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NABARD

Study of Freshwater Fish Seed Supply Chain for the Development of Aquaculture in Tripura and Manipur States of North Eastern Region

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DISCLAIMER

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STUDY OF FRESHWATER FISH SEED SUPPLY CHAIN FOR THE DEVELOPMENT OF AQUACULTURE IN TRIPURA AND MANIPUR STATES OF NORTH EASTERN REGION

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Project Summary

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Project Team

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About NABARD Research Study Series

The NABARD Research Study Series has been started to enable wider dissemination of research conducted/sponsored by NABARD on the thrust areas of Agriculture and Rural Development among researchers and stakeholders. The study titled 'Study of Freshwater Fish Seed Supply Chain for the Development of Aquaculture in Tripura and Manipur States of Northeastern Region' completed by College of Fisheries, Central Agricultural University (Imphal) is the forty-sixth in the series.

The northeastern states of Manipur and Tripura are blessed with abundant natural water resources, providing a fertile ground for the growth and development of the freshwater fishery sector. Despite this potential, the region's aquaculture industry faces significant challenges, particularly in the fish seed supply chain. Reliable and efficient fish seed supply is crucial for sustaining fish production, enhancing local livelihoods, and ensuring food security. However, issues such as inadequate infrastructure, limited access to quality seeds, and lack of coordination among stakeholders have hindered the full realization of the sector's potential.

This study delves into the freshwater fish seed supply chain in Manipur and Tripura, offering a detailed examination of its current state. It explores key challenges faced by the industry, identifies gaps in the supply chain, and highlights opportunities for improvement. By conducting field surveys with hatchery owners, natural seed collectors, nursery seed growers, seed markets, fish seed traders/vendors, commission agent cum wholesalers, fish farmers, etc. the study aims to provide actionable insights and bankable model for strengthening freshwater fish seed supply chain in Manipur and Tripura that can further guide policymakers, practitioners, and local communities in creating new employment opportunities for local youth and promoting economic growth in the region.

Hope this report would make a good reading and help in generating debate on issues of policy relevance. Let us know your feedback.

Kuldeep Singh
Chief General Manager
Department of Economic Analysis and Research

PREFACE

The North Eastern Hill (NEH) region of the country is blessed with abundant natural resources and biodiversity. However, due to hilly terrain and undulated topography, net sown area in the region is only 9.55 percent of total geographical area. The region is predominated by the rural population. The fisheries and aquaculture are one of the key sectors of rural economy of the region. There are vast fisheries resources in terms of ponds/tanks, lakes, reservoirs, low land, rivers and rivulets which are accessible to fishermen and fish farmers to pursue fishing or fish production activities. Despite huge potential, NEH region is facing challenges in terms of shortage of fish supply as compared to its demand and as results, each of NEH states is importing large quantity of fishes from other states like Andhra Pradesh, West Bengal, Assam and from the neighboring country of Bangladesh. To bridge the gap between supply and demand for fishes, increase in productivity of fisheries resources are urgently required. Increase in fish production and productivity of particularly for fish farmers' pond, adoption of technology and timely availability of inputs like seed, feed etc., financial support, markets etc. are crucial. Keeping this in view, this research study was planned to analyze the present status of fish seed supply chain in Tripura and Manipur and explore further scope of development of efficient fish seed supply chain for the timely availability of quality seeds to the farmers. This project on 'Study of freshwater fish seed supply chain for the development of aquaculture in Tripura and Manipur states of North Eastern Region' has been undertaken with financial support of DEAR, NABARD. In this study, socioeconomic conditions of supply chain stakeholders, supply chain maps showing physical flow and survivability at different stages, cost and returns in seed production and distribution, species composition, size of seed, quantity and quality of seed at production level, market level and farm level, financial analysis of seed production units, risks and risk management at different stages of fish seed supply chain, impact of supply chain on farm production, financial inclusions, uses of ICTs, etc. were analyzed and presented in detail in the report. The findings of the research study will be invaluable and useful to policy planners, developmental agencies, researchers and other stakeholders of the fish seed supply chain.

(A. D. Upadhyay)
Principal investigator

CONTENT

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

As compared to other regions of the country, aquaculture productivity in the North Eastern Hills (NEH) region is significantly low. Researchers have identified a number of reasons for low production, such as low input use, low quality of the soil and water, lack of seed and feed availability, inadequate and poor technology diffusion, etc. According to Upadhyay and Patel (2017), Tripura's rich biodiversity and high consumer demand for regional fish contribute to the state's higher than average degree of species diversity at farm level. Transfer of technology, timely and affordable availability of essential inputs like fish feed and seed, as well as service support, are critical to the state's adoption of scientific aquaculture techniques (Barman and Mandai, 2012). Since aquaculture in North Eastern states of the country is mainly dependent on rain water, the culture period for fish is about 9 months (June to February) in seasonal ponds. Hence, timely availability of quality seed of appropriate size of desired fish species to the fish farmers is the key actor as it determines the final weight of the fishes at the time of harvesting and leads to price realization.

Although it was reported that Tripura produced more fish seeds than it needed (Anon, 2018), the production of spawn and fry was only found in a few areas in the state, and the quantity of fry and fingerlings produced by raising nursery seed was also extremely restricted to certain areas. Furthermore, from review of literatures we could not notice the gap between supply and demand of fish seed for different species and seed size for stocking. The primary reason for low production of aquaculture in Tripura and Manipur is scarcity of high-quality stunted yearlings of the intended species or fingerlings of the desired species that are of the right size when stocking is necessary. The farmers of the entire Northeastern Regions have poor access to fish seed because of the region's undulating landscape and steep terrain. Additionally, it also causes poor seed survivability and an increase in mortality. One of the major challenges in the growth of aquaculture in Tripura and Manipur is to bridge the gap between supply and demand of high-quality seeds. Therefore, the purpose of this study was to map the status of fish seed supply chain of Tripura and Manipur in methodical manner. The specific objectives of the study are:

1. To map the fish seed supply chain of Tripura and Manipur
2. To analyze cost and return structure for different chain actors operating at different stages of seed supply chain
3. To assess risks involved in seed supply chain activities
4. To analyze impact of seed supply on farm level fish production
5. To develop bankable projects in fish seed supply chain of Tripura and Manipur

In this research study, two states such as Tripura and Manipur of North Eastern Region of the country were selected for fish seed supply chain mapping. The fish seed production and distribution involves a series of stakeholders, such as input suppliers, fish seed hatcheries owners, nursery seed growers, seed market functionaries, seed vendors, fish farmers and labourers. Hence, for drawing a representative sample of respondents from each category stakeholders, multistage stratified random sampling design has been applied to select districts, RD blocks, villages and respondents. In Tripura state, Gomati, Sepahijala, West Tripura, Dhalai and North Tripura districts were selected. Similarly, in Manipur state, lmphal East, lmphal West, Bishnupur, Thoubal and Chandel districts were selected based on area and production of fish. Further, for each district of Tripura two RD blocks were selected such as Gomati district - Matabari RD Block, Kakrabon RD Block; Sepahijala district-Bishalgharh Block, Nalcher RD Block; West Tripura district - Mohanpur RD Block, Jirania RD Block; Dhalai district - Ambassa RD Block, Durgachowmuhani RD Block; North Tripura district - Kalacharra RD Block, Laljuri RD Block, were selected. In Manipur, from each of the selected district two RD blocks were chosen based on aquaculture area and fish production. Selected blocks were: lmphal East & lmphal West district: Wangoi RD block, Sawombung RD block; Bishnupur district: Moirang RD block, Nambol RD block; Thoubal district: Thoubal RD block, Lilong RD block; Chandel district: Chandel RD block, Chakpikarong RD block. From the selected blocks, villages were selected and from each village, a representative number of respondents were selected in each category of stakeholders. The number of respondents selected from Tripura were: Hatchery-14, Nursery seed growers-46, Seed markets-4, Fish seed vendors-50, Commission agent-cum Wholesalers-20, Fish farmers-121, and labourers-31. From Manipur state, the number of respondents were: Hatchery (Chinese/Low cost/Pvt/Govt)-9, Nursery seed growers-12, Traders-16, Fish farmers-157, and labourers-44 for personal interview and data collection. Therefore, altogether 524 respondents were selected from both the states for personal interview and data collection. Separate survey schedule was developed and used to collect data from each category of respondents. The methodology for supply chain mapping recommended by the researchers (Barroso et al,2011) was used. In this method, supply chain mapping involved mapping of six dimensions such as a) supply chain entities b) relationship of supply chain entities e) material flow d) information flow e) management policy and f) lead time. The second objective was achieved by analyzing cost returns and margin of supply chain actors. Third objective is risk assessment for fish seed supply chain. To achieve this objective, risks at different stages of the fish seed supply chain were identified and measured by calculating survivability and mortality of seed. Further, identified risks were ranked using a ranking technique. Fourth objective of the study was achieved by analyzing data collected on sources of seed and their performance at farm level, financial inclusion of supply chain actors and usage level of ICT in their seed production and seed distribution business. In order to achieve the fifth objective, development of bankable projects in the fish seed

supply chain of Tripura and Manipur, financial and economic viability of establishment of hatchery unit in Tripura and Manipur were analyzed.

The salient findings of the study:

- In terms of geography, a skewed distribution in fish seed production was found in Tripura and Manipur. In Tripura, two districts such as Gomati and Unakoti accounted for 58.81 % of fish fingerling production. In Manipur, seed production is confined to valley districts like lmphal East, lmphal West, Thaubol, and Bishnupur. Hence, there is a need for effective fish seed supply chain to distribute seed in the whole state.

- Fish seed supply chain in Manipur was found to be very short comprising input suppliers, hatchery/nursery seed growers/traders of outside seed and fish farmers. Due to lack of nursery seed markets and specialized nursery seed growers, fish farmers of remote areas faced the challenge of seed availability. In contrast to this, fish seed supply chain in Tripura is more organized in terms of specialized stakeholders like input suppliers, hatchery operators, nursery seed growers, traders, commission agents, seed vendors and fish farmers.

- It was found that in Tripura, majority of hatchery owners, nursery seed growers, nursery seed vendors, fish farmers and labourers engaged in fish seed supply chain were males, middle aged, belonged to scheduled caste category. They had family size between 4-6 members, had marginal and small land holdings, their education level was middle to higher secondary level, and annual income except hatchery owners was less than Rs. 5 lakhs.

- Similarly, in Manipur majority of hatchery owners, fish farmers and labourers engaged in fish seed supply chain belonged to male, middle age, OBC caste category. They had small land holdings, education from middle to higher secondary level and annual income less than Rs. 5 lakh except hatchery owners.

- lnter-organizational relationship between supply chain actors in different tiers of supply chain have both horizontal and vertical integration. Supply chain maps showing physical flow of seed for Tripura and Manipur have been developed. It was found that in Tripura 65.2 % of total spawn supply is routed through hatchery-nursery seed growers. Similarly, for fry and fingerlings in Tripura, physical flow of seed through subchannels were 1) hatchery -seed growers-market- vendor-farmers (37.62%) and 2) hatchery - seed growers-market- farmers (39.86 % of total supply of seed). Hence, these two sub supply chains have been identified as dominant supply chains for fish seed delivery in Tripura. In Manipur it was found that 65% Fry and fingerlings were routed through hatchery cum nursery seed growers to the fish farmers.

- It was Interesting to note that two distinct supply chain models were found in Tripura and Manipur. In the case of Tripura, due to the physical existence of fish

seed market, seed supply chain activities are more organized in terms of production and distribution whereas in the case of Manipur, no fish seed markets were found. As a result, hatcheries produce spawn along with fry and fingerlings and they are directly supplied to the farmers. Majority of farmers purchase spawn and do the nursery rearing on their own farms.

Hence, development of fish seed market is very much required in Manipur for better seed supply.

- The flow of information within the supply chain plays a vital role in decision making. It was found that the information flow regarding seed availability and seed supplies were bidirectional from upstream to downstream of supply chains in both the states. However, in case of monetary flow, it was unidirectional from downstream to upstream. Physical flow of seed is also unidirectional from upstream to downstream.

- In Tripura, spawn survivability at hatchery level was found to be significantly high at 76.36 % and merely 33.19 % at nursery seed rearing unit. However, for distribution of fry fingerlings by seed vendors, survivability was found to be 93.84%. At farm level, survivability was estimated to be 80.78%. In Manipur, spawn survivability at hatchery level was found to be 70%; in nursery seed rearing level was 70%; at distribution of fry fingerlings survivability was found to be 90%. At farm level, survivability was found different for fry (56.47%) and for fingerlings (96%). Survivability of seed is one of the most important determinants of economic gain from the seed supply chain. The survivability, particularly at nursery level and seed vendor's level is required to be increased in order to minimize economic losses in fish seed supply chain. Hence, for better survivability of seed at farm level, effective and efficient supply chain is needed that ensures minimum mortality during production and distribution.

- In fish seed supply chain of both the states, all type of risks, their severity and risk mitigating strategies adopted by stakeholders were identified.

- An economic analysis of costs and returns in hatchery operation and spawn production in Manipur shows that for establishment of hatchery of 1 hectare with brooder pond for maintaining 2660 Kg of brooders involve capital cost of Rs. 30,28,469/- and operational cost of Rs. 17,58,827.0/annum. They earned a net return of Rs. 10, 95,861.0 unit/annum. Whereas, in Tripura, a hatchery owner with 1 ha water area and maintaining 2000 kg of brooders incurred capital cost of Rs 20,72,408.0/annum and operational cost of Rs. 12,76,885.0/annum and they earned a net return of Rs.18,87,393/annum. It indicates that establishment and operation of hatchery for spawn production in both states are highly profitable.

- Similarly, the cost and returns for nursery units and fish production were analyzed and it was found that nursery seed rearing was a profitable enterprise.

- Majority of farmers of Tripura and Manipur have adopted polyculture system with multiple stocking and multiple harvesting. Generally, they stock 6-7 species including IMC, exotic carp and one or two local fish species having high market demand and market price. But the seed production and availability of local species is very less. Hence, there is a need for promotion of breeding, seed production and seed supply of local fish species.

- The distribution of fish farm price along the sub supply chains of Tripura, value added at different stages, economic loss due to poor survivability of seed (mortality) was calculated. The producers' share in consumers' rupee of fish seed were about 84% in channel-1, 67.92% in Channel-IV, 58.28% in Channel-11 and lowest 48.84% in channel- III.

- The profit margin of fish seed vendors of Tripura showed that they earned a percentage margin of 24.3%. However, every day they lose money value of about Rs 143.79/- due to mortality of fingerlings during transportation and distribution. This amount is significant as they put a lot of hard work in distribution of fish seed.

- The impact of the supply chain in terms of performance of seed supplied to fish farmers through different sources (channels) such as seed vendors, seed markets, nursery seed growers, own seed or seed purchased from other farms were analyzed. It was found that the average weight of fish at the time of harvest is more when seeds were procured from seed vendors and markets as compared to those who purchased seed from hatchery or seed growers. Hence, these two supply chains have better performance at farm level output. It may be because seeds available in the market are of mixed type i.e. comprising both stunted fingerlings (yearlings) and fingerlings produced during the same year. Whereas nursery seed grower and own seed mostly provides seed produced during the same year. This clearly emphasizes the role of seed supply chain to encourage raising stunted fingerlings for enhancing aquaculture productivity.

- The usage of ICT for getting information regarding fish seed was encouraged in the whole seed supply chain in Tripura as well as in Manipur. However, digital literacy on secured digital payments and usage of social media are crucial for making the fish seed supply chain more efficient.

- Financial inclusion of core supply chain actors was found medium level but it was very poor in case of supporting supply chain actors such as seed vendors and labourers.

- Bankable Model Projects for the establishments of carp hatchery (Eco/Chinese hatchery) in Tripura and Manipur and nursery seed rearing in Tripura have been developed.

Recommendations:

i. Fish seed supply chain in Tripura is relatively better organized and structured as compared to Manipur because of the existence of seed markets in Tripura. Hence, development of aquaculture facilities, transport facilities etc. are necessary because seeds are transported in live conditions in low volume of water and high density of seed which is subject to high risk of mass mortality. Seed markets are to be developed at road side with easy access and with all the required infrastructural facilities.

ii. The fish seed supply chain requires some minimum facilities along the chain such as oxygen packing, water exchange facilities, aerator facilities, transport facilities etc. because seed is transported in live conditions in low volume of water and high density of seed which is subject to high risk of mass mortality. Hence, seed markets are to be developed at road side with easy access and with all the required, infrastructural facilities.

iii. The spawn production, nursery seed growing and fish production are all found to be profitable enterprises in Tripura and Manipur. Hence, institutional financing for these enterprises needs to be strengthened.

iv. The stunted fingerlings (yearlings) and fingerlings have better performance at farm level. Hence, technical and financial support for production and supply of stunted fingerlings or yearlings is important.

v. The research and technology interventions are required to develop fish seed transportation carriers.

vi. Financial inclusion and digital literacy, particularly for financial services are to be strengthened.

vii. The use of ICT is very crucial for fish seed supply chain. Hence, capacity building programmes are needed for supply chain actors on ICT applications in seed production and seed marketing.

1.0 INTRODUCTION

The timely supply of seed and feed are the most important drivers for aquaculture development in the country. The efficient production and distribution of these key inputs are essential to increase in aquaculture production. A number of regional and international scientific forums highlighted some of the most pressing issues concerning fish seed in global aquaculture development. These issues include inadequate and unreliable supply of quality seed, genetic quality, inadequate hatchery technology and facilities for rearing fry/fingerlings, distribution mechanisms, impact of release of cultured seed stocks, the need for more hatcheries with business orientation and others (FAO, 2007). For securing timely seed supply of IMC, exotic carp, minor carps and catfishes commonly used in freshwater aquaculture, seed production system, the fish seed availability, seed quality support services and seed distribution networks have to be understood well for developing efficient seed supply chain.

Fishery is one of the important sectors of rural economics of the North Eastern Hill region of the country. The NE region of the country is blessed with enormous fisheries resources including rivers/streams, beels/lakes, tanks/ponds, paddy/ fields, and other wetlands. This region is also rich in fish biodiversity. In spite of these, fish production and local supply of fish is less as compared to its demand, because of the per capita consumption fish in Tripura (29.29 Kg/per capita/ annum) and Manipur (14.1 kg/per capita/annum) which is higher than all states except A&N islands (59.47 kg/per capita/annum) and Kerala (19.41 kg/per capita/ annum) (Handbook on Fisheries Statistics- 2020, GOI,). The reason for high demand for fish is food habits and also it is a major source of protein in the whole NEH region. Hence, fish play a vital role in the nutritional security of people of this region. Due to very high demand for fish in the region, increase in fish supply through aquaculture production is at top priority of the governments of all the NEH states. The aquaculture productivity in the whole NEH region is low as compared to other parts of the country. Several impediments behind lower productivity were reported by researchers as low inputs, issues related to soil and water quality, poor availability of seed and feed, inadequate and poor technology dissemination, etc. Upadhyay and Patel,2017 reported that level of species diversity at farm level in Tripura is more because of rich biodiversity and high consumer demand for local fishes. In adoption of the scientific aquaculture practices in the state, transfer of technology, availability of key inputs such as fish seed and fish feed at right time and at reasonable prices, and service support system are crucial as reported by researchers (Barman and Mandai, 2012). Since aquaculture in North Eastern states of the country is mainly dependent on rainwater, it restricts the culture period of fish is about 9 months (June to February) in seasonal ponds.

Hence, timely availability of quality seed of appropriate size of desired fish species to the fish farmers is one of the key actors that determine final weight of fishes at the time of harvest and price realization.

Though, it was reported that there is surplus fish seed production in Tripura state (Anon, 2018), but production of spawn and fry, is confined to government and private hatcheries located in certain pockets of the state and production of fry/fingerlings through nursery seed rearing are also very limited in numbers and it is only confined to few locations. On the other hand, fish farms are distributed in the whole state.

Further, study on demand and supply of desired species and size of fingerlings for stocking could not be noticed through review of literature. The poor availability of good quality stunted yearlings of desired species or lack of appropriate size of fingerlings of the desired species required at the time of stocking are the main causes for lower productivity in aquaculture in Tripura and Manipur. Due to undulated topography and high terrain, fish farmers' accessibility to fish seed is poor in the whole North Eastern Region. It also increases mortality of fish seed, and leads to low survivability and price variability etc. To fill the gap between demand and supply of quality seeds remains a big challenge in development of aquaculture In Tripura and Manipur. Hence, this study has been undertaken for systematic mapping of the seed supply chain of Tripura and Manipur states.

1.1 OBJECTIVES

The specific objectives of the study are given below -

1. To map the fish seed supply chain of Tripura and Manipur
2. To analyze cost and return structure for different chain actors operating at different stages of seed supply chain
3. To assess risks involved in seed supply chain activities
4. To analyze impact of seed supply on farm level fish production
5. To develop bankable projects in fish seed supply chain of Tripura and Manipur

2.0 METHODOLOGY

2.1 Sampling Design

Seed production and distribution in Tripura involves a large number of stakeholders, including fish seed hatcheries owners, nursery seed growers, wholesaler-cum - commission agent, seed traders, seed vendors, fish farmers and labourers. Hence, in order to draw a representative sample from each category of stakeholders, multistage stratified random sampling design was applied. First of all, a sampling frame was developed with the help of secondary data and information collected from the Directorate of Fisheries, Government of Tripura as well as from offices of Fisheries Superintendent at subdivision level. Based on sampling frame, RD Blocks, and villages were selected. The geographical map of the study area and flow diagram of the sampling design is represented in Figure 2.1, 2.2, 2.3 and 2.4, respectively.

