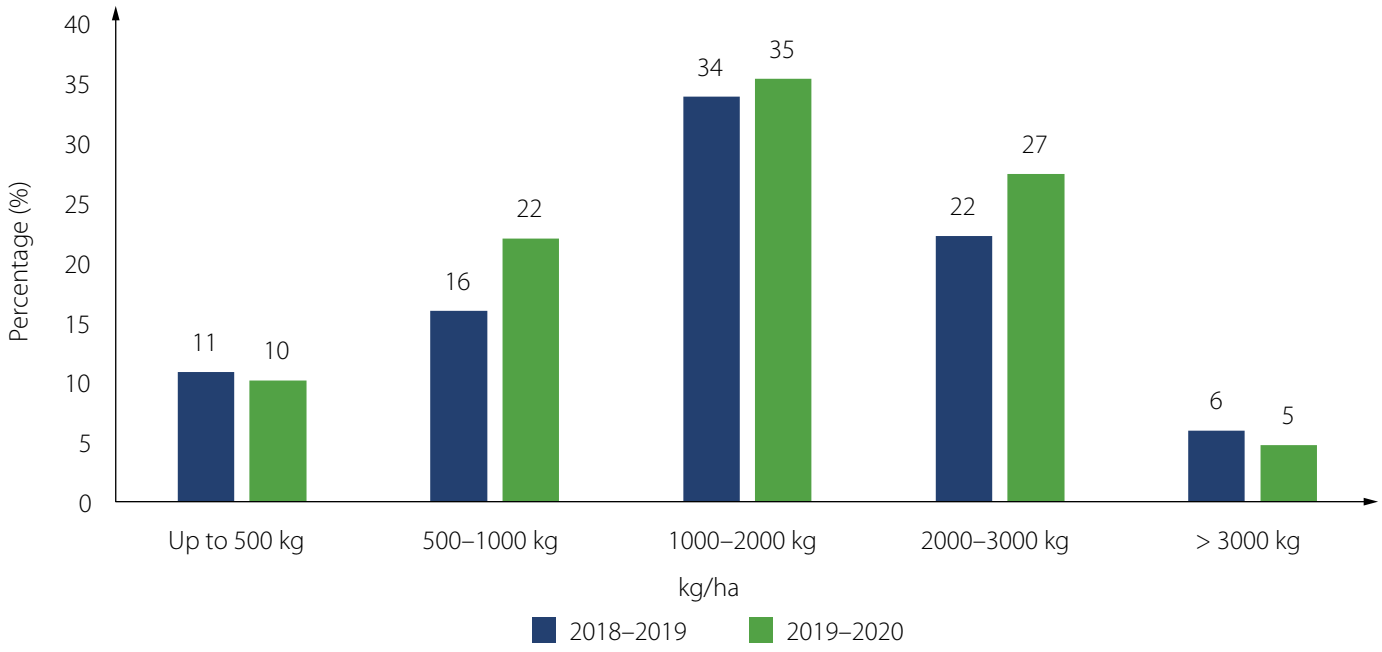

Figure 59. Average quantity of feed used.

Average quantity of floating pellet feed used

Sizable portions of the WSHGs depended significantly on floating pellet feed for fish growth, averaging 1620 kg/ha per crop in the first year and 1417 kg/ha in the second (Table 70, Figure 60). Most used between 500 and 3000 kg/ha.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	64	17.30	87	14.70
500–1000 kg/ha	63	17.03	147	24.83
1000–2000 kg/ha	96	25.95	183	30.91
2000–3000 kg/ha	72	19.46	149	25.17
> 3000 kg/ha	17	4.59	12	2.03

Table 70. Average quantity of floating pellet feed used.

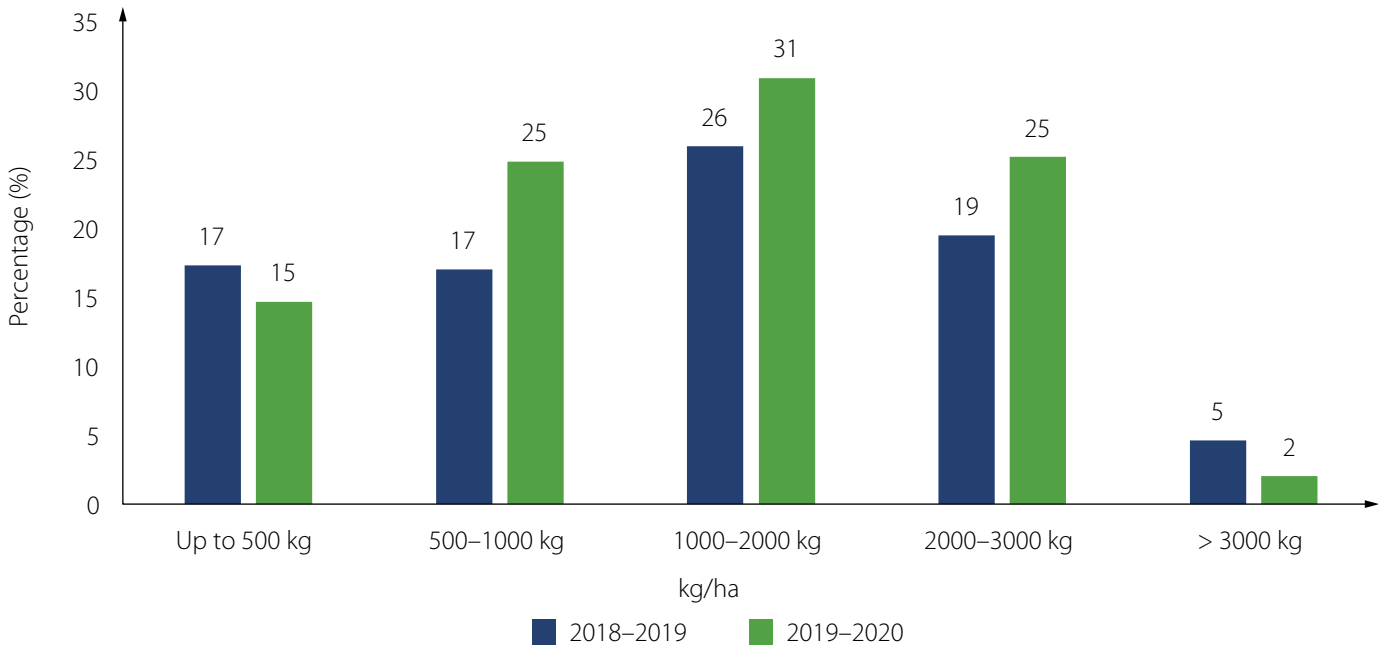

Figure 60. Average quantity of floating pellet feed used.

Average quantity of homemade feed used

Although most of the WSHGs preferred using homemade feed in combination with other commercial feeds, the average application rate of homemade feed to the fish tank was 862 kg/ha per crop in the first year and 840 kg/ha in the second (Table 71, Figure 61). Most of the WSHGs that used only homemade feed applied 1000 kg/ha or less.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	45	12.16	58	9.80
500–1000 kg/ha	28	7.57	39	6.59
1000–2000 kg/ha	13	3.51	19	3.21
> 2000 kg/ha	7	1.89	11	1.86

Table 71. Average quantity of homemade feed used.

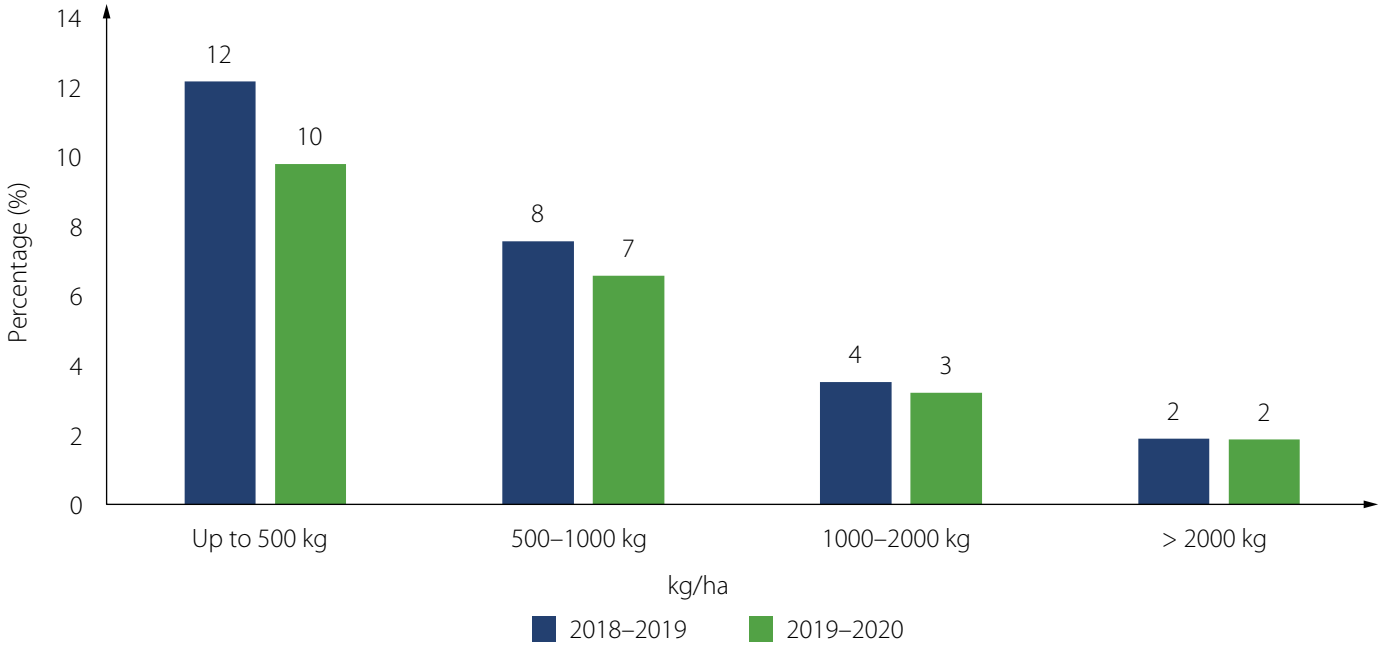

Figure 61. Average quantity of homemade feed used.

Average value	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Total feed used per crop	1384 ± 3394 (80–40,000)	1792 ± 2146 (57–27,181)	1518 ± 2370 (90–24,440)	1588 ± 968 (12–8382)
Homemade feed	612 ± 939 (50–7500)	862 ± 971 (49–7413)	747 ± 893 (50–5000)	839.52 ± 741 (62–4070)
Sinking pellet feed	500 ± 497 (100–1200)	546 ± 314 (124–824)	741 ± 1779 (20–7080)	649 ± 809 (20–2965)
Floating pellet feed	1266 ± 3453 (80–40,000)	1620 ± 2179 (57–27,181)	1364 ± 2171 (40–19,440)	1417 ± 881 (12–6405)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 72. Quantity of feed applied by WSHGs for a 1-year cropping period.

Photo credit: De Tour Odisha

The application of commercial feed in aquaculture is getting popular among the WSHGs in Odisha.

7. Water quality monitoring, fish health management and farm record keeping

Monitoring water quality

About two-thirds of the WSHGs monitored the water quality of their GP tank during the crop period as a part of BMPs (Table 73, Figure 62). The rest did not because they were unaware of the importance of monitoring water quality.

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	232	62.70	392	66.22
No	138	37.30	200	33.78

Table 73. Monitoring water quality.

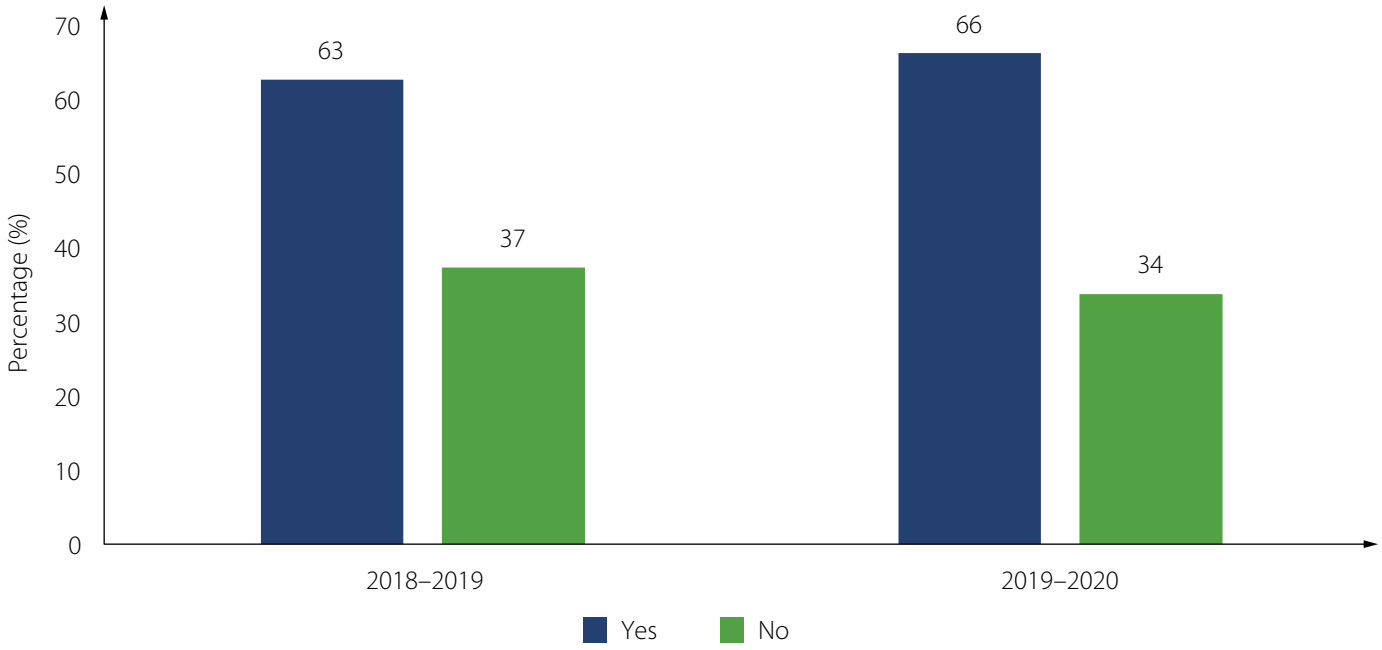

Figure 62. Monitoring water quality.

Testing water quality

The majority of the WSHGs measured the water quality on their own using field test kits. For many other WSHGs, department officials (including WorldFish project staff) helped them test the water quality (Table 74, Figure 63). Only a handful sent water samples from their tanks to a local laboratory for testing.

Method	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Department officials (FARD & WorldFish)	99	42.67	145	36.99
Self-service using a test kit	129	55.60	240	61.22
Laboratory	4	1.72	7	1.79

Table 74. Methods used for testing water quality.

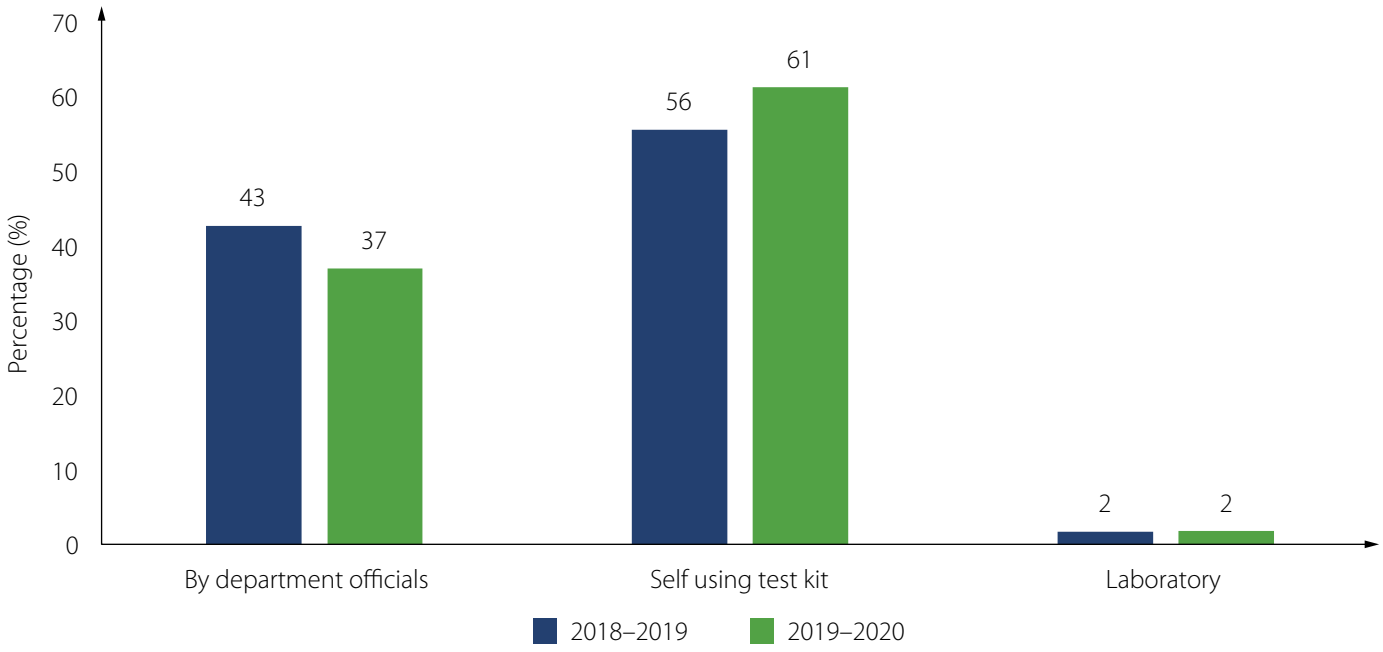

Figure 63. Methods used for testing water quality.

Monthly fish sampling

Over both survey years, the majority of the WSHGs adopted monthly fish sampling to check fish growth and health as a part of BMPs (Table 75, Figure 64). Most used cast netting.

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	221	59.73	404	68.24
No	149	40.27	188	31.76

Table 75. Monthly fish sampling.

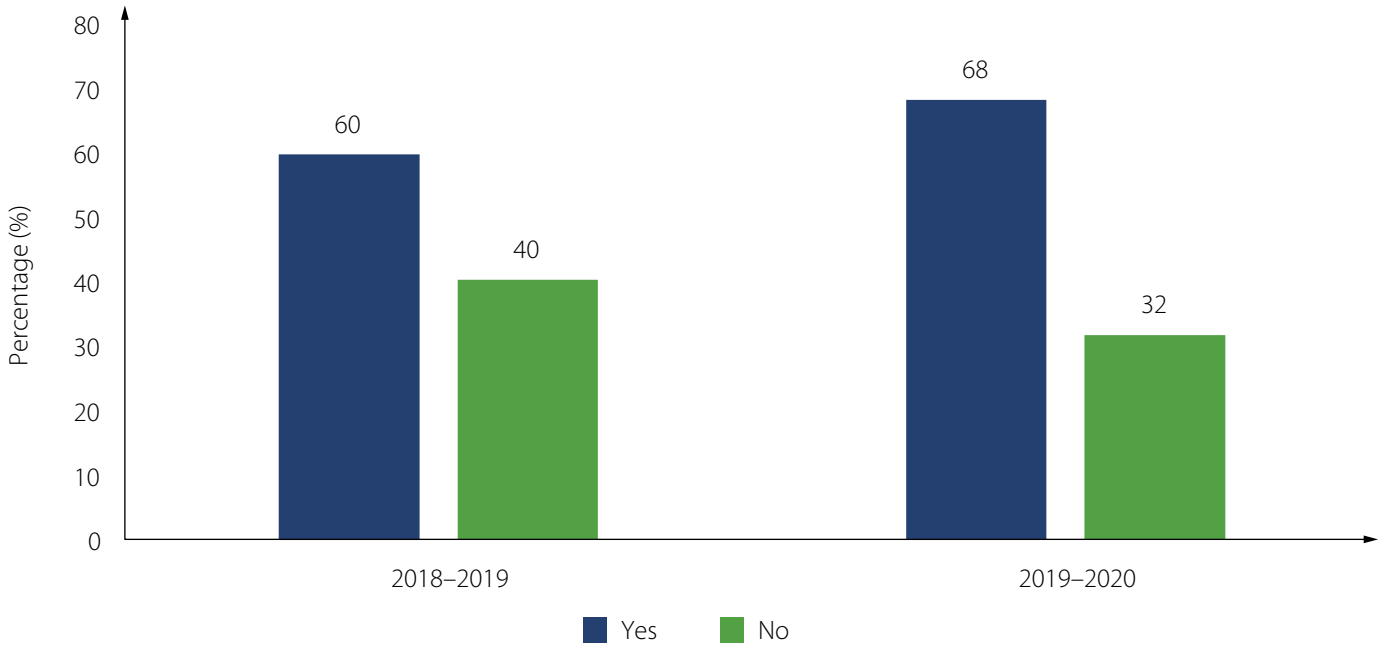

Figure 64. Monthly fish sampling.

Fish sampling parameters

Most WSHGs that performed monthly fish sampling also monitored fish growth, disease occurrence and feeding status (Table 76, Figure 65). Most only used monthly fish sampling to check fish growth, while some checked for fish diseases as well as growth.

Parameters	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Growth	140	63.35	283	70.05
Growth and diseases	75	33.94	105	25.99
Feeding	6	2.71	16	3.96

Table 76. Fish sampling parameters monitored by WSHGs.

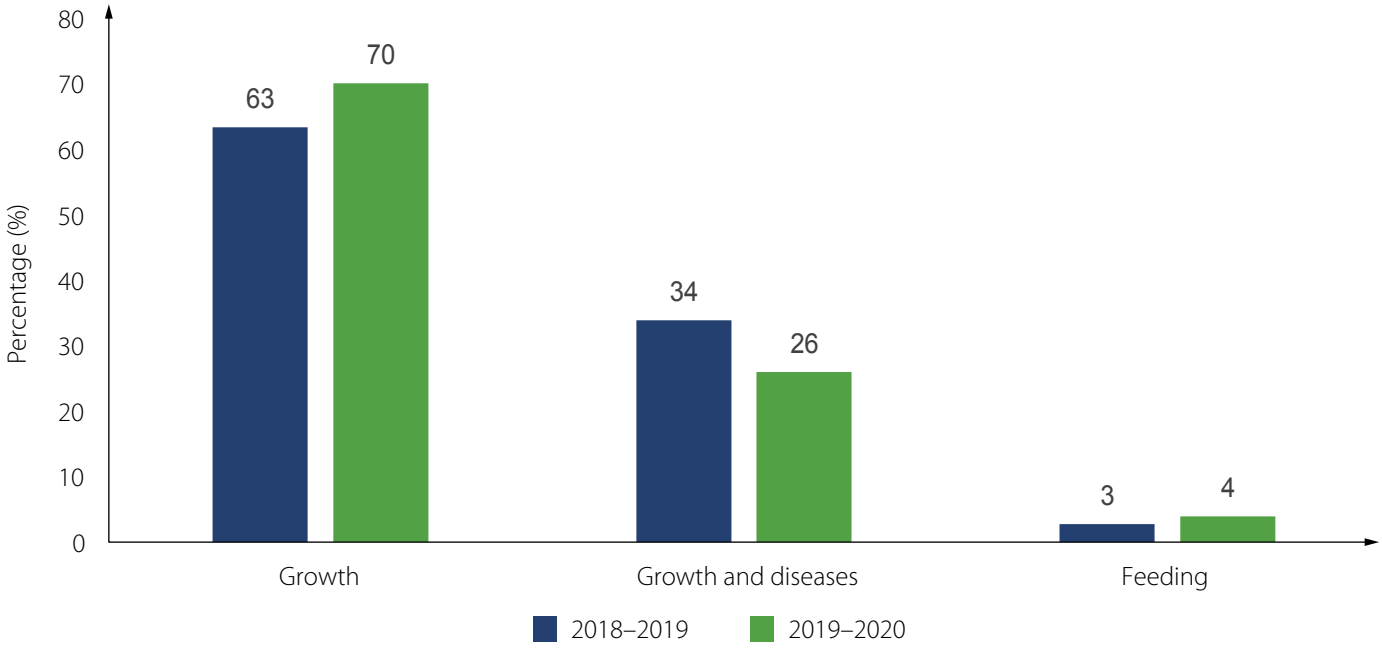

Figure 65. Fish sampling parameters monitored by WSHGs.

Reasons for not doing monthly fish sampling

Although most WSHGs did monthly sampling, many others did not adopt this practice. Among those who did not, the majority cited not having their own fishnets as the main reason why (Table 77, Figure 66). Expensive labor costs coupled with labor scarcity and high rental charges for fishnets by local fishers were other reasons given. About one-third did not know about the practice.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Lack of own nets	47	31.54	83	44.15
Expensive labor and netting cost	16	10.74	21	11.17
Water depth and aquatic weeds	12	8.05	10	5.32
Scarcity of labor	25	16.78	15	7.98
Not aware	49	32.89	59	31.38

Table 77. Reasons for not doing monthly fish sampling.

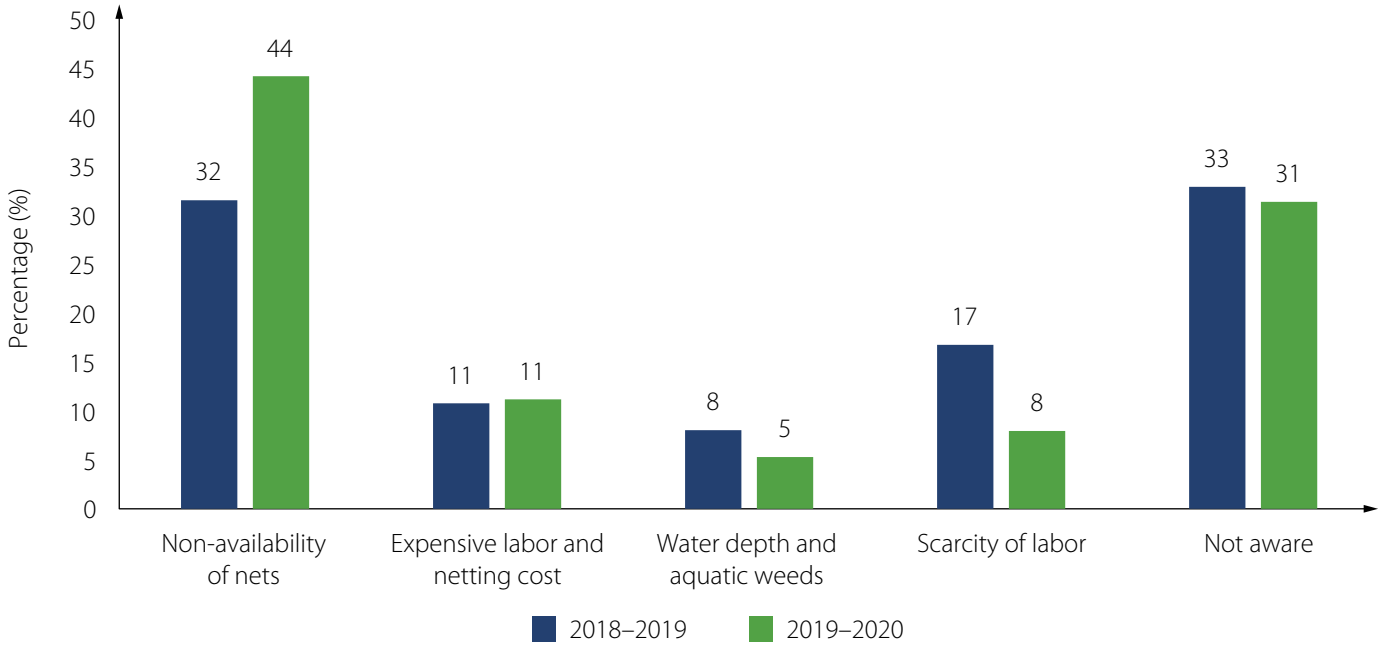

Figure 66. Reasons for not doing monthly sampling.

Record keeping

The vast majority of WSHGs kept daily records on fish farming-related information in a notebook distributed under the activity (Table 78, Figure 67).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	314	84.86	547	92.40
No	56	15.14	45	7.60

Table 78. Maintaining a tank record book.

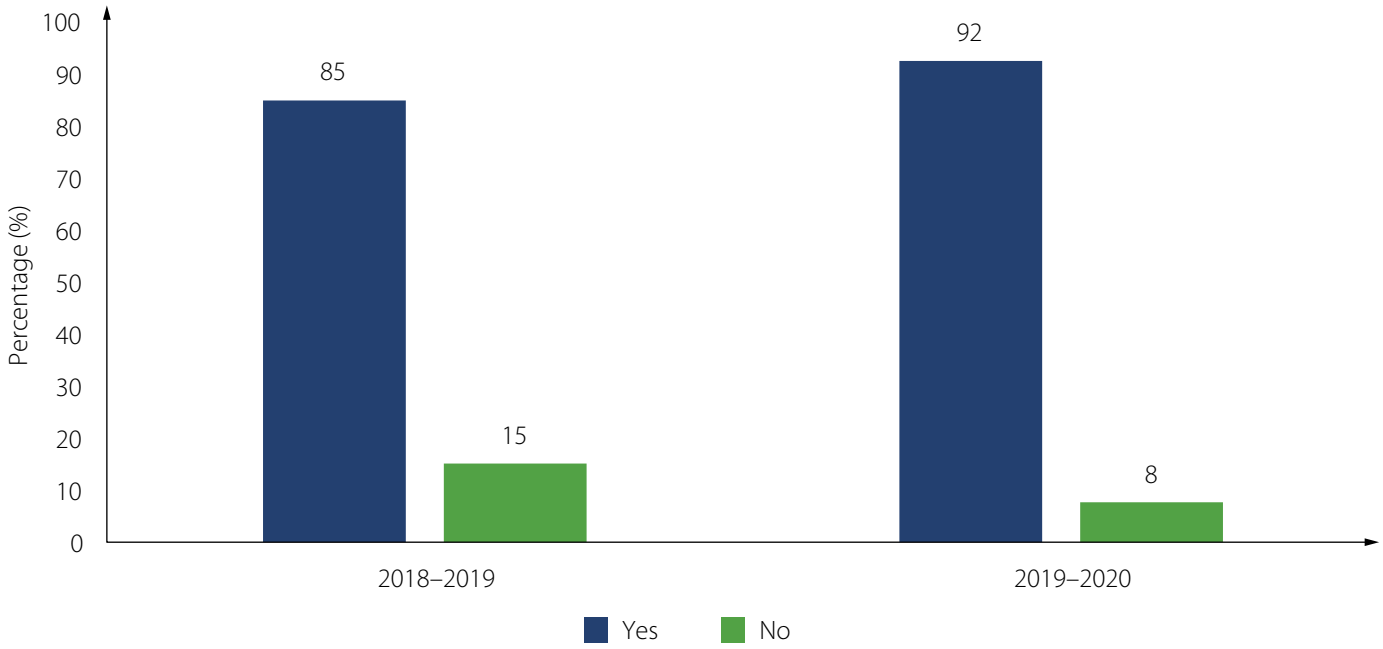

Figure 67. Maintaining a tank record book.

Progressive woman fish farmer, Ms. Sulochana, with a cast net, Balasore District.

8. Harvesting and fish production

Harvesting

About a quarter of the GP tanks were completely harvested within 12 months of stocking, while the rest were partially harvested (Table 79, Figure 68).

Complete or partial	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Fish completely harvested within 12 months of stocking	104	28.11	141	23.82
Fish partially harvested within 12 months of stocking	266	71.89	451	76.18

Table 79. Types of harvest.

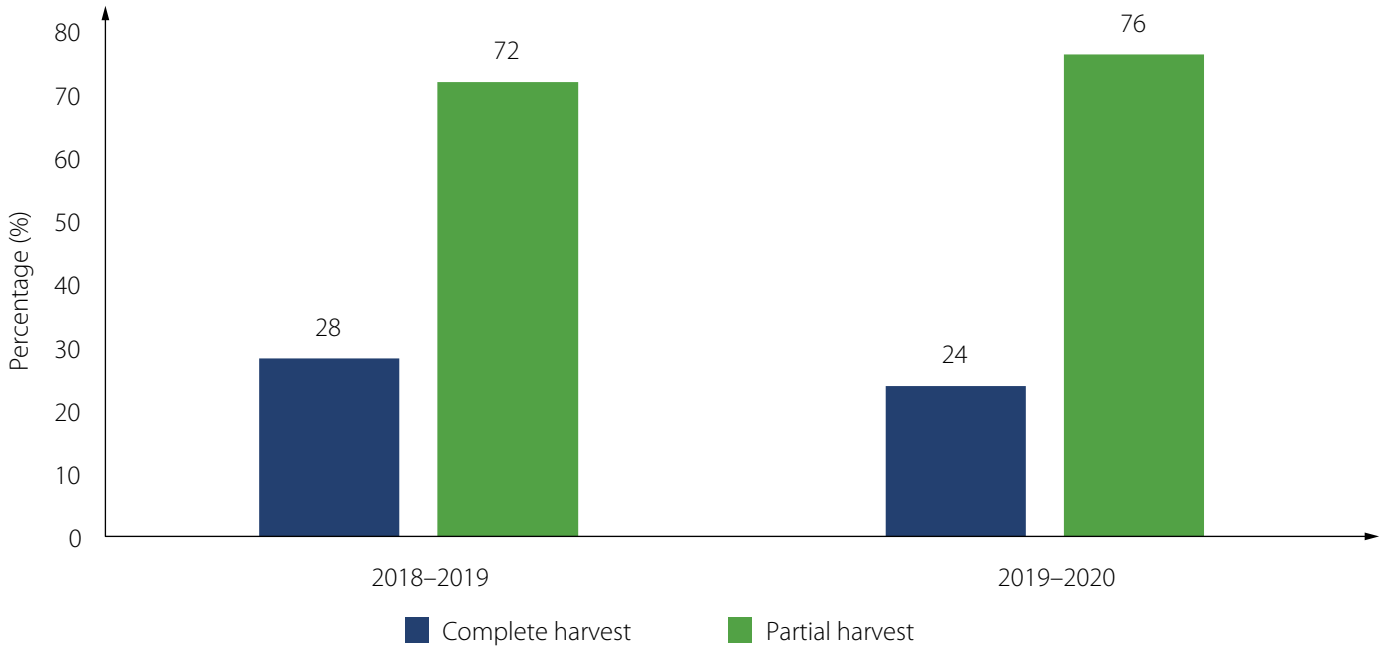

Figure 68. Types of harvest.

Frequency of harvesting

On average, WSHGs harvested fish from their GP tanks three times during the first 12 months after stocking (Table 80, Figure 69). The vast majority harvested two to five times a year, while about a quarter did so only once annually. Only a small percentage harvested more than five times a year.

Frequency	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
One time	86	23.24	149	25.17
2–5 times	264	71.35	419	70.78
> 5 times	20	5.41	24	4.05

Table 80. Frequency of harvesting during 12 months after stocking.

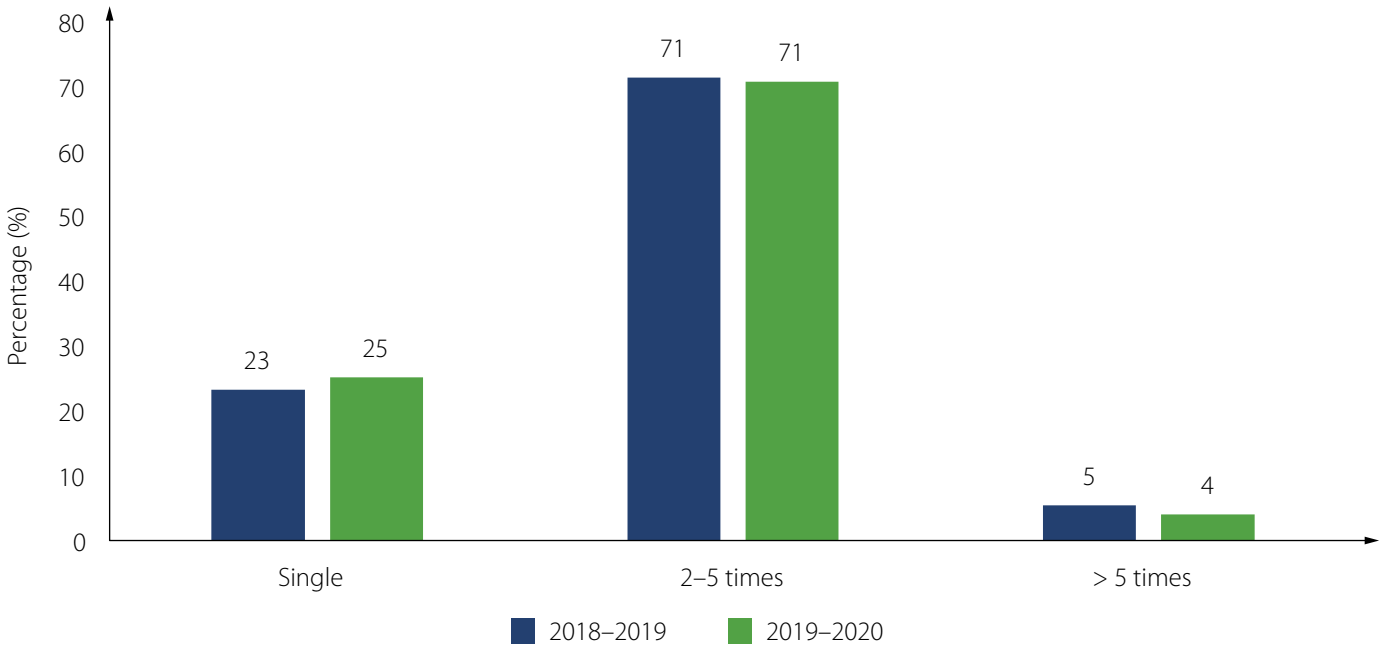

Figure 69. Frequency of harvesting during 12 months after stocking.

Fish production

Average fish production of the GP tanks included (a) fish harvested and sold, (b) fish consumed or gifted, and (c) estimated leftover fish after 12 months of stocking. Under the activity, targeted production was 2500 kg/ha, which included carps and other species, such as mola. The WSHGs came up short of this target, but they still averaged 1725 kg/ha in the first survey year and then increased it to 1956 kg/ha in the second (Table 81, Figure 70). It is important to note the increase, because the WSHGs raised their average production across every category from the first year to the second. The largest share of the WSHGs produced 1000–2000 kg/ha.

Average production	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 1000 kg/ha	103	27.84	114	19.42
1000–2000 kg/ha	152	41.08	233	39.69
2000–3000 kg/ha	81	21.89	163	27.77
3000–4000 kg/ha	20	5.41	47	8.01
> 4000 kg/ha	14	3.78	30	5.11

Note: Average fish production is calculated by adding the actual quantity of fish harvested and sold within 12 months of stocking, fish consumed and gifted, and estimated leftover fish in the tanks after the 12 months.

Table 81. Average fish production.

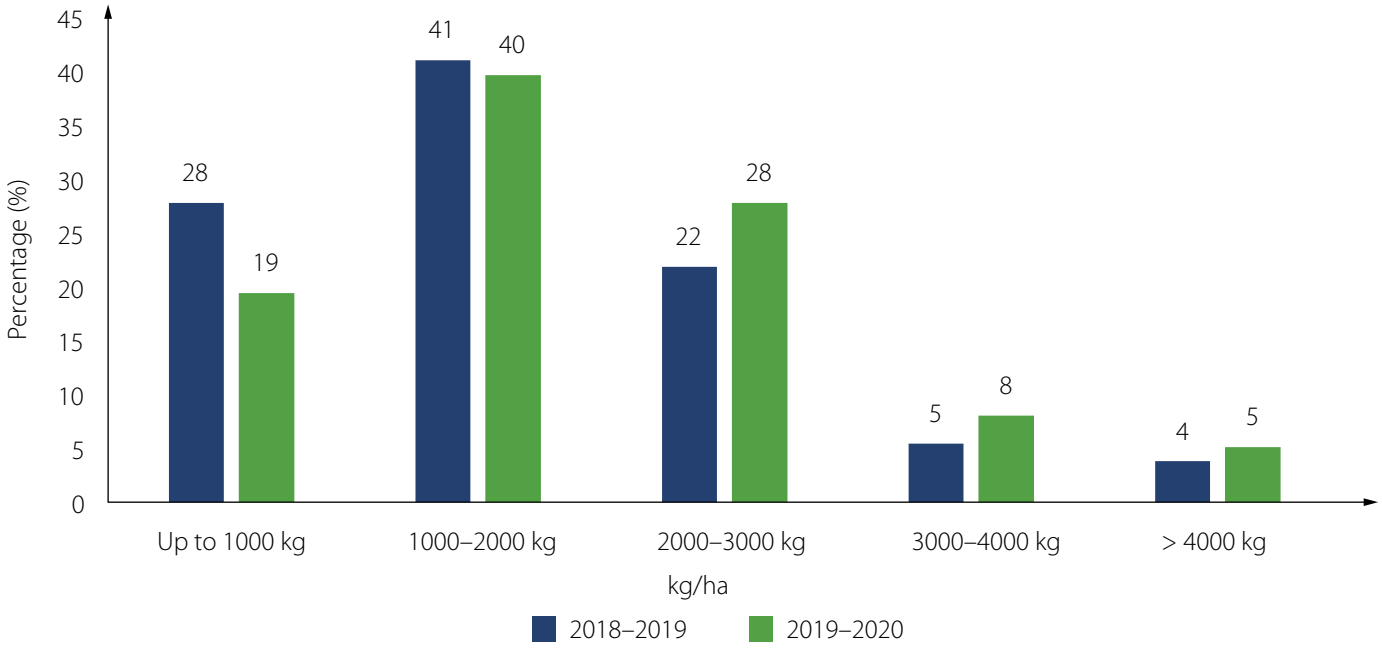

Figure 70. Average fish production.

Fish production within 12 months of stocking

The estimated average fish production within 12 months of the stocking date includes carps and other species, such as mola.

Almost all of the GP tanks were harvested within 12 months of stocking in both survey years. Among these, average fish production was 1392 kg/ha in the first survey year, which increased marginally to 1457 kg/ha in the second. WSHGs producing more than 1000 kg/ha of fish increased slightly year over year, as did those producing more than 2000 kg/ha (Table 82, Figure 71).

Average production	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	62	16.89	93	16.09
500–1000 kg/ha	85	23.16	102	17.65
1000–2000 kg/ha	145	39.51	241	41.70
2000–3000 kg/ha	59	16.08	107	18.51
3000–4000 kg/ha	8	2.18	26	4.50
> 4000 kg/ha	8	2.18	9	1.56

Table 82. Average fish production within 12 months of stocking.

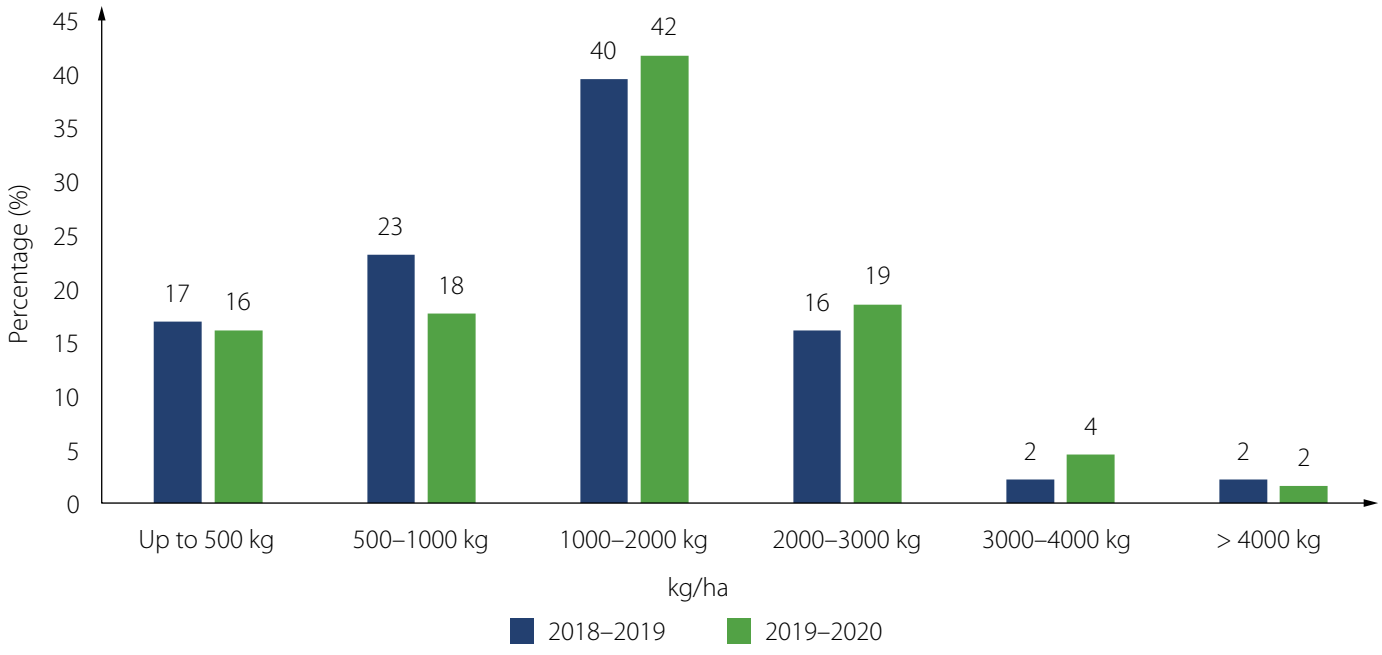

Figure 71. Average fish production within 12 months of stocking.

Carp production within 12 months of stocking

Average carp (IMCs and exotic carps) production in the GP tanks that WSHGs managed increased slightly from 1287 kg/ha in the first survey year to 1364 kg/ha in the second. The percentage of WSHGs that produced more than 1000 kg/ha and more than 2000 kg/ha both increased over the survey years (Table 83, Figure 72).

Average production	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	69	18.80	105	18.17
500–1000 kg/ha	96	26.16	117	20.24
1000–2000 kg/ha	145	39.51	233	40.31
2000–3000 kg/ha	45	12.26	88	15.22
> 3000 kg/ha	12	3.27	35	6.06

Table 83. Average carp production within 12 months of stocking.

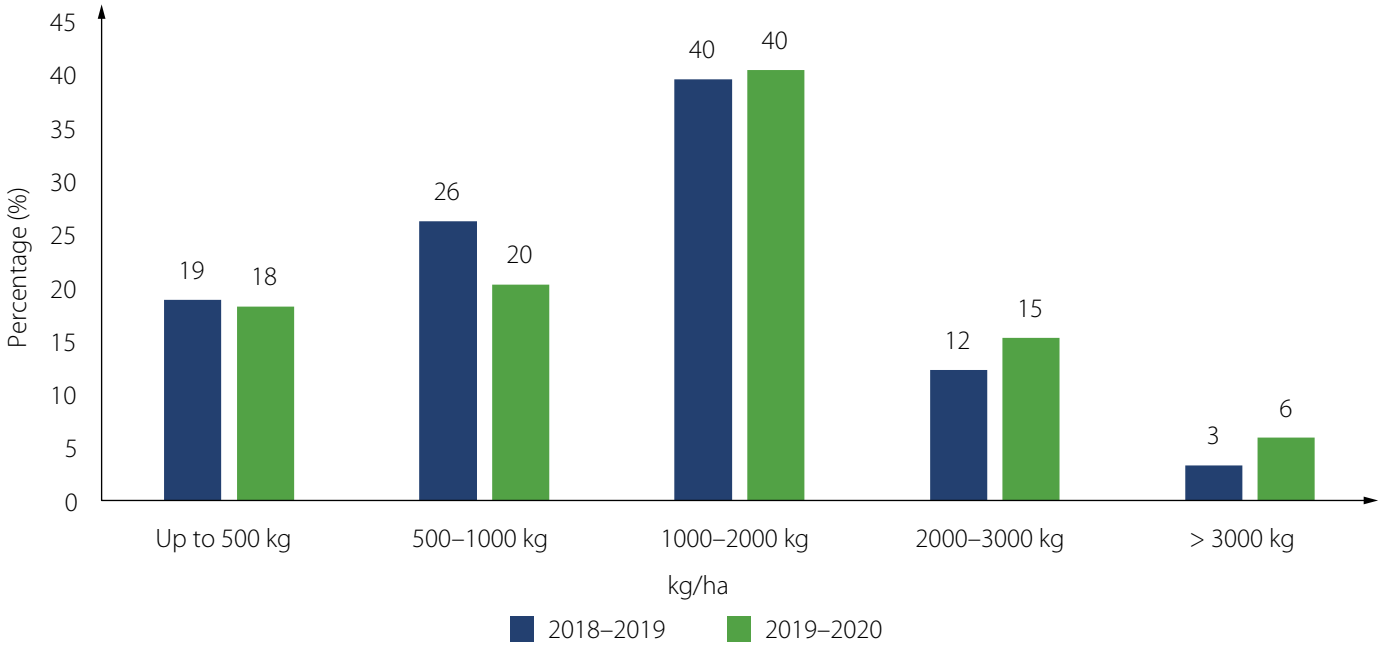

Figure 72. Average carp production within 12 months of stocking.

Mola production within 12 months of stocking

Mola was harvested from more than half of the surveyed GP tanks in both survey years (Table 84, Figure 73). Even among the WSHGs that did not stock mola, there were still some mola in their tanks because of their natural presence and their auto-breeding nature.

Overall, average mola production decreased slightly from 166 kg/ha in the first survey year to 148 kg/ha in the second. Production dropped across every category, except for those who produced 200–400 kg/ha, which saw a slight increase.

Average production	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
None	168	45.41	281	47.5
Up to 50 kg/ha	45	12.16	67	11.3
50–100 kg/ha	60	16.22	85	14.4
100–200 kg/ha	49	13.24	77	13.0
200–400 kg/ha	33	8.92	68	11.5
> 400 kg/ha	15	4.05	14	2.4

Table 84. Average mola production within 12 months of stocking.