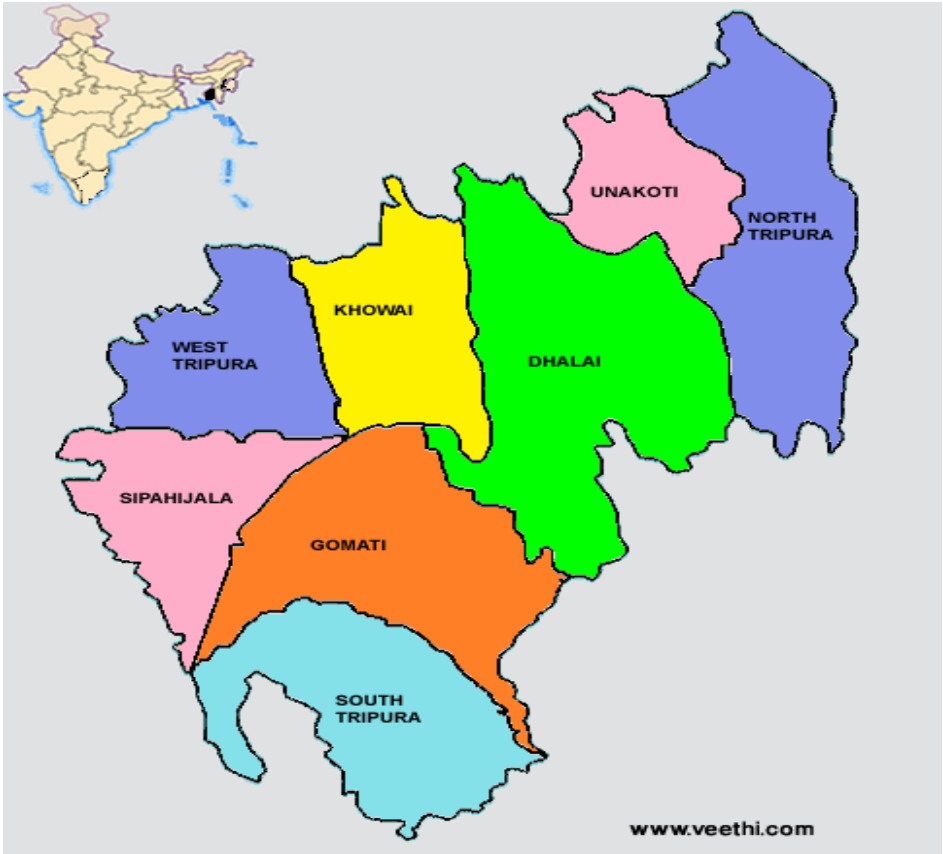


Fig 2.1: District boundaries of Tripura state of NEH

Fig 2.2: District boundaries of Manipur state of NEH Region

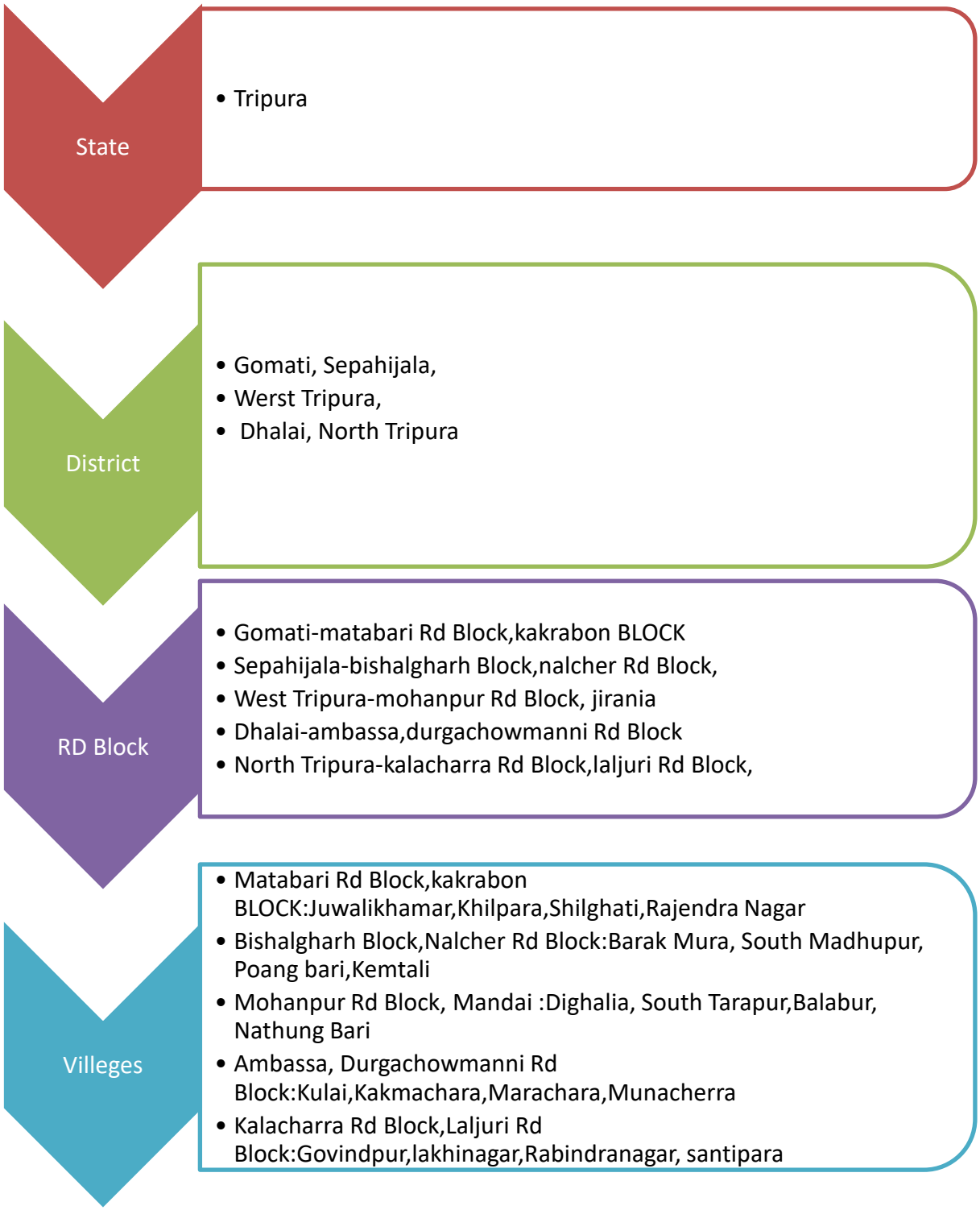


Fig 2.3: Flow diagram of the sampling design in Tripura

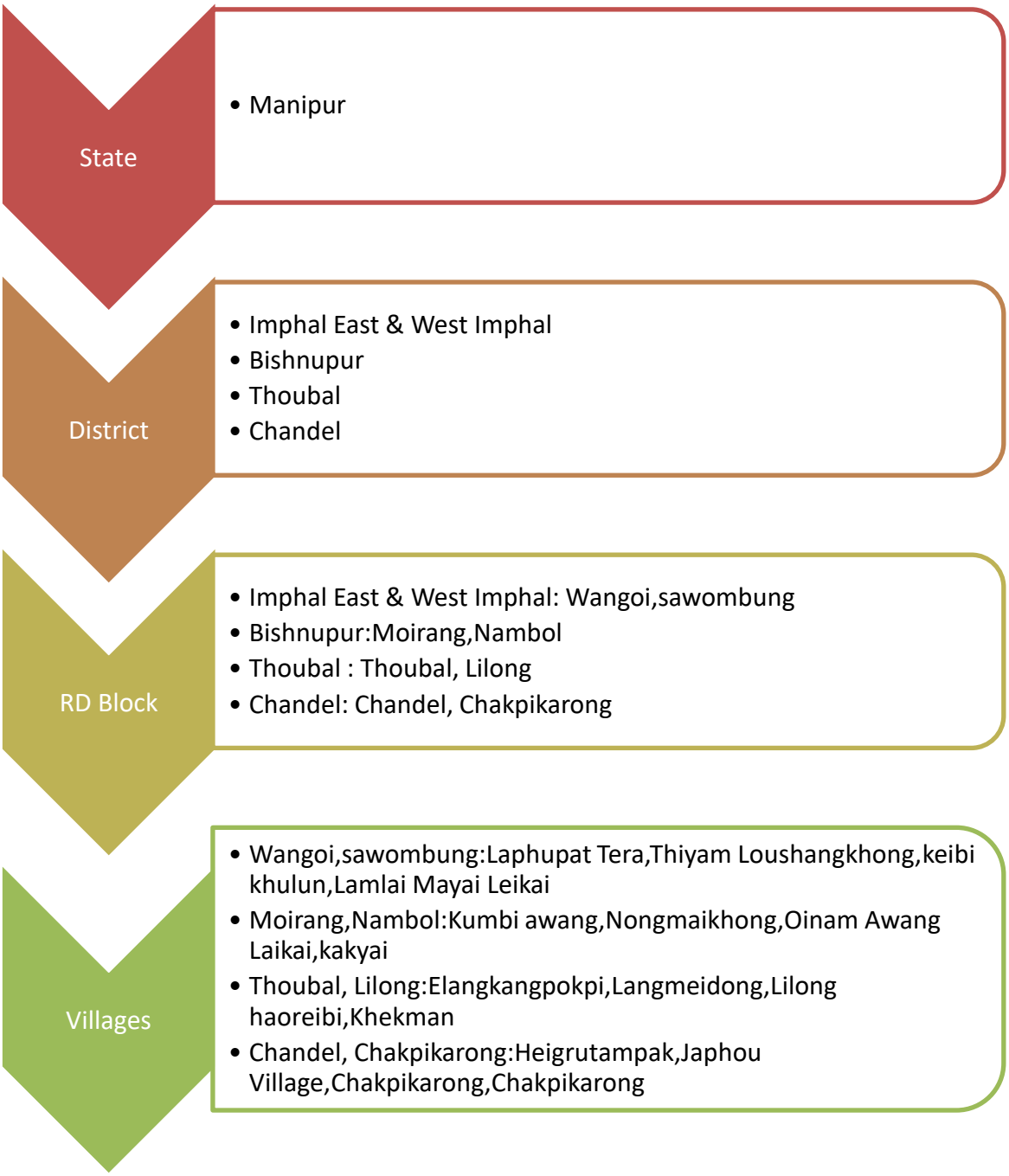


Fig 2.4: Flow diagram of the sampling design in Manipur

From each of selected RD Blocks, list of hatcheries, list of nurseries seeds growing villages and list of villages of fish farmers, fish seed markets were prepared, then a representative sample was drawn from each category of stakeholders involved in the fish seed supply chain of Tripura and Manipur states. The details of sample size are given in Table-2.1.

Table 2.1: Sample size of data collection in Tripura and Manipur

Sl. No.	Category of respondents	Sample Size		
		Tripura	Manipur	Total
1.	Hatchery (Chinese/Low cost/Pvt/Govt)	14	9	23
5	Nursery seed growers	46	12	58
6.	Seed markets	4	-	4
7.	Fish seed vendors	50	-	50
	Fish Traders	-	16	16
8.	Commission Agent-cum Wholesalers	20	-	20
9.	Laborers	31	44	75
10.	Fish farmers	121	157	278
	Total number of respondents	286	238	524

2.2 Data collection:

Further as per objectives of the study, primary data and secondary data were collected from different stakeholders of the fish seed supply chain of Tripura and Manipur. The details of observations to be collected from different categories of respondents is discussed below-

Secondary data

State Government Offices of Fisheries at state, subdivision and block level: The secondary data on number and places of hatcheries (private/ Govt.) located, district wise and block wise, spawn and fingerlings production, area under culture fisheries, fish production and number and place of fingerlings markets, etc. were collected from the Directorate of Fisheries, Government of Tripura as well as Directorate of Fisheries, Government of Manipur. Also, the Superintendent of Fisheries Offices at subdivision level, list of hatchery, list of nursery seed growers, fish seed markets, fish seed production in terms of spawn, fry and fingerlings and village wise aquaculture area, etc. were collected. The secondary information related to seed production in terms of spawn, fry and fingerlings and fish seed demand was collected from different sources and agencies through personal visit, telephonic contact, reviews of published reports and literature available online.

Primary Data

As per objectives of the study, primary data were collected from different stakeholders of the fish seed supply chain of Tripura and Manipur. The details of observations collected from different categories of respondents is discussed below-

a. **Hatchery owners** (Govt/Pvt/Eco-Hatchery/Low cost hatchery): The primary data on size of hatchery, capacity, initial capital investment in development of hatchery, installed capacity, year of establishment, infrastructure, fish species of which spawn is produced, maintenance of brood stock, season of spawn production, spawn production per cycle, level of survivability (%), input purchased, expenditure details, production of spawn, species wise fingerlings production, details of operational expenses during off season, preparatory stage and breeding season including pond preparation, cost of brooders, cost of Lime, FYM, MOC, fish feed, packaging materials, cost of inducing agent, electricity charges, packaging material for seed, labourers engaged, electricity charges, and other miscellaneous expenses. Details of sale of spawn, spawn price, agencies to which spawn is sold, marketing of spawn, price variation, packaging, species wise spawn demand, risks in spawn production and its marketing, physical and economic losses, destination to which spawn is transported, spawn distribution network, time gap between spawn production and spawn sale, uses of ICT in spawn production and marketing and information related to finance etc. were collected from the hatchery owners. A survey schedule has been developed for data collection from hatchery owners and it is given in Appendix-I.

b. **Nursery Seed Growers**: The information on water area, infrastructure facilities, period of nursery seed rearing(fry/fingerlings), number of cycle in a year, fish species of nursery seed rearing (fry/fingerlings), operational expenses of nursery seed rearing, places to which nursery seed supplied, source of spawn, transport of spawn, species, quantity details of nursery seed rearing, total fry/fingerling produced per cycle, level of survivability(%), sale, buying agency, selling price, risk details in nursery seed production(fry/fingerlings) and its marketing, variation in prices of fry/fingerlings, demand for fry/fingerlings available, packaging facilities, uses of ICT in input purchase, seed production and seed marketing, uses of ICT in in input purchase, seed production, and seed marketing, etc. were collected from nursery seed growers. A survey schedule has been developed for data collection from nursery seed growers and it is given in Appendix-II.

c. **Nursery Seed Market**: The nursery seed markets are the place from where a major proportion of nursery seed distribution takes place. In Tripura several nursery seed markets are in operation at places like Badtala, Udaipur, Sepahijala, Teliamura, North Tripura and out of these markets, Badtala fish seed market of West Tripura District, Kemtali fish seed market of Sepahijala district, Ramesh Chaumuhani fish seed market of Gomati district, Kalacherra Fish seed market of

North Tripura were selected for primary data collection. However, in Manipur none of the nursery seed markets were reported. Hence, from Tripura, name of market, information on marketing infrastructural facilities, marketing management committee, type of and number market functionaries present in the market, species wise market arrival of nursery seed, source of nursery seed for the market, destinations where nursery seed supplied from the market, wholesale nursery seed prices species wise, mode of transportation of seed available in market, water exchange facilities, oxygen packing facilities, period of operation of market, variation in availability of nursery seeds in term of species, quantity, size, price, marketing charges in terms of commission, counting, loading/unloading of labourers etc., have been recorded. A survey schedule has been developed for data collection from nursery seed markets and it is given in Appendix-III.

d. **Wholesaler cum commission agent:** From the selected nursery seed markets, wholesaler- cum commission agents were selected for primary data collection. From the wholesaler- cum commission agents, details of daily species wise nursery seed arrival and sale, places of supply, agency who brought the seed for sale, agency to whom seed is sold, wholesale prices, commission charges, any other marketing charges paid by buyers and sellers, periodic variation in seed arrival and seed demand, period of operation of market, risks in seed marketing, off season engagement of wholesaler- cum commission agents, uses of ICT and finance etc. have been collected. A survey schedule has been developed for data collection from nursery seed markets and it is given in Appendix-IV.

e. **Nursery Fish Seed Vendors**: In Tripura nursery seed vendors are the most important supply chain entity, as they deliver nursery fish seed door to door to the fish farmers in remote areas. Hence, fish seed vendors functioning in seed markets as well beyond seed markets in different places were selected for personal interview and data collection. The data related to daily quantity of species wise seed purchase, transportation and sale, species, size, purchase price, sale price, mode of transport, transportation and other charges, total period engagement in business, level of knowledge about seed quality, mortality and other risks involved in fish seed transportation and seed distribution, offseason employment, socio-economic conditions, uses of ICT, information related to finance, etc. were collected from seed vendors. A survey schedule has been developed for data collection from nursery fish seed vendors nursery seed markets and it is given in Appendix-V.

f. **Fish Farmers:** The ultimate aim of this study was to analyze whether the fish farmers are getting nursery seed for stocking in terms of desired species, desired quantity, desired size, desired quality, at the time they need, at reasonable price. Therefore, fish farmers were chosen using stratified random sampling, for the primary data collection. The primary data on socio-economic characteristics, land holding, agricultural land, water area, number of ponds, own water area, water area

leased in, rental value of leased in water area, terms and condition for leasing, fish culture practice, culture period, water depth, pond preparation, stocking details including species, sources of seed, size of seed, price of seed, stocking density, stocking ratio, post stocking management, growth, disease, detail of operational costs of fish total harvest of fish, selling price, marketing, risks in fish production, requirement of seed, uses of ICT in input purchase including fish seed, fish production and marketing, information on financial services available, etc. were collected through personal interview of fish farmers. A survey schedule has been developed for data collection from fish farmers and it is given in Appendix-VI.

g. **Labourers:** Labourers engaged in the fish seed supply chain are the main supporting facilitating entity. They play a vital role in each stage of seed production, distribution and also in fish production. Their key roles include hatchery operation, nursery seed production, transportation, in market loading and unloading of seed, at farm level for different operations. In fish seed supply chain, their function, number of days of employment in fish seed supply chain, off season employment, their socioeconomic conditions, daily wages, monthly income and expenditure pattern, uses of ICT and financial inclusion etc. have been collected from this category of respondents. A survey schedule has been developed for data collection from labourers and it is given in Appendix-VI.

2.3 Method of data collection

The semi structured survey schedule including both closed -ended and open-ended questions for each category of fish seed supply chain actors has been developed separately. The entire sets of schedules were pretested before administering the final data collection. For the primary data collection, a personal interview method of data collection was applied. Further, Focused Group Discussion (FGD) method of data collection was also used. Focused Group Discussion (FGD) have been done with hatchery owners of Tripura and Manipur, nursery seed growers of Tripura, wholesalers cum commission agent and fish farmers. Through FGD and personal interview of respondents, detailed information on fish seed production, fish seed demand, periodic variation in demand, supply and prices, distribution of seed, infrastructural facilities available along fish seed supply chain, major risks and challenges in fish seed production and distribution, input availability, institutional supports, etc. have been gathered for the state of Tripura as well as Manipur.

2.4 Data Analysis

2.4.1 Mapping the fish seed supply chain:

The Agri-supply chains are economic systems which distribute benefits and risks among supply chain participants. Thus, supply chains enforce internal mechanisms and develop chain wide incentives for assuring the timely performance of production and delivery commitments. Supply chain stakeholders linked and interconnected by virtue of shared information and reciprocal scheduling, product quality assurances and transaction volume commitments. The real measure of supply chain performance is how well activities are

coordinated across the supply chain to create value for consumers, while increasing the profitability of every link in the supply chain.

The supply chain mapping is a tool that allows for a macro-graphic representation of the supply chain in the current state. It is also a visual representation of goods, information, process, and money flows that occurs throughout the supply chain, both upstream and downstream. A variety of models were developed over time for supply chain analysis and supply chain management. The SCOR model (Supply Chain Operations Reference) which was developed in 1996 and endorsed by the Supply-Chain Council is commonly used by industries. SCOR model further revised in 2006 and a supply chain configuration by capturing the state of five core processes of its constituent entities: i) plan, ii) source, iii) make, iv) deliver, and v) return, were developed. Similarly, six dimensions for supply chain maps were identified by Barroso *et al*., 2011 are i) supply chain entities; ii) relational links between supply chain entities; iii) material flows; iv) Information flows; v) management policies; and vi) lead times.

Hence, in the first objective i.e. Mapping of the fish seed supply chain of Tripura and Manipur was achieved using methodologies suggested by Barroso et al., 2011 and other researchers.

2.4.2 Analysis of cost and return structure for fish seed supply chain:

a) Cost and return in spawn production, nursery seed rearing and fish culture:

i) Estimation of cost–.

Cost A = Operational expenses for fish seed production

Cost B = Cost A + interest on investment on fixed assets

Cost C = Cost B + imputed value of family labour

ii) Estimation of Return

Total Revenue (TR) = Total number fish seed sold (Q) X unit price (P)

Net Income (NI) of Seed producers= TR– cost C

Farm Business Income (FBI) of Seed producers = TR– Cost A

Family Labour Income (FLI) of Seed producers = TR– Cost B

b) Estimation of marketing costs, margins, price spread and marketing efficiency of fish seed supply chain-In fish seed supply chain different types of intermediaries such as wholesalers-cum-commission agents, seed vendors, labourers, seed transporters, suppliers of packaging materials, etc. are involved. Hence, for identified sub channels, marketing cost, marketing margins, price spread and marketing efficiency have been estimated using following methods:

Absolute margin (profit) of i^{th} middlemen in fish seed supply chain

$$= PRi - (PPi + Cmi)$$

Percentage margin (profit) of i^{th} middlemen in fish seed supply chain

$$= (PRi - (PPi+Cmi) X100) / PRi$$

Whereas,

PRi = Total value of receipts per unit (sale price) by i^{th} middlemen

Ppi = Purchase value of goods per unit (purchase price) by i^{th} middlemen

Cmi = Cost incurred on marketing per unit (marketing cost) by i^{th} middlemen

Profit earned by facilitative middlemen in seed supply chain= Service charge- cost incurred on rendering particular service.

Price spread is generally referred to as the difference between the price paid by the ultimate consumer and net price received by the producer per unit of the commodity. It helps in estimating the share of different market functionaries in the consumer's rupee and thus facilitates the understanding of efficiency of marketing channels. The price spread for each of identified sub channels for fish seed supply was calculated.

Marketing efficiency was estimated by the Modified Measure of Marketing Efficiency (MME) developed by Acharya and Agrawal (2007) which takes into account both marketing cost and margins per unit of product marketed and farmers price.

ME = NFP/ (MC + MM)

Where, ME = Marketing efficiency,

NFP: Net price received by farmer,

MC: Marketing Costs

and MM: Market Margins.

2.4.3 Assessment of risks involved in supply chain:

The risks in spawn production and sale at hatchery involved several risks including non-spawning, poor spawning, environmental risks, poor hatching of egg, disease, delay in supply of input, unsold seed due to poor demand fish, price fluctuation, etc. ultimately these risks cause poor survivability and economic loss to hatchery owners. Similarly, nursery seed growers face risks of non-availability of spawn, quality of spawn, mortality during transportation, disease, poor demand, low prices, etc. The seed vendors facing risks like less availability of seed in the market, price fluctuation, poor availability of transport, mortality, unsold seed, etc. Hence, at different stages of seed production as well as in distribution several types of risks and uncertainty are involved which causes poor survivability of seed and economic losses. Hence, risks at different stages are measured by calculating percentage survivability of seed at each stage as well as economic loss due to mortality of seed.

Further, the causes of risks for all the supply chain actors were identified and ranked using Garratt Ranking.

$$Per\ cent\ position\ = \frac{100\ (Rij\ -\ 0.5)}{Nj}$$

Where,

R_{ij} = Rank given for i^{th} item by the the individual

N_j= Numbers of items ranked by j^{th} individual

The quantification and ranking of the risk factors helped in suggesting strategies to minimize economic losses in the supply chain. Further the risks mitigating strategies to minimize economic loss, adopted by supply chain actors were also identified.

2.4.4 Analysis of impact of fish seed supply chain at farm level:

Timely availability of quality fish seed and other inputs to the fish farmers have a significant impact on productivity level, overall production, total revenue and profitability of fish production. In this study the impact of purchase of seed by the farmers from different sources (channels) on average weight of fishes at the time of harvest and also the impact of stocking of different size of seed on average weight of fishes at the time of harvest at farm level were analysed. Further, the impact of supply chain was analyzed in terms of financial inclusion of fish seed supply chain actors. The uses of ICT by stakeholders in the seed supply chain activity were also analyzed using tabular methods.

2.4.5 Development of model bankable projects in fish seed supply chain of Tripura and Manipur:

In order to achieve the fifth objective, which is to develop bankable projects in the fish seed supply chain of Tripura and Manipur, a Bankable model for establishment of Hatchery units in Tripura and Manipur has been worked out using financial analysis of the project. Economic life of the project was assumed to be 10 years and NPV, B-C Ratio and IRR have been calculated using a standard formula and assuming discounting factor 0.15.

3.0 RESULTS AND DISCUSSION

3.1 Status fish seed production in Tripura and Manipur

Tripura

The analysis of secondary data on the distribution of aquaculture area, spawn production and fingerlings production across the RD blocks of Tripura revealed that there is a skewed distribution of spawn and fingerlings productions across the RD blocks in Tripura (Table 3.1 and Fig. 3.1). Further it was found that 45 percent of total spawn production was confined to Sepahijala district and 58.81 percent of fingerlings production confined to two districts namely Gomati and Unakoti. It indicates that an efficient fish seed supply chain for distribution of fish seed in the entire state is very important for increase in aquaculture production.