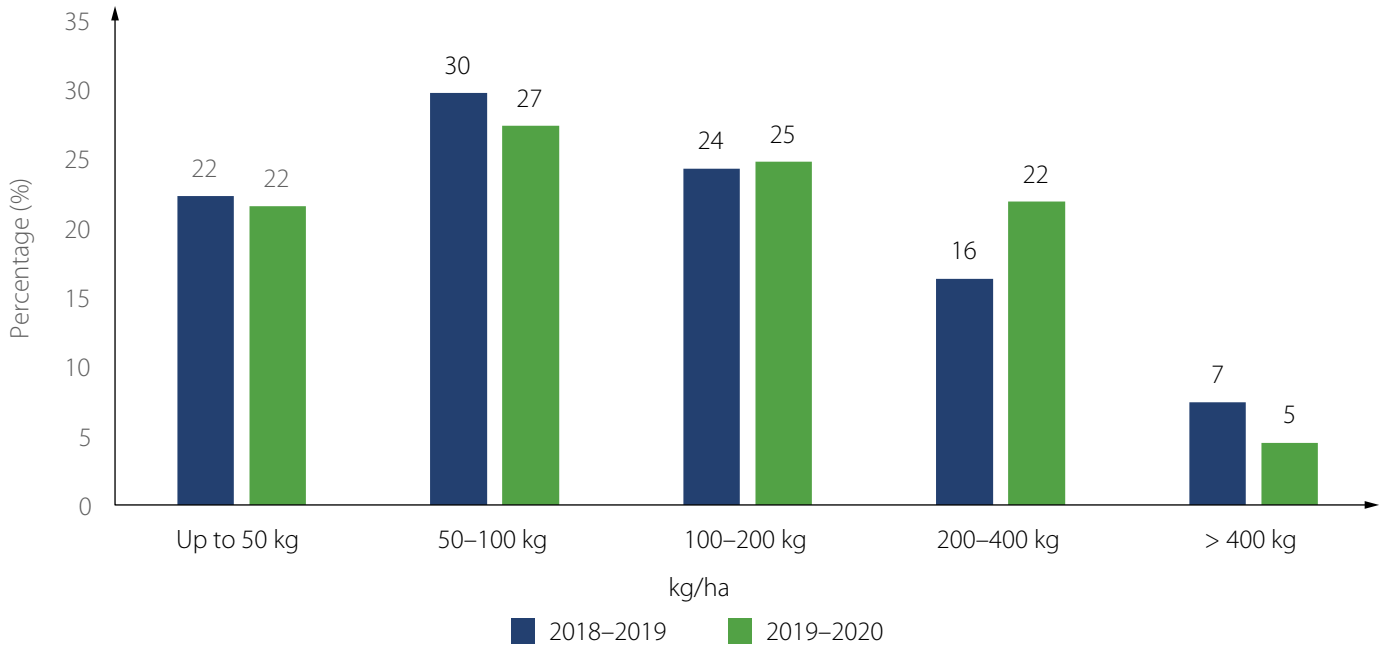

Figure 73. Average mola production within 12 months of stocking.

Other SIS production within 12 months of stocking

A total of 33 GP tanks (8.92%) produced other small indigenous fish (other than mola) during the first survey year and 51 tanks (8.61%) during the second (Table 85, Figure 74). Average production increased slightly from was 148 to 172 kg/ha over the survey period.

Average production	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
None	337	91.08	541	91.39
Up to 100 kg/ha	16	4.32	24	4.05
100–200 kg/ha	9	2.43	14	2.36
> 200 kg/ha	8	2.16	13	2.20

Table 85. Average production of other SIS within 12 months of stocking.

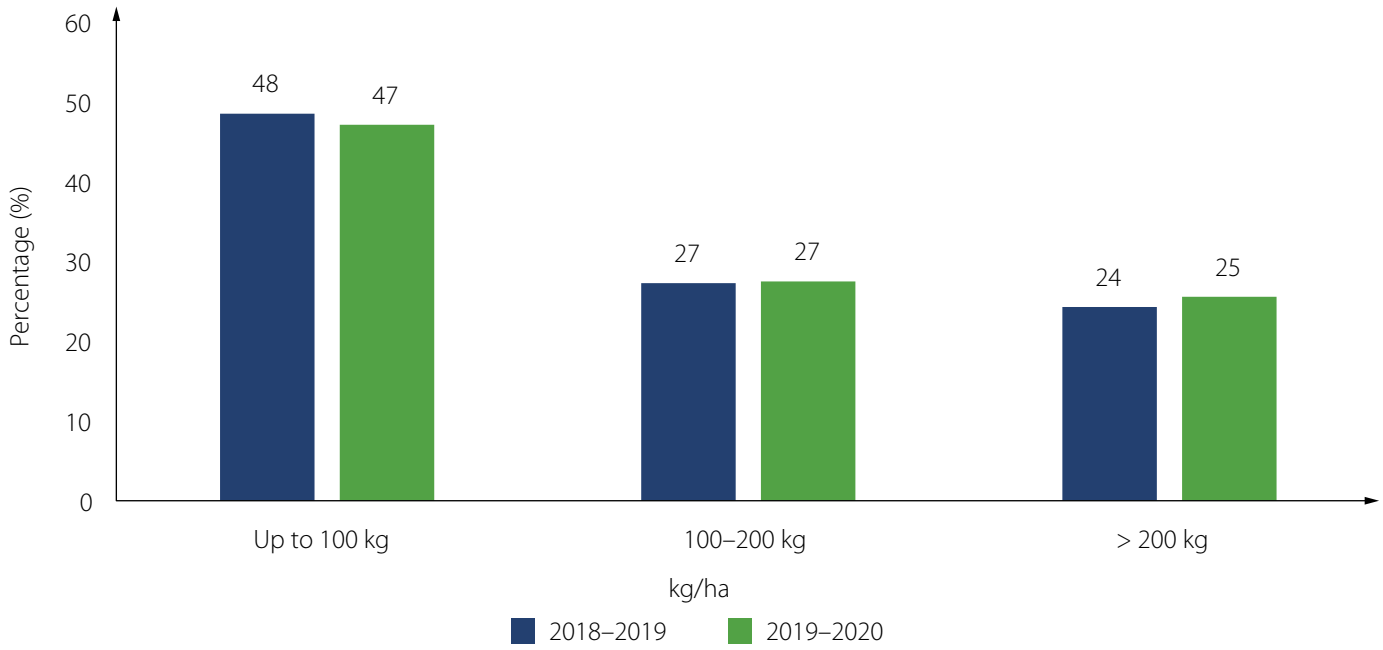

Figure 74. Average production of other SIS within 12 months of stocking.

Contribution of SIS to total fish production

Over the 2 years of the survey, mola and other SIS made up 6%–7% of total fish production from GP tanks (Table 86, Figure 75).

Contribution	Proportion of SIS produced (%)			
	2018–2019		2019–2020	
Total fish harvested (kg)	197,587	7%	732,856	6%
Total SIS harvested (kg)	14,452		49,699	

Table 86. Contribution of SIS to total fish production.

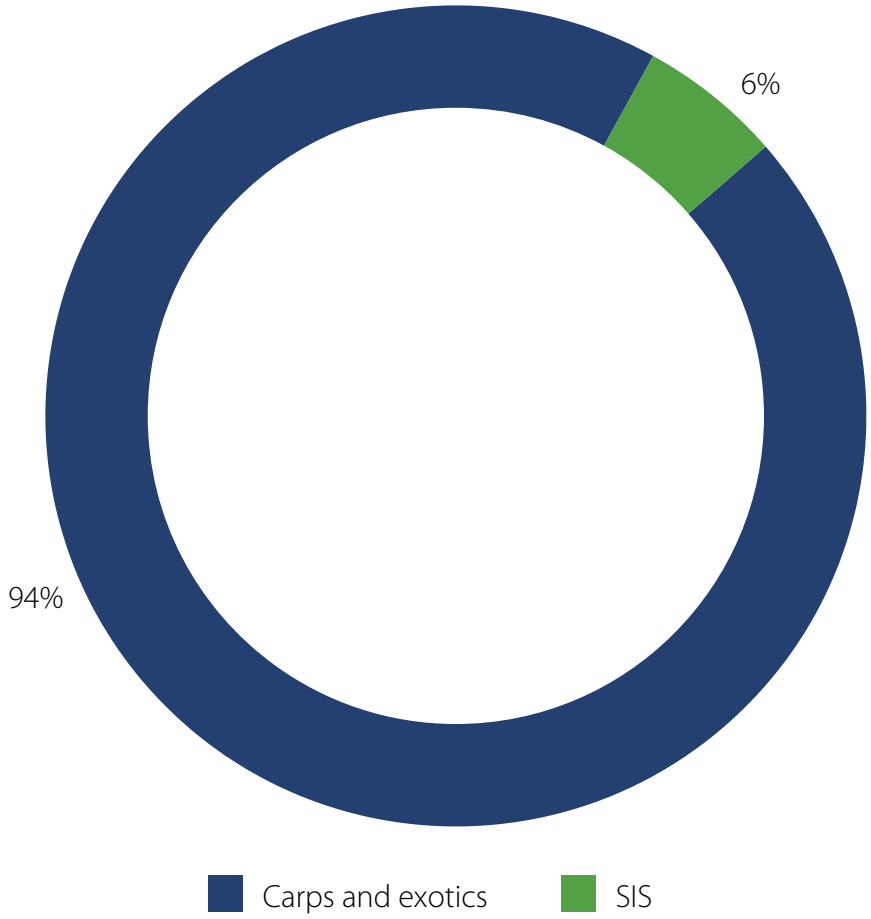

Figure 75. Contribution of SIS to total fish production.

Average value	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Total fish production*	1301 ± 2400 (100–40,550)	1725 ± 1173 (106–9266)	1728 ± 2180 (37–17,579)	1956 ± 1294 (12–11,047)
Total fish harvested**	1015 ± 1418 (50–20,550)	1392 ± 1007 (106–9266)	1268 ± 1583 (20–17,440)	1457 ± 929 (11–5233)
Carps harvested	950 ± 1379 (50–20,000)	1287 ± 958 (99–8649)	1185 ± 1497 (10–16,065)	1364 ± 912 (11–5233)
Mola harvested	102 ± 118 (5–800)	166 ± 213 (8–1977)	119 ± 173 (5–1850)	148 ± 129 (4–890)
Other SIS harvested	105 ± 129 (5–450)	148 ± 139 (6–618)	249 ± 385 (10–2072)	172 ± 228 (10–1483)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

**Total fish production = Fish harvested and sold + fish consumed/gifted + estimated leftover fish in tank after 1 year.*

***Total fish harvest = Fish harvested and sold + fish consumed/gifted.*

Table 87. Fish production from GP tanks over a 1-year cropping period.

Community fish farming in GP tank provides a decent livelihood opportunity for the tribal-dominated WSHGs in Odisha.

9. Use of harvested fish

Share of tanks from which WSHGs sold harvested fish

In the first survey year, carps were harvested from 367 GP tanks within 12 months of stocking, and WSHGs sold carps for financial gains from all 367 tanks. Although mola were harvested from 202 tanks, WSHGs were only able to sell them from 152 of the tanks (55%). In the case of other SIS, WSHGs harvested them from 33 tanks but were only able to sell SIS from 22 of them (9%).

Similarly, in the second year 578 GP tanks were harvested within 12 months of stocking, and WSHGs sold carps for financial gains from all 578 tanks. Although mola were harvested from 311 tanks, WSHGs were only able to sell them from 250 (53%) of the tanks. In the case of SIS, WSHGs harvested them from 51 tanks and sold them from 46 of the tanks (90%) (Table 88, Figure 76).

Fish harvested and sold	2018–2019			2019–2020		
	Number of tanks from which fish were harvested	Number of tanks from which fish were sold	Fish producing tanks (%)	Number of tanks from which fish were harvested	Number of tanks from which fish were sold	Fish producing tanks (%)
Carps	367	367	100	578	578	100
Mola	202	152	54.59	311	250	52.54
Other SIS	33	22	8.91	51	46	8.61

Table 88. Share of tanks from which WSHGs sold harvested fish.

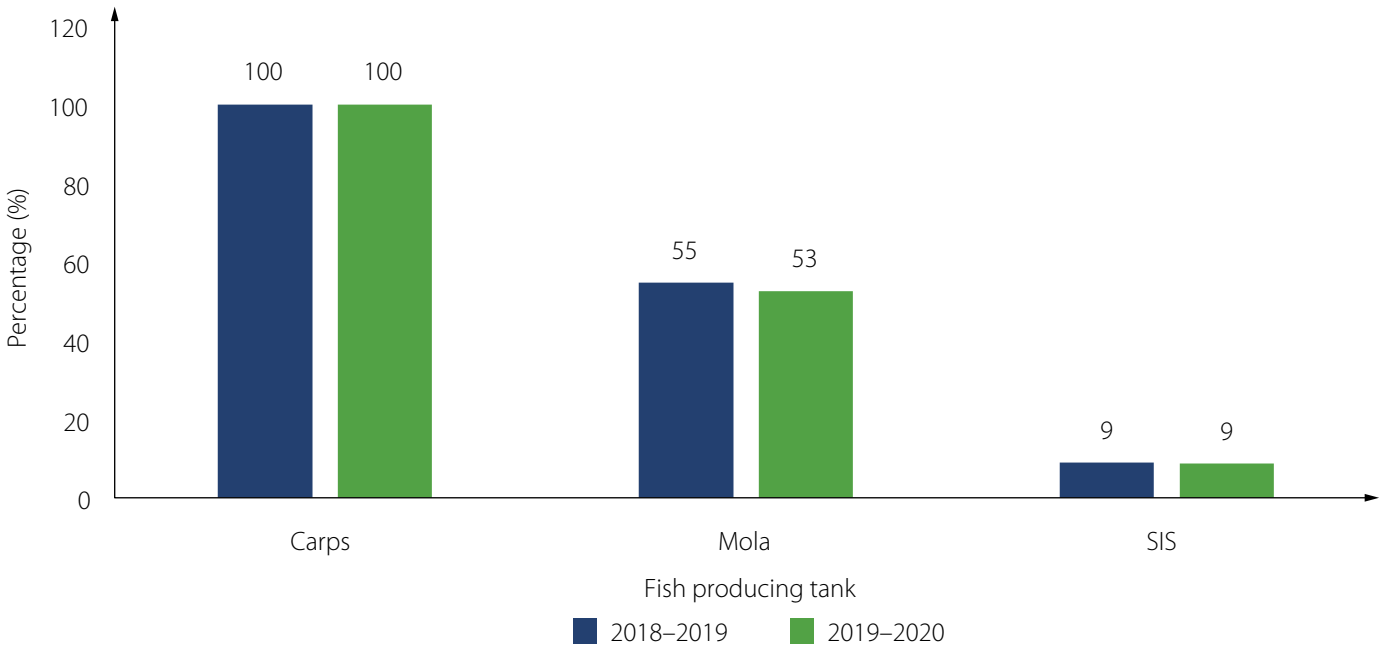

Figure 76. Share of tanks from which WSHGs sold harvested fish.

Quantity of fish sold

On average, WSHGs sold 1281 kg/ha of harvested fish from their GP tanks in the first survey year and 1369 kg/ha in the second (Table 89, Figure 77). The percentage of WSHGs that sold more than 1000 kg/ha of harvested fish increased slightly from 55% in the first year to 61% in the second.

Average quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	76	20.71	109	18.86
500–1000 kg/ha	89	24.25	115	19.90
1000–2000 kg/ha	140	38.15	233	40.31
2000–3000 kg/ha	52	14.17	90	15.57
> 3000 kg/ha	10	2.72	31	5.36

Note: Total quantity of fish includes carps, mola and other self-recruited indigenous fish.

Table 89. Average quantity of fish sold.

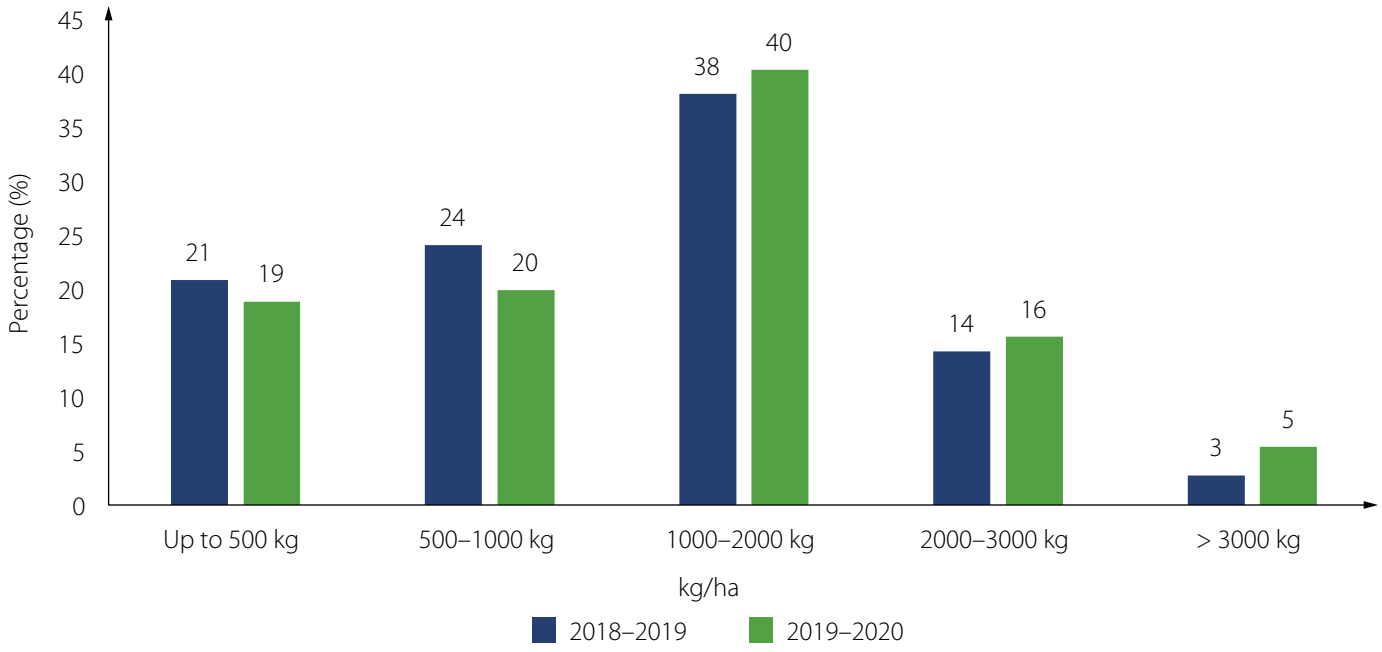

Figure 77. Average quantity of fish sold.

Average quantity of carps sold

On average, WSHGs sold 1215 kg/ha of harvested carps in the first survey year and 1306 kg/ha in the second (Table 90, Figure 78). Approximately half of the WSHGs sold more than 1000 kg/ha of harvested carps in the first year, which increased slightly in the second.

Average	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 kg/ha	80	21.80	119	20.59
500–1000 kg/ha	100	27.25	128	22.15
1000–2000 kg/ha	135	36.78	219	37.89
2000–3000 kg/ha	41	11.17	80	13.84
> 3000 kg/ha	11	3.00	32	5.54

Table 90. Average quantity of carps sold.

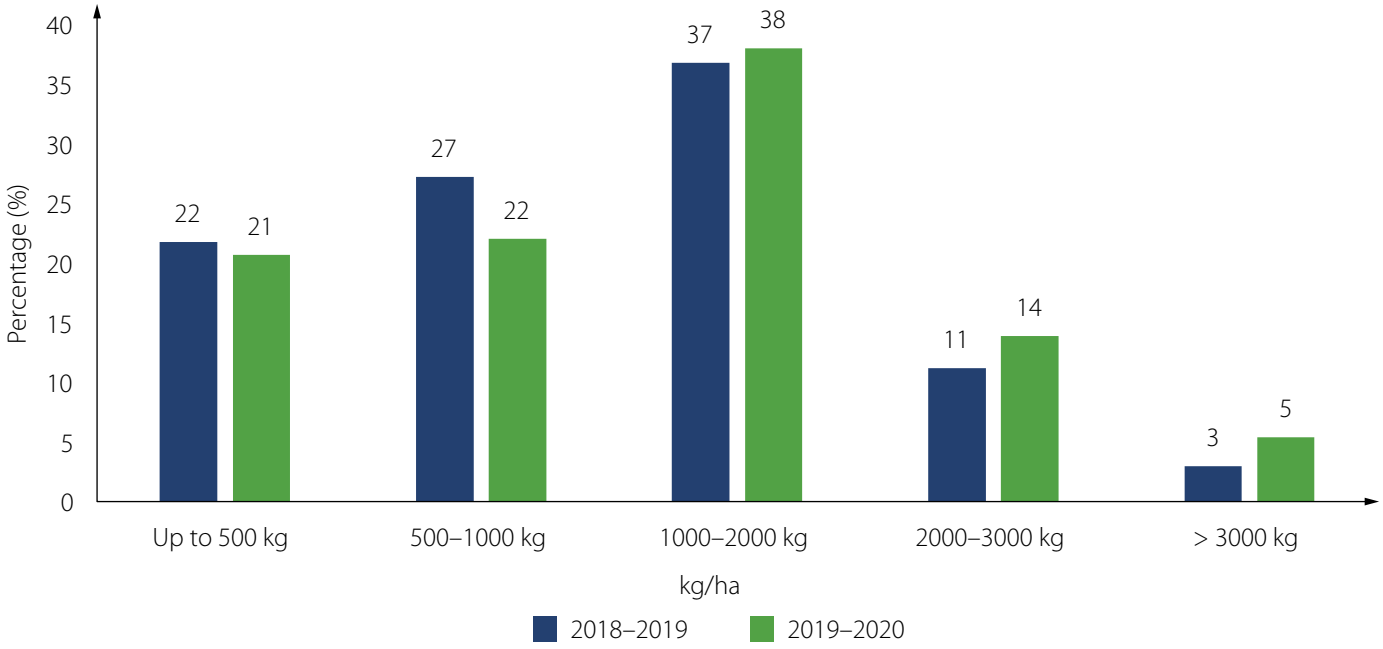

Figure 78. Average quantity of carps sold.

Average weight of carps at harvest

The average weight of carps at harvest was almost the same in both survey years, at 862 g in the first and 864 g in the second (Table 91, Figure 79). Most of the WSHGs harvested and sold carps weighing an average of 700–1000 g. In each survey year, less than a quarter sold carps weighing less than 700 g, and even fewer sold carps weighing over 1 kg.

Average weight	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Less than 500 g	22	5.99	10	1.73
500–700 g	59	16.08	97	16.78
700–1000 g	236	64.31	430	74.39
More than 1000 g	50	13.62	41	7.09

Table 91. Average weight of carps at harvest.

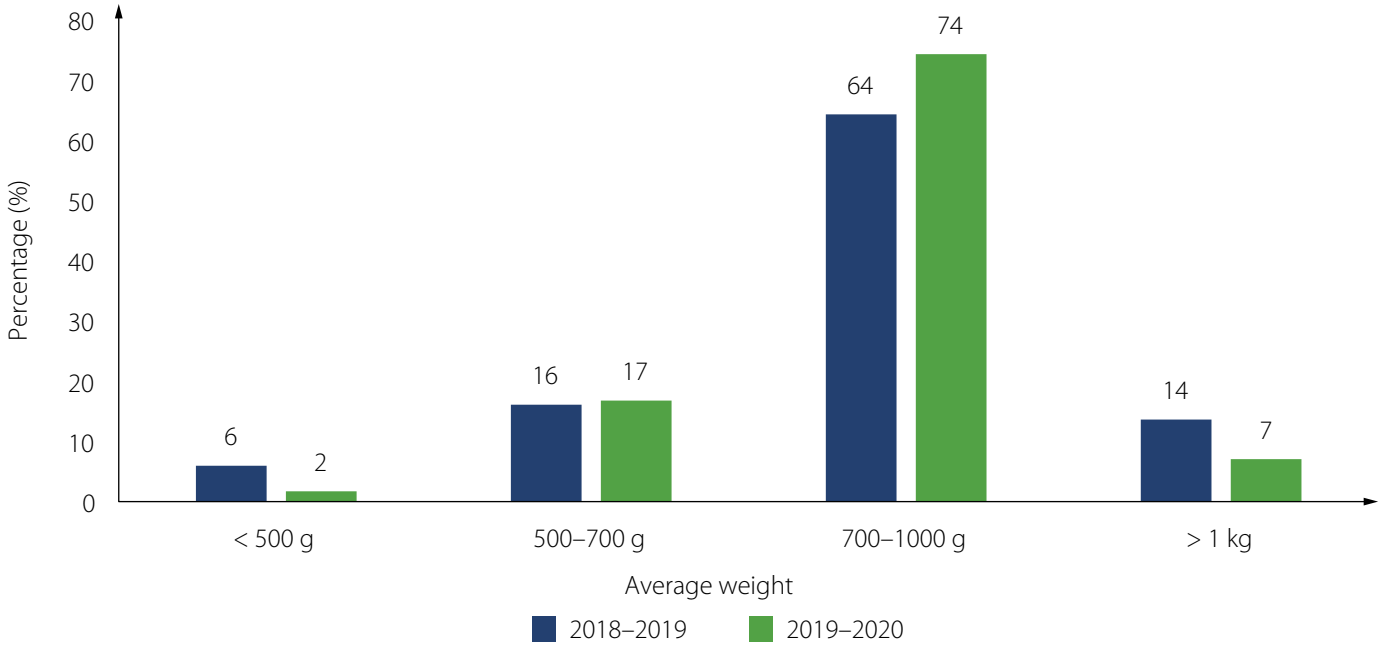

Figure 79. Average weight of carps at harvest.

Carp buyers

The largest share of WSHGs sold carp to retail fish vendors in local markets followed by those that sold them directly to villagers at farmgate (Table 92, Figure 80). The smallest share were those that sold carp to wholesale traders.

Buyer	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Local retail fish market	165	44.96	240	41.52
Farm-side villagers	152	41.42	211	36.51
Wholesale traders	50	13.62	127	21.97

Table 92. Carp buyers.

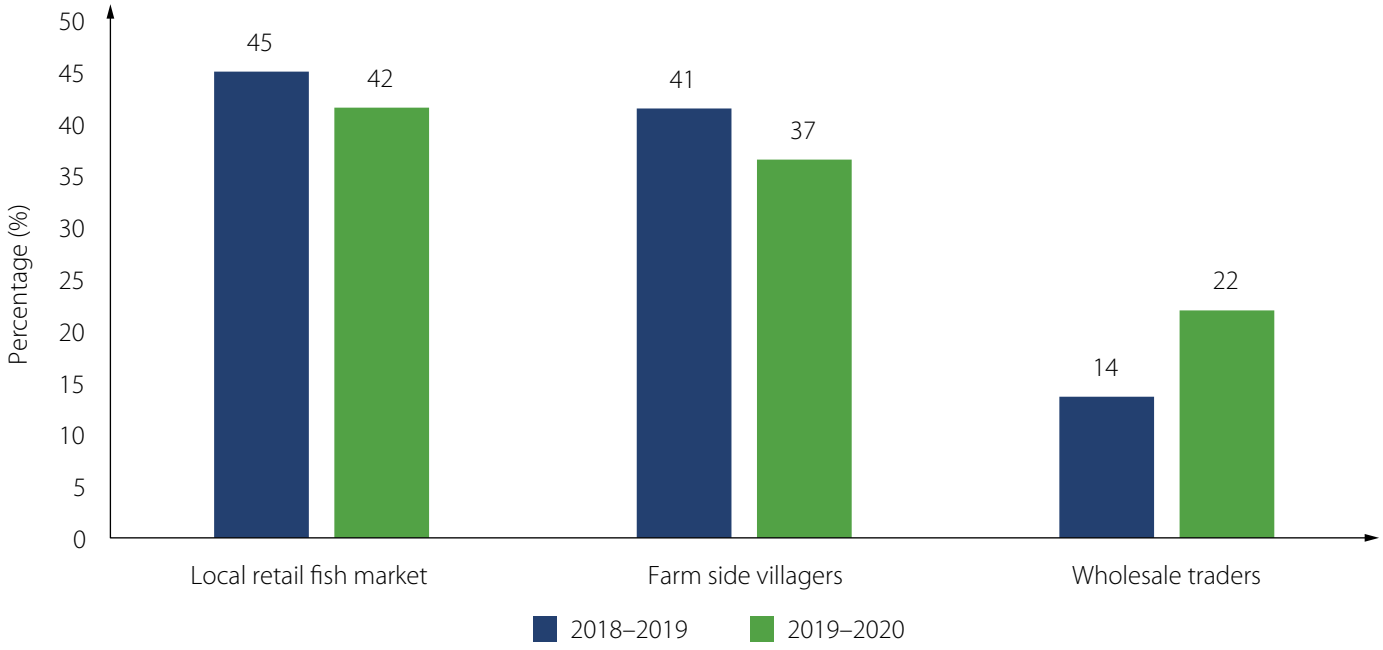

Figure 80. Carp buyers.

Avergae farmgate price of carp

Over the 2 years of the survey, the average farmgate price of carp remained almost the same at INR 145/kg and then INR 146/kg (Table 93, Figure 81). About three-quarters of the WSHGs received a farmgate price in the range of INR 120–160/kg. A few received a very good farmgate price of INR 160–200/kg, while a handful received INR 100–120/kg.

Average	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
<100 INR/kg	-	-	17	2.94
100–120 INR/kg	60	16.35	80	13.84
120–140 INR/kg	138	37.60	203	35.12
140–160 INR/kg	131	35.69	214	37.02
160–180 INR/kg	14	3.81	30	5.19
180–200 INR/kg	24	6.54	32	5.54
>200 INR/kg	-	-	2	0.35

Table 93. Average farmgate price of carp.

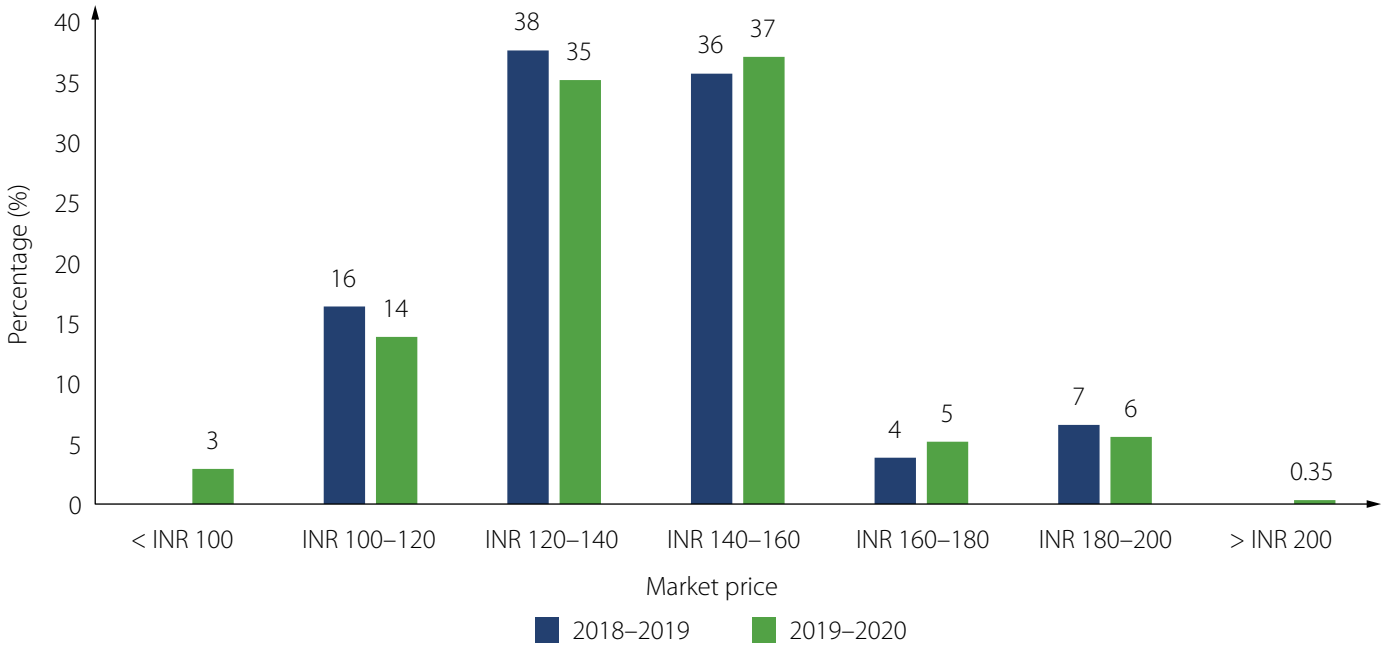

Figure 81. Average farmgate price of carp.

Average quantity of mola sold

Among the WSHGs that could harvest mola from their GP tank, they averaged 142 kg/ha and then 133 kg/ha in the 2 years of the survey (Table 94, Figure 82). Just over half of them sold less than 100 kg/ha in each year.

Average	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
<50 kg/ha	38	25.00	67	26.80
50–100 kg/ha	43	28.29	63	25.20
100–200 kg/ha	36	23.68	67	26.80
>200 kg/ha	35	23.03	53	21.20

Table 94. Average quantity of mola sold.

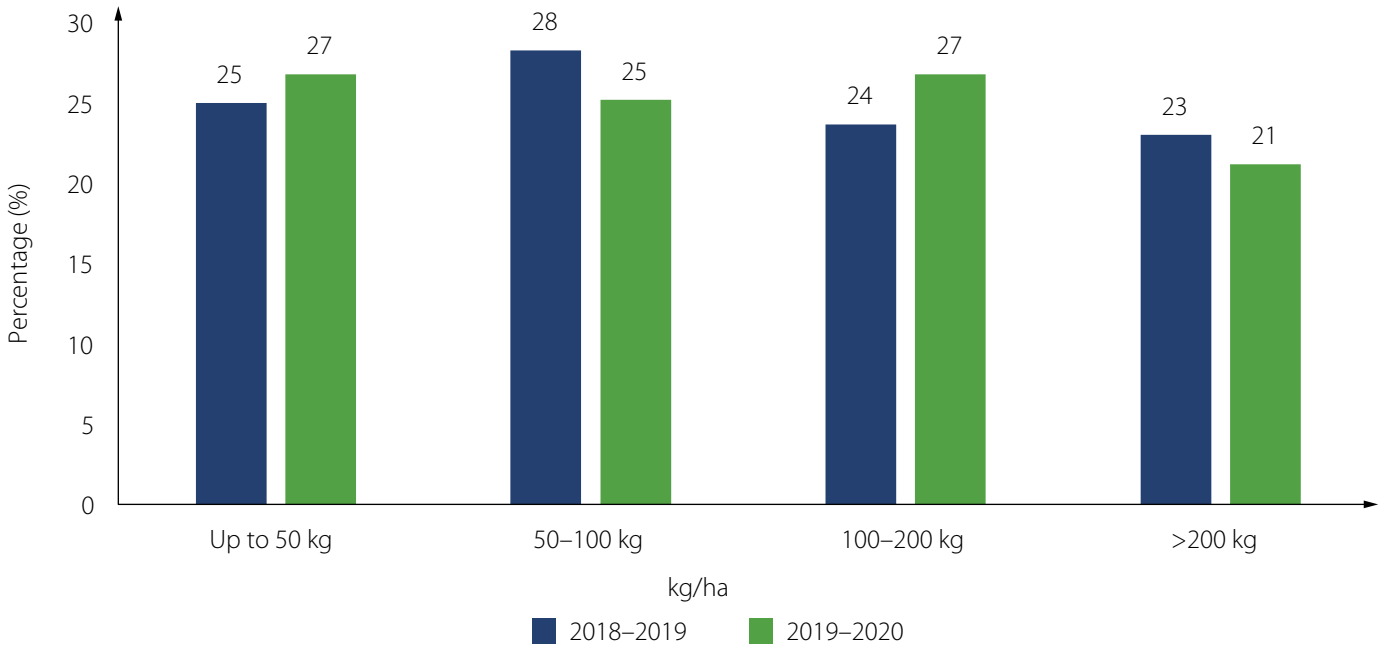

Figure 82. Average quantity of mola sold.

Mola buyers

Among the WSHGs that harvested mola, over half sold them mostly to nearby retail villagers in both survey years (Table 95, Figure 83). The next most popular buyers were local retail markets. Very few WSHGs sold mola to wholesale fish traders or other WSHG members.

Buyer	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Farm-side villagers	85	55.92	148	59.20
Local retail fish market	57	37.50	72	28.80
Wholesale traders	6	3.95	19	7.60
WSHG members	4	2.63	11	4.40

Table 95. Mola buyers.

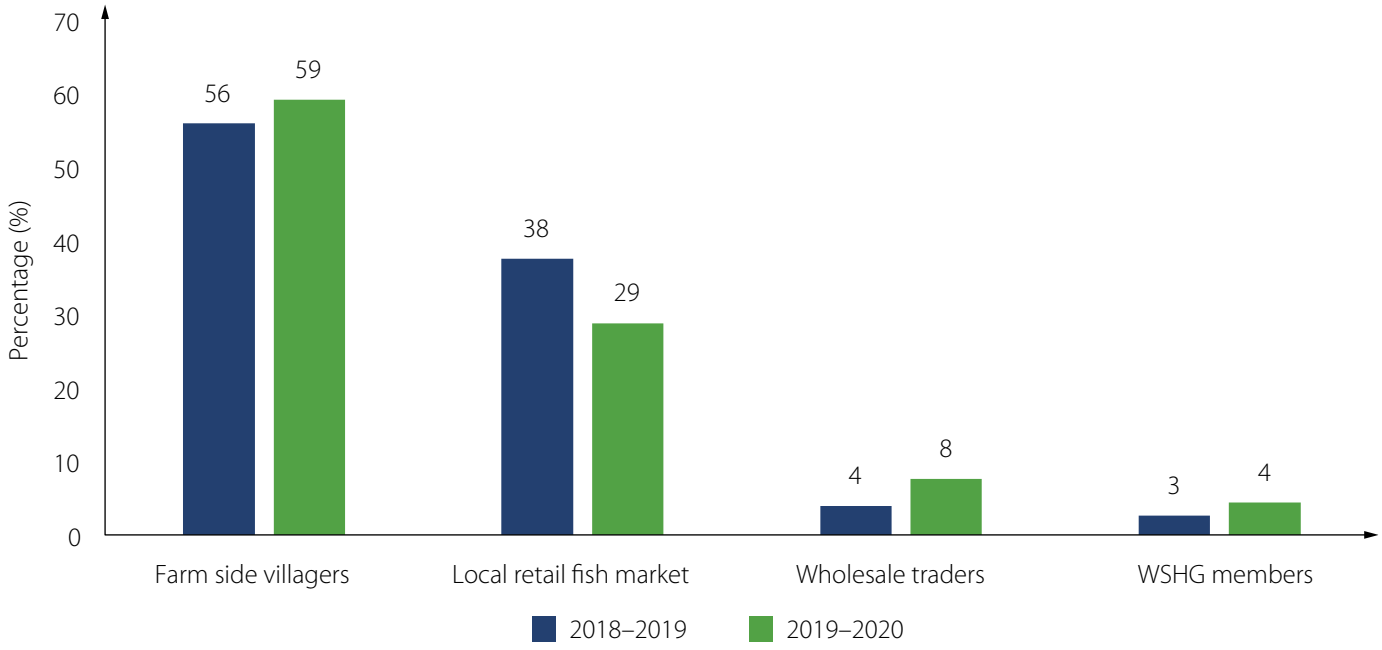

Figure 83. Mola buyers.

Average farmgate price of mola

The average farmgate price that WSHGs received for mola was virtually unchanged from the first survey year (INR 112/kg) to the second (INR 113/kg). The highest recorded price in the survey was INR 300/kg (Table 96, Figure 84). Among the WSHGs that sold mola, over half in each survey year received a farmgate price of less than INR 100/kg and around one-third received INR 100–150/kg. Only a handful of the WSHGs received more than INR 150/kg.

Average price	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 100/kg	88	57.89	128	51.20
INR 100–150/kg	46	30.26	97	38.80
> INR 150/kg	18	11.84	25	10.00

Table 96. Average farmgate price of mola.

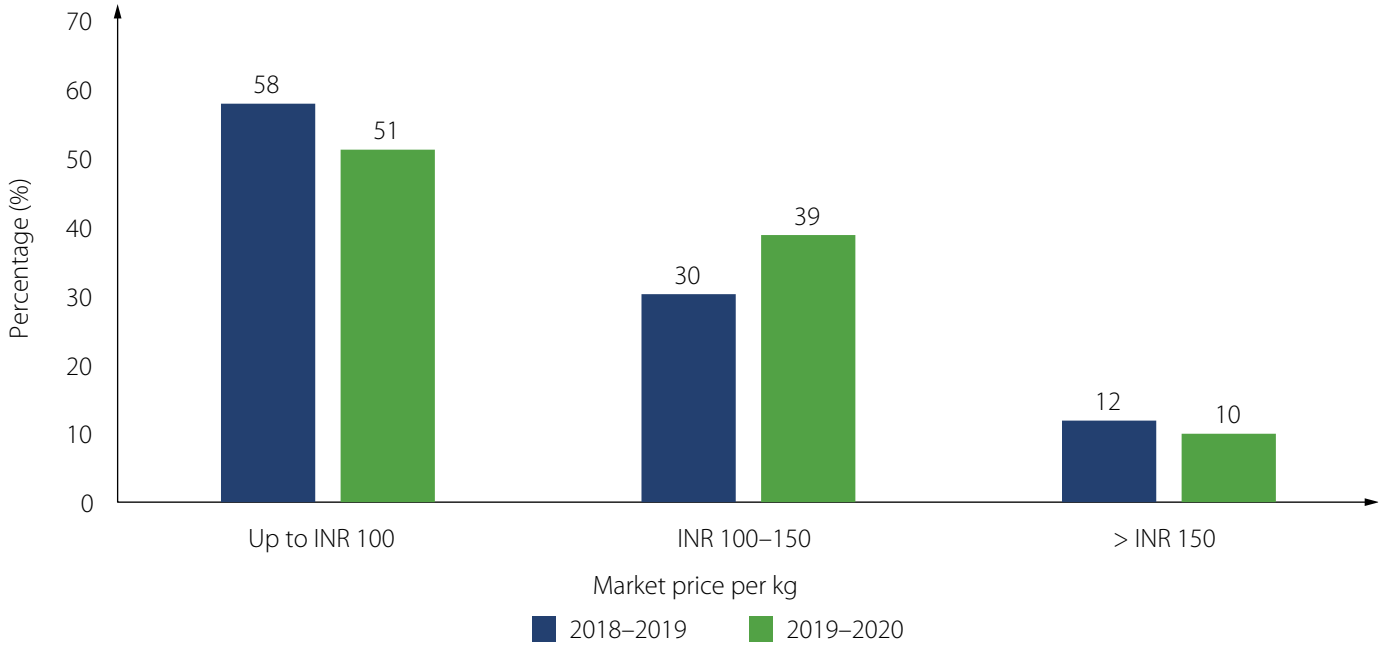

Figure 84. Average farmgate price of mola.

Average quantity of other SIS sold

Among the WSHGs that could harvest self-recruited indigenous fish species from their GP tank, they sold almost the same average amount in the first survey year (149 kg/ha) as they did in the second (151 kg/ha) (Table 97, Figure 85). Most sold less than 100 kg/ha in each year.

Average	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< 100 kg/ha	10	45.45	25	54.35
100–200 kg/ha	6	27.27	13	28.26
>200 kg/ha	6	27.27	8	17.39

Table 97. Average quantity of other SIS sold.

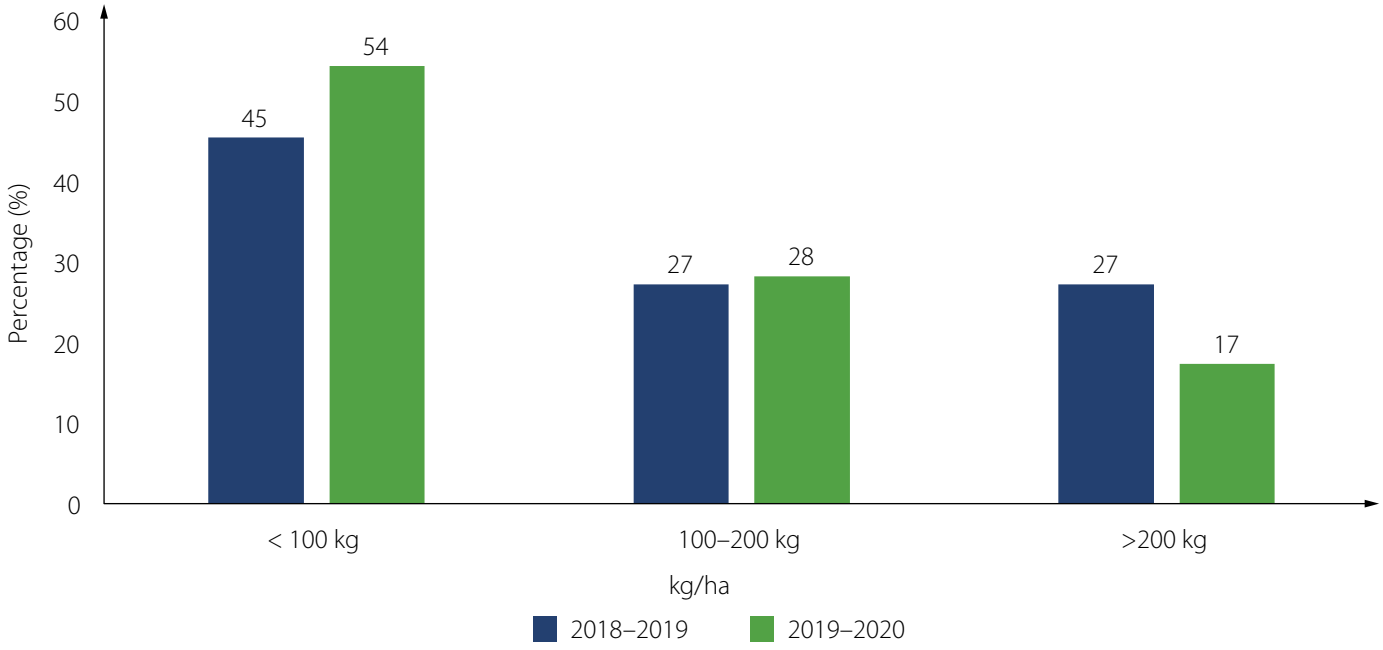

Figure 85. Average quantity of other SIS sold.

Average value sold	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Carp (IMCs and exotics)	907 ± 1336 (28–19,000)	1215 ± 943 (88–8649)	1137 ± 1470 (20–16,000)	1306 ± 904 (11–5233)
Mola	85 ± 94 (3–700)	142 ± 137 (6–1063)	109 ± 168 (5–1800)	133 ± 111 (5–618)
Other indigenous fish	113 ± 134 (5–450)	149 ± 127 (6–494)	232 ± 356 (10–2000)	151 ± 192 (7–1071)
All types of fish	952 ± 1367 (28–19,500)	1281 ± 953 (88–8649)	1197 ± 1540 (10–17,300)	1369 ± 911 (11–5233)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 98. Fish sold from GP tanks in a 1-year cropping period.

Average value	2018–2019	2019–2020
Average size of harvested carp (g)	862 ± 250 (150–1500)	864 ± 189 (200–1500)
Average farmgate price of carp (INR/kg)	145 ± 22 (80–200)	146 ± 21 (90–250)
Average farmgate price of mola (INR/kg)	112 ± 39 (30–300)	113 ± 36 (40–300)
Average farmgate price of other indigenous fish (INR/kg)	122 ± 48 (50–300)	102 ± 59 (50–350)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 99. Average farmgate price of fish sold.

10. Fish consumption pattern among WSHGs

Types of complimentary fish

Among the WSHGs, carps were the most preferred choice for complimentary distribution, at more than 40% (Table 100, Figure 86), and the vast majority of the groups distributed them in this manner for household consumption in both survey years. In each survey year, slightly less than half of the WSHGs only distributed carps, while about 38% distributed both carp and mola during both survey years. A significantly lower percentage of mola was distributed on a complimentary basis.

Species	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Only carps	162	45.13	286	48.31
Only mola	38	10.58	51	8.61
Carps and mola	141	39.28	227	38.34
Other fish	18	5.01	28	4.73

Table 100. Types of fish WSHGs distributed on a complimentary basis.

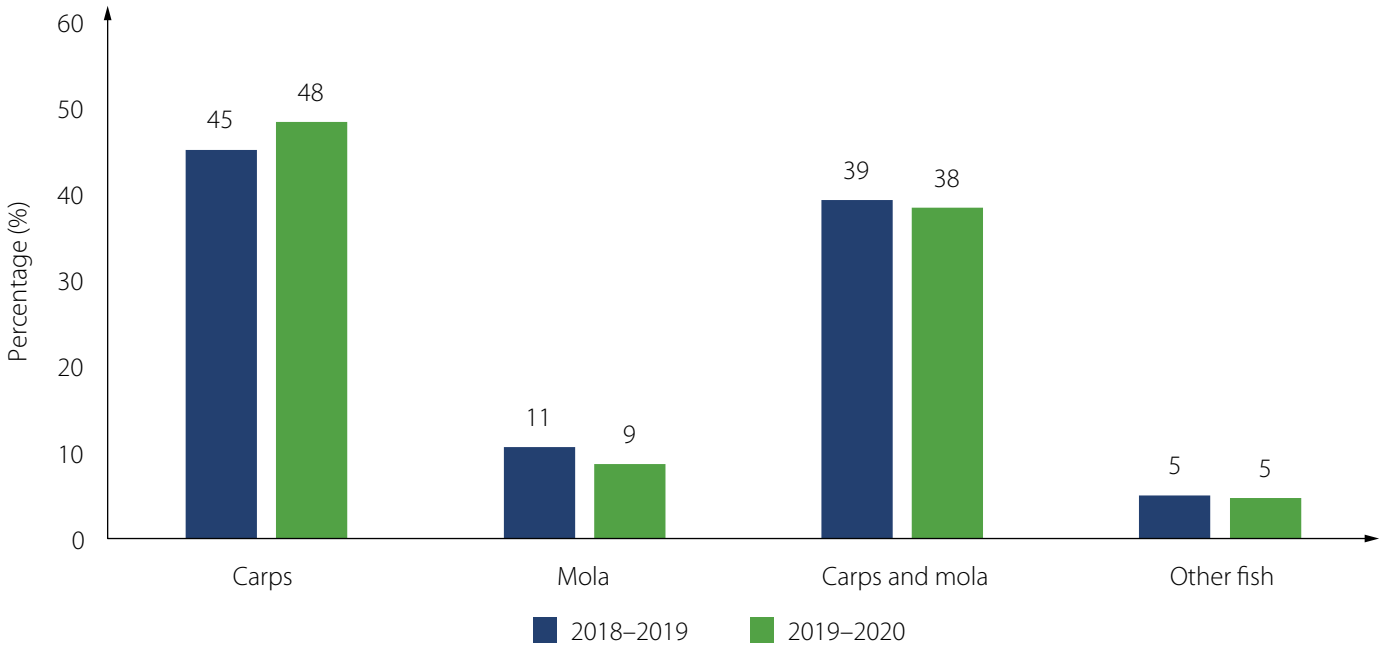

Figure 86. Types of fish WSHGs distributed on a complimentary basis.

Quantity of complimentary fish

Over a 1-year production cycle, each WSHG gifted an average of 75 kg of fish in the first survey year and 82 kg in the second. Less than half gave away up to 50 kg, and less than quarter gave more than 100 kg in each year (Table 101, Figure 87).