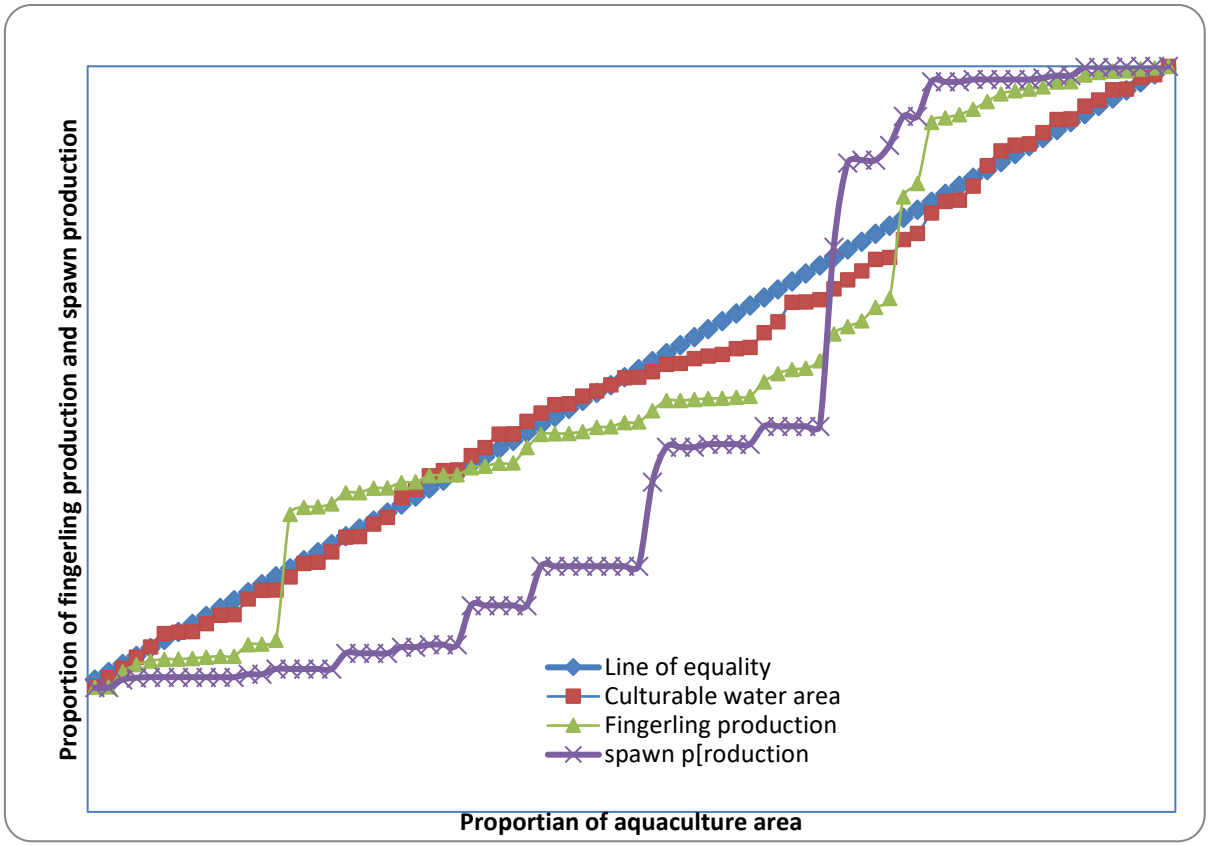


Fig 3.1: Distribution of aquaculture area, fingerlings and spawn production in Tripura

Table 3.1: District wise water area, fish production, fingerlings production and spawn production (2019-20)

SN.	District	Water area (Ha)	Fish Production (mt)	Fingerlings Production (No. Lakh)	Spawn Production (Ltr)
1	North Tripura	3356.61 (11.65)	8465.27 (10.99)	213.86 (5.08)	186.6 (1.68)
2	Unnakoti	2398.29 (8.33)	6233.19 (8.09)	1008.64 (23.95)	146.6 (1.32)
3	Dhalai	4309.06 (14.96)	11940.48 (15.51)	218.03 (5.18)	434 (3.91)
4	Khowai	3061.99 10.63)	10008.35 (13)	280.1 (6.65)	1400 (12.62)
5	West Tripura	2598.5 (9.02)	6727.24 (8.74)	247.17 (5.87)	2178.24 (19.64)
6	Sepahijala	4129.54 (14.34)	11052.63 (14.35)	610.75 (14.50)	5070 (45.72)
7	Gomti	5297.07 (17.39)	13592.38 (15.65)	1468.1 (34.86)	1438.45 (12.97)
8	South Tripura	3652.29 (12.68)	8983.53 (11.67)	165.03 (3.92)	236 (3.13)
	Total	28803.35	77003.07	4211.68	11089.89

Source: Directorate of Fisheries, Government of Tripura, Agartala
(Figures in parentheses indicates percentage of total)

Manipur :

In Manipur also though the fish seed production is gradually increasing as reflected from the table 3.2 and figure 3.2 but the seed production is mainly confined to valley districts like lmphal East, lmphal West, Thoubal and Bishnupur districts of Manipur. Whereas, fish production is distributed to all districts of Manipur. Hence the importance of seed supply chain and seed distribution in Manipur is also immense. The species wise distribution of spawn, fry and fingerlings is presented in table 3.3 and figure 3.3, 3.4, 3.5, It was found that in Manipur, Indian Major Carps (Rohu, Catia, Mrigal), Indian Minor Carp, and Exotic Carps (Grass Carp, Silver Carps, Common Carp) comprises about 92 % of total spawn, fry and fingerlings production. Remaining 8 % includes catfishes (magur, singi), Tilapia and anabas.

Table 3.2: Year wise fingerlings production (Lakh Fry) in Manipur (2019-20)

Year	Fingerlings production (Lakh fry)
2015-16	2190.0
2016-17	2150.0
2017-18	2500.0
2018-19	4060.8
2019-20	2494.8
2020-21	2788.0

Source: Handbook of statistics-2022, DoF, GOI

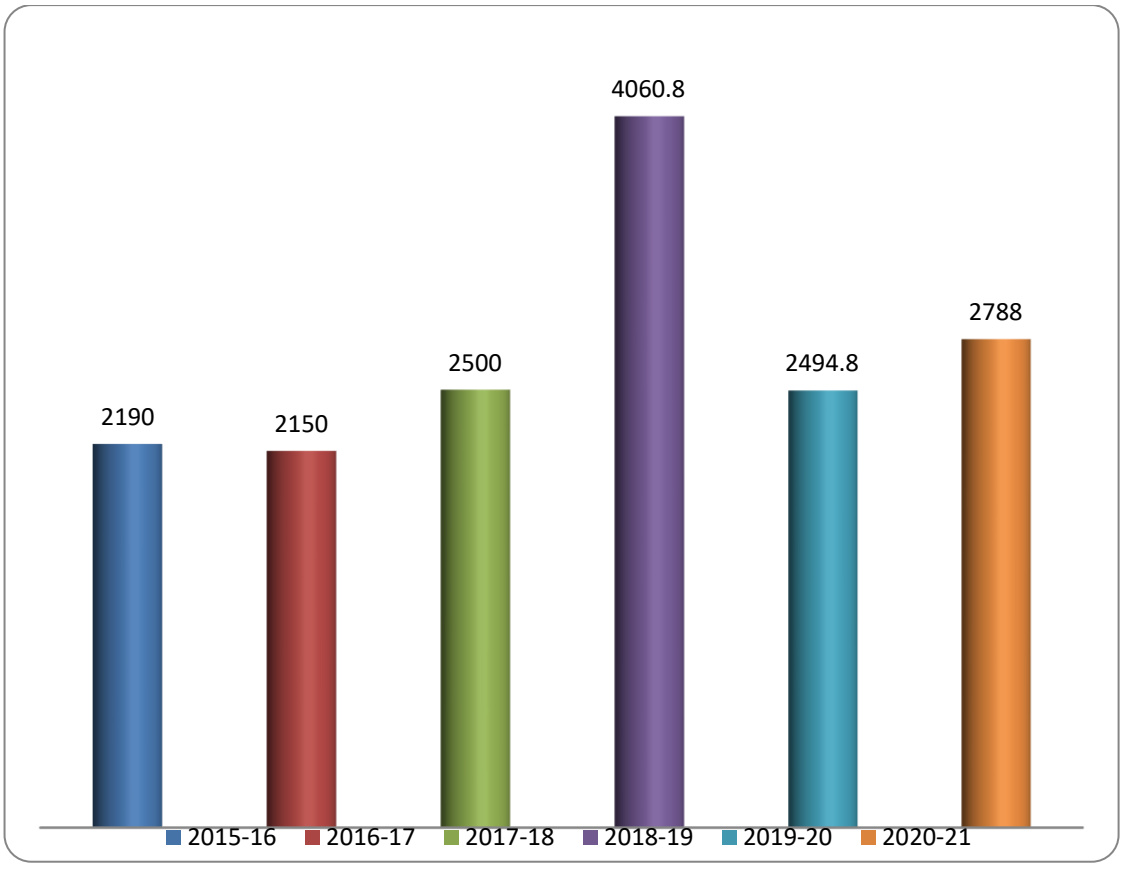


Fig 3.2: Trends of fingerling production (Lakh fry) in Manipur

Table 3.3: Species wise seed production in Manipur (2020-21)

Sl.	Species	Spawn Production (Million)	Fry Production (Million)	Fingerlings Production (Million)
1.	Indian Major Carp	157.8 (24.28)	62.3(23.35)	40.5(22.34)
2	Indian Minor Carp	112.4(17.30)	47.2(16.93)	28.5(15.72)
3	Common Carp	125.7(19.34)	68(24.39)	43.8(24.16)
4	Grass carp	128.2(19.73)	51.2(18.36)	36.3(20.02)
5	Silver carp	72.6(11.17)	29.6(10.62)	18.4(10.15)
6	Magur (*C. batrachus*)	8.2(1.26)	3.6(1.29)	3.1(1.71)
7	Singhi (*H. fossilis*)	6.4(0.98)	2.8(1.0)	1.6(.88)
8	Tilapia	36.0(5.54)	12.5(4.48)	8.5(4.69)
9	Anabas	2.5(0.38)	1.1(0.39)	0.6(0.33)
	Total	649.8(100)	278.8(100)	181.3(100)

Source: Directorate of Fisheries, Government of Manipur, Imphal
(Figures in parentheses indicates percentage of total)

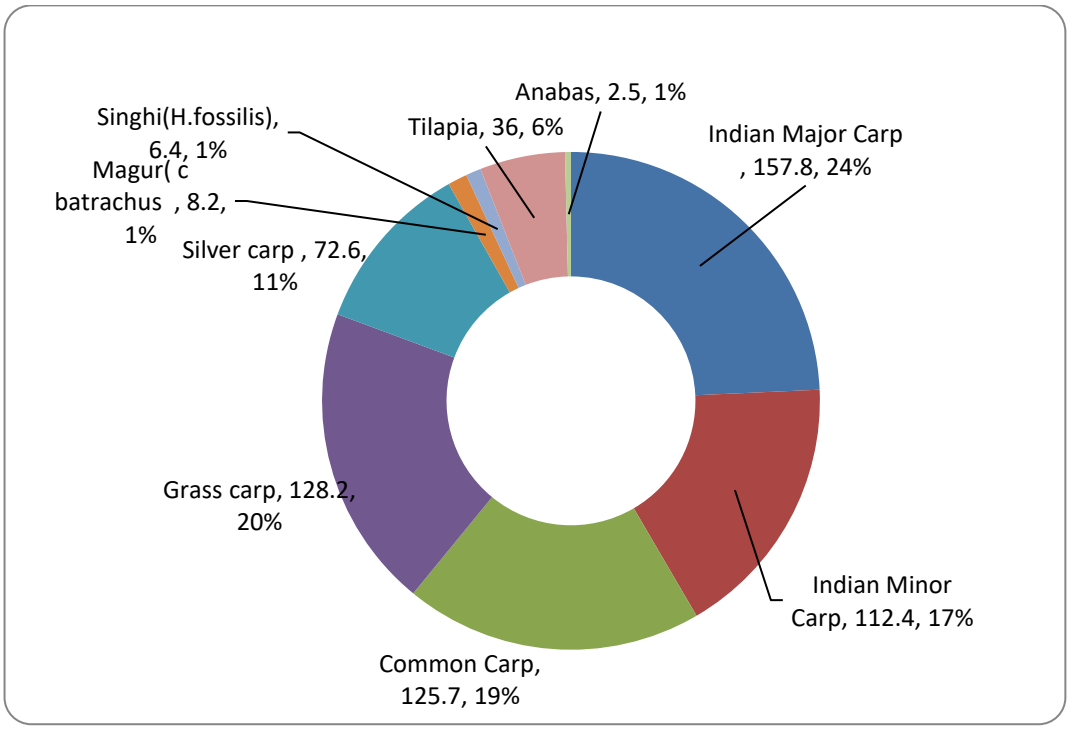


Fig 3.3: Species wise spawn production (Million) in Manipur 2020-21

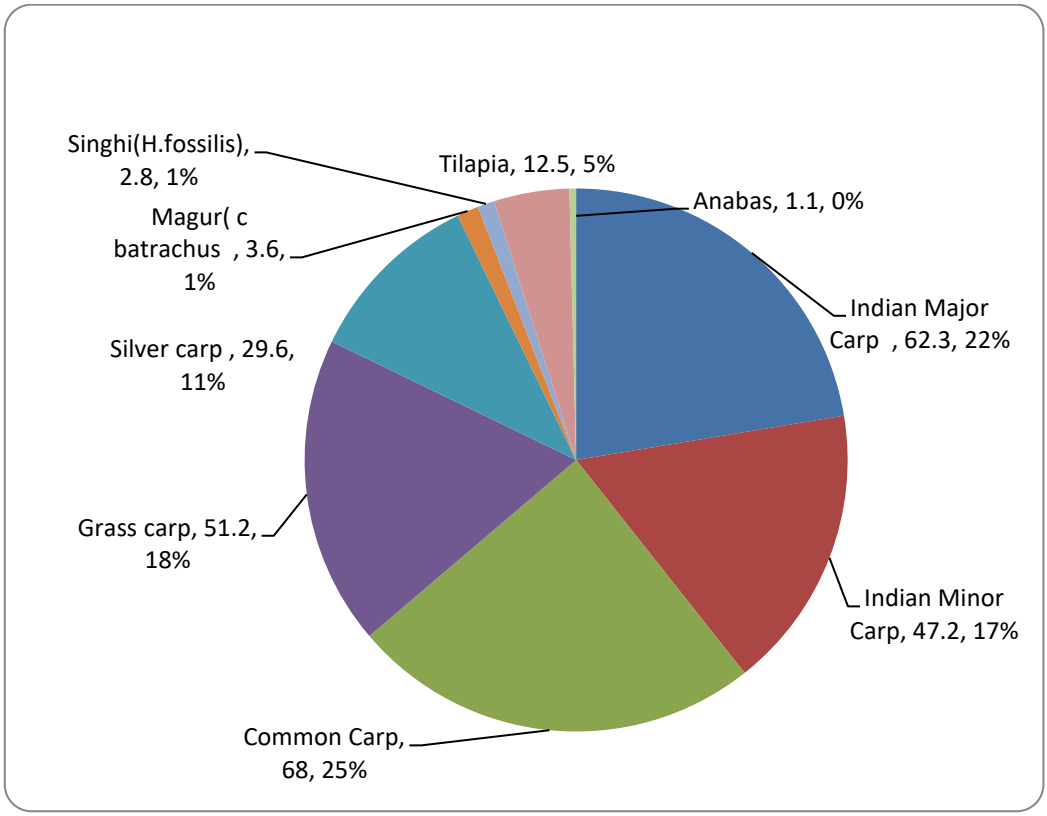


Fig 3.4: Species wise fry production in Manipur

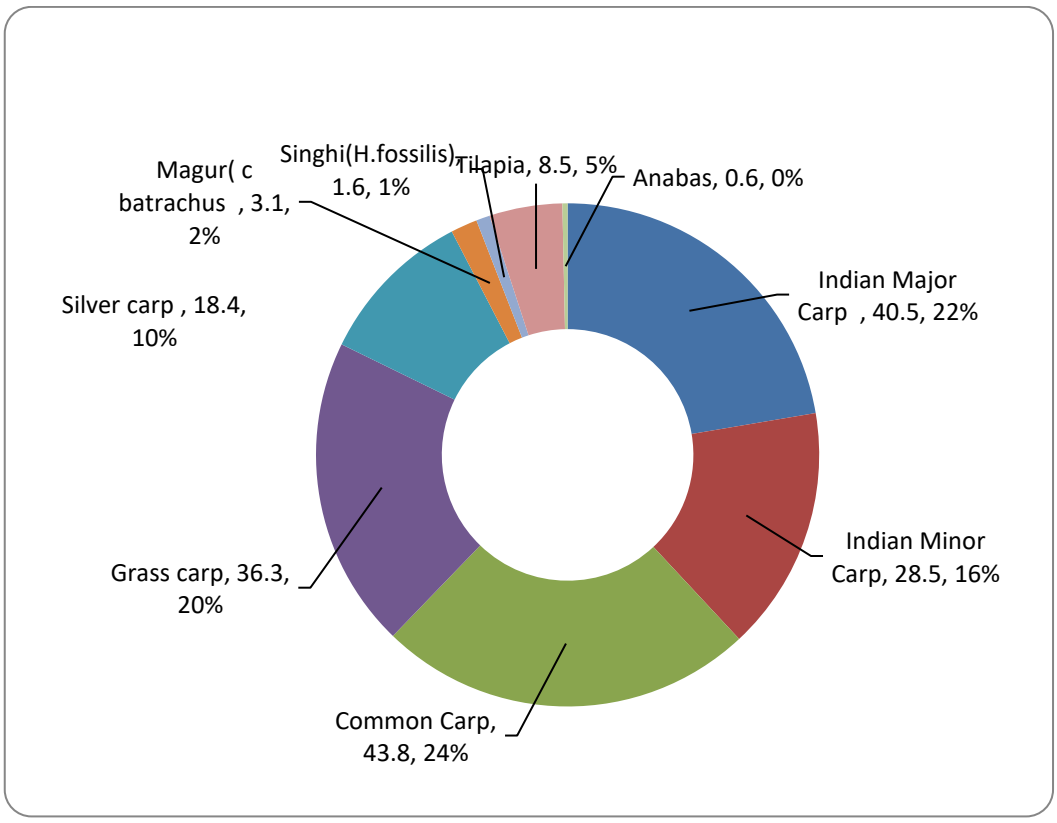


Fig 3.5: Species wise fingerling production in Manipur

3.2 Mapping of Fish Seed Supply Chain

The fish seed supply chain mapping involves the mapping of whole process starting from input supply, spawn production, spawn distribution, nursery seed rearing, nursery seed distribution and finally delivery of fish seed to the end users that is fish farmers. Supply chain mapping allows a macro-graphic representation of the supply chain in its current state. Supply chain mapping also includes a visual representation of goods, information, process, and money flows that occurs throughout the supply chain, both upstream and downstream. In this research study, for mapping of fish seed supply chain, six dimensions of supply chain i.e. i) supply chain entities; ii) relational links between supply chain entities; iii) material flows; iv) Information flows; v) management policies; and vi) lead times were analyzed for mapping complete supply chain. This methodology was suggested by Barroso et al., 2011 and other researchers. Hence, fish seed supply chain of Manipur and Tripura were mapped using these six dimension and results are discussed below:

3.2.1 Supply chain entities, their function and socio-economic conditions

The entities of the fish seed supply chain of Tripura and Manipur were identified. The supply chain entities and their functions are represented in figure 3.6 and figure 3.7.

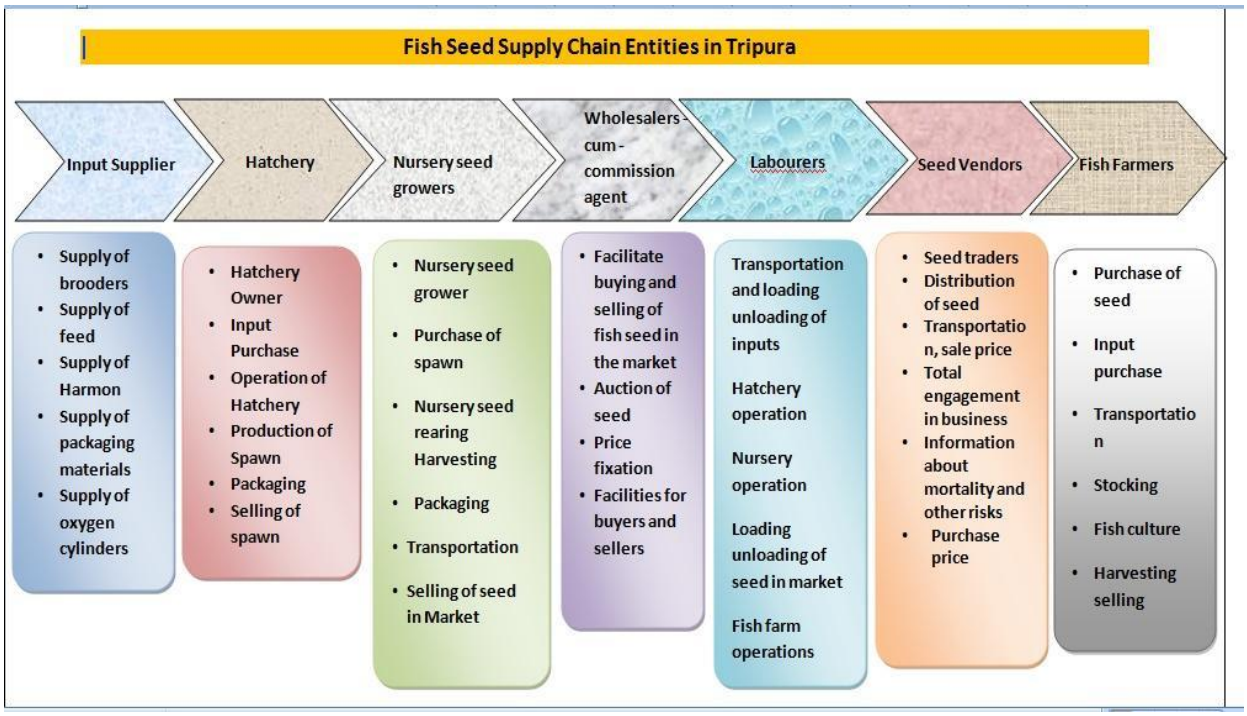


Fig 3.6: Fish seed chain entities, their functions in Tripura

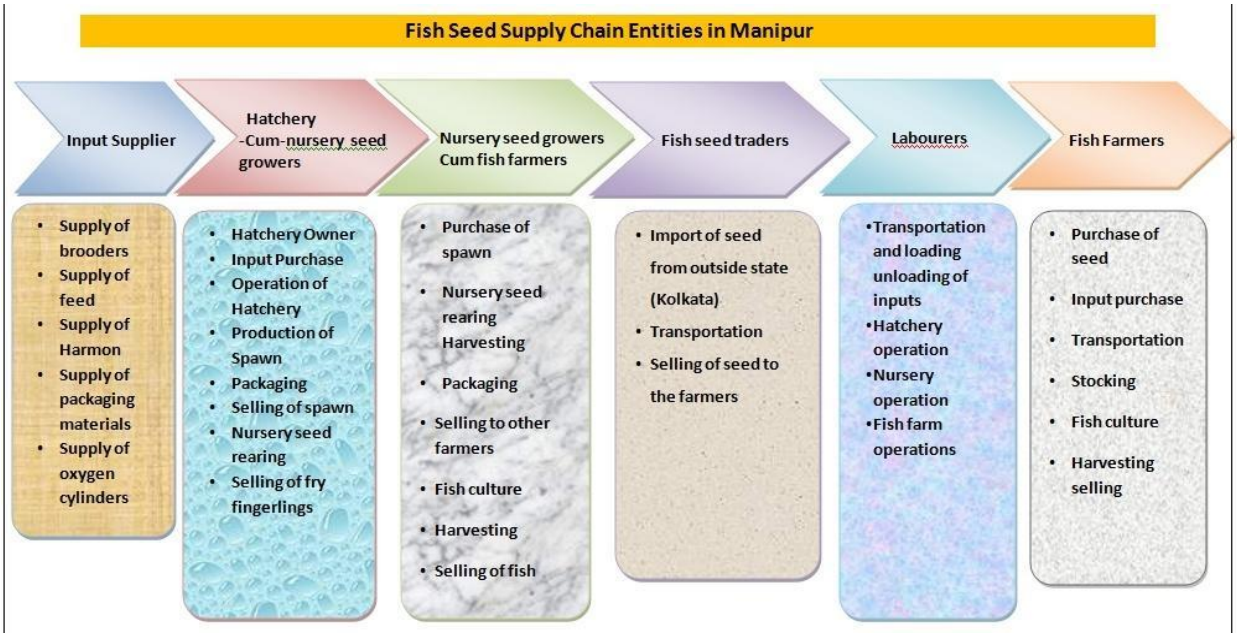


Fig 3.7: Fish seed chain entities, their functions in Manipur

3.2.1.1 Input supplier: Input suppliers are responsible for supply of feed, fertilizers, lime, cow dung, hormone, net, oxygen cylinder, packaging material etc. In Manipur, scale of operation of hatchery are found bigger and they have better relationship with input suppliers. Whereas, in Tripura a lot of variation in scale of operation of hatchery exists and they do not maintain persistent relationship with input suppliers. In both the states, the hatchery owners have to approach and purchase these inputs. Further, the hatchery owners frequently change input suppliers to bargain for input prices. During hatchery operation, brooders, hormone, oxygen cylinder, packaging materials are critical inputs. These inputs have a greater impact on hatchery operation and spawn production.

3.2.1.2 Hatchery owners: Hatcheries are responsible for spawn production as per demand of fish species including Indian major carps (IMC): catla, rohu, mrigal; Exotic carps: grass carp, silver carp and common carp and several other species: Minor carps, cat fishes etc. In Tripura and Manipur, the Chinese eco-hatchery models are found more common for spawn production. However, in Tripura some of the nursery seed growers and fish farmers are also using low-cost hatchery such as FRP or hapa breeding for spawn production but their capacity is very limited. The hatchery owner performs activities like procurement input, brooders, feed, fertilizer, lime, medicine, hormone, packaging material, oxygen cylinder, etc. They maintain brooder during hatchery operation. Several activities like breeding, egg collection, putting eggs in spawning pools, spawn collection, packaging and selling etc. Further, hatchery operation is a seasonal activity confined to the period between March-July, however, some fish species particularly common carp breed in November-December. Hence hatcheries also operated during this period. Hatchery owners are engaged in a maintenance of brooder pond and nursery seed rearing, etc. The continuous electricity as well as water supply is an essential requirement in hatcheries operation during the season.

Fig 3.8: Glimpse of hatchery of Manipur

Fig 3.9: Glimpse of hatchery operation in Tripura

Socio-economic condition of hatchery owners:

The socio-economic condition of hatchery owners in Tripura and Manipur is given in table-3.4. It is observed that in Tripura, most of hatchery owners (71.42%) belong to schedule caste, whereas, in Manipur majority of hatchery owners are OBC (66.66%). The majority (57.15%) of hatchery owners belong to the higher age group in Tripura, and in Manipur 66.67% belong to the higher age group. It is observed that the education status of hatchery owners in Manipur is relatively better as compared to Tripura. In Tripura about 35.71% hatchery owners were found to have experience of less than 5 years, whereas, in Manipur majority of hatchery owners (44.44%) are having experience above 20 years. Social participation of hatchery owners was found poor in both the states. In Tripura major sources of information for hatchery are fellow farmers, whereas in Manipur extension officers are the major source of information (Fig. 3.1O). It is interesting to note that 100 percent of hatchery owners have annual Income more than 5 Lakh. The occupational structure of hatchery owners is given in table 3.5.