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 50 kg	141	43.12	221	43.68
50–100 kg	109	33.33	164	32.41
> 100 kg	77	23.55	121	23.91

Table 101. Quantity of complimentary fish WSHGs distributed.

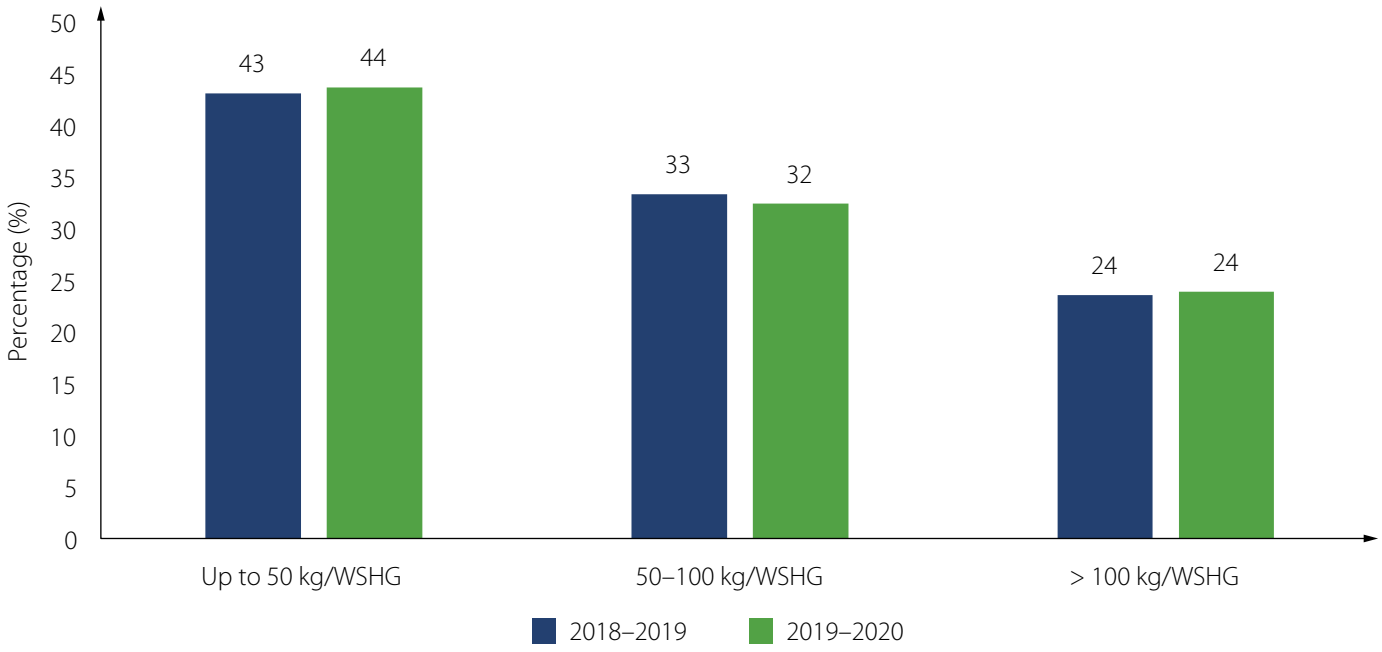

Figure 87. Quantity of complimentary fish WSHGs distributed.

Complimentary carp

Carps were mostly distributed among the WSHG members themselves for household consumption, while the rest were given to close relatives and friends (Table 102, Figure 88).

Receivers	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
WSHG members	210	66.25	394	74.06
Relatives and friends	107	33.75	138	25.94

Table 102. People who were given complimentary carp.

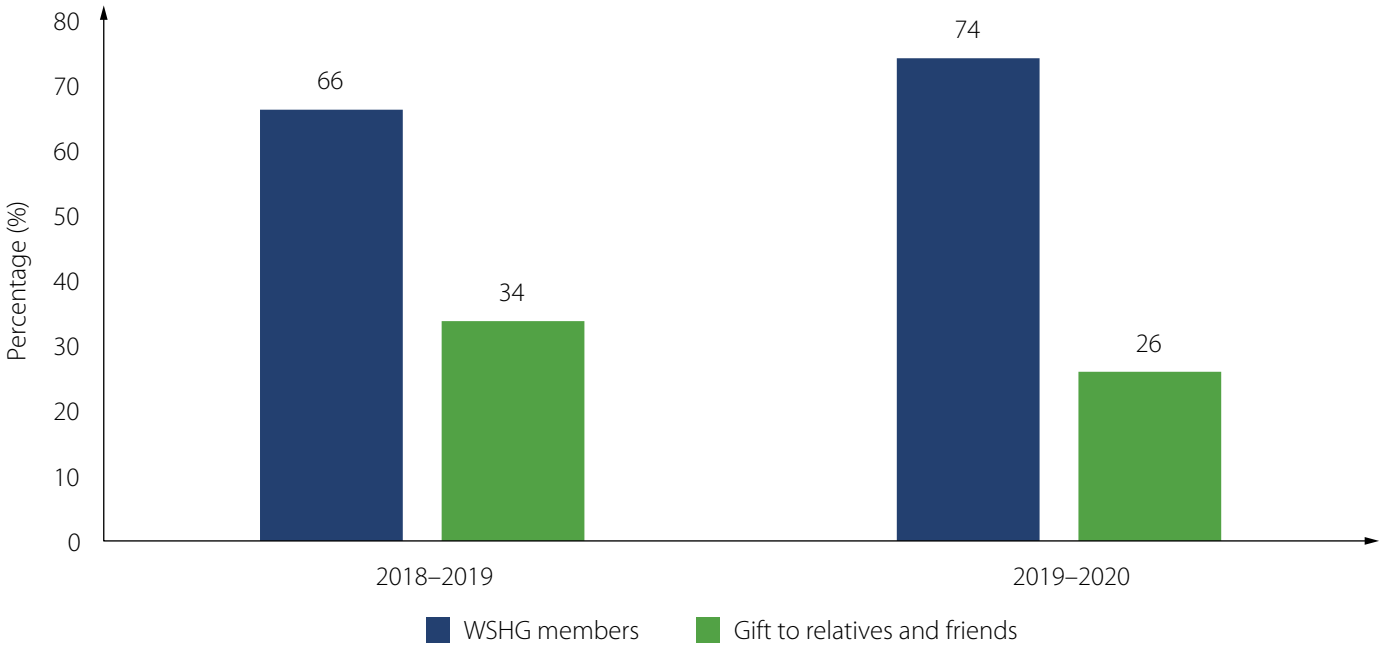

Figure 88. People who were given complimentary carp.

Quantity of complimentary carp

Over a 1-year production cycle, each WSHG gave away an average of 56 kg in the first survey year and 65 kg in the second. In each year, nearly a quarter gifted carps at a rate of up to 50 kg, while less than a fifth gifted 50–100 kg (Table 103, Figure 89).

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 50 kg	205	72.70	323	71.15
50–100 kg	52	18.44	80	17.62
> 100 kg	25	8.87	51	11.23

Table 103. Quantity of complimentary carps WSHGs distributed.

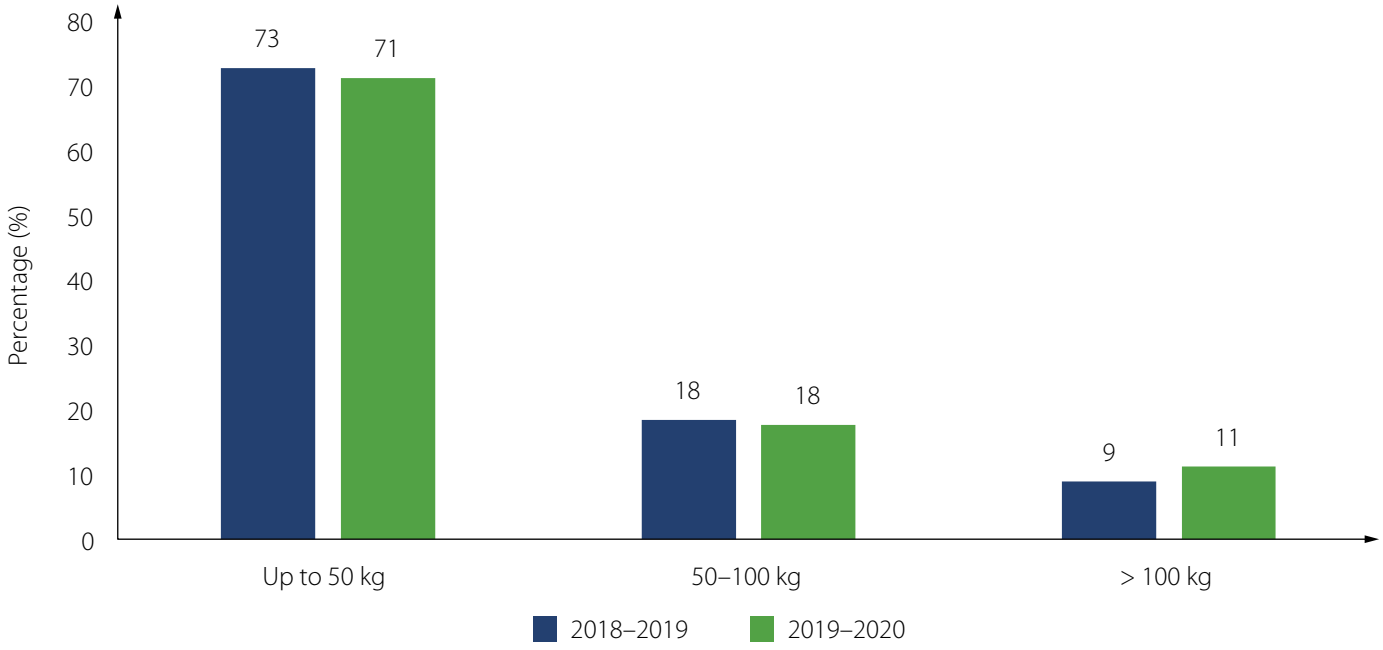

Figure 89. Quantity of complimentary carps WSHGs distributed.

Weight of complimentary carps

Slightly less than half of the WSHGs preferred to distribute carps weighing an average of between 750 g and 1 kg. About 7%–11% gave away carps averaging more than 1 kg for consumption (Table 104, Figure 90).

Average weight	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 500 g	49	17.07	67	14.76
500–750 g	68	23.69	138	30.40
750 g to 1 kg	138	48.08	215	47.36
> 1 kg	32	11.15	34	7.49

Table 104. Average weight of complimentary carps.

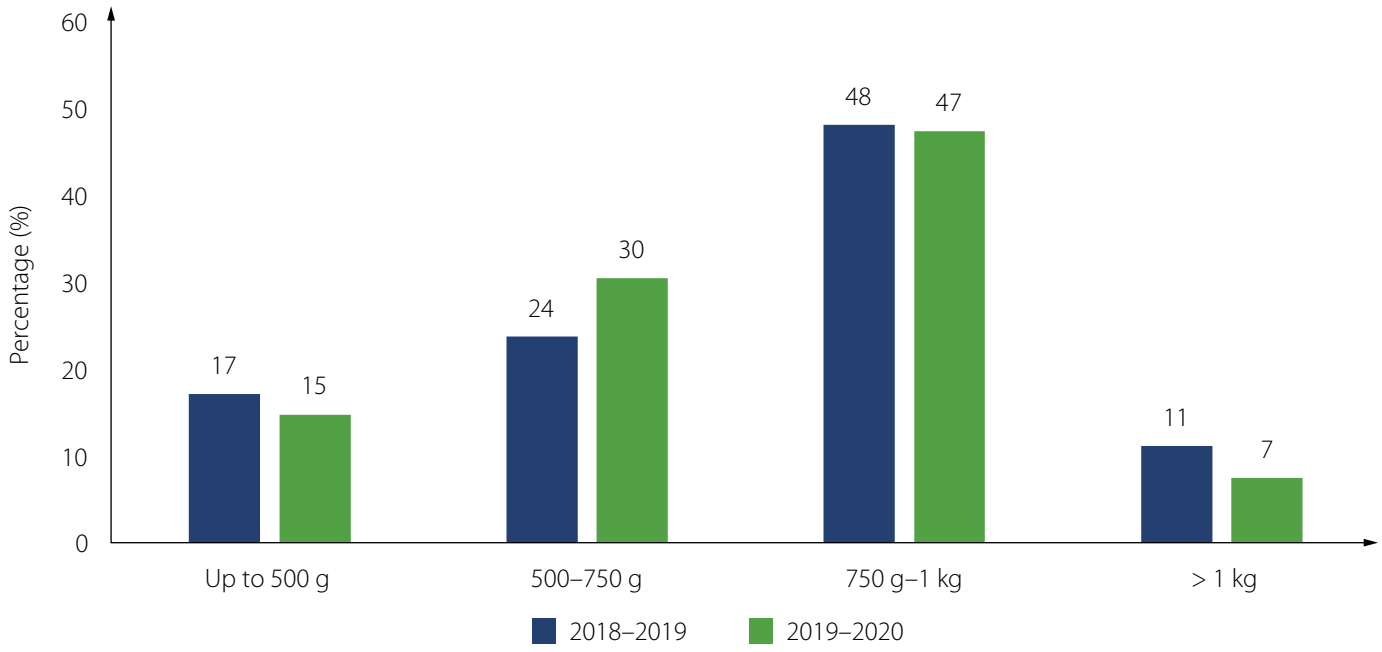

Figure 90. Average weight of complimentary carps.

Complimentary mola

In most cases, mola was given to WSHG members for household consumption. The rest was given to their relatives and friends (Table 105, Figure 91).

Receivers	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
WSHG members	118	65.56	225	80.36
Relatives and friends	62	34.44	55	19.64

Table 105. People who were given mola.

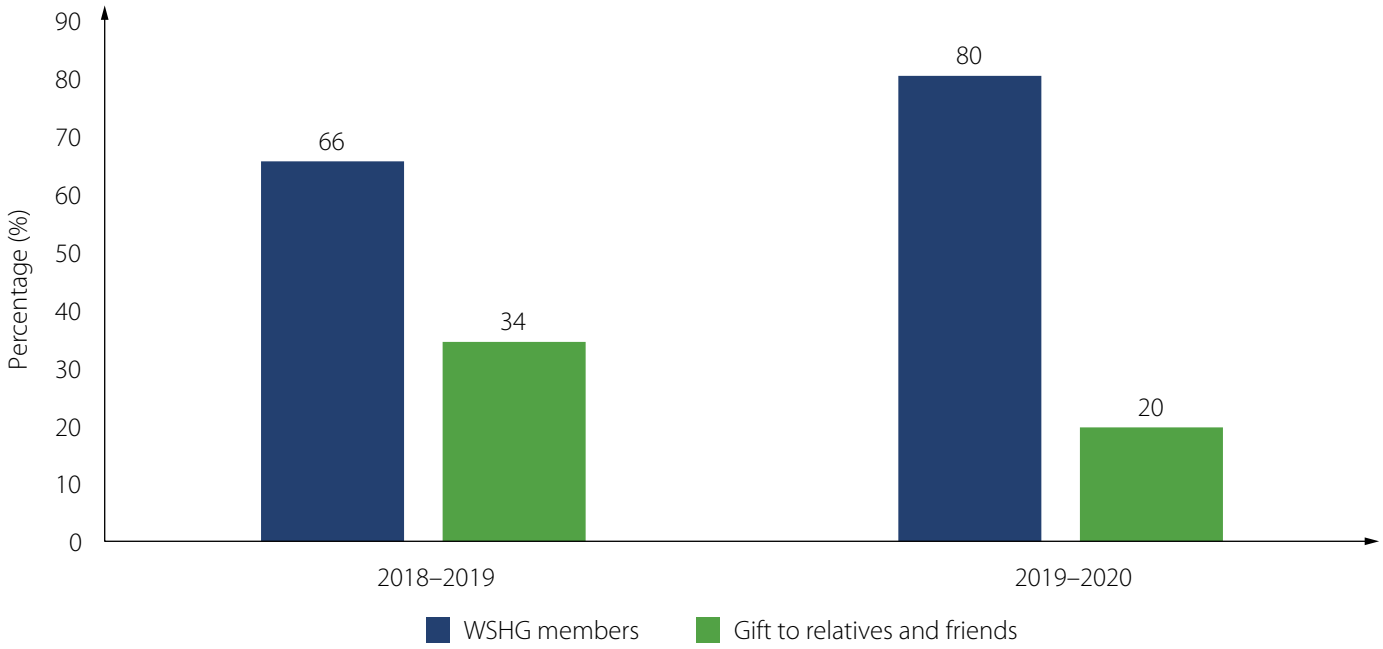

Figure 91. People who were given mola.

Quantity of complimentary mola

On average, WSHGs gave 43 kg of mola in the first survey year and 36 kg in the second (Table 106, Figure 92). In either year, more than half gave less than 25 kg to their members as well as relatives and friends, while about a quarter gave 25–50 kg. The rest gave more than 50 kg.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 25 kg	104	58.10	172	62.55
25–50 kg	43	24.02	66	24.00
50–100 kg	24	13.41	27	9.82
> 100 kg	8	4.47	10	3.64

Table 106. Quantity of complimentary mola WSHGs distributed.

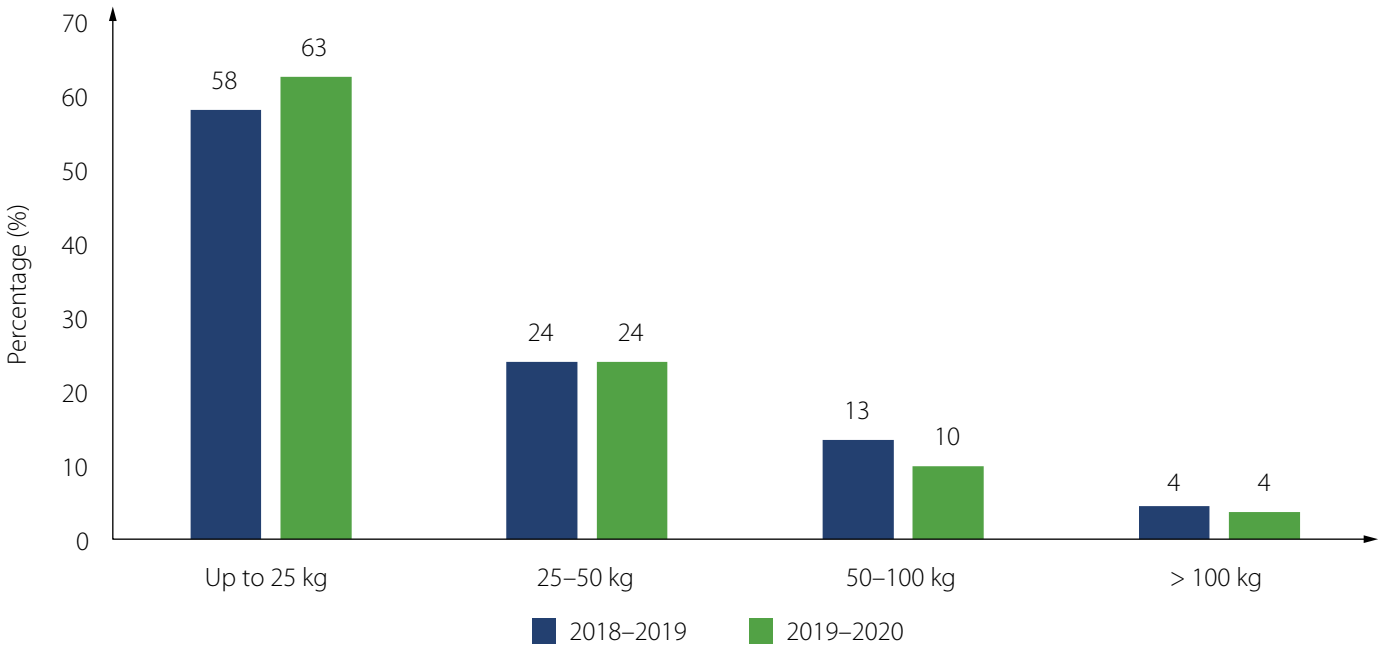

Figure 92. Quantity of complimentary mola WSHGs distributed.

Quantity of other complimentary SIS

On average, WSHGs gave away 43 kg of other SIS in the first survey year and 51 kg in the second, but the percentages varied widely from year to year in terms of total weight (Table 107, Figure 93). More than half of the WSHGs gave away less than 25 kg of SIS in the first survey year, but only about a quarter did so in the second, and the share of WSHGs that gave away 25–50 kg nearly tripled from year to year.

Quantity	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Up to 25 kg	13	56.52	11	27.50
25–50 kg	3	13.04	15	37.50
50–100 kg	5	21.74	10	25.00
> 100 kg	2	8.70	4	10.00

Table 107. Quantity of complimentary SIS WSHGs distributed.

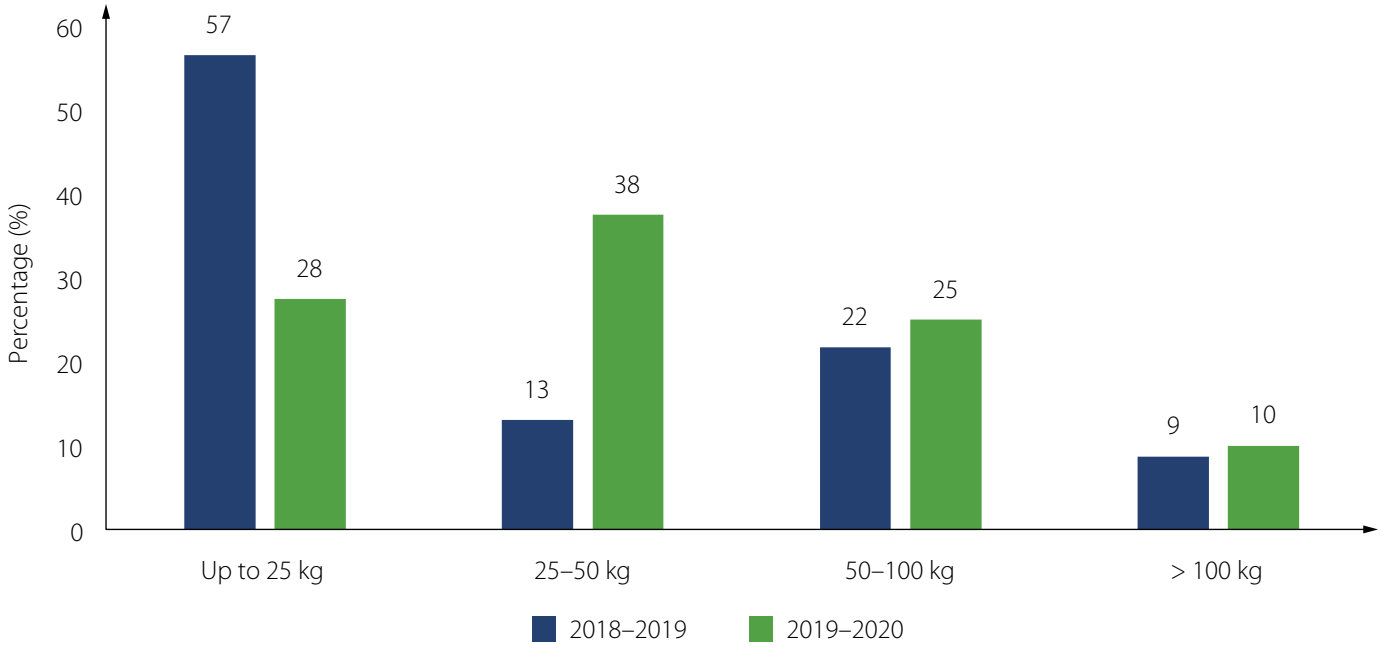

Figure 93. Quantity of complimentary SIS WSHGs distributed.

Average annual value	2018–2019		2019–2020	
	kg/WSHG	kg/ha	kg/WSHG	kg/ha
Carp consumed/gifted (kg)	56 ± 81 (5–1000)	94 ± 92 (6–865)	65 ± 144 (1–2625)	79 ± 74 (1–811)
Mola consumed/gifted (kg)	43 ± 70 (2–700)	67 ± 146 (5–1730)	36 ± 50 (5–500)	47 ± 45 (2–346)
Other SIS consumed/gifted (kg)	43 ± 60 (10–300)	70 ± 76 (6–371)	51 ± 77 (10–500)	46 ± 68 (1–412)
Total fish consumed/gifted (kg)	75 ± 106 (2–1050)	123 ± 178 (5–2595)	82 ± 165 (1–3125)	100 ± 92 (1–965)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 108. Fish that WSHGs gave away for household consumption to other WSHG members and their relatives and friends.

Photo credit: De Tour Odisha

Processed fish mixed with turmeric powder, a traditional method of cooking fish by Indians.

11. Econometric information and return from fish farming

Average lease value of GP tanks

As per the long-term leasing policy of the Government of Odisha, the GP tanks under the administrative control of Gram Panchayats are subjected to an open auction system with priority given to WSHGs at a nominal lease value. However, the lease value of GP tanks differs considerably according to various local factors.

In the first survey year, the average annual lease value was INR 10,948/ha, which decreased slightly in the second to INR 10,789/ha (Table 109, Figure 94). The value was less than INR 10,000/ha for 70% of the tanks in the first year and for 67% of them during the second.

Average	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 2000/ha	24	6.49	49	8.28
INR 2000–5000/ha	111	30.00	163	27.53
INR 5000–10,000/ha	125	33.78	186	31.42
INR 10,000–15,000/ha	38	10.27	77	13.01
INR 15,000–20,000/ha	30	8.11	39	6.59
> INR 20,000/ha	42	11.35	77	13.01

Table 109. Average lease value of GP tanks.