Table 3.4: Socio economic characteristics of hatchery owners-

Explanatory Variables	Tripura % age	Manipur % age	Overall % age
Age Group			
Upto14	0	0	0
15 – 50	42.85	33.33	39.13
Above 50	57.15	66.67	60.87
Caste			
SC	71.42	11.11	47.82
ST	7.14	0	4.34
OBC	7.14	66.66	30.43
General	14.28	22.22	17.39
Gender			
Male	100	100	100
Religion			
Hindu	78.57	100	89.28
Muslim	14.28	0	8.63
Christian	7.14	0	4.34
Resident type			
Rural	71.42	100	82.60
Urban	28.57	0	17.39
House type			
Katcha	14.28	100	47.82
Pucca	85.71	0	52.17
Resident House area			
Upto 1 kani	42.85	100	65.21

>1 kani	57.14	0	34.78
Agricultural land holding			
No Agricultural land	0	44.44	17.39
Up to 1 kani/ Up to 1 Sangam	0	22.22	8.69
>1 to 5 kani/ >1 to 5 sangam	28.57	11.11	21.73
>5to 10 kani/ >5to 10 sangam	21.42	22.22	21.73
>10 kani/ >10 sangam	50	0	30.43
Economic status instruction			
BPL	14.28	100	47.82
APL	85.71	0	52.17
Marital status			
Married	100	100	100
Family type			
Nuclear	71.42	88.88	78.26
Joint	28.57	11.11	21.73
Family size			
4 to 6	57.14	55.55	56.52
Above 6	42.85	44.44	43.34
Family member's educational qualification			
Illiterate	1.58	1.47	1.51
Primary	34.92	14.70	24.24
Upper primary	33.33	8.82	20.45
Secondary	17.46	25	21.96
Higher secondary	4.76	17.64	11.36
Graduate and above	7.93	32.35	20.45
Annual income			
Above 5 Lakh	100	100	100
Working experience (years)			
Upto 5 years	35.71	0	21.74
>5 to 10 years	21.43	22.22	21.74
>10 to 20 years	21.43	33.33	26.09
>20 years	21.43	44.44	30.43
Social participation			
No membership	64.29	88.88	73.91
Member of one organization	28.57	11.11	21.73
Member of more than one organization	7.14	0	4.34

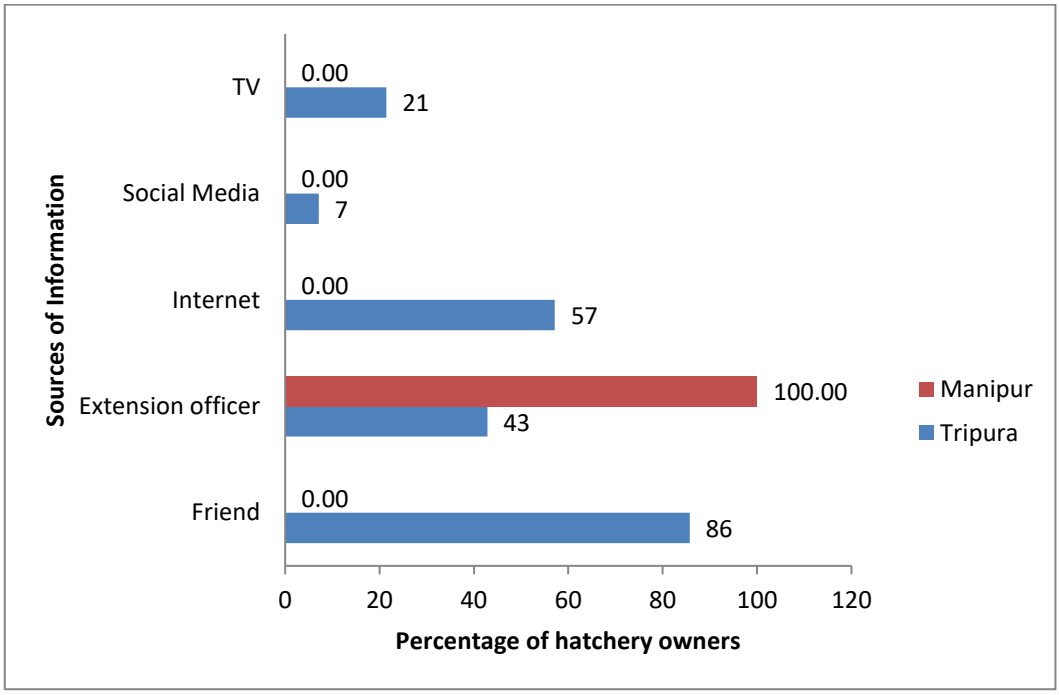


Fig 3.10: Sources of farm information used by the hatchery owners

Table 3.5: Occupational structure of hatchery owners of Tripura-

Primary Occupation	Secondary Occupation	Percentage
Hatchery Operation	Nursery seed rearing	61.54
	Fish production	15.38
	Business	23.08

3.2.1.3 Nursery seed growers: Nursery seed growers are another important entity in the fish seed supply chain. They procure spawn from hatchery and they rear it up to fry or fingerling stage. Some progressive farmers and rural youth acquired the skill in nursery seed rearing and started nursery seed rearing business. In nursery seed rearing, they required pond and input like spawn, lime, MOC, cow dung, fertilizer, feed, medicine, packaging material, etc. They also required electrical pump, packaging material, etc. The nursery rearing is done in high stocking density of either a single species or multiple species. Nursery seed rearing for spawn to fry stage (1-2 cm size) takes about 2-3 weeks whereas from fry to fingerling stage (10-15 cm size) takes about 6-8 weeks.

Socio -economic characteristics of nursery seed growers:

The socio-economic condition of nursery seed growers is given in table 3.6. Majority of seed growers were found to be in the middle age group (67.85% in Tripura and 72.41% in Manipur). In Tripura major nursery seed growers also belong to schedule caste (45.94%), whereas, in Manipur 51.72% belong to OBC followed by ST (34.48%). 4-6 members in the family are model class in both states. Educational status of nursery seed growers in Manipur were relatively better as compared to Tripura. 33.33% and 24.13% in Tripura and

Manipur, respectively have annual income above 5 lakhs. In Manipur majority of nursery seed growers have less than 10-years of experience whereas, in Tripura majority of nursery seed growers have experience of more than 10 years. Social participation of nursery seed growers was found poor in both states. In Tripura, sources of information were from friends (35.71%), extension officers (26.19%), internet (21.43%), social media (13.10%) and private agency or Input suppliers (3.5%). In Manipur extension officers were the main sources of information as reported by 58.62% nursery growers, followed by colleagues and friends (41.37%) (Fig 3.11). The occupational structure of nursery seed growers is given in table 3.7.

Table 3.6: Socio economic characteristics of nursery seed growers

Explanatory Variables	Tripura (%)	Manipur (%)	Overall (%)
Age Group			
15 – 50	67.85	72.41	70.17
Above 50	32.14	27.58	29.83
Caste			
SC	45.94	0	25.75
ST	24.32	34.48	28.78
OBC	21.62	51.72	34.84
General	8.10	13.79	10.60
Gender			
Male	100	100	100
Religion			
Hindu	43.08	11.76	47.69
Muslim	40.00	0.00	4.62
Christian	10.77	58.82	20.00
Buddhist	6.15	0.00	1.54
Others	43.08	20	26.15
Resident type			
Rural	75.67	100	86.36
Urban	24.32	0	13.63
House ownership			
Owned	97.29	100	98.48
Rental	2.70	0	1.51
House type			
Katcha	50	86.20	66.66
Pucca	50	13.79	33.33
Resident house area			
Up to 1 kani/ 1 sangam	76.66	100	88.13
>1 kani/ >1 sangam	23.33	0	11.86
Agricultural land holding			
No Agricultural land	9.09	3.44	6.45

Up to 1 kani/ Up to 1 Sangam	12.12	13.79	12.90
>1 to 5 kani/ >1 to 5 sangam	45.45	51.72	48.38
>5to 10 kani/ >5to 10 sangam	6.06	31.03	17.74
>10 kani/ >10 sangam	27.27	0	14.51
Economic status instruction			
BPL	48.64	68.96	57.57
APL	51.35	31.03	42.42
Marital status			
Married	100	100	100
Family type			
Nuclear	65.95	68.96	67.10
Joint	34.04	31.03	32.89
Family size			
Below 4	15.21	6.89	12
4 to 6	71.73	65.51	69.33
Above 6	13.04	27.58	18.66
Family member's educational qualification			
Illiterate	13.16	1.15	4.80
Primary	27.63	12.07	16.80
Upper primary	11.84	9.20	10.00
Secondary	14.47	17.82	16.80
Higher secondary	15.79	33.91	28.40
Graduate and above	17.11	25.86	23.20
Annual income			
Below 1 Lakh	12.5	20.68	16.98
1 Lakh - 2.5 Lakh	37.5	34.48	35.84
2.51 Lakh - 5 Lakh	16.66	20.68	18.86
Above 5 Lakh	33.33	24.13	28.30
Working experience (years)			
Up to 5 years	16.67	20.69	18.46
>5 to 10 years	13.89	48.28	29.23
>10 to 20 years	33.33	13.79	24.62
>20 years	36.11	17.24	27.69
Social participation			
No membership	72.72	100	85.48
Member of one organization	27.27	0	14.51

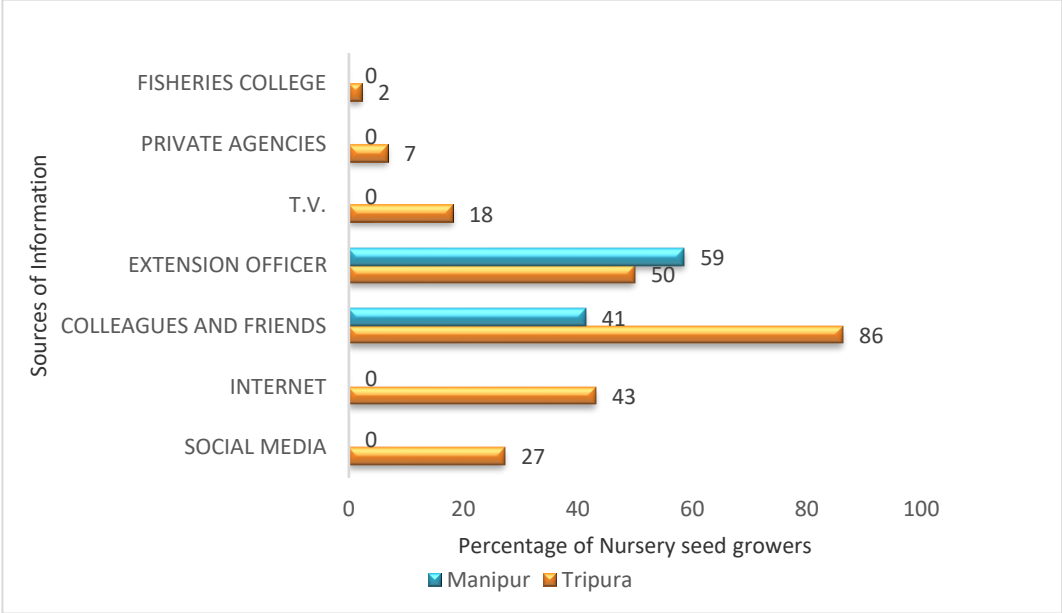


Fig 3.11: Sources of farm information used by the Nursery Seed Growers

Table 3.7: Occupational structure of Nursery Seed Growers in Tripura

Primary Occupation	Secondary Occupation	Percentage
Nursery seed Rearing	Fish Production	28.57
	Commission agent	5.71
	Shop	22.86
	Hatchery	5.71
	Agriculture	5.71
	Driver	5.71
	Poultry	2.86
	Rubber plantation	17.14
	Areca nut plantation	2.86
	Seed Vendor	2.86

3.2.1.4 Seed Market-Wholesaler-cum commission agent and traders:

Several seed markets are found operating in Tripura. In this study information from Badtala Fish Seed Market, West Tripura, Kemtali Pona bazar, Sepahijala, Ramesh Chowmuhani Pona Bazar Samiti, Gomati district and Kalacherra Fish seed market in North Tripura were collected. It was found that in seed markets, specified space with few Wholesaler -cum commission agents commission agents facilitates buying and selling of seeds. Generally, nursery seed growers brought seeds for sale and seeds are purchased by seed vendors or fish farmers themselves. The wholesaler-cum-commission agents were found in a seed market in Tripura. They were absent in Manipur as there was no fish seed market in Manipur. In Manipur, seed traders import fish seed from other states and supply

them to the farmers. The whole sellers cum commission agents in fish seed markets in Tripura collect charges with 10% commission on sale value from the sellers of seed.

Fig 3.12: Nursery seed markets in Tripura

Wholesalers cum- commission agents have permanent establishment in fish seed markets. They actively provide facilities like water exchange facilities, platform for seed sellers, auction of seeds etc. Sometimes they also provide financial support to seed growers so that they can produce and sell their seed through them. The socio- economic condition of wholesaler cum commission agent is given in table 3.8. It is found that the majority of wholesaler cum- commission agents of fish seed markets in Tripura (68.75%) and majority of seed traders in Manipur (87.05%) were in the middle age group. Majority of the wholesaler cum- commission agents in Tripura belong to SC (72.2%) category and in Manipur majority of traders were OBC (50%). Their family size ranges between 4-6

members. Education level of traders was higher in Manipur as compared to wholesaler-cum-commission agents of Tripura. Majority of wholesaler cum-commission agents in Tripura had annual income between Rs.2.5 to Rs. 5 lakhs, whereas, in Manipur 63% of traders had annual income above Rs. 5 lakhs. Majority of these functionaries had experience between 5 to 20 years. Social participation is poor in both the states. These agencies use different sources of information (Fig. 3.13). The occupational structure of wholesalers cum commission agent is given in table 3.9.

Table 3.8: Socio-Economic characteristics of wholesalers cum- commission agent of Tripura and traders of Manipur

Explanatory Variables	Wholesalers in Tripura (%)	Traders in Manipur (%)	Overall (%)
Age Group			
15 – 50	68.75	87.5	71.875
Above 50	31.25	12.5	28.125
Caste			
SC	72.22	6	35.5
OBC	11.11	50	30
General	27.77	44	34.5
Gender			
Male	100	94	97
Religion			
Hindu	80	94	87
Muslim	20	6	13
Resident type			
Rural	55	88	171.5
Urban	45	12	28.5
House ownership			
Owned	100	100	100
House type			
Katcha	55	25	40
Pucca	45	75	60
Resident house area			
Up to 1 kani/ Upto 1 Sangam	100	100	100
Agricultural land holding			
No Agricultural land	15	0	13.15
Up to 1 kani/ Upto 1 Sangam	10	12.5	8.77
>1 to 5 kani/ >1 to 5 sangam	55	25	51.75
>5to 10 kani/ >5to 10 sangam	15	31.25	17.54
>10 kani/ >10 sangam	5	31.25	8.77
Economic status instruction			

BPL	55	100	77.5
APL	45	0	22.5
Marital status			
Single	5	6	5.5
Married	95	94	94.5
Family type			
Nuclear	25	37	31
Joint	75	63	69
Family size			
Below 4	15	18.75	15.51
4 to 6	60	62.5	60.34
Above 6	25	18.75	24.13
Family member's educational qualification			
Illiterate	8	5.06	6.67
Primary	10	11.39	10.56
Upper primary	32	7.59	21.11
Secondary	30	11.39	22.22
Higher secondary	15	16.45	15.56
Graduate and above	5	48.10	23.89
Annual income			
Below 1 Lakh	21.05	0	3.36
1 Lakh - 2.5 Lakh	31.57	6	10.08
2.51 Lakh - 5 Lakh	36.84	31	31.93
Above 5 Lakh	10.52	63	54.62
Working experience (years)			
Up to 5 years	33.33	50	41.17
>5 to 10 years	33.33	18.75	26.47
>10 to 20 years	27.77	31.75	29.41
>20 years	5.55	0	2.94
Social participation			
No membership	20	0	10
Member of one organization	80	100	90

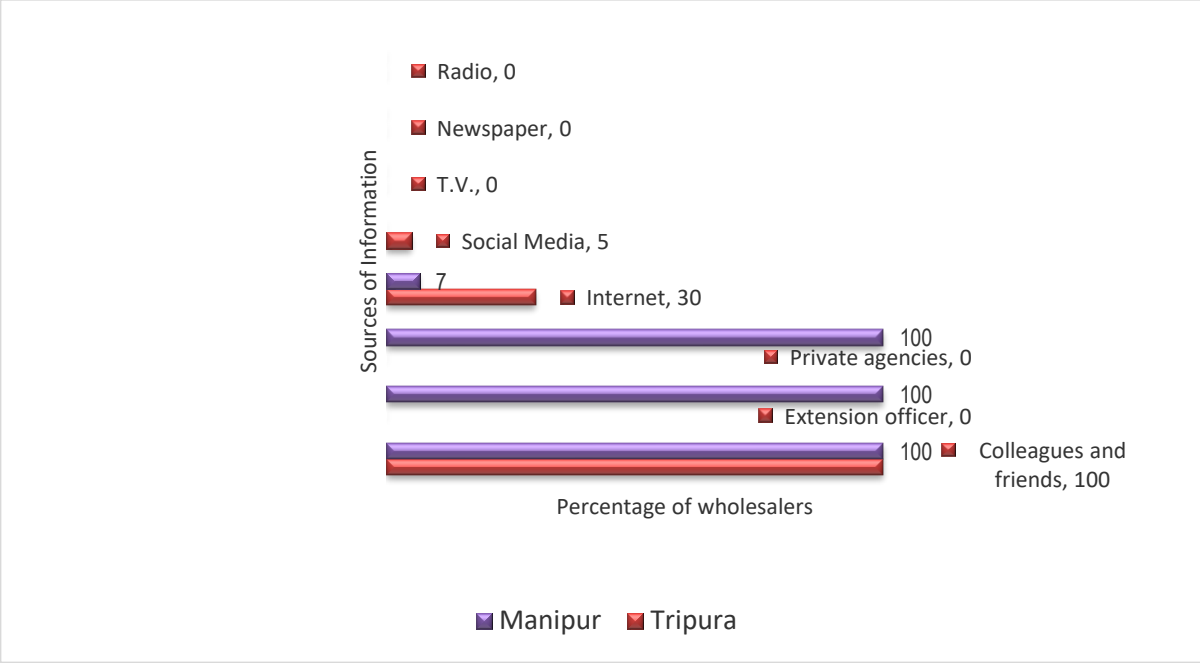


Fig 3.13: Sources of information used by wholesalers cum- commission agent/traders

Table 3.9: Occupational structure of wholesalers cum- commission agent of Tripura

Primary Occupation	Secondary Occupation	Percentage
Wholesalers cum Commission agent	Nursery seed grower	25
	Fish farmer	15
	Shop	20
	Agriculture	10
	Doctor	5
	Fish commission agent	5
	No occupation	20

3.2.1.5 Seed vendors: The seed vendors were found functional in Tripura. In Manipur due to absence of fish seed market and seed vendors, farmers directly purchased seed (spawn, fry and fingerling) from hatchery owners. Seed vendors play a vital role in seed distribution in Tripura. During the season (February- August), the seed vendors purchase fingerlings either from the seed market or nursery seed growers and transports them to remote villages to deliver to the farmers. Every day they travel about 10 to 60 km, out of which 5-10km by walk and carry two handi with seed (average 1134 number) in water. The seed vending is a very difficult task performed by seed vendors. The socio-economic condition of seed vendors of Tripura is given in table-3.1O. The majority of seed vendors were in age group of 15 - 50-year, majority of them are SC (79.59%), majority of them belonged to rural areas (46.94%), majority of them have no land less (51.02%), below

poverty line (48.98%), majority of them are working seed vending for more than 10 years. Their social participation was poor (69.34%). Colleague and friends were found to be only source of information (93.85%) (Fig. 3.15). The occupational structure of seed vendors is given in table 3.11.

Fig 3.14: Fish seed vendors carrying seeds to distribute

Table 3.10: Socio-economic conditions of fish seed vendors of Tripura

Explanatory Variables	Tripura (%)
Age Group	
Upto14	
15 – 50	55.10
Above 50	26.53
Caste	
SC	79.59
General	20.41
Gender	
Male	100
Religion	
Hindu	79.59
Muslim	20.41
Resident type	
Rural	46.94
Urban	22.45
House ownership	
Owned	100
House type	
Katcha	71.43
Pucca	22.45
Resident house area	
Up to 1 kani	77.55
>1 kani	10.20
Agricultural land holding	
No Agricultural land	51.02
Up to 1 kani/ Up to 1 Sangam	20.40
>1 to 5 kani/ >1 to 5 sangam	26.53
>5to 10 kani/ >5to 10 sangam	2.04
Economic status instruction	
BPL	69.38
APL	30.61
Marital status	
Single	4.08
Married	93.87
Widowed	2.04
Family type	
Nuclear	63.26
Joint	26.53
Family size	
Below 4	20.40

4 to 6	59.18
Above 6	16.32
Family member's educational qualification	
Illiterate	5.30
Primary	19.70
Upper primary	27.27
Secondary	27.27
Higher secondary	11.36
Graduate and above	9.09
Annual income	
Below 1 Lakh	48.98
1 Lakh - 2.5 Lakh	38.77
2.51 Lakh - 5 Lakh	2.04
Above 5 Lakh	
Working experience (years)	
Up to 5 years	12.24
>5 to 10 years	14.28
>10 to 20 years	26.53
>20 years	32.07
Social participation	
No membership	69.39
Member of one organization	28.57
Member of more than one organization	2.041

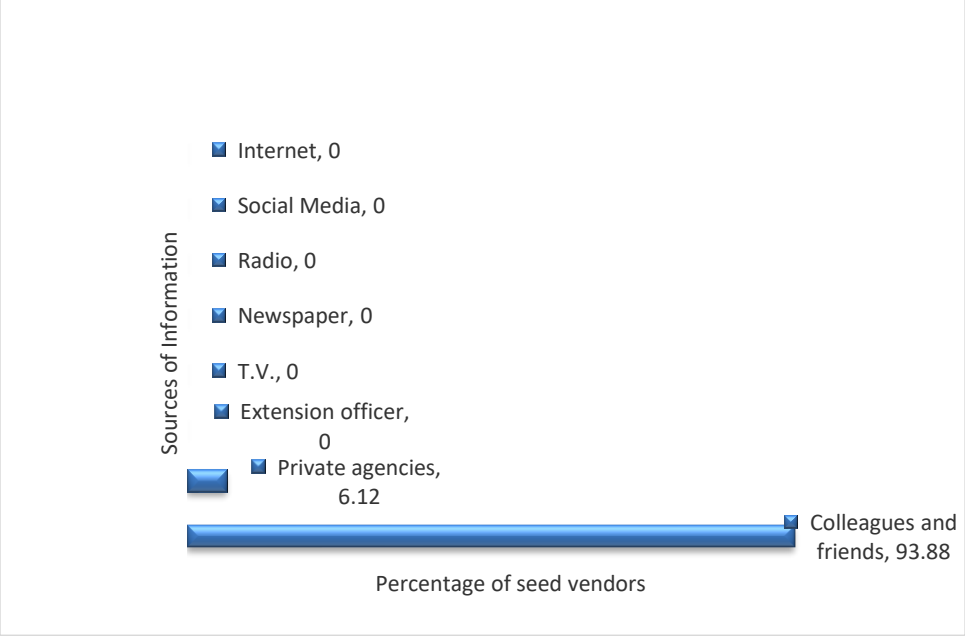


Fig 3.15: Sources of information used by the seed vendors in Tripura

Table 3.11: Occupational structure of fish seed vendors of Tripura

Primary Occupation	Secondary Occupation	Percentage
Fish seed vendor	Agriculture	2.04
	Daily labour	40.82
	Dairy	2.04
	Driver	2.04
	Fish labour	10.20
	Fish farmer	16.33
	Poultry	2.04
	Selling fish	4.08
	No Secondary Occupation	20.41

3.2.1.6 Fish farmers: In case of seasonal ponds, the culture period of fish in Tripura and Manipur starts with the onset of monsoon (April-May) and it continue upto February-March. However, it depends upon monsoon and availability of the seed. Fish seed stocking in ponds continue till July and August. Since majority of ponds are rainfed, culture of fish starts once sufficient water level is maintained in the pond through rainfall. In fish seed supply chain, farmers are at the receiving end and their satisfaction determines the supply chain performance. Farmers purchase seed either from seed vendors, seed markets or nursery seed growers. In Tripura, only in a few cases, farmers themselves purchase spawn and do nursery seed rearing. However, in Manipur, most of the farmers purchase spawn from hatchery and do nursery seed rearing. This is the basic difference in the fish seed supply chain of Tripura and Manipur. Most of the seed requirements of fish farmers in Tripura are met by the fish seed vendors. However, some farmers also purchase seed either from seed markets or from nursery seed growers. In this case, they have to arrange for transport of seed and owe risk of mortality during seed transportation etc. However, in this method they can ensure better quality of seeds.