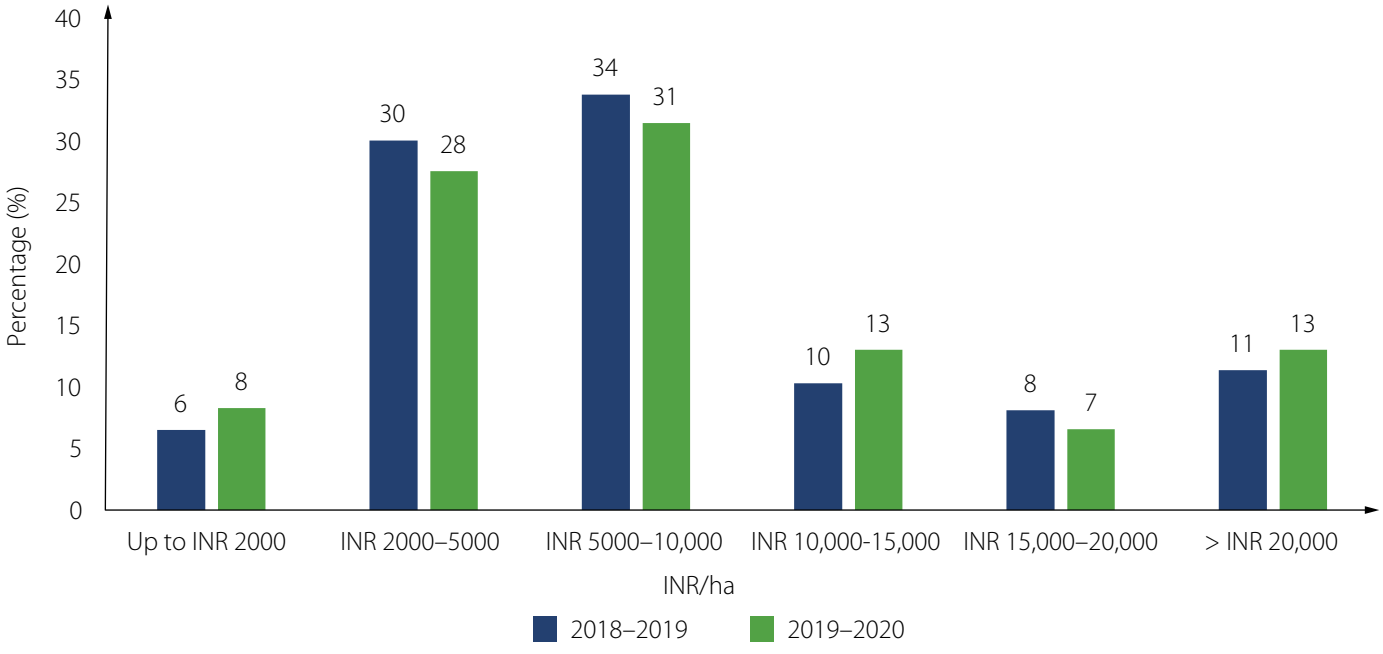

Figure 94. Average lease value of GP tanks.

Average seed cost

The average cost of fish seed per hectare increased from INR 40,195 in the first year to INR 44,265 in the second (Table 110, Figure 95). The cost of fish seed per hectare varied widely among WSHGs, from less than INR 10,000 to more than INR 100,000, but the vast majority of WSHGs spent between INR 20,000 and INR 60,000 in each survey year.

Average cost	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 10,000/ha	12	3.27	7	1.19
INR 10,000–20,000/ha	30	8.17	27	4.58
INR 20,000–40,000/ha	171	46.59	228	38.71
INR 40,000–60,000/ha	124	33.79	260	44.14
INR 60,000–100,000/ha	19	5.18	48	8.15
> INR 100,000/ha	11	3.00	19	3.23

Table 110. Average cost of seed.

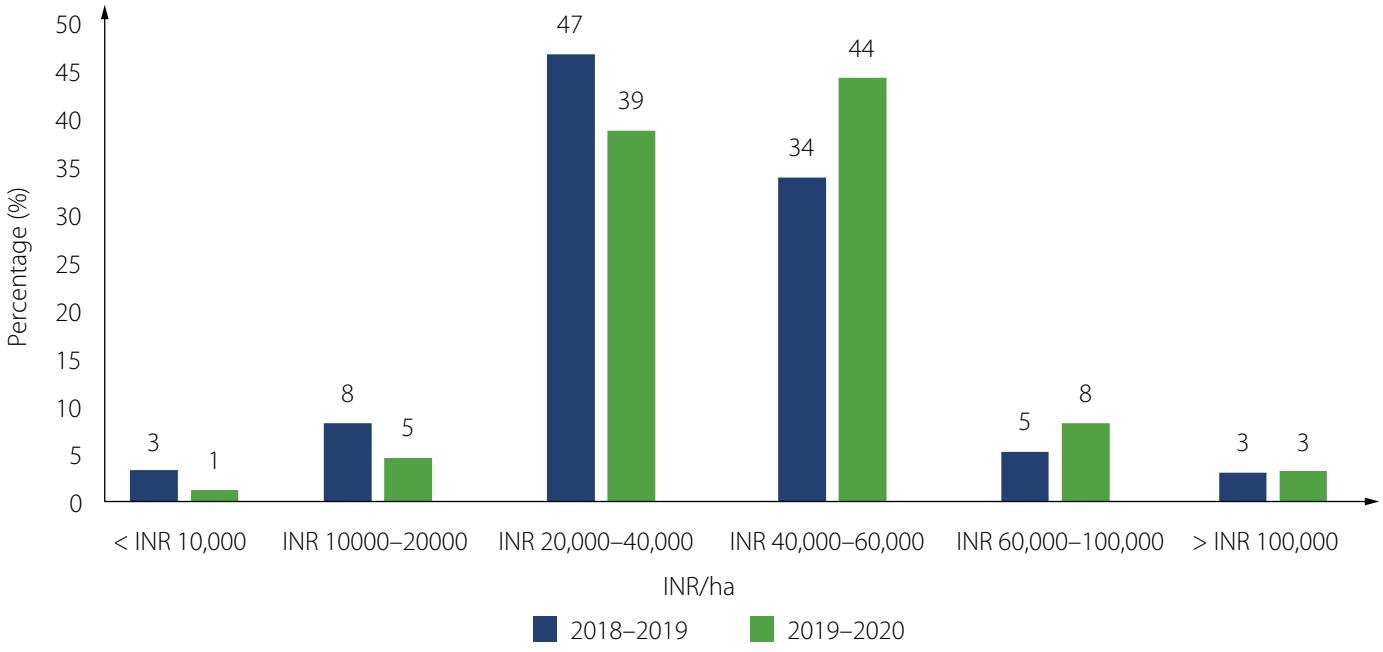

Figure 95. Average cost of seed.

Average feed cost

The amount of money WSHGs spent on GP tanks depended on the quantity of feed applied, but it remained virtually unchanged from the first survey year (INR 58,531/ha) to the second (INR 58,572/ha (Table 111, Figure 96). In both survey years, about two-thirds of the WSHGs spent more than INR 40,000/ha on buying feed.

Average cost	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 10,000/ha	10	3.05	20	3.40
INR 10,000–20,000/ha	38	11.59	42	7.13
INR 20,000–40,000/ha	60	18.29	131	22.24
INR 40,000–60,000/ha	82	25.00	153	25.98
60,000–100,000/ha	109	33.23	200	33.96
> INR 100,000/ha	29	8.84	43	7.30

Note: Supplementary feed cost includes homemade feed, sinking pellet and floating pellet feed, where applicable.

Table 111. Average cost of feed.

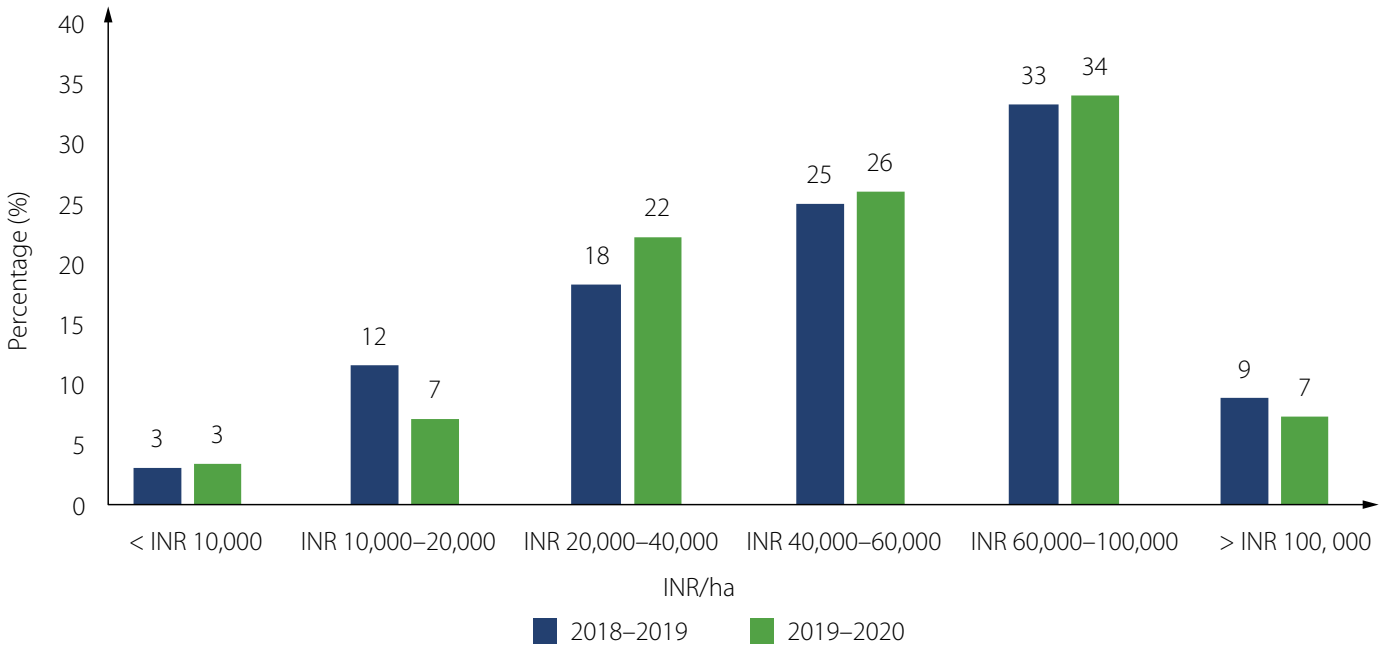

Figure 96. Average cost of feed.

Average harvesting cost

The average harvesting cost was INR 13,843/ha in the first survey year, but it dropped substantially to just INR 10,814/ha in the second (Table 112, Figure 97). About two-thirds of WSHGs spent less than INR 10,000 on harvesting in each year, while about a quarter spent between INR 10,000 and INR 20,000. The rest spent more than INR 20,000 in a year.

Average cost	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 5000/ha	97	27.40	133	24.09
INR 5000–10,000/ha	129	36.44	237	42.93
INR 10,000–20,000/ha	87	24.58	140	25.36
INR 20,000–40,000/ha	21	5.93	33	5.98
> INR 40,000/ha	20	5.65	9	1.63

Table 112. Average cost of harvesting.

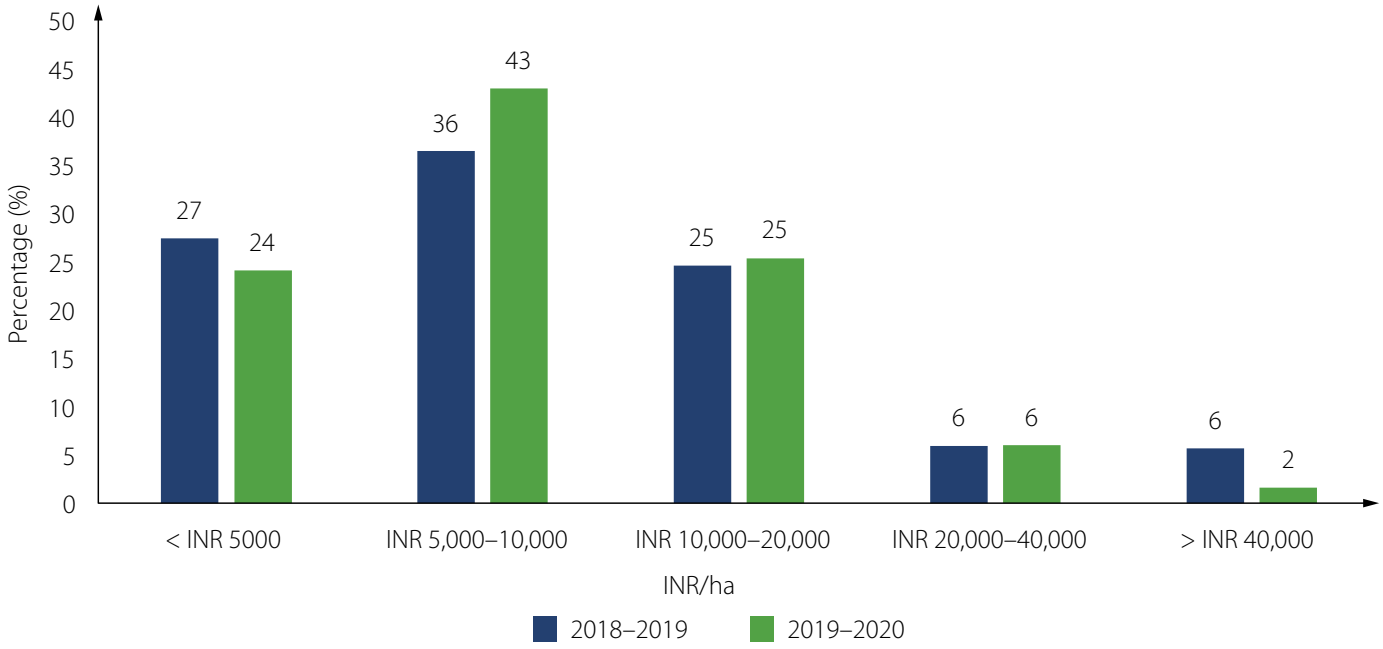

Figure 97. Average cost of harvesting.

Average contribution to the cost of production

For fish production in GP tanks, WSHGs were entitled to government financial assistance of INR 90,000/ha, which is 60% of the unit cost of INR 150,000/ha. WSHGs were expected to bear the remaining amount of INR 60,000/ha from their own funds or through a bank loan. The average value of fish produced (sold + consumed/gifted + leftover) from GP tanks was INR 115,947/ha in the first survey year, which increased slightly to INR 123,377/ha in the second. In each year, about half of the WSHGs spent INR 100,000–200,000/ha on production (Table 113, Figure 98).

Average contribution	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 50,000/ha	40	10.81	23	3.9
INR 50,00–100,000/ha	117	31.62	195	33.0
INR 100,000–200,000/ha	184	49.73	335	56.7
INR 200,000–300,000/ha	28	7.57	36	6.1
> INR 300,000/ha	1	0.27	2	0.3

Note: Value of total fish produced = fish sold + fish consumed/gifted + estimated leftover fish in the tank.

Table 113. Average contribution to the cost of production.

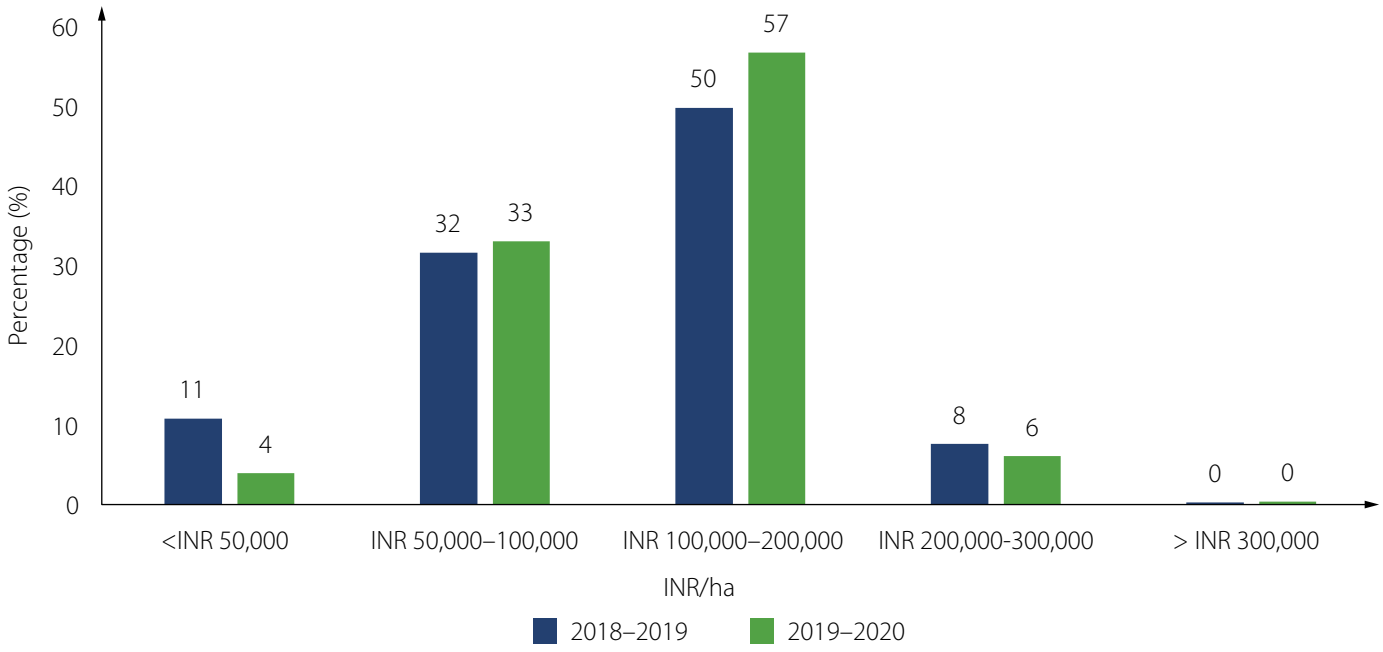

Figure 98. Average contribution to the cost of production.

Average value of fish produced

In the first survey year, WSHGs sold an average of INR 243,570/ha of fish from their GP tank, which increased substantially to INR 278,333/ha the following year (Table 114, Figure 99). In both years, over half of the WSHGs sold, on average, between INR 100,000/ha and INR 300,000/ha worth of fish. About a quarter sold more than INR 300,00/ha in the first year, and about one-third did so the following year. The rest sold less than INR 100,000/ha.

Average value	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 50,000/ha	19	5.14	20	3.38
INR 50,00–100,000/ha	36	9.73	38	6.43
INR 100,000–200,000/ha	115	31.08	149	25.21
INR 200,000–300,000/ha	107	28.92	182	30.80
INR 300,000–400,000/ha	50	13.51	100	16.92
> INR 400,000/ha	43	11.62	102	17.26

Table 114. Average value of fish produced.

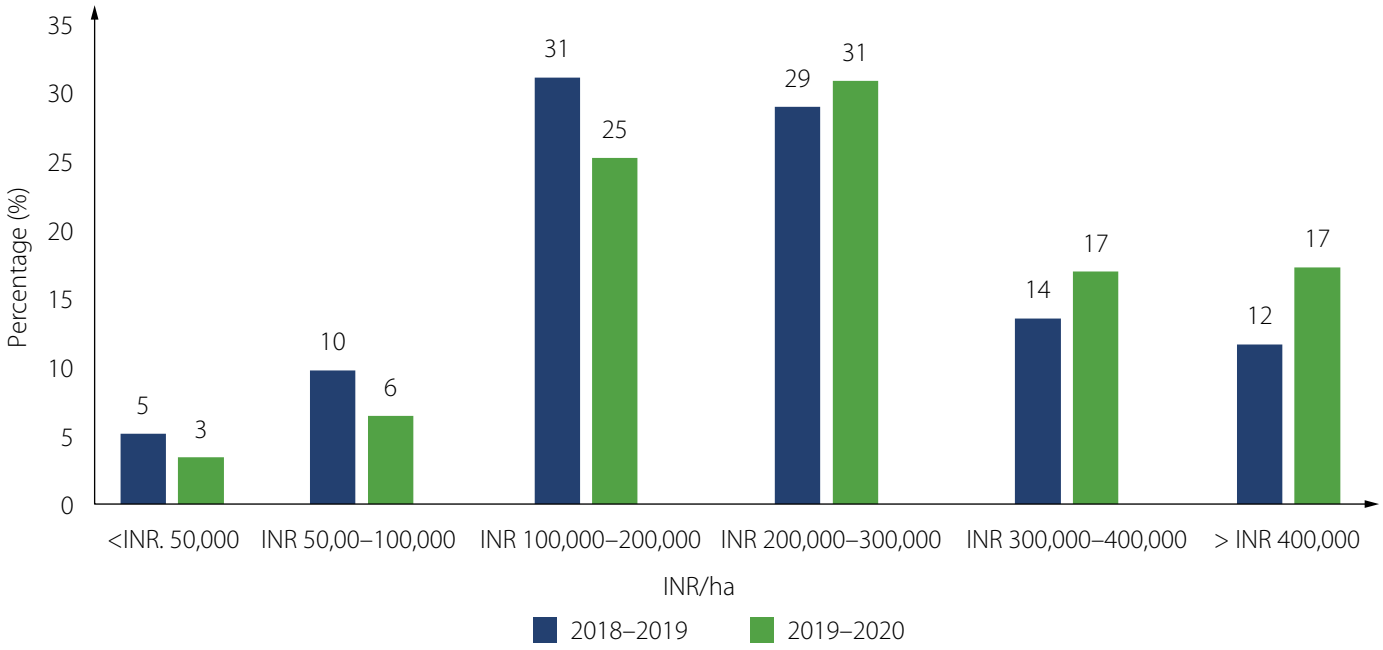

Figure 99. Average value of fish produced.

Profit and loss

In the first survey year, about 85% of the WSHGs (316 tanks) turned a profit from fish farming and nearly 90% (532 tanks) the following year, while the rest reported a loss (Table 115, Figure 100). The average margin was INR 127,622/ha in the first year, which increased significantly to INR 153,543/ha in the second.

Profit or loss	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Profit	316	85.4	532	89.86
Loss	54	14.6	60	10.14

Note: Margin is calculated as follows: total value of fish production (fish sold + fish consumed/gifted + estimated leftover fish in tank) – total costs of production (lease cost + seed cost + feed cost + harvesting cost).

Table 115. Profit and loss.

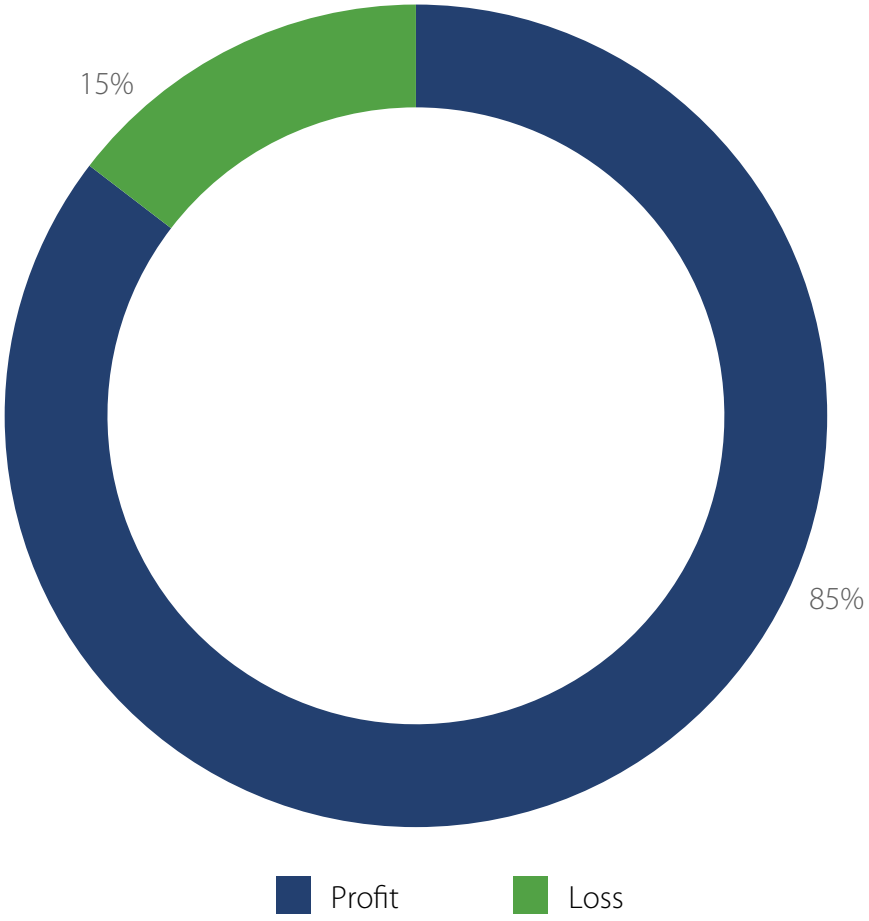

Figure 100. Profit and loss.

Average profit

Among the WSHGs that turned a profit, the average increased from INR 156,983/ha in the first year to INR 174,901/ha in the second. Although margins varied widely in each survey year, the largest share (just over one-third) of WSHGs made a profit of between INR 100,00 and INR 200,000 per hectare, while roughly a quarter made more than INR 200,000 (Table 116, Figure 101). A total of 69% of the WSHGs in the first year and 57% in the second were able to manage corpus funds up to INR 100,000 through 1 year of fish farming.

Average profit	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
< INR 50,000/ha	54	17.09	71	13.35
< INR 50,000-100,000/ha	62	19.62	114	21.43
INR 100,000–200,000/ha	119	37.66	198	37.22
INR 200,000–300,000/ha	52	16.46	76	14.29
> INR 300,000/ha	29	9.18	73	13.72

Table 116. Average profit.

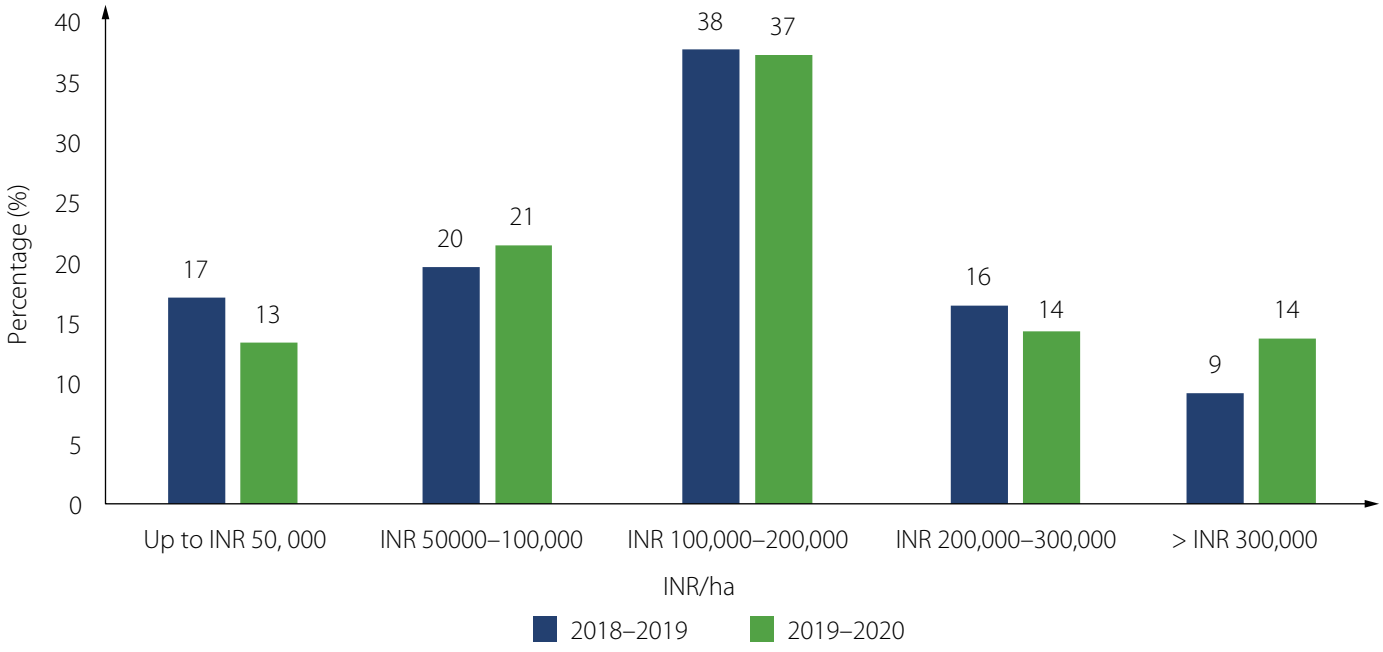

Figure 101. Average profit.

Average value	2018–2019		2019–2020	
	INR/WSHG	INR/ha	INR/WSHG	INR/ha
Lease value of GP tank	8084 ± 18,538 (367–287,000)	10,948 ± 14,432 (324–141,835)	10,223 ± 20,692 (200–239,000)	10,789 ± 12,033 (247–116,548)
Seed cost	29,602 ± 48,463 (1250–830,500)	40,195 ± 20,920 (1059–187,796)	39,747 ± 48,893 (500–687,000)	44,265 ± 22,688 (386–197,680)
Feed cost	42,852 ± 91,468 (3100–1,544,000)	58,531 ± 36,576 (2866–243,570)	55,232 ± 82,707 (504–846,100)	58,572 ± 34,200 (602–269,042)
Harvest cost	9,014 ± 19,027 (1–251,250)	13,843 ± 23,535 (1–221,728)	9510 ± 13,113 (100–120,000)	10,814 ± 11,296 (148–123,550)
Total cost of production	84,058 ± 146,496 (8000–2,570,500)	115,947 ± 62,766 (6589–436,626)	113,764 ± 147,162 (1000–1,598,850)	123,377 ± 53,668 (1328–537,146)
Value of fish sold from harvested lot	129,841 ± 167,635 (3640–2,125,000)	179,531 ± 132,858 (8825–1,167,548)	164,014 ± 197,064 (1200–2,177,000)	193,932 ± 131,634 (1446–847,200)
Value of fish consumed/ gifted from harvested lot	9997 ± 14,135 (224–150,153)	17,926 ± 31,295 (154–511,991)	11,155 ± 22,943 (146–439,794)	13,537 ± 12,548 (181–135,841)
Value of leftover fish without harvesting within 12 months	54,214 ± 189,100 (72–2,891,200)	64,739 ± 80,714 (89–580,463)	85,343 ± 181,266 (146–1,753,320)	92,776 ± 135,375 (90–1,031,537)
Value of total fish produced (sold + consumed/gifted + leftover)	180,263 ± 312,738 (12,737–5,166,353)	243,570 ± 162,526 (11,376–1,236,649)	240,782 ± 292,217 (4574–2,285,320)	278,333 ± 186,749 (1536–1,634,407)
Average margin	96,205 ± 186,572 (-153,178–2,595,853)	127,622 ± 142,630 (-236,570–1,035,263)	125,796 ± 197,801 (-483,514–2,041,320)	153,543 ± 165,716 (-108,048–1,266,373)
Average profit among profit-making tanks	117,214 ± 194,188 (13–2,595,853)	156,983 ± 132,988 (338–1,035,263)	144,858 ± 197,986 (28–2,041,320)	174,901 ± 161,157 (54–1,266,373)
Average loss among loss-making tanks	-26,742 ± 29,230 (32–153,178)	-44,193 ± 41,095.9 (156–236,570)	-42,905 ± 83,165 (650–483,514)	- 35,468 ± 29,639 (1002–108,048)

Note: Data is expressed as Mean ± Standard Deviation (SD) and range. Figures within the parentheses indicate the range.

Table 117. Overall economics and profitability of fish farming from GP tanks.

12. WSHGs' perception of fish farming and BMP adoption at the community level

Willingness of WSHGs to continue fish farming

Almost every WSHG expressed a willingness to continue fish farming in its GP tank—without financial assistance—after the program ended (Table 118, Figure 102).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	356	97.53	578	99.66
No	9	2.47	2	0.34

Table 118. Willingness to continue fish farming.

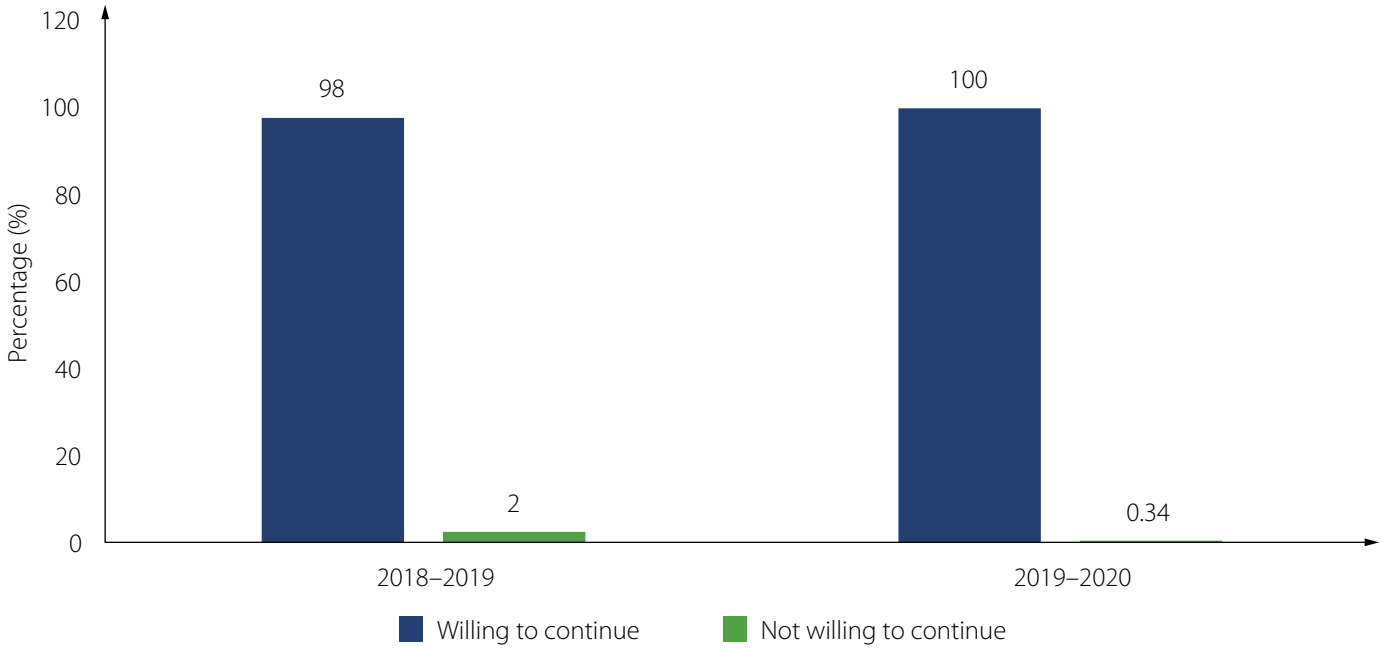

Figure 102. Willingness to continue fish farming.

Willingness to renew the tank lease agreement

Almost all of the WSHGs wished to renew their lease agreement to continue fish farming in their GP tank, with only 21 groups in each survey year unwilling to do so (Table 119, Figure 103).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Yes	344	94.25	569	96.44
No	21	5.75	21	3.55

Table 119. Willingness to renew the tank lease agreement.

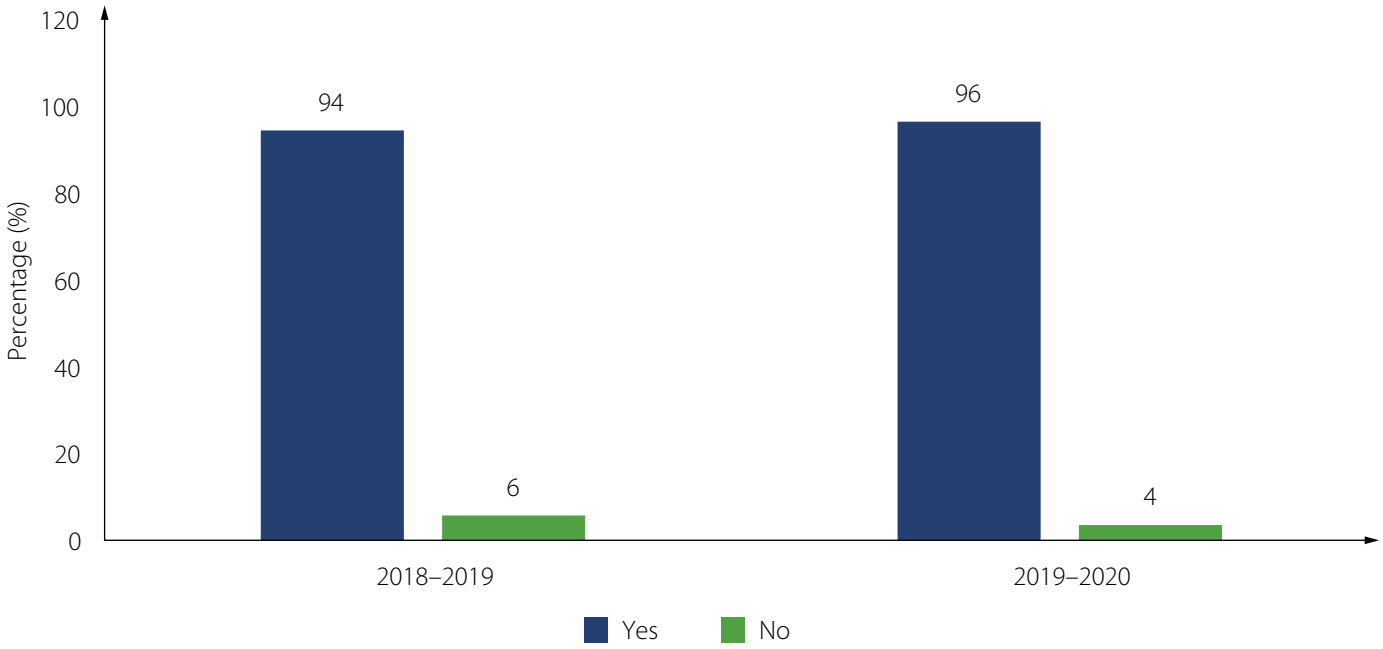

Figure 103. Willingness to renew the tank lease agreement.

Members who adopted fish farming at the household level

According to the respondents, very few WSHG members adopted fish farming at the household level due to various factors; however, the rate of those who did almost doubled from the first year to the second (Table 120, Figure 104).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
No	304	89.41	468	81.68
Yes	36	10.59	105	18.32

Table 120. Members who adopted fish farming at the household level.

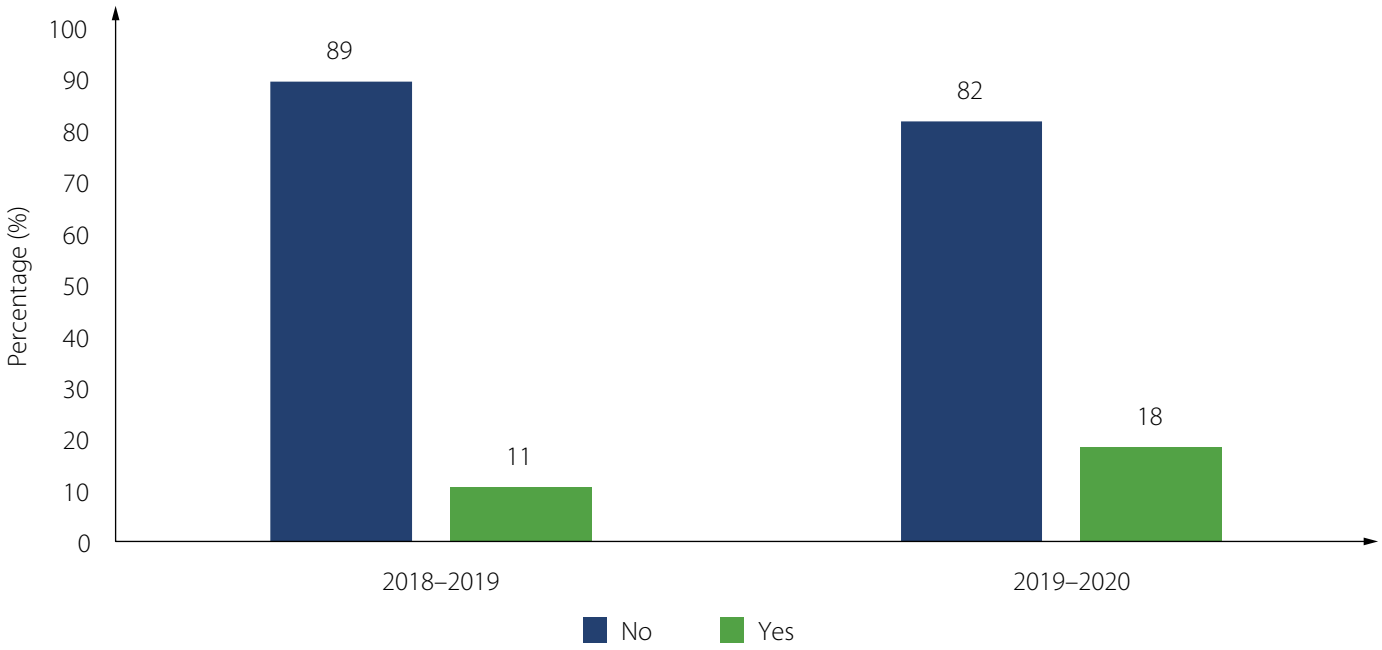

Figure 104. Members who adopted fish farming at the household level.

Perception of community fish farming as an attractive business option

Almost all of the WSHGs felt that fish farming is an attractive business option (Table 121, Figure 105).

Response	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
More attractive	347	95.59	560	96.89
Less attractive	16	4.41	18	3.11

Table 121. Perception of community fish farming as an attractive business option.

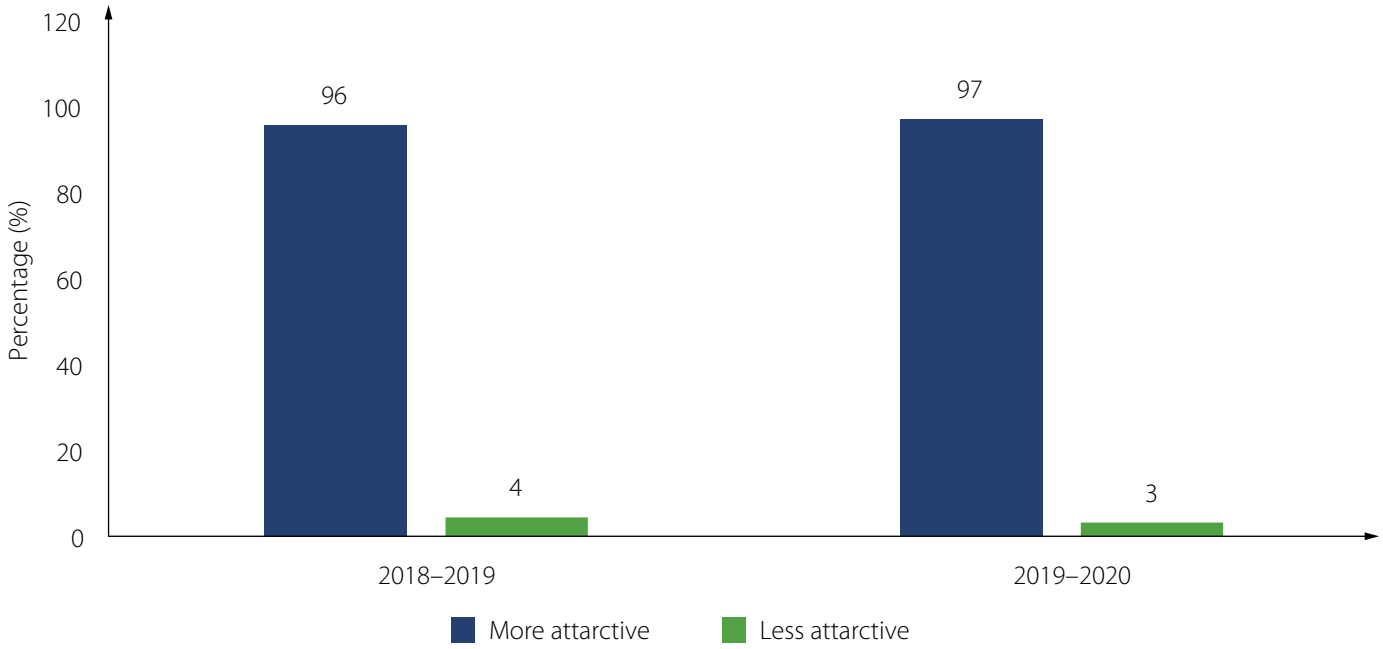

Figure 105. Perception of community fish farming as an attractive business option.

Reasons for participating in the program

More than half of the WSHGs participated in community fish farming through the program due to low investment and good economic return (Table 122, Figure 106). Few WSHGs feel that fish farming is easier and more profitable than agriculture, while some other WSHGs felt that fish farming is less labor- and time-intensive. WSHGs that took up fish farming in a GP tank due to the perception that it would increase household income and nutrition nearly doubled from the first survey year to the second.

Reason	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Low investment and good economic return	178	55.11	307	57.28
Easier and more profitable than agriculture	65	20.12	76	14.18
Less labor- and time-intensive	48	14.86	67	12.50
Household income and nutrition	23	7.12	70	13.06
High market demand	9	2.79	16	2.99

Table 122. Reasons for participating in the program.

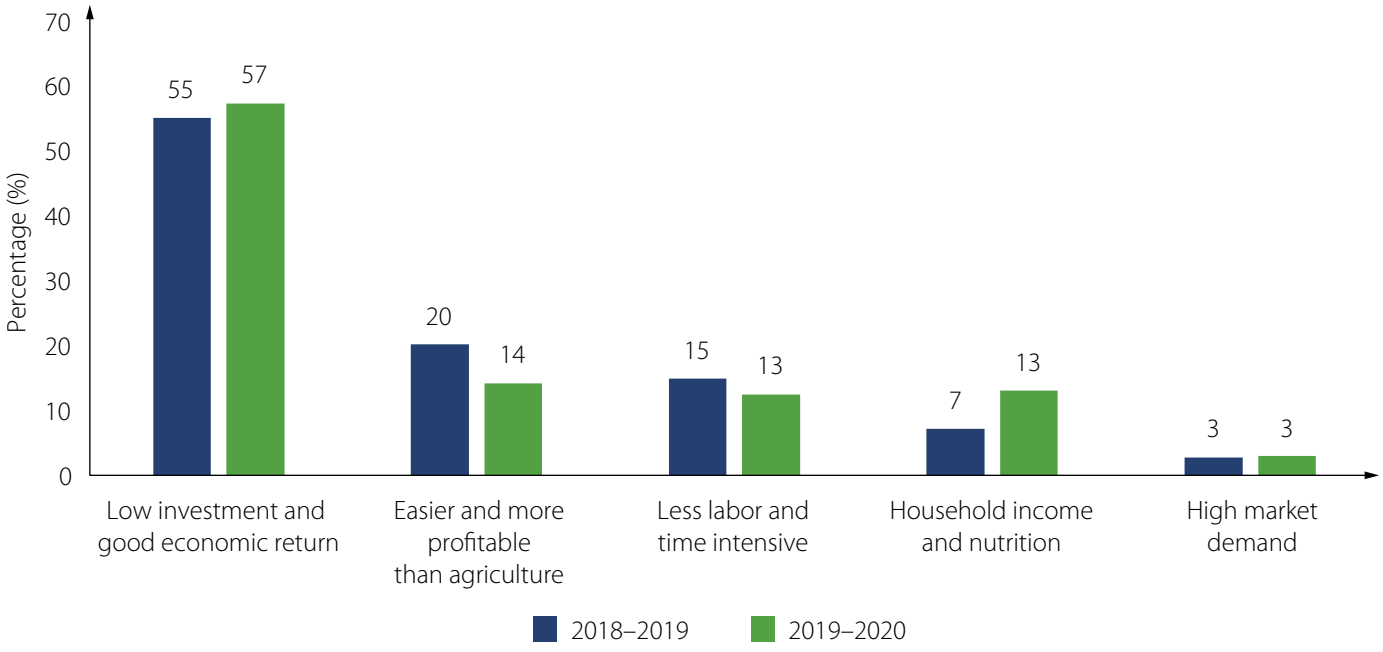

Figure 106. Reasons for participating in the program.

13. Major constraints and challenges, and proposed mitigation strategies

Major challenges

On average, well over half of the WSHGs said that they did not face any major constraints during fish farming. The rests listed various constraints and challenges. Among them, more than 50% listed the most important problems as fish theft and poisoning, no support from villagers, high harvesting costs, limited technical knowledge, difficulties accessing credit, and non-availability of quality inputs, such as seed and feed (Table 123, Figure 107).

About 30%–50% of the respondents listed other problems, such as high input cost, lack of available labor, less support from their GP, unfavorable tank water quality, high lease cost, natural calamities, less collective action and cohesiveness among members, less support from family members and disease incidence. Interestingly, the problems seemed to decrease in the second year of program.

Apart from these issues, other obstacles were unearthed during the interview process. These included resistance among villagers to applying lime, fertilizer and medicine during the culture period, as well as aquatic weed infestations, greater pond depth and large water areas, problems with marketing, lack of financial support for culture operation, and lack of a net for sampling and harvesting.

Financial transparency and sharing profit are important in community fish farming.

Major challenges	2018–2019 (n = 370) (%)				2019–2020 (n = 592) (%)			
	None	Low	Moderate	High	None	Low	Moderate	High
Group members unwilling to work together	66.49	20.27	6.76	6.49	70.10	17.23	10.81	1.86
Group members unwilling to invest the funds	59.46	22.97	11.89	5.68	65.54	20.61	10.64	3.21
No support from household members	59.73	30.27	5.68	4.32	69.59	24.32	4.73	1.35
No support from villagers	44.59	31.62	14.05	9.73	68.24	20.27	6.59	4.90
Difficult to get a bank loan	49.19	27.03	11.89	11.89	55.74	19.43	12.67	12.16
No support from elected members and officials in local Gram Panchayat	53.78	29.73	12.97	3.51	65.37	22.97	9.29	2.36
High lease cost	58.38	27.30	10.00	4.32	58.78	25.00	12.33	3.89
Water level unsuitable for fish production	58.11	23.51	14.05	4.32	60.64	22.97	11.99	4.39
Lack of training or awareness	48.65	22.16	20.00	9.19	55.24	22.64	16.39	5.74
Lack of quality inputs	49.46	30.81	15.68	4.05	59.63	22.47	14.36	3.55
High input costs	50.81	29.46	16.76	2.97	50.34	29.90	14.70	5.07
Lack of available labor	51.35	27.03	14.59	7.03	59.12	21.28	13.51	6.08
Social issues, fish theft, poisoning, etc.	42.97	28.92	14.86	13.24	50.68	22.13	17.23	9.97
Disease incidence/fish death	65.14	29.73	3.78	1.35	67.23	27.70	3.72	1.35
High harvesting costs	45.68	23.78	19.73	10.81	51.18	25.84	17.40	5.57
Natural calamities	58.92	31.35	5.68	4.05	59.29	26.86	8.11	5.74

Low Moderate High

Table 123. Major challenges faced by WSHGs.