Socio economic condition of fish farmers in Tripura and Manipur is given in table 3.12. Fish culture in Tripura and Manipur is done across all social classes, majority of fish farmers have *Kachha* houses (52.8%) in Tripura and 100% had *Kachha* houses in Manipur. Majority of farmers in Manipur belong to BPL (68.55%). Whereas in Tripura 41 .93% farmers were below poverty line, majority of farmers in both states have family size between 4-6 members. It is evident from the table that the education level of farmers in Manipur was better as compared to Tripura. A good number of fish farmers have less than 5 years of experience, which indicates interest of young farmers in fish culture. The occupational structure of farmers is given in table 3.13. Social participation of farmers was poor in both states. The extension officers, colleagues and friends were important sources of information utilized by the farmers of Tripura and Manipur (Fig.3.17).

Fig 3.16: Glimpse of fish farms in Tripura and Manipur

Table 3.12: Socio economic characteristics of fish farmers

Explanatory Variables	Tripura (%)	Manipur (%)	Overall (%)
Age Group			
15 – 50	67.42	92.45	148.43
Above 50	32.58	7.55	34.59
Caste			
SC	37.40	1.26	17.02
ST	22.76	25.16	24.11
OBC	24.39	46.54	36.88
General	15.45	27.04	21.99
Gender			
Male	98.55	81	87.98
Female	1.45	18.23	12.01
Religion			
Hindu	84.68	0.00	37.10
Muslim	7.26	8.18	7.77
Christian	8.06	25.16	17.67
Others	0.00	66.67	37.46
Resident type			
Rural	96	100	98.29
Urban	4	0	1.71
House ownership			
Owned	100	100	100
House type			
Katcha	52.8	100	79.22
Puccha	47.2	0	20.77
Resident house area			
Upto 1 kani	94.89		94.89
>1 kani	5.10		5.10
Agricultural land holding			
No Agricultural land	72.15		72.15
Up to 1 kani/ Up to 1 Sangam	27.84		27.84
Economic status instruction			
BPL	41.93	68.55	56.89
APL	58.06	31.44	43.10
Marital status			
Single	18.4	0	8.12
Married	80.8	100	91.87
Widowed	0.8	0	0.35
Separated		0	

Family type			
Nuclear	56	92.30	79.57
Joint	44	7.70	20.42
Family size			
Below 4	14.16	4.40	8.60
4 to 6	66.66	83.64	76.34
Above 6	19.17	11.94	15.05
Family member's educational qualification			
Illiterate	14.05	0.76	5.53
Primary	21.21	3.98	10.18
Upper primary	19.83	4.13	9.78
Secondary	17.91	19.72	18.68
Higher secondary	14.33	42.97	32.91
Graduate and above	12.67	28.44	22.92
Annual income			
Below 1 Lakh	47.06	12.58	22.41
1 Lakh - 2.5 Lakh	36.76	74.21	63.79
2.51 Lakh - 5 Lakh	10.29	11.95	11.21
Above 5 Lakh	5.88	1.26	2.59
Working experience (years)			
Up to 5 years	26.53	29.68	28.46
>5 to 10 years	25.51	52.90	42.29
>10 to 20 years	35.71	15.48	23.32
>20 years	12.24	1.94	5.93
Social participation			
No membership	76.66	198.81	89.47
Member of one organization	23.34	3.18	10.53

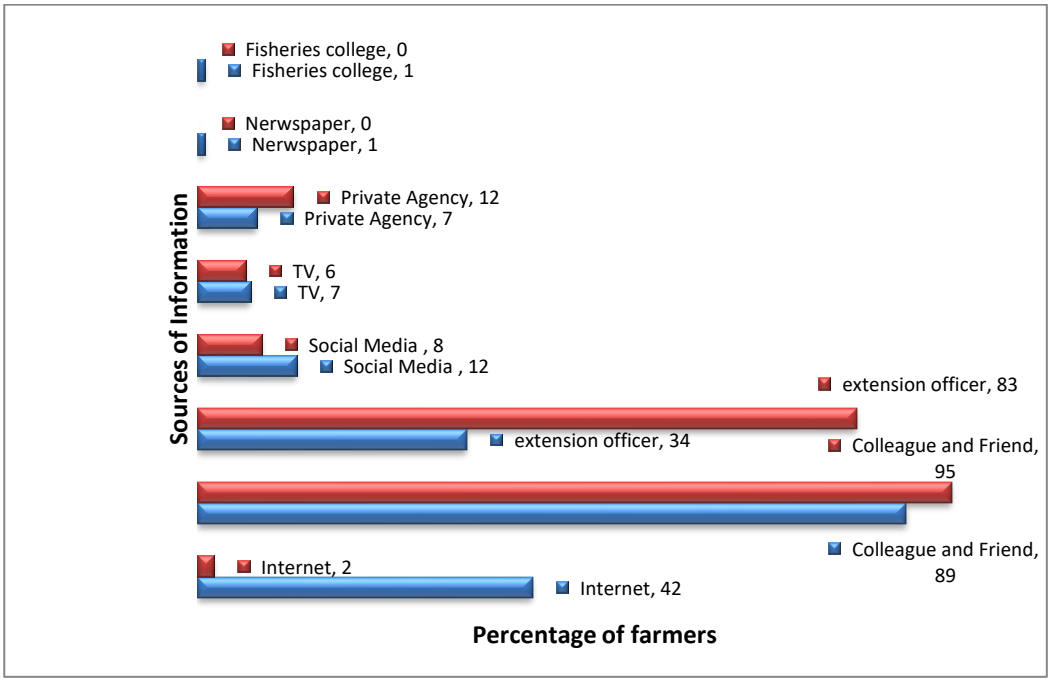


Fig 3.17: Sources of farm information used by the fish farmers in Tripura and Manipur

Table 3.13: Occupational structure of fish farmers in Tripura

Primary Occupation	Secondary Occupation	Percentage
Fish Production	Nursery Seed Rearing	6.38
	Agriculture	18.09
	Livestock	3.19
	Rubber plantation	9.57
	Service(pvt,/govt)	8.51
	Shop	15.96
	Labour	18.09
	Fish vendor	1.06
	Milk vendor	2.13
	Driver	7.45
	Jhum farming	2.13
	Technician	3.19
	Business	4.26

3.2.1.7 Labourers: The labourers are playing important role in the seed supply chain. At hatchery, they perform various functions like maintenance of brooder pond, feeding, brooder collection, activities related to hatchery operation including egg collection, spawn collection, packaging of seed etc. At nursery level pond preparation, fertilization, stocking, netting, feeding and conditioning of seed, loading unloading are performed. At the market, they are involved in most of the market operations including loading and un-loading, packaging, transportation, fish seed handling, facilitating water exchange, seed counting, etc.

Fig 3.18: Labourers working at hatchery

Socio economic condition of labourers is given in table- 3.14. Majority of labourers (68.18%) of Tripura belong to SC category. Similarly in Manipur a high proportion (70.11%) belong to OBC category. In the seed supply chain mainly male labourers (100%) were engaged in Tripura, (93.18%) in Manipur. Only (6.8%) of women labour is found in Manipur. It Indicates poor participation of women in the fish seed supply chain. Majority of labourers have *Kachha* houses and majority of them are landless and below poverty line. About 68.75% labour in Tripura and 50% in Manipur have annual income below Rs. 1 lakh, remaining 31.25% in Tripura and 45.45% in Manipur have annual income in between Rs. 2.1 - Rs. 2.5 lakh per annum. Their social participation is poor, labourers in Tripura were using multiple sources of information as against Manipur, where they mostly use information sources as colleagues and friends. The occupational structure of labourers is given in table 3.15.

Table 3.14: Socio-economic characteristics of labourers of Tripura and Manipur

Explanatory Variables	Tripura (%)	Manipur (%)	Overall (%)
Age Group			
15 – 50	72.72	93.18	90.47
Above 50	27.27	6.81	14.28
Caste			
SC	68.18	0	22.72
ST	9.09	0	3.03
OBC	9.09	70.45	50
General	16.63	29.54	24.24
Gender			
Male	100	93.18	95.45
Female	0	6.81	4.55
Religion			
Hindu	86.36	4.54	31.81
Muslim	13.63	0	4.54
Others	0	95.45	63.63
Resident type			
Rural	0	100	100
House ownership			
Owned	0	44	
House type			
Katcha	68.18	100	89.39
Pucca	31.81	0	10.61
Resident house area			
Upto 1 kani/ >10 sangam	86.36	97.72	93.93
>1 kani/ >1 sangam	13.64	2.27	6.06
Agricultural land holding			
No Agricultural land	86.67	56.81	71.74
Up to 1 kani/ Up to 1 Sangam	6.67	9.09	7.88
>1 to 5 kani/ >1 to 5 sangam	6.67	31.81	19.24
>5to 10 kani/ >5to 10 sangam		2.27	2.27
Economic status			
BPL	72.72	95.45	87.87
APL	27.27	4.54	12.13
Marital status			
Single	9.90	13.63	12.12
Married	9.09	86.36	87.88
Family type			
Nuclear	31.81	84.09	66.66

Joint	68.18	15.90	33.33
Family size			
Below 4	33.33	13.63	20
4 to 6	63.33	89.54	75
Above 6	3.33	6.81	5
Family member's education			
Illiterate	12.33	0.42	3.24
Primary	30.14	3.39	9.71
Upper primary	23.29	4.24	8.74
Secondary	23.29	13.18	15.53
Higher secondary	6.85	28.81	23.62
Graduate and above	4.11	50.00	39.16
Annual income			
Below 1 Lakh	68.75	50	55
1 Lakh - 2.5 Lakh	31.25	45.45	41.66
2.51 Lakh - 5 Lakh	0	4.55	3.33
Working experience (years)			
Up to 5 years	14.28	56.82	43.07
>5 to 10 years	66.66	27.27	40
>10 to 20 years	19.04	6.82	10.76
>20 years		9.09	6.15
Social participation			
No membership	66.66	100	89.23
Member of one organization	33.33	0	10.76

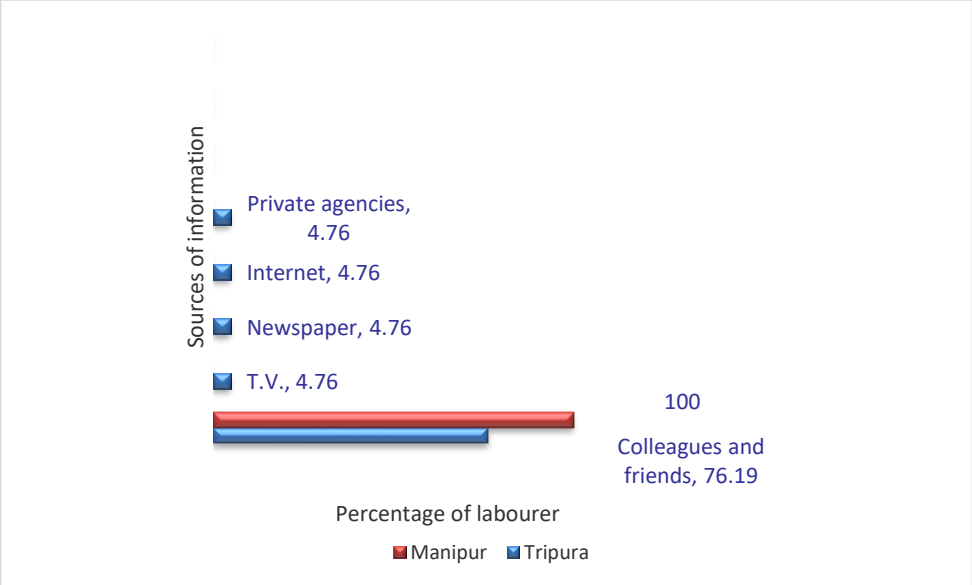


Fig 3.19: Sources of information used by the labourer

Table 3.15: Occupational structure of labours of Tripura

Primary occupation	Secondary Occupation	Percentage
Labour in Fish seed supply chain	Driver	4.0
	Daily Labour	48.0
	Fish Farm	12.0
	Net mending	4.0
	Shop	4.0
	Rickshaw	4.0
	other agricultural labour	4.0
	Farming	12.0
	Labour at fish farm	8.0

3.2.2 Relational link between supply chain entities

3.2.2.1 Relational Links

The relational link between fish supply chain entities of Tripura and Manipur is represented through diagram in figure 3.20 and 3.21. In the case of Tripura, input suppliers supply different input to hatcheries, nursery seed growers and farmers. They maintain one to many relationships. The entity relationship between supply chain actors is of three types: exclusive, preferred and vendor type. An input supplier supplies the same input to multiple hatchery units, nursery seed growers and farmers. However, in case of hatchery, bargaining power is more as they purchase inputs in bulk quantities particularly lime, feed and hormones. In case of some inputs, input suppliers are exclusive suppliers as there is single or few input dealers e.g. hormone, pituitary gland etc. Hatchery unit produce the spawn and sell it to nursery seed growers. Commonly, hatcheries of Tripura sell spawn at hatchery, however in some cases they supply spawn to outside states like Assam and Mizoram. Hatchery and nursery seed grower relationship were found as preferred suppliers in which strategies are important for hatchery owners is more, at the same time buyers also have high bargaining powers. Hatchery owners are specialized in spawn production, their information exchange is frequent, and hatchery owners provide information about production, price and quality to the nursery seed growers. Delivery schedule is frequent and the number of suppliers is few. At seed farms, nursery growers are in a better position to bargain with seed vendors and farmers hence, they have a preferred relationship. It is characterized by specialized product frequent information exchange, incentive price, frequent delivery and fewer suppliers whereas, in the seed market, there are many seed sellers and many seed buyers (seed vendors and farmers). Hence, in the market they have vendor type relationships in which bargain powers of buyers are more as many seed suppliers are present in the market. Length of contract is short, information exchange sporadic, price, delivery schedule is frequent, numbers of suppliers many. Relationship between seed vendors and farmers at fish farms is under type and here bargaining powers of farmers (buyers) are more. Since fish seed is transported in the handi in which a greater number of fingerlings are kept in small amounts of water,

hence there is risk of mortality due to deficiency of oxygen in water. Hence, seed vendors are in hurry to settle seeds in order to avoid mortality and heavy economic loss.

In this study the relationship between input suppliers and hatchery owners was found to be the exclusive type, hatchery owners and nursery seed growers were found to be the preferred relationship. In the case of nursery seed growers and seed vendors at seed farms, seed growers were in a better position to bargain. Hence a preferred relationship was found. However, in the seed market seed buyers are in a better position to bargain for seed as many sellers are present in the market in this case relationships were vendor type. At the farm level, farmers are in a better position to bargain with seed vendors which indicates a preferred relationship.

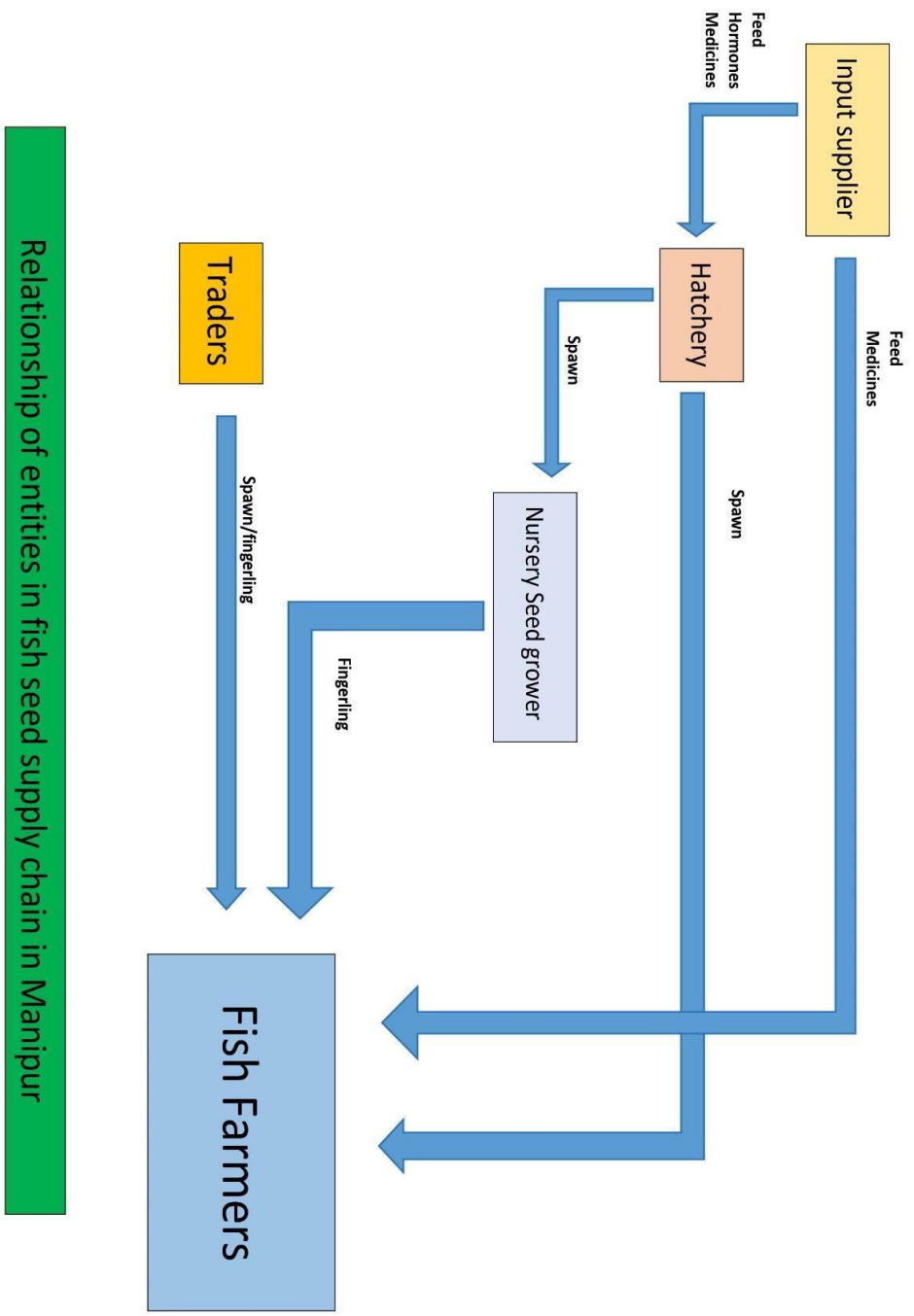
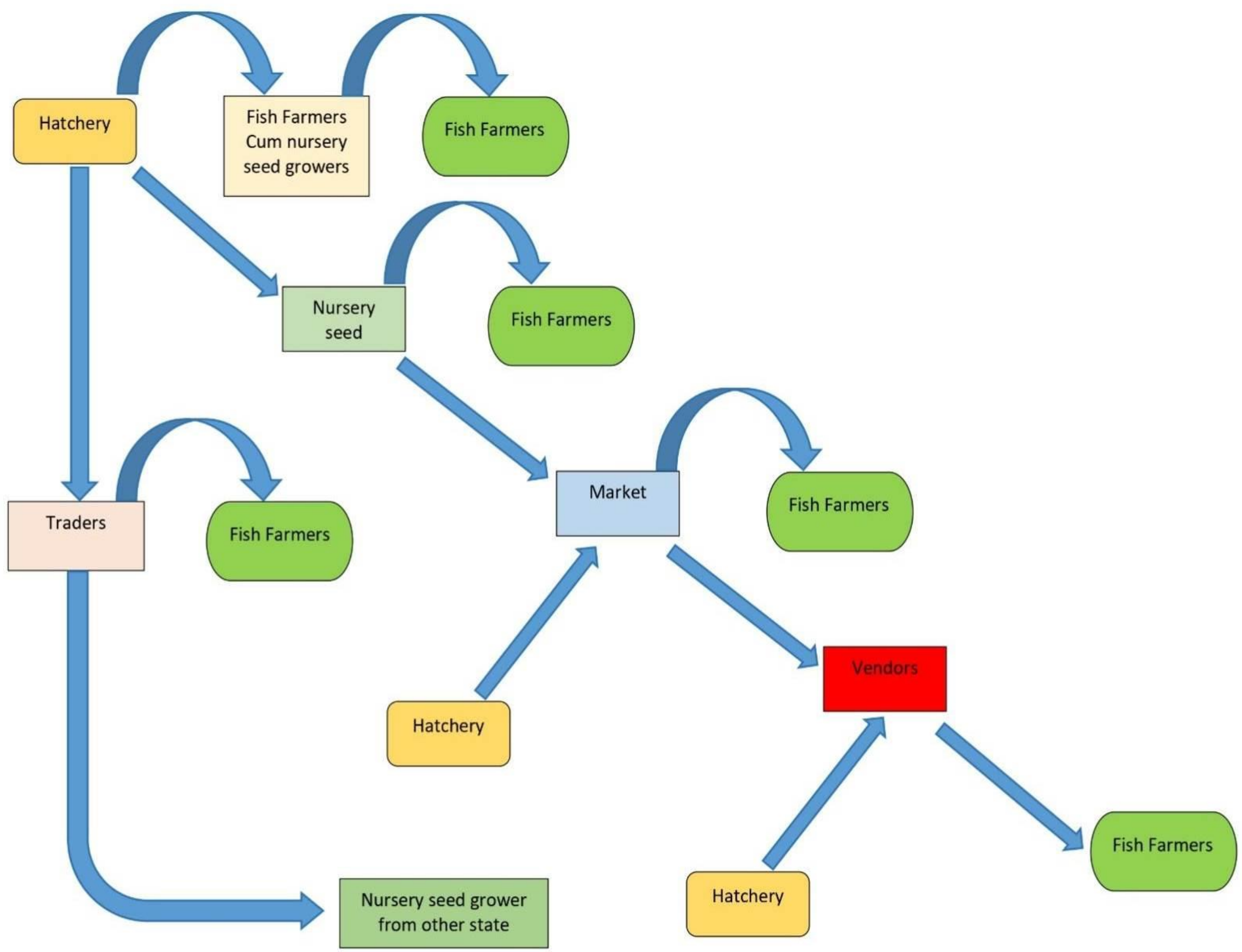

Relationship of entities in fish seed supply chain in Manipur
Input supplier
Feed
Hormones
Medicines
Feed
Medicines
Hatchery
Spawn
Spawn
Nursery Seed grower
Fingerling
Traders
Spawn/fingerling
Fish Farmers

Fig. 3.20



Relationship of entities in fish seed supply chain of Tripura

Fig.3.21

Input suppliers for hatcheries supplies brooder, feed, fertilizers, lime, cow dung, hormone, net, oxygen cylinder, packaging material, etc. In Manipur, scale of operation of hatcheries are bigger as compared to Tripura. Hence, they purchase the inputs from the same suppliers and also in bulk quantities. The relationship between input suppliers and hatchery owners in Manipur can be characterized as specialized, frequent suppliers of input, information sharing, incentive price and better services and only one or few suppliers of inputs exists in the area. These characteristics reflect either preferred or exclusive suppliers' relationship. Whereas, in Tripura a lot of variation exists in size and scale of hatcheries operations, hence, input purchases are in smaller quantities. In Tripura, hatchery owners have to approach input suppliers for supply of inputs. Also, the hatchery owners in Tripura frequently change input suppliers to bargain for input prices. Hence, in Tripura relationships between input suppliers and hatchery owners were more of vendor type or preferred suppliers type rather than exclusive suppliers. During hatchery operation, brooders, hormone, oxygen cylinder, packaging materials are critical inputs. These inputs have greater impact on hatchery operation and spawn production

Supply Chain interaction

The supply chain is considered to be either vertically or horizontally integrated. The vertical relation is a set of inter organizational relations between actors in different tiers. The complete vertical chain links initial suppliers to all the way to the end users i.e. fish farmers. The vertical integration is when an actor increases in its ownership to include other actors in different tiers. In the case of fish seed supply chain, hatchery owners are commonly involved in spawn production as well as fingerlings production, but in Tripura it is not the common practice. Similarly, nursery seed growers in Tripura produce fingerlings but sometimes they transport seed to sell it in the seed markets. Similarly, fish farmers generally buy seed from seed vendors but in some cases, it was found that they also purchased seed either from seed market or from nursery seed growers and transported it to their farms.

Horizontal relationship:

Since supply chain actors within the same tier play the same functions in the seed supply chain, the relations are between actual and potential competitors. The supply chain actors functioning at the same level want to form alliances with competing actors, due to several benefits such as shared information on demand of fish seed or availability of seed with competing hatchery owners and nursery seed growers. Through horizontal integration hatchery owners share technology of breeding of new fish species or technology related to nursery seed rearing technology for new species. They also shared information on availability of seed with competing seed producers.

3.2.3 Material flows

3.2.3.1 Seed Supply Chain Map Showing Material Flow in Tripura

The fish seed supply chain in Tripura is composed of networks involving hatchery, nursery seed grower, vendors, traders and fish farmers. There are few seed markets which supply the seeds to most parts of the state. The seed from the market is distributed by the vendors. The farmers also collect seed directly from the nursery seed growers or fish seed market, physical flow of seed from hatchery to the end user that is the farmer depicted in fig. 3.22. The diagram also represents proportion of seed flows through different channel. It is observed that, out of total spawn produced at hatchery ,65.13% are sold to nursery seed growers, 19.88% spawn are sold to fish farmers cum nursery seed growers. About 9.99% spawn are sold to seed traders who export seed to other states. However, 5% of total spawn produced are retained to hatchery owners for rearing up to fry and fingerling stage. Nursery seed growers rear and spawn up to fry or fingerling stage. They sell fry and fingerling to seed vendors and fish farmers or transport it to sell in the seed market. It is found that out of total production of fry/fingerlings, 62.71%are sold by them in the market, 17.81% directly to vendors at seed farms and 5.86% to fish farmers at farms. In the market seed suppliers sell 51.44% seed to farmers and 49.66% to seed vendors. It is reflected from the flow diagram that fish farmers are buying seed from nursery seed growers, seed vendors, seed markets and only few farmers are getting seed from fellow fish farmers cum nursery seed growers.

Table 3.16: Sub channels in Fish Seed Supply chain in Tripura

Channels		Physical flow %
Spawn		
I.	Hatchery-Nursery seed growers	65
II.	Hatchery-Traders	10
III.	Hatchery-Farmers	20
IV.	Hatchery, self-seed production	5
	Total	100.0
Fry and Fingerlings		
I.	Hatchery –Seed Growers-Farmers	6
II.	Hatchery –Seed Growers-Market-Vendor-Farmers	37
III.	Hatchery –Seed Growers-Market-Farmers	39
IV.	Hatchery –Seed Growers-Vendor-Farmers	18
	Total	100.0

In Tripura a total of 4 market channels for spawn delivery and 4 market channels for fry/fingerling delivery have been identified and presented in table 3.16. Further, proportion of seed flows in different channels are also given in the table. It was found that

in case of spawn marketing channel I i.e. Hatchery-Nursery seed growers was found to be dominating as 65.20% of total spawn is traded through this marketing channel. In case of fry and fingerlings marketing channel II that is hatchery-seed grower-wholesaler- cum commission agent -farmer and marketing channel III i.e., hatchery seed grower - commission agent cum wholesaler - vendors - farmers were dominant marketing channels as they shared about 37% and 39% of total seed supply.

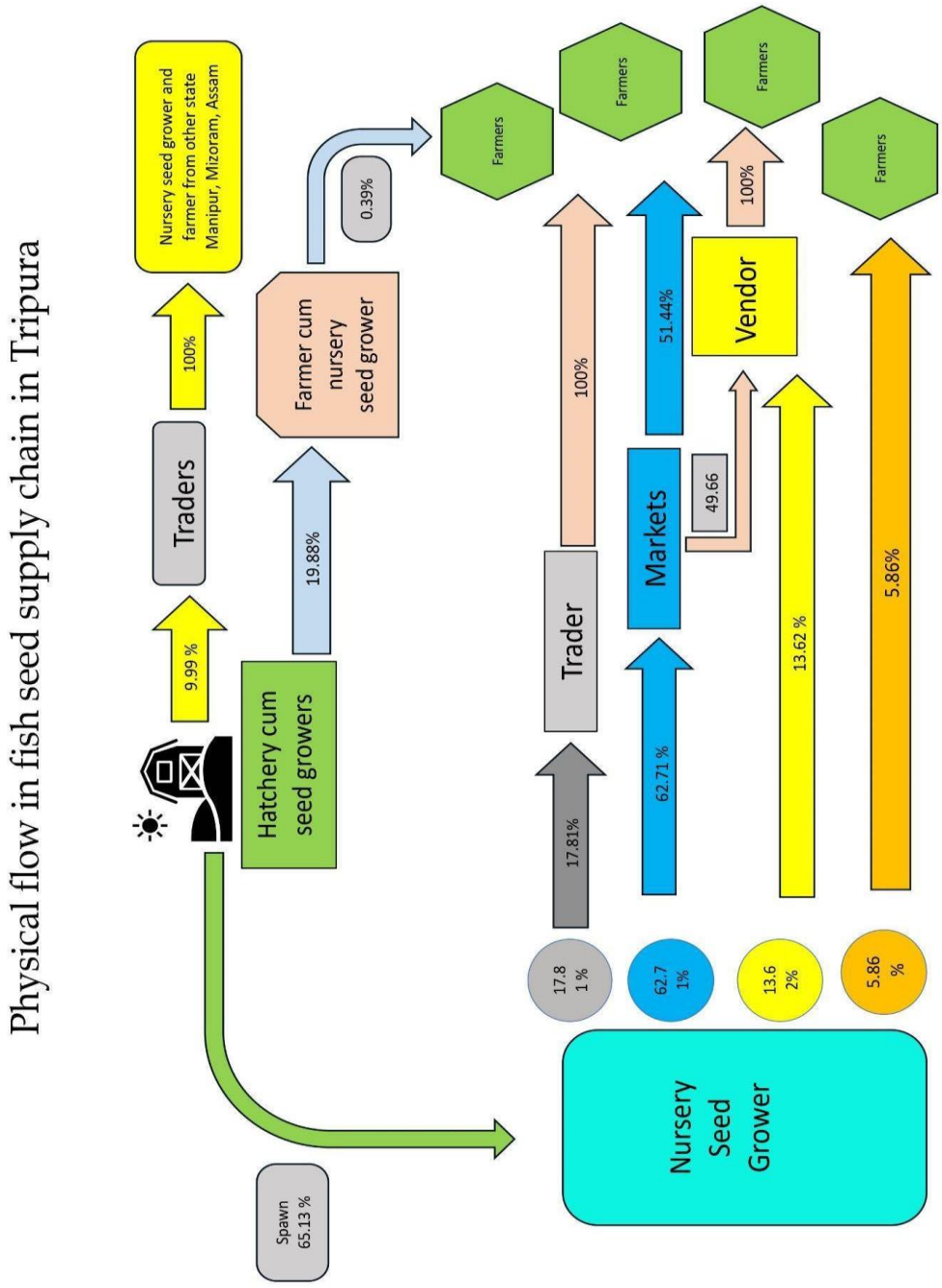


Fig 3.22 Physical flow of fish seed supply chain in Tripura

Fig 3.23: Glimpse of supply chain activities In Tripura

3.2.3.2 Seed Supply Chain Showing Material Flow in Manipur:

The supply of fish seed in Manipur is mainly done by hatchery owners, seed growers and the traders. There is no fish seed market in Manipur and the farmers are collecting seed directly from the hatchery owner and nursery seed growers. The seed trader imports seed from Kolkata and distribute it to local farmers. The traders also distribute fish spawns to the nursery seed growers. The hatcheries of Manipur also supply seed through seed traders to outside states like Mizoram. Material flow in fish seed supply chain of Manipur is represented in figure 3.24. It is observed from the figure that the fish farmers purchase seed (55.43% fry and 38.69% fingerlings) directly from hatchery cum nursery seed growers. Whereas, 6.49% of total seed requirement of farmers is met by the traders who import fish seeds from outside state i.e. Kolkata. Further, about 15.28% of fish farmers' purchases spawn do nursery seed rearing at their own farms and they meet out their requirement as well of the neighboring farmers. All together four sub channels were identified for seed supply in Manipur (Table 3.17). In marketing channel I hatchery- cum-nursery seed growers-farmers was accounted for about 65 percent of total physical flow of fish seeds. However, marketing channel II hatchery- nursery seed growers cum fish farmers accounted for about 23%, marketing channel III i.e. hatchery-seed Traders-farmers through which fish seeds are supplied to outside states shared about 5 % and marketing Channel IV Hatchery/nursery seed growers (Kolkata)-fish seed traders-fish farmers contribute about 7% of total fish seed supply of Manipur.

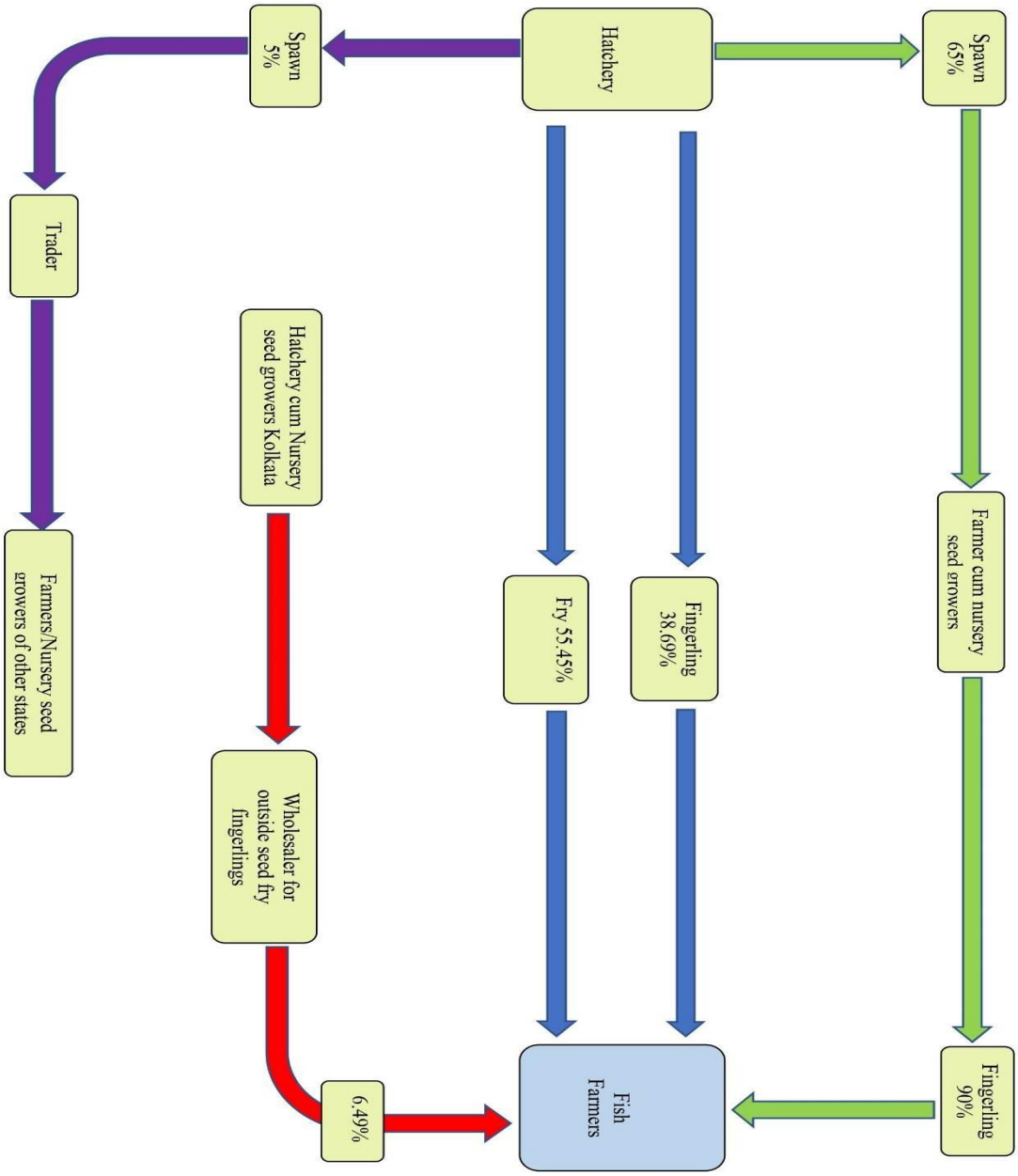


Fig. 3.24 Physical flow in fish Seed Supply chain of Manipur.





Fig 3.25: Components of fish seed supply chain of Manipur

Table 3.17: Sub channels in Fish Seed Supply chain in Manipur

Channels		Physical flow %
I.	Hatchery- cum-Nursery seed growers-Farmers	65
II.	Hatchery- Nursery seed growers cum fish farmers	23
III.	Hatchery-Seed Traders-Seed supply to outside states	5
IV.	Hatchery/Nursery seed growers (Kolkata)-Seed Traders-Farmers	7
	Total	100.0

3.2.4 Information flows

The fish seed supply chain information includes availability of fish seeds of particular species, size and quality. For a successful supply chain, regular interaction between the supplier and buyers is necessary.

The flow of information, money and seed is separately depicted for Tripura and Manipur in fig 3.26 and 3.27, respectively. Information flow was found to be bi- directional, information regarding seed availability and seed supplies flows from upstream to downstream of supply chain whereas information about seed demand in terms of species, size, quality, flows from downstream to upstream. Monetary flow is unidirectional from downstream to upstream. Physical flow of seed is also unidirectional i.e., from upstream to downstream. Similarly, in Manipur physical flow of seed is unidirectional i.e. from hatchery to fish farmers. Whereas, money flow is unidirectional opposite to physical flow, hence, money flows from farmers to seed producers. Information flow was found to be bidirectional i.e. from upstream to downstream and vice versa.

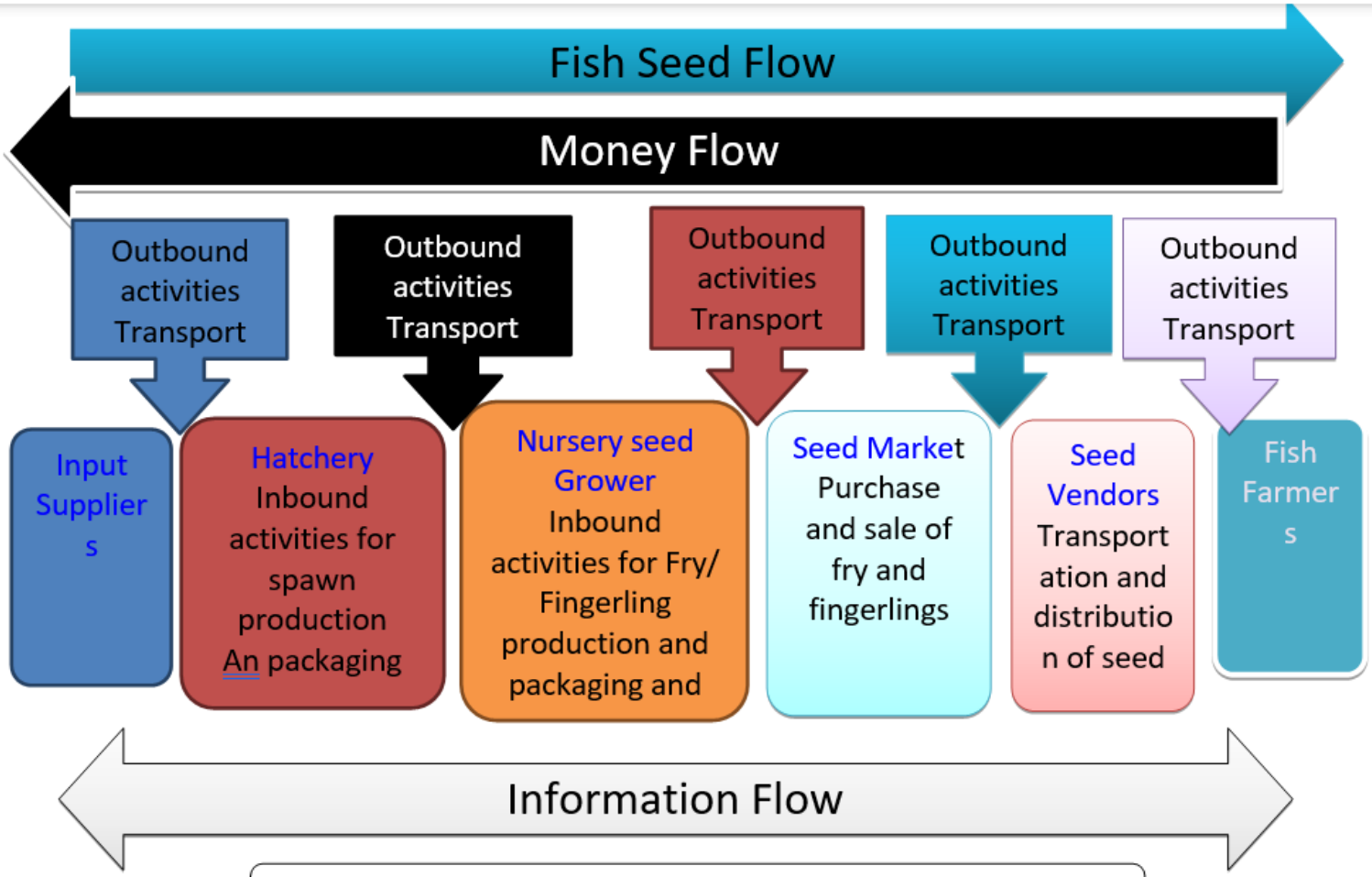


Fig 3.26: Flow of information, money and fish seed along fish seed supply chain in Tripura

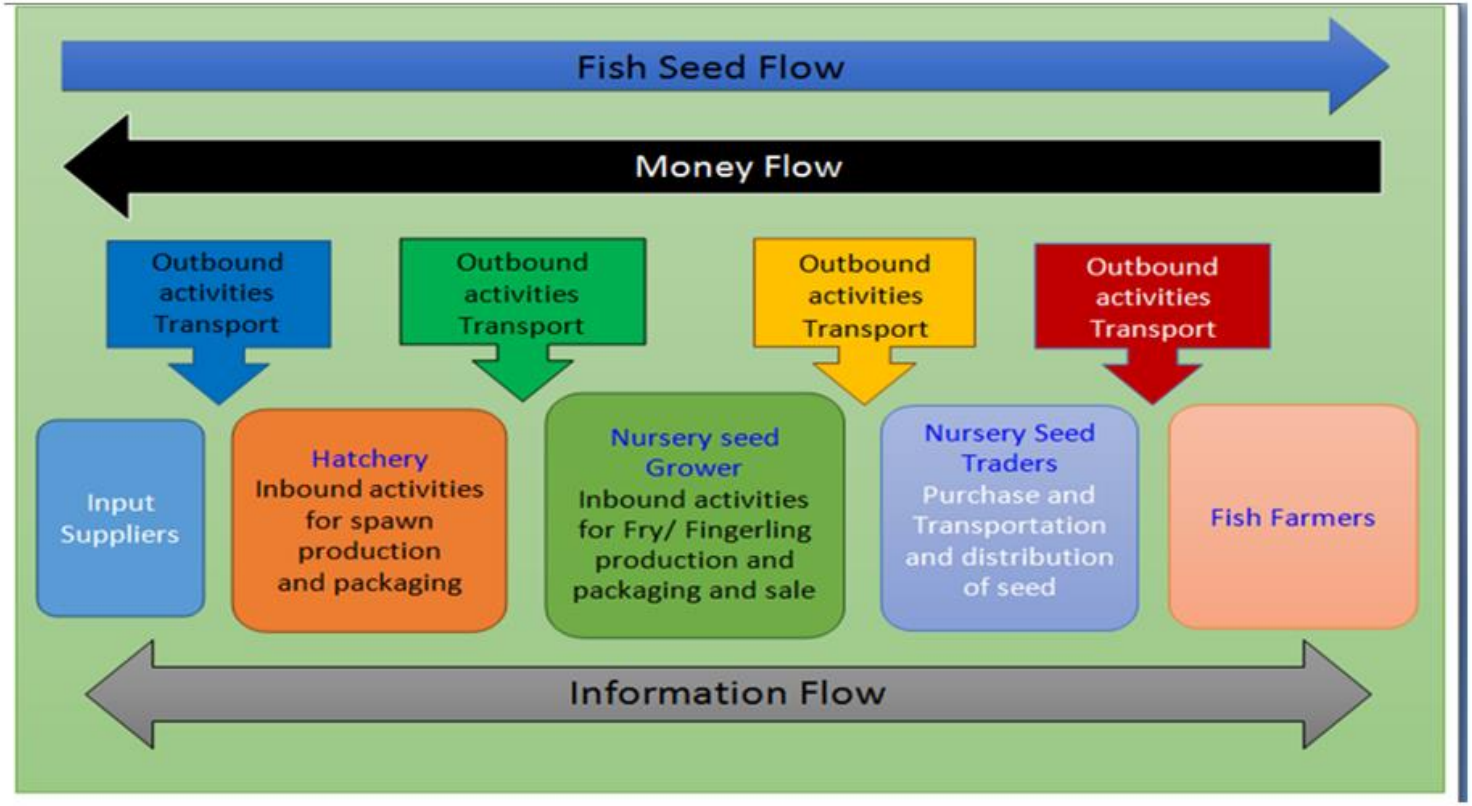


Fig 3.27: Flow of information, money and fish seed along fish seed supply chain in Manipur

3.2.5 Lead Time

The lead time in supply chain is the time that elapses between a customer order and the receipt. The upstream lead times refer to all the activities required to produce and deliver finished product whereas the downstream lead time refers to all the activities that are needed to transport the finished products from production point (Nursery seed growers) to end user (fish farmers). The lead time for fish seed supply chain of Tripura has been calculated and presented in table 3.18. Lead time of fish seed supply chain includes three components, i.e. Operational Time (OF), Transportation Time (TT), and Delivery Time (DT). Operational Time, in this case is the average production period of spawn or fry and fingerlings, whereas the transportation time is the period reported for transportation of seed and delivery time, is the time taken for packaging or distribution of seed. The lead time for spawn and fry/fingerlings are separately calculated and is given in table. It is observed from the table that in case of spawn, 4 sub supply chains were identified such as I. hatchery-nursery seed growers II. hatchery-traders III. hatchery-farmers, IV. hatchery self-seed production and average lead time for these channels were estimated to be 78 hours, 80 hours, 78 hours and 72 hours, respectively. Out of total lead time, 72 hours is operational time or time taken for spawn production, remaining. 4 to 8 hours were the average time taken for packaging, transportation and delivery of spawn. The spawn are live products and are highly sensitive, hence shortest period from packaging to its release in nursery ponds gives better result. Any lapse of time in transportation and delivery can lead to mass mortality and total economic loss to its buyer.

In case of fry/fingerlings, lead time for four sub supply chains such as I. Hatchery -Seed Growers-Farmers, II. hatchery -seed growers- market-vendor-farmers III. hatchery -seed growers-market-farmers, and IV. hatchery -seed growers-vendor-farmers were worked out. In case of sub-chains, I, II, III and IV, lead time were estimated as 922 hours,925 hours, 923 hours and 923 hours, respectively. In sub-chain I, fish farmers themselves purchase the seed from nursery seed growers and transported it to his farm. In this case time lapse in delivery and transportation is less. Whereas, when nursery seed is routed through the market then time lapse in delivery and transportation is more. For the reduction in transportation and delivery time, a greater number of seed markets with modem facilities are required to be developed. Further, the oxygen packaging facilities are most important but, it is not found in any market. Design and development of nursery seed carriers for delivery of nursery seed in rural areas are crucial for the development of fish seed supply chain in Tripura and other states of NE region.

Further, the details of transportation time, delivery time and economic loss of seed vendors in Tripura is given in Table 3.19. It is observed from the table that the average time required for transportation of fish seed from market to village by seed vendors was 2.13 hours and this duration ranged from 30 minute to even 6 hours. Further, average time required for seed distribution by seed vendors was 3.07 hours and distribution time ranges between 1 hour to 6 hours. Due to lapse of time between purchase of seed from market to delivery of seed to farmers on an average 6.1% mortality was estimated. This leads to economic loss of Rs. 143.79 per day to seed vendor. It is a significant amount for seed vendors, who did hard work to earn their livelihood through door-to-door seed distribution. To some extent, it can be minimized through regular water exchange and conditioning of seed before transportation.