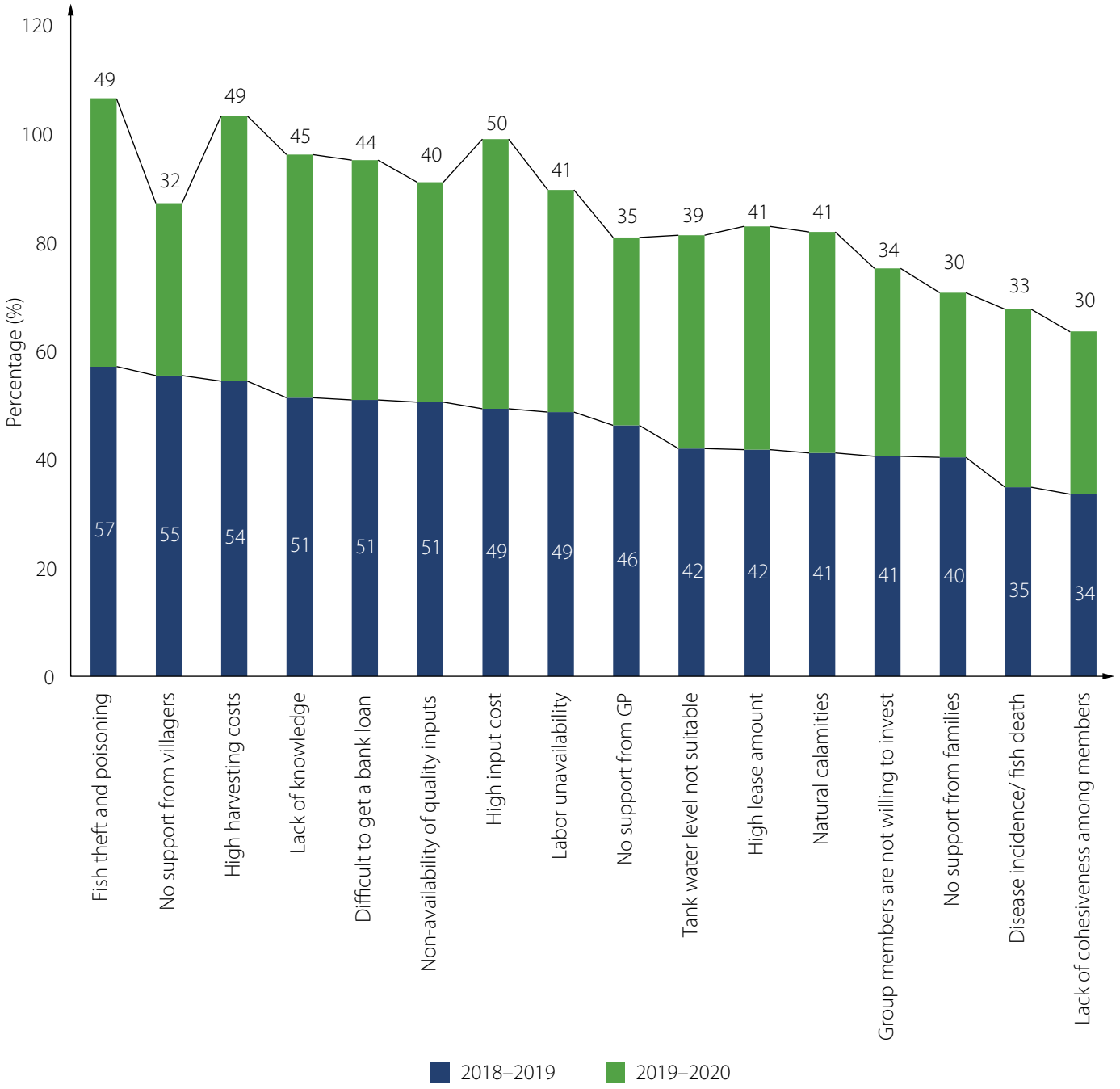

Figure 107. Major challenges faced by WSHGs.

WSHGs' adaptation strategies to mitigate challenges

WSHGs who faced some of these challenges used various adaptive strategies to overcome or minimize the problems. However, very few WSHGs followed these coping measures (Table 124, Figure 108).

To overcome social and administrative problems, some WSHGs often contacted GP representatives. Others, sometimes conducted meetings among the group members to resolve internal problems and to strengthen collective actions. To prevent fish poaching and vandalism, some WSHGs became watchwomen. To overcome fish farming-related problems, a few WSHGs often contacted the local AFO and took various consultations. To reduce operational costs, a few WSHGs contacted banks for credit and government for subsidy, made group efforts to minimize the cost of operations, and used homemade feed to reduce the cost of feed. To avoid disease problems in their fish, some WSHGs netted their tank frequently to check fish health and applied medicine and other prophylactic measures. To maintain proper pond water quality and to cure fish diseases, a few WSHGs applied additional lime to their fish tank. To mitigate climate

change impacts, such as droughts and recurring floods, WSHGs sometimes added water to their tank and maintained netting and fencing around it. Some WSHGs also increased the height of the dike to prevent floodwater from entering their tank. Few WSHGs practiced partial harvesting in summer to reduce crop loss.

Adaptation strategy	2018–2019		2019–2020	
	WSHGs	%	WSHGs	%
Informed GP of problems/challenges	22	12.94	15	6.33
Periodic meetings among WSHG members	18	10.59	45	18.99
Used watchwomen to prevent theft and poisoning	17	10.00	24	10.13
Informed local AFO of problems/challenges	14	8.24	25	10.55
Group efforts to minimize operations costs	11	6.47	16	6.75
Netting to monitor fish growth and health	5	2.94	8	3.38
Netting/fencing around the tank and increased dike height	4	2.35	22	9.28
Added water from irrigation canal	4	2.35	10	4.22
Partial harvest in summer	2	1.18	14	5.91
Medication and prophylaxis to prevent diseases	2	1.18	15	6.33
Contacted bank to receive credit	2	1.18	5	2.11
Applied lime to maintain water quality	1	0.59	24	10.13
Used homemade feed to reduce cost of feed	1	0.59	19	8.02
Contacted government for subsidy	1	0.59	6	2.53

Low Moderate High

Table 124. WSHGs' adaptation strategies to mitigate challenges.

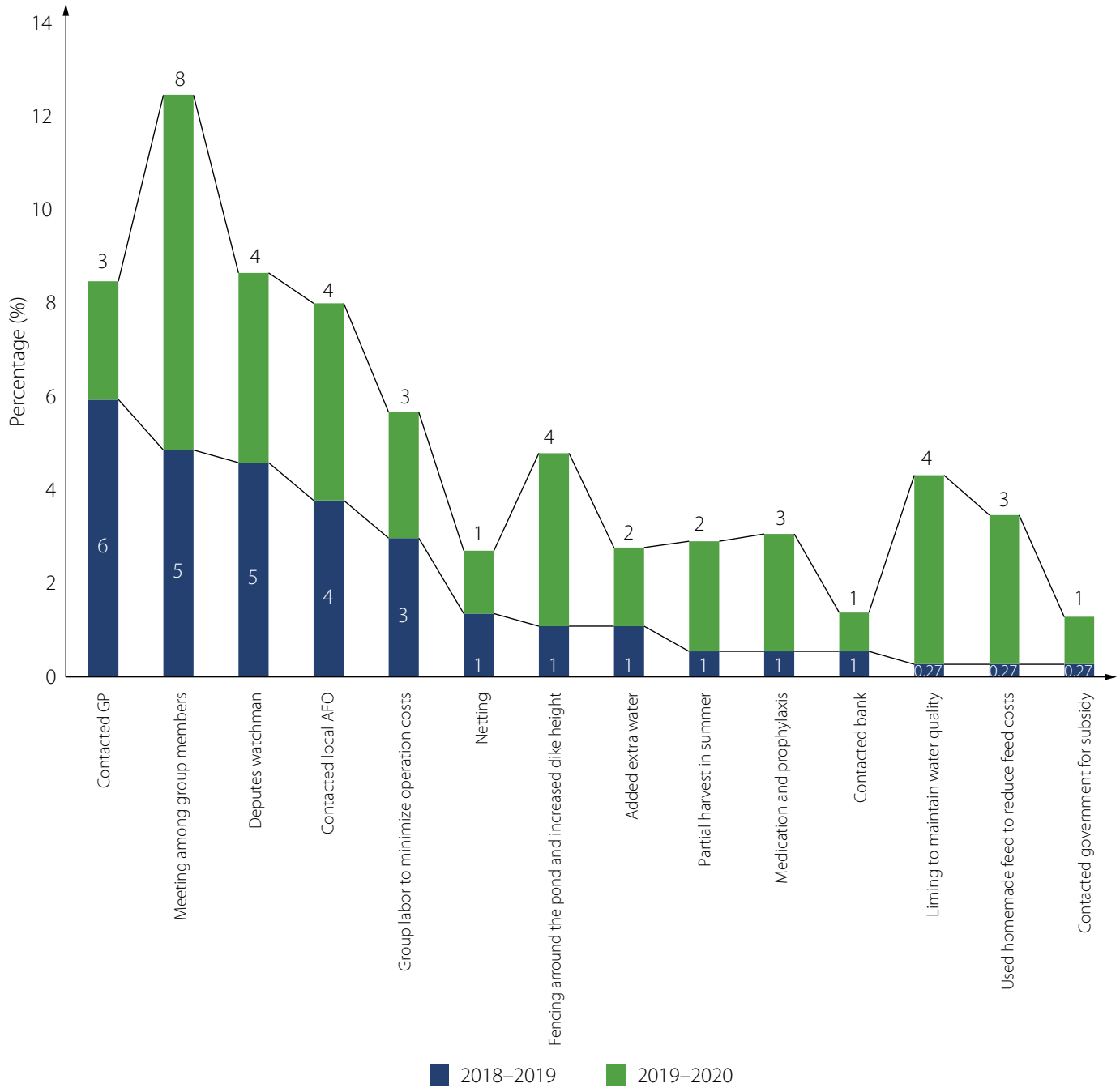

Figure 108. WSHGs' adaptation strategies to mitigate challenges.

14. Lessons learned and recommendations for future

The convergence program resulted in several benefits to the women in village communities, regardless of their caste, tribe, religion, etc. This will have a long-lasting socioeconomic impact, including food and nutritional security, gender equity and environmental sustainability in villages across Odisha. The growing demand for this program from WSHGs across the state demonstrates its success.

The program has directly helped empower women through income generation from fish farming activities. The WSHGs considered fish farming in a GP tank an attractive business because it generated an average farmgate value of INR 180,000–240,000 per WSHG, with an average profit of INR 96,000–125,000 per WSHG and an impressive return on investment of 110%–114% over the 2 years of the survey. Since the financial risks from this business are very low (only 10%–14% of the WSHGs incurred a loss), this program has made new entrant WSHGs very successful and confident in continuing their business with more interest and aggressiveness. The overall business experience of WSHGs through fish farming has shown that the program unleashed the entrepreneurial spirit among the women involved.

Nutritional gains were another important outcome. The program made live and fresh fish available at affordable prices and on regular basis to local village communities. Most of the WSHGs (83%–87%) distributed small quantities of fish, especially mola (75–82 kg per WSHG or about 5%–7% of production) among themselves without any financial gains. This led to higher consumption of nutritious fish among the WSHG households, which is an effective tool for tackling the issue of malnutrition across in the state.

WSHGs also made positive environmental changes to the GP tanks and their surroundings by cleaning before starting fish farming. Although most of the tanks were multipurpose water bodies used to harvest rainwater, most were in poor condition. Many of the tanks were infested with aquatic plants and weeds (88%–90%), and many of tank dikes/surroundings were overgrown with bushes and full of village waste/garbage (64%–70%), mainly plastic. WSHGs cleaned the tank area and removed aquatic weeds, turning the tanks into clean and usable water bodies.

The program was reasonably effective and efficient at delivering technical extension support to the WSHGs at their doorstep. The collective work of field-level officials from FARD, Mission Shakti and the Odisha-WorldFish project brought overall positive changes in the knowledge, attitude and practices of WSHGs for profitable and sustainable fish farming in their GP tanks. For 80% of WSHG members, fish farming was a new venture in which they never had any experience. WSHGs received block-level hands-on training about the technical aspects of fish farming. In addition, they received awareness building on program conditions and entitlements, as well as regular support at the farmgate over the phone. This made the WSHGs proactive and confident about fish farming practices and marketing their fish at profitable prices.

The crop outcome survey result has clearly shown that the program was not only successful in achieving the usual physical and financial target indictors at the government level but also in achieving the outcome indicators such as increased fish production, consumption, income and women participation for their empowerment.

Alongside the government intervention through the program, adopting proper BMPs in fish farming, the collective actions of WSHGs and the collaborative institutional efforts from field level to government decision level were many of the building blocks of success. This program could be replicated as a best practice model for promoting community fish production in public waterbodies, including Minor Irrigation Projects across the state.

Notes

[1] For more details, please visit https://www.kobotoolbox.org/

SIS are an important tool to eradicate malnutrition and poverty among tribes in Odisha.

Appendix 1. The survey questionnaire

ODISHA WORLDFISH PROJECT
Fish farming in GP tanks by WSHGs: Crop Result Survey form

Year of WSHGs scheme: **2018–19 (Year1)** ☐ **2019–20 (Year2)** ☐ **2020–21 (Year3)** ☐

Introduction and consent

(Before starting the interview, read the two paragraphs below loudly and ensure that the WSHG respondents understand before asking for their consent.)

Good morning/afternoon, Madam. We are from the Odisha-WorldFish project of the Fisheries and Animal Resources Development Department. We are conducting a survey to understand the participation of WSHGs in fish farming in GP tanks, implementation of better management practices by WSHGs, fish production and marketing details, and various challenges WSHGs have faced during fish farming. We would like to share some of this information widely in order that more WSHGs can learn about fish farming in GP tanks and its benefits.

We have randomly selected only 20% of the WSHGs who participated in the scheme. You are one of the selected WSHGs. Your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Your participation in the survey is voluntary and you do not have to participate if you do not want to. You may withdraw from the study at any time, and if there are questions that you would prefer not to answer then we respect your right not to answer them. You may ask questions at any time, and if after the survey/interview you have any questions, you can contact Ms. Neetha, monitoring officer, Odisha-WorldFish Project, Cuttack at +91 8073204406. This interview will take about one hour.

A.WSHG information

1. Name of the WSHG .....
2. District.....
3. Block.....
4. Gram Panchayat .....
5. Village/Cluster .....
6. WSHG formation year and month .....
7. What are the various business activities of this WSHG?

.....

8. Name of the president .....
9. Contact number .....
10. Name of the secretary .....
11. Contact number .....
12. Total number of members in group .....

SC category : .....

ST category : .....

OBC/General : .....

Now, please answer the following questions based on your fish farming experience from the first crop during the program period ONLY.

B. GP Tank information

1. Name of GP tank ……..
2. Water area (in acres) ……..
3. Is the GP tank situated in the same village as the WSHG village?
   Yes ☐ No ☐
4. If no, how far is the tank from the WSHG village? ……. km
5. Lease duration …… .Years
6. Lease agreement starting / signing date
   Year …… . Month …… .
7. Lease value per year for the tank (INR) …… .
8. Average water level in the tank …… . feet
9. Primary use of tank in the village: …… .
10. Was there any fish farming in this GP tank prior to it being leased out to you?
    Yes ☐ No ☐
11. How many months in a year is there water in the GP tank:
    …… . months
12. Water source for GP tank:
    Rainwater storage ☐ Borewell ☐ Canal ☐
    Natural groundwater seepage ☐

C. WSHG mobilization and awareness

1. Did your WSHG members attend block-level training on fish farming that was conducted by the fisheries department and Mission Shakti? Yes ☐ No ☐
2. If yes, when did you attend the training?
   ☐ Before releasing fish seed into the GP tank
   ☐ After releasing fish seed but before harvesting
   ☐ After harvesting the first crop of the scheme
3. How many members of the WSHG attended the training?
   ……..
4. Did you attend any other training on fish farming conducted by any other department or private companies?
   Yes ☐ No ☐
5. How many members of your WSHG have had experience in fish farming, prior to this scheme?
   ……..
6. Did you receive any technical advice at your farm site from the department officer during the crop period?
   Yes ☐ No ☐
7. If yes, how many times did the officer visit your tank during the crop period? …… .
8. Other than training from the department, where did you get additional information on fish farming practices?
   Books ☐ Newspaper ☐ TV ☐
   Leaflets ☐ Radio ☐

D. BMP implementation by WSHGs

1. Did you write down the farm activities in the pond book? Yes ☐ No ☐
   a. If no, why? …… .
2. Did you prepare the pond dike? Yes ☐ No ☐
   a. If yes, what methods were used …… .
   b. If no, why? …… .
3. Were the predatory fish removed? Yes ☐ No ☐
   a. If yes, what methods were used …… .
   b. If no, why? …… .

4. Were pond weeds/plants removed? Yes ☐ No ☐

a. If yes, what methods were used .....

b. If no, why? .....

5. Was liming done? Yes ☐ No ☐

a. If yes, what was the total quantity of lime used during the entire crop period ..... kg

b. If no, why? .....

6. Did you use fertilizers during the crop period? Yes ☐ No ☐

a. If yes, what type of : .....

b. Total quantity of fertilizer used for the entire crop period ..... kg

c. If no, why? .....

7. Did you test the water quality of your GP tank? Yes ☐ No ☐

a. If yes, then how?

Laboratory ☐ Self using test kit ☐ By department officers ☐

8. Stocking details

a. What was the size of fish seed?

☐ Zero size advanced fingerlings of 50–100 g ☐ Fingerlings less than 50 g in size ☐ Fry

b. How many times did you stock the GP tank during the first crop season of the scheme? .....

c. Did you stock according to the advised seed numbers? Yes ☐ No ☐ Don't know ☐

d. Details of fish species stocked

Species stocked	**Avg. Size of fish seed stocked**	**Date or month of stocking**	**Seed source (government hatchery, private nursery, seed trader, own stock, other source)**	**Quantity of seed**	**Total Cost (INR)**
Mixed IMC carps				Nos.	
Catla				Nos.	
Rohu				Nos.	
Mrigala				Nos.	
Grass carp or Common carp				Nos.	
Mola (kg basis)				kg	

• *Note: If the WSHG does not know the individual species stocking details, then just collect the mixed species stocking details.*

9. Feeding practices

a. Have you used any feed? Yes ☐ No ☐

b. If yes, from where did you get your fish feed?

☐ Homemade feed

☐ Local shop/dealer

☐ Organized by the fisheries department

c. If homemade feed, what materials/ingredients did you use?

d. Type of commercial feed used: Sinking pellet ☐ Floating pellet ☐ Both ☐

e. Total quantity and cost of feed

Quantity and cost of feed			
Feed name or ingredient	**Total quantity of feed purchased (kg)**	**Total cost (INR)**	**Transportation cost if any (INR)**

10. How many hours per day did WSHG members spend on fish farming in the GP tank? .....hours

11. Did you sample the fish monthly?

a. If no, why?.....

b. If yes, what did you check?.....

12. Harvesting practices

a. How did you harvest the fish?

☐ By directly hiring local fishermen

☐ Local fish trader arranged fishermen for harvesting

☐ By myself, with the help of family members and friends

b. How much did you spend on harvesting during the entire crop period? .....INR

E. Fish harvesting details

2. During the first year of the program (maximum 12 months from the date of seed release), how many times did you harvest your pond?

   .....

3. Total fish production during the scheme period (kg):

   i. Carps (catla, rohu, mrigal, grass carp, common carp). .....kg

   ii. Mahurali or other small fish .....kg

   iii. Other fish .....kg

4. Has your tank been completely harvested? Yes ☐ No ☐

   i. If no, estimate leftover quantity of fish (kg).

5. Use of harvested fish

Fish sales from GP tank for income generation					
Type of fish	Total quantity of fish sold	Avg. size of fish harvested	To whom fish was sold? a. Farm side villagers (grams) b. Local retail fish market c. Wholesale traders	Fish price (INR/kg)	Total price (INR)
1. Carps					
2. Mahurali					
3. Other fish					

Fish used and distributed for consumption by WSHGs in their households and free distribution to their friends			
Type of fish	To whom fish was distributed? a. WSHG members b. Gift to relatives and friends	Total quantity of fish distributed (kg)	Avg. size of fish harvested (grams)
1. Carps			
2. Mahurali			
3. Other fish			

6. How much money did your WSHG invest from its own pocket for fish farming? .....INR

7. Did you make a profit or incur a loss in fish farming during first crop under the scheme? Profit Loss

8. How much profit or loss? .....INR

F. Continuation of fish farming by WSHGs in GP tanks or own private tanks

13. Are you continuing fish farming in the GP tank after scheme period? Yes ☐ No ☐

   a. If no, why? .....

14. Do you plan to renew the GP tank lease or lease out another GP tank in the near future? Yes ☐ No ☐

15. After the scheme, did any of the WSHG members start fish farming in her own tank or private leased tank? Yes ☐ No ☐

G. Challenges encountered by WSHGS during fish farming in GP tanks

1. When compared to other alternative business opportunities for WSHGs, is fish farming more attractive or less attractive?

   Why? .....

2. What are the major challenges faced by WSHGs during fish farming in GP tanks?

Problems/constraints	Intensity of problem (0=None, 1=Lower, 2=Moderate, 3=High)	Measures taken to overcome problem
Group members not willing to work together		
Group members are not willing to invest the amount		
No support from household members		
No support from villagers		
Difficult to get a bank loan		
No support from local Gram Panchayat elected members and officials		
High lease amount and it is unaffordable		
GP tanks/water level not suitable for fish production		
Lack of training or awareness		
Non-availability of quality inputs (seed, feed, fertilizer, etc.)		
Input costs are not affordable (high cost)		
Problems with labor availability		
Lack of tank security and fish theft, poisoning, etc.		
Disease incidence/fish death		
High harvesting costs		
Natural calamities such as excessive rain and overflooding of tanks, draught, cyclone, too hot during summer or too cold during winter		
Other issues		

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

For reference of the project staff only

Government approved unit cost of fish farming in GP tanks by WSHGs (unit cost per acre)					
Activity (for 1-acre tank)	**Unit**	**Unit cost (INR)**	**WSHG contribution (INR)**	**Govt contribution (INR)**	**Total (INR)**
Pond and dike cleaning for weeding, sludge removal	1	2000	2000		2000
Water pumping, fertilizer, lime, etc.	1	2000	2000		2000
Advanced carp fingerlings (50–100 g)	1080	12.5		13,500	13,500
Mola seed	10 kg	400		4000	4000
Feed (28/3 @ FCR 1:1:1)	1080 kg	32	16,060	18,500	34,560
Farm labor			3940		3940
Total (INR)			**24,000**	**36,000**	**60,000**

Appendix 2. List of enumerators who participated in door-to-door survey

Sl. No.	Enumerator	Designation	Zone/Districts
1	Ms. Aparajita Priyadarshini	Technical Coordinator	Sambalpur, Bargarh
2	Mr. Abinash Panigrahi	Technical Coordinator	Angul, Deogarh, Dhenkanal
3	Mr. Arddhendu Sekhar Mohanty	Technical Coordinator	Bhadrak, Balasore
4	Mr. Jugal Kishor Naik	Technical Coordinator	Balangir, Boudh, Sonepur
5	Mr. Khirod Chandra Nayak	Technical Coordinator	Puri, Khordha, Nayagarh
6	Mr. Manoj Kumar Sahoo	Technical Coordinator	Kalahandi, Nuapada, Rayagada
7	Mr. Saurava Kumar Biswal	Technical Coordinator	Cuttack, Kendrapara, Jajpur
8	Mr. Susanta Kumar Mishra	Technical Coordinator	Koraput, Malkangiri, Nabarangpur
9	Mr. Suvendra Kumar Dash	Technical Coordinator	Ganjam, Kandhamal
10	Mr. Aditya Narayana Dash	Technical Assistant	Jagatsinghpur
11	Mr. Anil Kumar Sahoo	Technical Assistant	Gajapati
12	Mr. Arup Ranjan Lenka	Technical Assistant	Mayurbhanj
13	Mr. Soumya Ranjan Mishra	Technical Assistant	Jharsuguda, Sundargarh
14	Mr. Reshma Naik	Technical Assistant	Keonjhar

WorldFish

About WorldFish

WorldFish is a nonprofit research and innovation institution that creates, advances and translates scientific research on aquatic food systems into scalable solutions with transformational impact on human well-being and the environment. Our research data, evidence and insights shape better practices, policies and investment decisions for sustainable development in low- and middle-income countries.

We have a global presence across 20 countries in Asia, Africa and the Pacific with 460 staff of 30 nationalities deployed where the greatest sustainable development challenges can be addressed through holistic aquatic food systems solutions.

Our research and innovation work spans climate change, food security and nutrition, sustainable fisheries and aquaculture, the blue economy and ocean governance, One Health, genetics and AgriTech, and it integrates evidence and perspectives on gender, youth and social inclusion. Our approach empowers people for change over the long term: research excellence and engagement with national and international partners are at the heart of our efforts to set new agendas, build capacities and support better decision-making on the critical issues of our times.

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