Table 3.18: Estimated lead time for each stage as well as different sub supply chain of Tripura

Channel	Physical flow%	Hatchery (Hours)			Nursery seed growers (Hours)			Market (Hours)			Seed Vendors (Hours)			Farmers (Hours)			Total time (Hours)			Total lead time (Hours)
Spawn		OT	TT	DT	OT	TT	DT	OT	TT	DT	OT	TT	DT	OT	TT	DT	OT	TT	DT	
1. Hatchery-Nursery seed growers	65	72		2		2											72	2	2	76
2. Hatchery-Traders	10	72		2					6								72	6	2	80
3. Hatchery-Farmers	20	72		2											2		72	2	2	76
4. Hatchery self seed production	5	72		0		0											72	0	0	72
Total	100.0																			
Fry and Fingerlings																				
1. Hatchery –Seed Growers-Farmers	6	72		2	840	2	1							1	2	2	913	4	5	922
2. Hatchery –Seed Growers-Market-Vender-Farmers	31	72		2	840	2	1	2				3	3	1			915	5	6	925
3. Hatchery –Seed Growers-Market-Farmers	32	72		2	840	2	1							2	3	1	914	5	4	923
4. Hatchery –Seed Growers-Vender-Farmers	18	72		2	840	2	1					3	3	1			912	5	6	923

OT-Operation Time, TT-Transportation Time DT Delivery Time

Table 3.19: Lead time and economic loss of seed vendors in seed supply chain of Tripura

S.N.	Particulars	Values
1.	Average Seed Transportation Time (hours)	2.23
2.	Min Seed Transportation Time (hours)	0.3
3.	Max Seed Transportation Time (hours)	6
4.	Average Seed distribution Time (hours)	3.07
1.	Min Seed distribution time (hours)	1
2.	Max Seed distribution time (hours)	6
3.	Mortality (%)	6.16
4.	Economic Loss Due to mortality (Rs. /day)	143.79

3.2.6. Management Policy:

Supply chain process is a network of activities repeated in time, whose objective is to create value to the external or internal customer. In fish seed supply chain in Tripura and in Manipur it was found that whole supply chain processes were decentralized. The supply chain activities like input supply, spawn production, spawn marketing, fry and fingerlings production, fingerling marketing, fingerling wholesaling, fingerling retailing, fish farming etc. are performed by the individual stakeholder independently. Supply chain management policy which largely focus on coordination between stakeholders, that is, agreement between individuals who cooperate, and agreement about their competence. In the process management of a supply chain there are three important roles, namely: process owner - who is responsible for the strategies direction concerning the process; process manager - who is responsible for how the process is controlled operatively, i.e. process fulfills the goals that have been set for it and competence of Supplier - who is responsible for supplying the appropriate competence needed in the process. Supply chain management policies of any industry comprise a. Demand Management, b. Acquisition Management, c. Logistics Management, d. Disposal Management, e. Risk Management, the demand management stakeholders like hatchery owners plan and forecast for the species wise and period wise demand of spawn. Accordingly, they start maintenance of brooders because for achieving targeted production of spawn, quantity and size of brooders and number of male female brooders are key requirements. The breeding and spawn survivability and production is also highly dependent on monsoon and other climatic factors. Similarly, the nursery seed growers also plan and forecast for the species wise and period wise demand of fry and fingerlings and according to his available resources he starts preparation of nursery ponds in advance to increase the number of cycles, fry and fingerlings production and sale for maximizing their revenue. In acquisition management, since, in the north eastern states, many inputs required by hatchery owners, nursery seed growers and fish farmers are dependent on import from other part of the country and during monsoon some time transportation is frequently dislocated in the region, hence,

input prices increase enormously. Most of the hatchery owners and nursery seed growers procure these inputs in advance and store it as per their requirement and availability of storage facility. Transportation of spawn fry fingerlings and brooders in live condition with minimum stress is the most challenging task and is becoming more challenging in hilly regions. In Manipur mostly seed is transported in oxygen packed while in Tripura only when hatchery owners supply spawn they supply it in oxygen pack otherwise most of seed either spawn, fry or fingerlings transported in Handi filled with water. The limitation of transportation of seed in Handi or any plastic tanks filled with water is that limited number of seeds can be kept and it requires frequent exchange of water and manual oxygenation of water. In some cases, conditioning of seed is done before transportation in order to avoid stress and mortality.

Disposal Management- The hatchery owners produce a large number of spawn in a cycle and at time of harvesting of spawn there should be buyers otherwise complete loss because huge numbers of spawn cannot be stocked/stored. Hence disposal management is the most crucial part of hatchery management. Sometimes the hatchery owners are performing demand-based breeding to avoid disposal problems and risk of marketing of spawn. Further, hatchery owners are developing linkages with nursery seed growers and farmers to raise the demand for spawn. Nowadays seed growers are using phones, social media like WhatsApp, YouTube channels for promoting their seed products in the market. Similarly, nursery seed growers continuously follow the seed market, demand, seed, prices and also develop linkages with seed vendors and fish farmers for direct marketing. They also used phones, social media like WhatsApp and YouTube channels for promoting their seeds in the market.

Risk Management-In north eastern region majority of ponds are seasonal and rainfed, hence, fish production is highly dependent on monsoon. Further, the breeding and seed production of IMCs and other fishes are highly dependent on monsoon and other weather-related factors particularly temperature. Hence, planning and management of hatchery operation and seed production are very crucial and those hatcheries and nursery seed growers that have efficient management. They earn more money and also reduce the losses due to many production and marketing related risks. Nursery seed growers minimize risks of mass mortality due to overcrowding and pond environment through their better management skill and avoid over stocking.

Those stakeholders who are involved in the fish seed supply chain for a longer period have a better understanding of the supply chain process and have better strategies to adopt the Demand management, Acquisition management, Logistics management, Disposal management, Risk management to improve the supply chain performance over the period of time. However, for new entrepreneurs it takes time to understand the environment of the fish seed supply chain and respond to it.

4.0 Cost and Return structure for different chain actors:

4.1.1 Cost and Return structure of Hatchery for Spawn Production

a) Manipur

The cost and return structure spawn production unit (hatchery) for Manipur has been estimated. The capital cost of establishment of a hatchery unit is presented in table 4.1. It is reflected from the table that total capital cost of establishment of a hatchery unit was Rs. 30,28,469.0 and the major costs in establishment of hatchery were construction of shallow tubewell, construction of overhead tanks and construction of brooder tank etc. The cost and return structure of hatchery operation is given in table 4.2 which indicates that out of total operational cost, Rs. 17,58827 was fixed cost which shared about 56% and remaining Rs. 7,71,000 was variable cost. Items among the variable costs were pond preparation, cost of feed and cost of labour which accounted for about 13.37%, 12.03% and 9.55%, respectively. The profitability of seed production at hatchery has been calculated and given in table 4.3. Gross return in hatchery operation was calculated to be Rs. 28,54,688.0 and net return over total cost was Rs. 10,95,861.0. However, it is to be mentioned that the profitability of spawn production varies from hatchery to hatchery on the basis of performance of hatchery, species selected for breeding, spawn production, survivability, market demand and market prices, etc. Further, the species wise share in gross income is given in fig. 4.1.

Table 4.1: Capital cost for establishment of hatchery (Manipur)

Sl. No.	Head	Qty	Unit	Total Cost (Rs.)	Percentage
1.	Construction of brooder ponds (area in ha)	1.05 (Ha.)	Ha.	266206	8.79
3.	Hatchery shed	0.011	Ha.	17000	0.56
4.	Overhead tank (in liter)	1	Liter	530000	17.50
5.	Circular breeding pool	1.67	meter (diameter)	121429	4.01
6.	Hatching pool	4.67	meter (diameter)	137778	4.55
7.	Guard shed and office room (in ft.)	1	Sq. feet	55000	1.82
8.	Water supply pipe		Inch (diameter)	5000	0.17
10.	Shallow tube well	1	Inch (diameter)	250000	8.25
11.	Water pump	4.67	H.P.	207222	6.84
12.	Generator cost	1	Kw.	220000	7.26

13.	Brood stock (ha)	2666.66	Kg	1066668	35.22
14.	Oxygen cylinder (year)	2	D type	23333	0.77
15.	Electricity fittings and other equipment, nets etc.	LS		133833	4.42
	Total capital cost			**3028469**	**100.00**

Table 4.2: Cost and return in hatchery operation and spawn production in Manipur

Sl. No.	**Head**	**Unit**	**Total Cost (Rs)**	**%age of total cost**
A.	**Fixed Cost**			
5	Annual depreciation on fixed assets	Rs.	398264	22.64
6	Water supply pipe	Rs	5000	0.28
7	Permanent labour cum guard	Number	312000	17.74
8	Annual Interest on fixed capital (9%)	Rs	272562	15.50
	Total fixed cost	**Rs**	**987826**	**56.16**
B.	**Operational cost**			
1.	Preparation of brooder ponds (ha)	Ha.	235220	13.37
2.	Manuring	Kg	12000	0.68
3.	Fertilization	Kg	1440	0.08
4.	Lime	Kg.	10240	0.58
5.	Disease management	LS	10000	0.57
6.	Feed	Kg.	211500	12.03
7.	Netting	No	23750	1.35
8.	Feed cost	Kg.	95000	5.40
9.	Additional labour for hatchery (per days)	Man-days	168000	9.55
10.	Packaging cost	LS	90000	5.12
11.	Electricity	Monthly	16000	0.91
12.	Mic. cost for pituitary gland	No.	16600	0.94
	Total Operational Cost	**Rs**	**771000**	**43.84**
	Total cost(A+B)	**Rs**	**1758827**	**100.00**

Table 4.3: Spawn production, total revenue and net returns

Sl. No.	Head	Unit	Amount
1.	Quantity of female brooders (Kg)	kg	1450
2.	Number of spawns produced per kg body weight of female brood fish (in lakh/100 ml/kg)	No.	375000
3.	Total spawn production (Lakh)	No.in lakh	4215
4.	Survivability (%)	%	70
5.	Net spawn production (Lakh)	No.in lakh	2951
6.	Average price (per lakh or 100 ml)	Rs/lakh	750
7.	Gross return (Rs)	Rs.	2854688
8.	Net return (Rs)	Rs.	1095861

a) Tripura

Similarly, for the state of Tripura the cost and returns of hatchery unit was analyzed. The capital cost of hatchery establishment is presented in table 4.4. It is observed that total capital cost of a hatchery establishment in Tripura was Rs. 2072408.0 and major costs in establishment of hatchery were construction of brooder ponds (38.18%), construction of complete hatchery unit (23.22%) and cost of brooders (38.6%). The cost and return structure of hatchery operation is given in table 4.5. Out of total operational cost of Rs.1276885.0, about 38.11% was fixed cost (Rs. 486631.0) and remaining 61. 89 % was variable cost (Rs.790254). The cost of feed, packaging costs and cost of labour accounted for about 32.55%, 10.41% and 5.33%, respectively. The profitability in hatchery operation in Tripura has been calculated and given in table 4.6. Gross return in hatchery was calculated to be Rs.3164277.94 and net return over total cost was calculated to be Rs. 1887393.0. In Tripura state also profitability of hatchery operation or spawn production depends on performance of hatchery, species selected for breeding, weather conditions, spawn production, survivability, market demand and market prices etc. Sometimes demand for spawn becomes major constraints in production and profitability of hatchery units. Further, the species wise share in gross income is given in fig. 4.2.

Table 4.4: Capital cost for establishment of hatchery (Tripura)

SN.	Head	Qty	Unit	Total Cost (Rs)	Percentage
1.	Construction of brooder ponds	1	Ha.	791250	38.18
3.	Hatchery shed	1		45000	2.17
4.	Overhead tank (in liter)	1	Liter	80000	3.86
5.	Circular breeding pool	1	meter (diameter)	31400	1.52

6.	Hatching pool	2	meter (diameter)	33750	1.63
7.	Guard shed and office room (in ft.)		Sq. feet	103333	4.99
8.	Water supply pipe		Inch (diameter)	8625	0.42
10.	Shallow tube well	1	Inch (diameter)	19214	0.93
11.	Water pump	1	H.P.	42125	2.03
12.	Generator cost	1	Kw.	41500	2.00
13.	Brood stock (ha)	2000	Kg	800000	38.60
14.	Oxygen cylinder (year)		D type	22466	1.08
15.	Electricity fittings and other equipment, nets etc etc.		Misc	53745	2.59
	Total capital cost			2072408	100

Table 4.5: Cost and return in hatchery operation and spawn production in Tripura

Sl. No.	Head	Unit	Total Cost (Rs)	%age of total cost
A.	Fixed Cost			
1	Annual depreciation on fixed assets		248689	19.48
2	Water supply pipe		8625	0.68
3	Permanent labour cum guard		114800	8.99
4	Annual Interest on fixed capital (9%)		114517	8.97
	Total fixed cost		486631	38.11
B.	Operational cost			0.00
1	Preparation of brooder ponds (ha)	Ha.	14000	1.10
2	Manuring	Kg	18500	1.45
3	Fertilization	Kg	3666	0.29
4	Lime	Kg.	19600	1.53
5	Disease management	LS	6625	0.52
6	Feed	Kg.	415600	32.55
7	Netting	no	17833	1.40
8	Additional labour for hatchery (per days)	Man-days	68000	5.33
9	Packaging cost	LS	132900	10.41

10	Electricity	RS	25500	2.00
11	Mic. cost for pituitary gland	No.	68030	5.33
	Total Operational Cost		790254	61.89
	Total cost(A+B)		1276885	100.00

Table 4.6: Spawn production, Total revenue and Net Returns

Sl. No.	Head	Unit	Amount
1.	Quantity of female brooders (number)	Nos	820
2.	Number of spawns produced per kg body weight of female brood fish (liter)	Liter	0.725
3.	Total spawn production (liter)	Liter	591.81
4.	Survivability(%)	%	75
5.	Net spawn production (liter)	Liter	443.86
6.	Average Price (per liter)	Rs/liter	7129
7.	Gross Return (Rs)	Rs.	31,64,277.94
8.	Net return(Rs)	Rs.	1887393.0

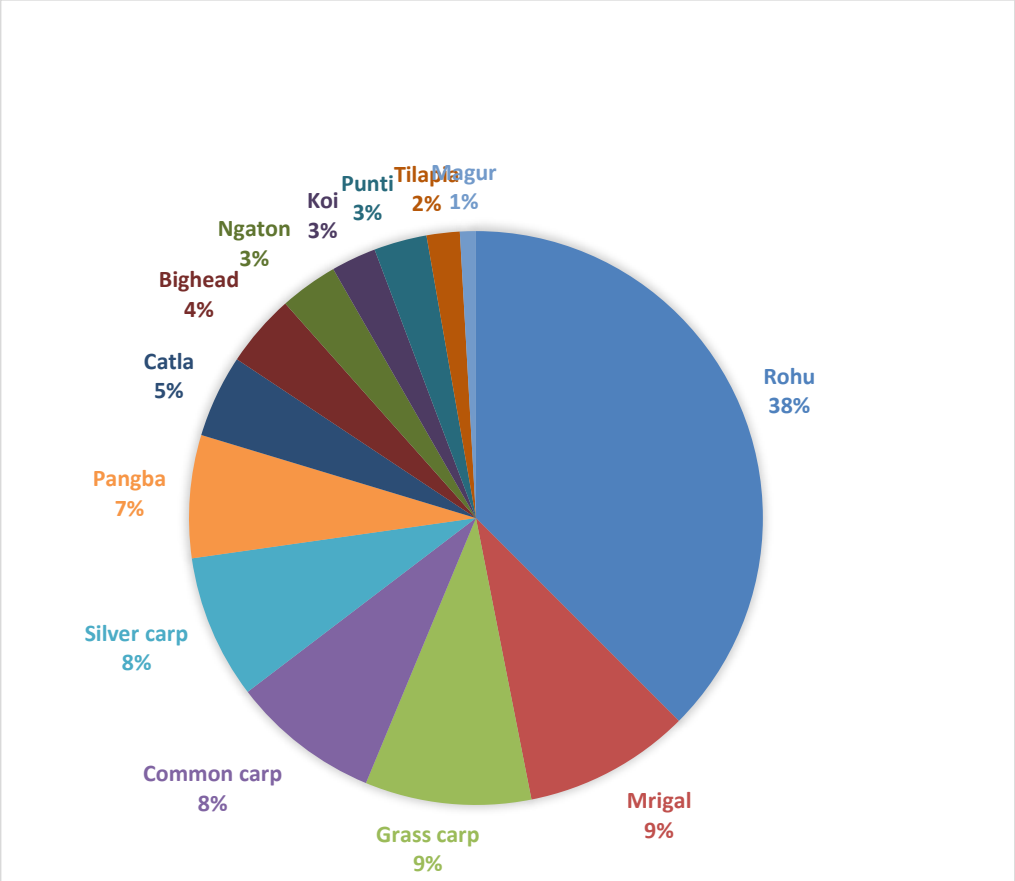


Fig 4.1: Species wise share in gross income (spawn) level in Manipur

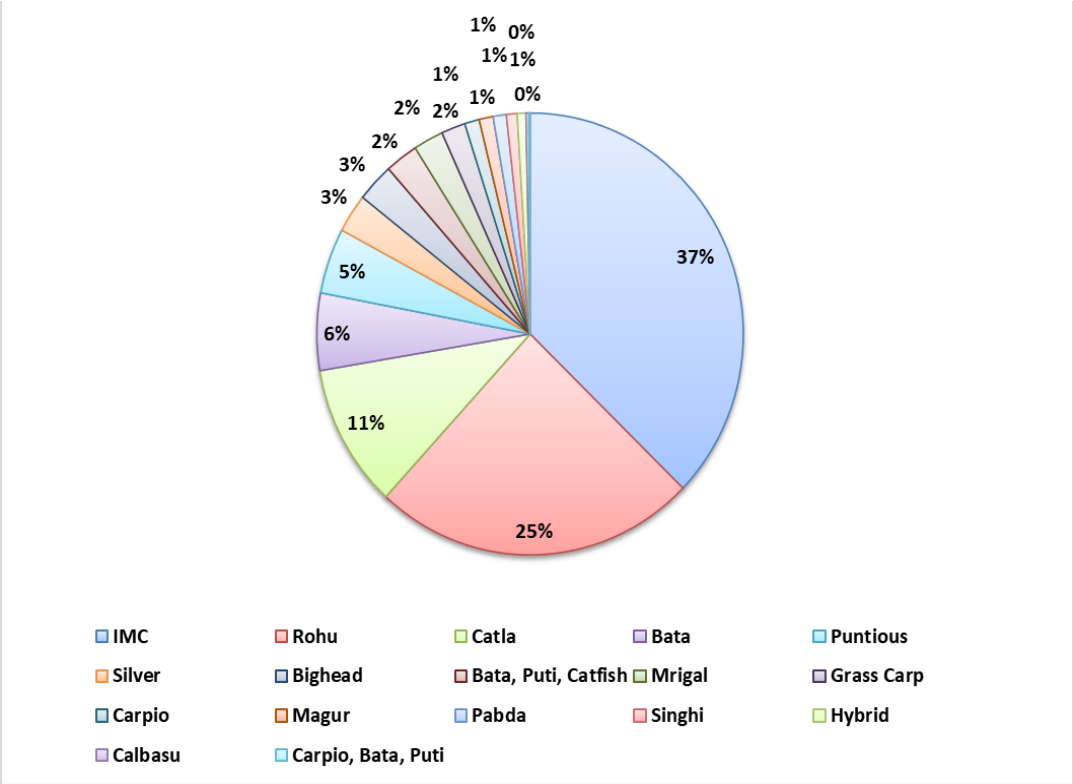


Fig 4.2: Species wise share in gross income (spawn) in Tripura

4.1.2 Cost and return structure of nursery seed rearing in Tripura

The cost and return structure per hectare of nursery seed rearing was calculated and is given in table 4.7. It is observed from the table that the total cost of nursery seed rearing was Rs. 614213 per hectare. Fixed cost accounts for about 49% of the total cost. The major items in total fixed cost are rental value of pond (19%) followed by annual depreciation of fixed assets 16% and annual interest on fixed capital about 14%, respectively. The variable cost of nursery seed rearing was Rs. 311363 per hectare out of which, the cost of harvesting, input costs like feed, cow dung, spawn, MOC, lime, labour cost, electricity charges etc. were important cost items and together they constitute about 51% of total cost. The gross return and net return were calculated to be Rs. 1375437 per ha. and Rs. 761226 per ha., respectively. It shows that nursery seed rearing is a profitable business in Tripura. The variation in prices of nursery seeds of different species is presented in Table 4.8.

Table 4. 7: Cost and return structure (per ha) of Nursery units (Tripura)

Sl. No.	Items	Cost (Rs./ha)	Percentage
A.	**Fixed Cost**		
1.	Rental Value of pond	118456	19
2.	Annual depreciation on fixed assets	97050	16
3.	Annual interest on fixed capital	87344	14
	Total Fixed Cost	302850	49
B.	Variable Cost		
1.	Cleaning and weeding (Labour)	34725	6
2.	Cow Dung (kg)	32419	5
3.	Dewatering	11138	2
4.	Lime (kg)	4769	1
5.	Stocking of spawn	28431	5
6.	MOC & other feed	38788	6
7.	Labour	16675	3
8.	Transportation Cost	36956	6
9.	Average Electricity	61788	10
10.	Watch and Ward	23175	4
11.	Harvesting	61288	10
	Total Variable cost	311363	51
	Total Cost(A+B)	614213	100
	Returns		
1.	Fry production	508913	
2.	Fingerlings	455356	
3.	Selling Price Fry	0.60	
4.	Selling Price fingerlings	2.35	
5.	Gross Return	1375437	
6.	Net Return Over total cost	761226	

Table 4.8: The variation in prices of nursery seed of different species

Species	Fry						Fingerlings					
	Quantity		Purchase (Rs)		Sale(Rs)		Quantity		Purchase price(Rs)		Sale value(Rs)	
	No	Size	Price	Value	Price	Value	No.	Size	Price	Value	Price	Value
Rohu	23830	4.5	2.36	53190	3.37	72425	7020	12.45	7.39	48100	10.59	68200
Bata	400	3	1	400	2.00	800	360	6	5	1800	6.94	2500
Catla	300	5	2.3	700	3.33	1000	1441.7	14.25	15.33	18000	18.61	21600
Bighead	660	7	2.12	1399	3.60	2376						
Mixed Carp	11400	4.5	1.4	10520	1.90	14900						
common carp	3900	6.25	3.75	10500	5.69	14675	500	15	11.75	6200	18.42	9600
Mrigal	4600	4.62	1.17	6050	2.53	13625	600	15	11	6500	12.50	7500
Puti	6600	7.2	4.32	21400	5.88	26600						
Silver	1440		2.43	2810	4.33	5030	390	13.75	8.67	3500	12.60	5200
EMC	1000	fry	2.5	2500	3.5	3500						
Grass carp										7000		8000

4.1.3 Cost and return structure of Grow out (Fish production):

The predominant fish farming pattern in Tripura was found to be multiple stocking and multiple harvesting (55% cases) and least popular farming pattern is multiple stocking and single harvesting (only 6% cases) (Table 4.9). It was found that in Tripura farmers adopted polyculture with a number of species ranging from minimum 2 species to maximum 11 species (Table 4.10). However, 4 to 7 species combinations were more common and it was adopted by 83 %. The combination of IMC (Rohu Catia, Mrigal), Exotic Carps (Grass Carp, Silver Carps and Common Carps) along with any of one or two species from japani puti, bata, bighead, calbasu, tilapia, pabda were reared by the farmers. These species were added for generating additional income from fish farming.

In the case of Manipur 100 % farmers adopted multiple stocking and multiple harvesting patterns of fish farming. In Manipur also, polyculture dominated aquaculture practice followed by the majority of farmers. The species combinations range from 5 species to 9 species and above (Table 4.11). Whereas, 6 species combinations accounted for about 41 % and 5 species combinations were reared by almost 28% farmers of Manipur. IMC and exotic carps along with one or two species from pengba, tilapia, koi, bighead were included by the farmers in Manipur.

Table 4.9: Culture system of adopted by fish farmers of Tripura and Manipur

Sl no	Culture system	% of Farmers	
		Tripura	Manipur
1	Single stocking/Single harvesting	11.43	0
2	Single stocking/Multiple harvesting	27.62	0
3	Multiple stocking/Multiple harvesting	55.24	100
4	Multiple stocking/Single harvesting	5.71	0

Table 4.10: Species combination adopted by fish farmers of Tripura

No of species	Species combination	Percentage
2	b) Rohu, grass carp	1
3	a) Rohu, catla, mrigal b) Rohu, catla, common carp c) Mrigal, common carp, pabda	5
4	a) Rohu, catla, mrigal, common carp b) Rohu, catla, grasscarp, puti c) Rohu,catla, mrigal, silver carp d) Rohu, catla, silver, puti e) Rohu, catla, mrigal, common carp f) Rohu, mrigal, grass carp, silver carp,	18
5	a) Rohu, catla, mrigal, common carp, silver carp b) Rohu, cala, mrigal, common carp, grass carp c) Rohu, catla, carpio, grass carp, silver carp, d) Rohu, catla, mrigal, common, silver carp e) Rohu, catla, mrigal, common carp, puti, f) Rohu, catla, mrigal, grass carp puti, g) Rohu, catla, mrigal, silver carp, bighead h) Mrigal, silver, common carp, puti, pabda i) Rohu,Catla,mrigal,grass,tilapia	22
6	a) Catla, rohu, mrigal, grass, silvercarp , common carp, b) Rohu, catla, mrigal, grass carp, puti, bata c) Rohu,catla, mrigal, grass carp, common carp, puti, d) Rohu, catla, mrigal, grass carp, silver carp, puti	21

	e) Rohu, catla,mrigal, common carp, puti, tilapia, f) Rohu,catla, mrigal, silver carp,common carp , bighead g) Rohu, catla, mrigal,common carp, silver carp, puti h) Rohu, catla, mrigal, common carp, puti, calbasu	
7	a) Rohu, catla, mrigal, grass carp, silver carp, common carp, j puti, b) Rohu,catla, mrigal, grass carp, silver carp, bata, j. puti c) Rohu, catla, mrigal, grass carp,commoncarp ,puti, bata d) Rohu, catla, mrigal, silver carp, common, bighead, tilapia e) Rohu, catla, mrigal, common carp, bighead, puti, bata f) Rohu, catla, mrigal, grass carp, silver carp, common carp, bighead, g) Rohu, catla, mrigal, grass carp, common carp, japaniputi, calbasu h) Rohu, catla,mrigal, grass carp, common carp, calbasu, prawn	22
8	a) Rohu, catla, mrigal, silver carp,common carp, puti,bighead, calbasu, b) Rohu, catla, mrigal, grass carp,silver carp, common carp, japaniputi, bata, c) Rohu,catla, mrigal, grass, silver carp, common carp, puti, kanla(notopterous), d) Rohu, catla, mrigal, grass carp, silver carp, common carp, puti, tilapia	6
9	a) Rohu,catla, mrigal, grass, silver carp, common carp, bighead, puti, tilapia, b) Rohu, catla, mrigal, grass carp, common carp, silver, bata, puti, tilapia	2
10	a) Rohu, mrigal, catla, silver carp, bigheat, common, grass, calbasu, bata, japaneseputi	2
11	a) Rohu, catla, mrigal, grass carp, silver carp, common carp, calbasu, singhi, prawn, pabda, magur	1
	Total	100

Table 4.11: Species combination adopted by fish farmers of Manipur

Sl. No.	Species combination	Percentage
5	Rohu, grass carp, silver carp, common carp, tilapia, Rohu, mirgal, grass carp, silver carp, common Carp	28
6	Rohu, catla, mirgal, grass carp, silver carp, common carp Rohu, mirgal, grass carp, silver carp, common carp, tilapia Rohu, catla, mirgal, grass carp, common carp, tilapia, Rohu, mirgal, grass carp, silver carp, common carp, koi	41
7	Rohu, catla, mirgal, grass carp, silver carp, common carp, bighead, Rohu, catla, mirgal, grass carp, silver carp, common carp, tilapia	16
8	Rohu, catla, mirgal, grass carp, silver cap, common carp, pengba, koi Rohu, catla, mirgal, grass carp, silver carp, common carp, pangasius/ tilapia	12
9 and above	Rohu, catla, mirgal, grass carp, silver carp, common carp, puntius/ wallago attu/ tilapia/ amur carp/koi/bighead	3
	Total	100

The cost and returns of fish production in Tripura was calculated and it is presented in Table-4.12. The total cost of fish production was Rs. 438810.80 per hectare, out of total cost, variable cost was Rs. 310815 per hectare which accounted for about 59.42% and fixed cost was Rs. 178070.5 per hectare which accounted for about 40.58%. Gross return was Rs. 587892.60 per hectare and net return over total cost was Rs. 149081.90 per hectare. These results clearly indicates that fish production is profitable in Tripura.

Table 4.12: Cost and return structure per hectare of fish farmer (Tripura)

Sl. No.	Items	Quantity	Rate (Rs/unit)	Amount (Rs)	Percentage
A.	**Fixed Cost**				
1.	Rental Value of Land	1 ha	116567.6	116567.60	26.56
2.	Annual depreciation on fixed assets			42423.88	9.67
3.	Annual interest on fixed capital		12% interest	19078.98	4.35
	Total Fixed cost			178070.5	40.58
A	**Operational cost**				
A	**Pre-stocking**				
1.	Cleaning of Weed	29 man-days	350	10150	2.31
2.	Dewatering	29 hours pump	556.25	13828	3.15
3.	Removing of Weed Fish	19	350	6650	1.52
4.	Lime Basal Dose	576 kg	27.86	15324	3.49
5.	Cow dung	6245 kg	1.92	11970	2.73
6.	Fertilizers (NPK)	193	20.86	3898	0.89
7.	Total Labour	74 man-days	350	25900	5.90
B.	**Stocking**				
8	Fish seed	13911 no. of fingerlings	4.30	59817.3	13.63
C.	**Post Stocking**				
9.	Feed	3766 kg	35.90	135274.72	30.83
10	Regular netting and monitoring of growth			11583	2.64
11	Medicines for disease control			2070	0.47
12	Harvesting	41 man-days	350	14350	3.27
	Total variable cost			310815	59.42
	Total cost (fixed + variable cost)			438810.80	100
B	Returns				
1	Fish production	2356			
2	Average selling price of fish		249.53		
3.	Total Revenue			587892.60	
	Net return over variable cost			149081.90	

3.1.4 Marketing cost and margin of seed vendors

The seed vendors are playing a vital role in distribution of seed in Tripura. They are functional in each and every place of Tripura. They purchase seed either from nursery seed growers or from the seed markets and deliver it to farms in distant places of Tripura.

Fig 4.3: Seed vendors carrying seed for distribution to farmers

They are the major seed suppliers to the farmers in Tripura. Their profit margin has been calculated and given in table 4.13. It is observed from the table that on an average they handled about 1134 number of fingerlings daily in two handi and by selling these seeds they earned an amount of Rs. 960.68 per day. They invest an amount of Rs. 2752.27 on purchase of seed and their daily profit margin was 24.032%. However, every day they lose about Rs. 143.79/- due to mortality of fingerlings during transportation and distribution. It is a significant amount for them. They purchase the seeds in cash and sometimes on a credit basis which they return after selling the seed. Their emergent financial needs are also met by the seed growers or wholesalers cum commission agent of the market. They engaged in this business for about 6 months and in off season. They are also engaged in other activities including daily paid labourers or other activities.

Table 4.13: Marketing cost and margin of seed vendor (merchant middleman) in Tripura

Sl no.	Particulars	Value (Rs/unit)
1	Average purchase price	2.43
2	Average sale price	3.52
3	Transportation cost in rupees	0.15
4	Other cost in rupees	0.10
5	Gross margin in rupees	1.10
6	Absolute Margin in rupees	0.85
7	Percentage Margin (%)	24.03
8	Average quantity handled per day (nos)	1133.99
9	Sale in rupees	3996.46
10	Purchase in rupees	2752.28
11	Marketing cost in rupees	283.50
12	Net profit daily in rupees	960.68
13	Mortality (%)	6.16
14	Economic Loss due to mortality (Rs./day)	143.79

4.1.5 Price spread and Marketing efficiency of different marketing channel of fish seed in Tripura

Marketing cost, margin, price spread and marketing efficiency of identified marketing channels for fish in Tripura was analyzed and the results are presented in Table 4.14. The price spread in marketing channel I, II, III and IV were found to be Rs.66000 .0, Rs.124391.6 Rs.104391.6 and Rs. 86000.0 per lakh seed, respectively.

Table 4.14 Marketing cost, margin, price spread and marketing efficiency of sub supply chain of fish seed in Tripura (Estimation are for 1 lakh fingerlings)

Particulars	Marketing channel -I	Marketing channel -II	Marketing channel -III	Marketing channel -IV
	Hatchery-Nursery seed growers-Fish farmers	Hatchery-Nursery seed growers-Wholesalers cum commission agent-Seed Vendors-Fish farmers	Hatchery-Nursery seed growers-Wholesalers cum commission agent-Fish farmers	Hatchery –Seed Growers-Vendor-Farmers
% of total seed supplied to farmers	6%	37%	39%	18%
Price paid by the farmers	416000.0	373000.0	419227	340000.0
Price received by nursery seed growers	350000.0	195000	204750	230944.0
Producers' share in consumers Rupee	84.13	52.28	48.84	67.92
Marketing costs	66000.0	124391.6	104391.6	86000.0
Marketing margin	0	53608.4	110085.4	23056.0
Price spread	66000.0	178000	214477	109056
Marketing efficiency	5.30	1.10	1.95	2.69

Table 4.15: Distribution of farm seed price in seed supply chain (Hatchery-Nursery seed growers-Seed Vendors-Fish farmers) (Total 18% of total fingerlings is distributed through this channel) (Per lakh fingerlings)

Particulars	Hatchery	Nursery Seed Growers	Seed Vendors	Fish Farmers
Price Received	4800.70	230944.0	340000.0	
Price Paid	-	4800.70	230944.0	340000.0
Production cost	2876.774	64000	-	
Marketing cost		-	86000	
Total Cost	2876.774	68800.7	316944	
Value Added	1923.926	162143.3	23056	
Survivability	76.36	33.0	93.84	22.45
Economic loss due to mortality	3665.815	3696.539	20944	

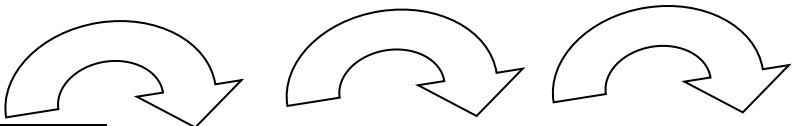
The marketing efficiency was found to be highest (5.30) in marketing channel- I (Hatchery-Nursery seed growers-Fish farmers) in which the farmers were directly buying seed from nursery seed growers, In Marketing channel IV (Hatchery -Seed Growers-Vendor-Farmers) marketing efficiency was 2.69. The marketing efficiency of marketing channel III (Hatchery-Nursery seed growers- Wholesalers cum commission agent-Fish farmers) and marketing channel II (Hatchery-Nursery seed growers-Wholesalers cum commission agent-Seed Vendors-Fish farmers) were 1.95 and 1.10, respectively. These results showed lower marketing efficiency of marketing channel Il and marketing channel III are low. However, physical flow of these two channels were 37 % and 39%, respectively.

Hence more focus is needed to increase the marketing efficiency of these two important marketing channels of fish seed supply in Tripura state. Further, the distribution of farm seed price among the supply chain actors, value added at different stages of supply chain and economic loss due to poor survivability have been calculated for all four subchannels of Tripura and results are given in Table 4.15 to 4.18.

Table 4.16: Distribution of Farm seed price in seed supply chain (Hatchery-Nursery seed growers-Wholesalers cum commission agent-Seed Vendors-Fish farmers) (Total 37% of total fingerlings is distributed through this channel) (Per lakh fingerlings)

Particulars	Hatchery	Nursery Grower	Wholesalers	Seed Vendors	Fish Farmers
Price Received	4800.70	195000	255944	373000.0	
Price Paid	-	4800.70	195000	255944	373000.0
Production cost	2876.77	64000	-	-	
Marketing cost		-	38391.6	86000	
Total Cost	2876.774	68800.7	233391.6	341944	
Value Added	1923.926	126199.3	22552.4	31056	
Survivability	76.36	33.0	95.0	93.84	22.45
Economic loss due to mortality	3665.815	3696.539	9750	20944	

Table-4.17: Distribution of Farm seed price in seed supply chain (Hatchery-Nursery seed growers-Wholesalers cum commission agent-Fish farmers) (Total 39% of total fingerlings is distributed through this channel) (Per lakh fingerlings)



Particulars	Hatchery	Nursery Seed Grower	Wholesalers	Fish Farmers
Price Received	4800.70	204750	353227	
Price Paid	-	4800.70	204750	353227
Production cost	2876.77	64000	-	
Marketing cost		-	38391.6	66000
Total Cost	2876.774	68800.7	233391.6	419227
Value Added	1923.926	126199.3	148477	
Survivability	76.36	33.0	95.0	22.45
Economic loss due to mortality	3665.815	3696.539	10237.5	

Table 4.18: Distribution of Farm seed price in seed supply chain (Hatchery-Nursery seed growers-Fish farmers) (Total 6% of total fingerlings is distributed through this channel) (Per lakh fingerlings)

Particulars	Hatchery	Nursery Seed Growers	Fish Farmers
Price Received	4800.70	350000.0	
Price Paid	-	4800.70	350000.0
Production cost	2876.77	64000	
Marketing cost		-	66000
Total Cost	2876.774	68800.7	416000
Value Added	1923.926	281199.3	
Survivability	76.36	33.0	22.45
Economic loss due to mortality	3665.815	3696.539	

5.0 Assessment of Risks in Fish Seed Supply Chain

5.1 Level of seed survivability at different stages of supply chain

The level of physical risk in terms of survivability of fish seed at different stages of the seed supply chain are represented in fig. 5.1 and fig 5.2. It is reflected from the figure 5.1 that the survivability of spawn at hatchery level in Tripura was 76.36%. The spawning rate and survivability of spawn is highly dependent on hatchery management and weather condition. In general survivability from egg to spawn as reported by the researchers was 40-90%. The survivability in nursery seed rearing was estimated to be 33.19% in Tripura. The survivability from spawn to fry (20-25 mm in 12-15 days) was lower as compared to fry and fingerling stage. The nursery seed rearing is skillful activity; hence nursery management is very important for quality seed production. Further, the quality of spawn and climatic condition also affect survivability during nursery seed rearing. In literature., survival of spawn to fry was reported 50% and 70-75 % in the case of fry to fingerling (100-150 mm in 60-90 days). The survivability during distribution of seed was found to be 93.84%. However, survivability during transportation and distribution highly depends on distance, packaging of seed, water exchange, time required for transportation and delivery time, etc. Survivability can be improved by conditioning of seed before transportation, frequent water exchange or through oxygen packing of seed. Survivability of seed at farm level was recorded to be 80.78%. The seed survivability is one of the most important factors in fish seed supply chain as it determines quantity of production, sale and finally profit of the seed supply chain actors. Survivability of spawn at hatchery level also varies from species to species which are evident from fig. 5.3. and fig. 5.4.

In case of Manipur, flow diagram of fish seed and survivability at different stages is presented in figure 5.2. The survivability of spawn at hatchery level in Manipur was 70%. The survivability in nursery seed rearing was estimated to be 70% in Manipur. Survivability of seed at farm level ranges between 56.47 to 96 80.78% depending upon the size of seed stocked. If farmers are stocking fry (20-25 mm in 12-15days) survivability was found 56.47% at farm level whereas in case of stocking of fingerlings (100-150 mm in 60-90 days) survivability was found to be 96%. It shows that stocking of fingerlings is more beneficial for farmers as compared to fry. Survivability of spawn at hatchery level also varies from species to species which are evident from fig 5.4.

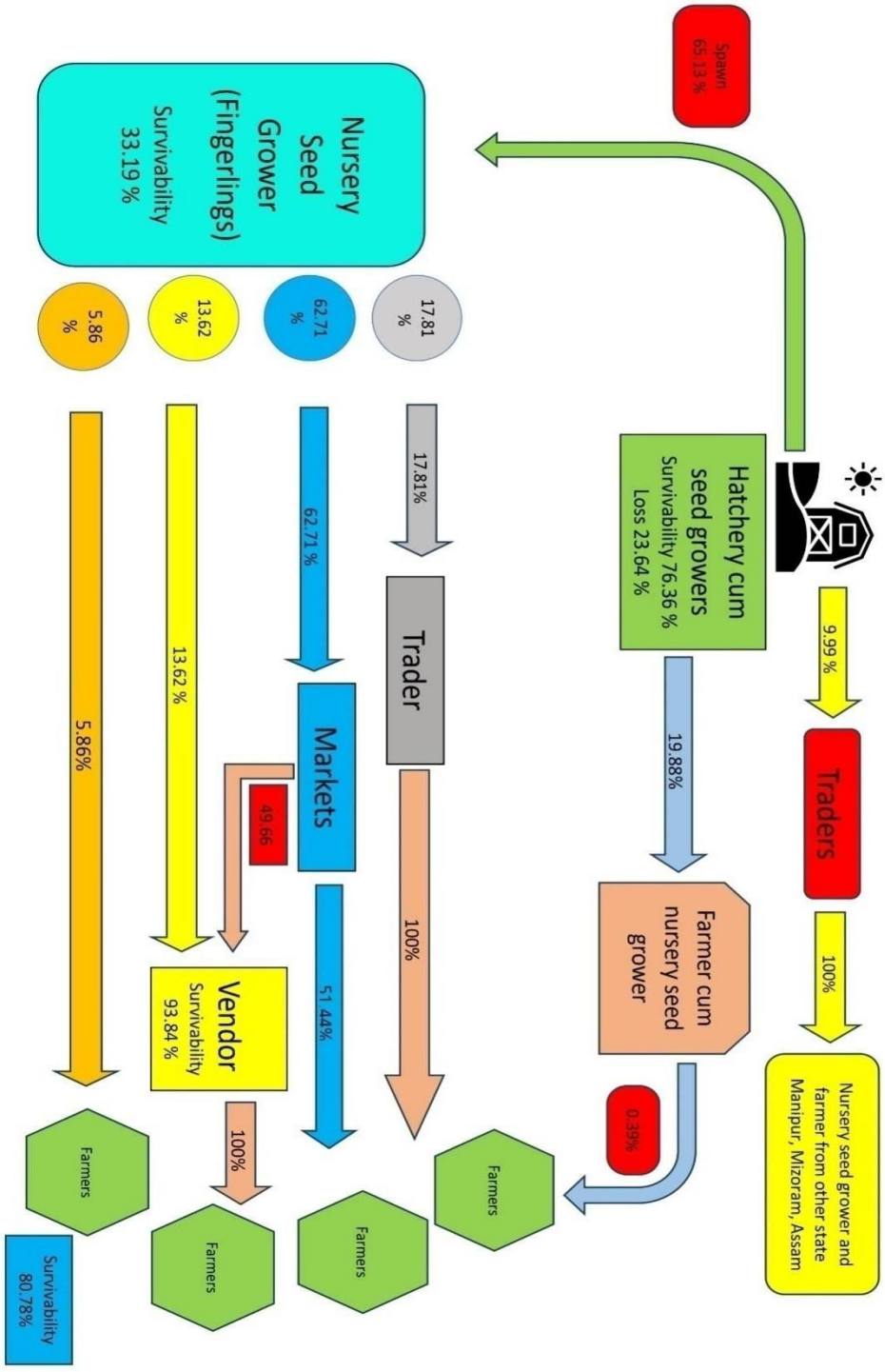


Figure 5.1: Survivability at different stages of seed supply chain in Tripura

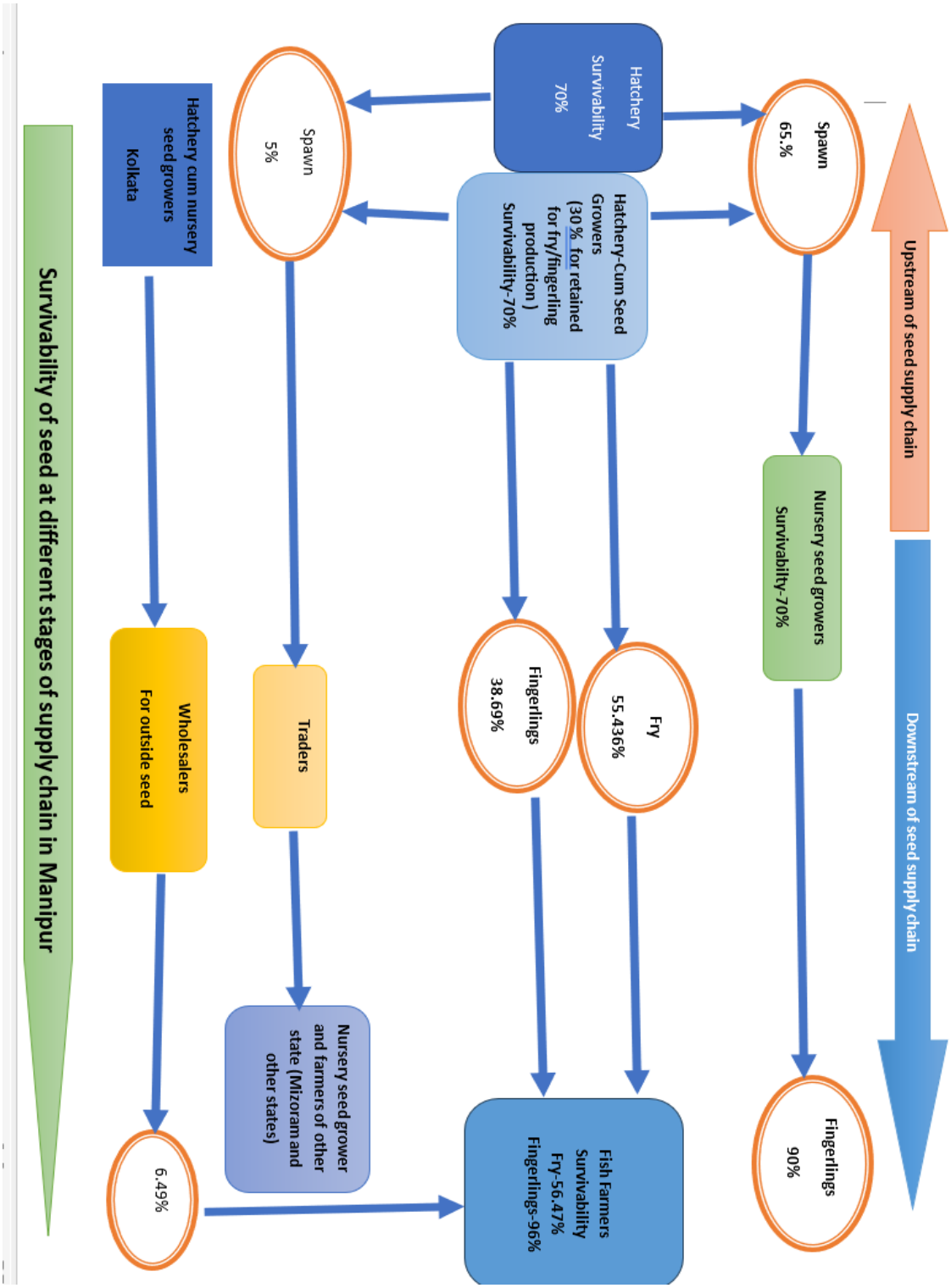


Figure 5.2: Survivability at different stages of seed supply chain in Manipur

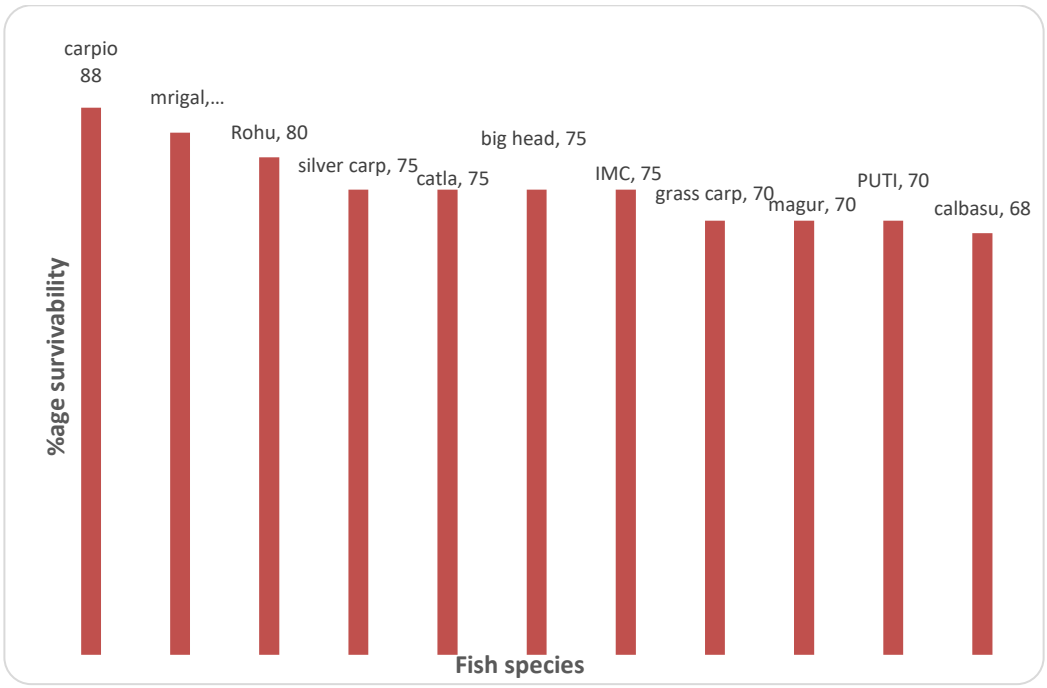


Fig. 5.3: Species wise survivability at hatchery level in Tripura

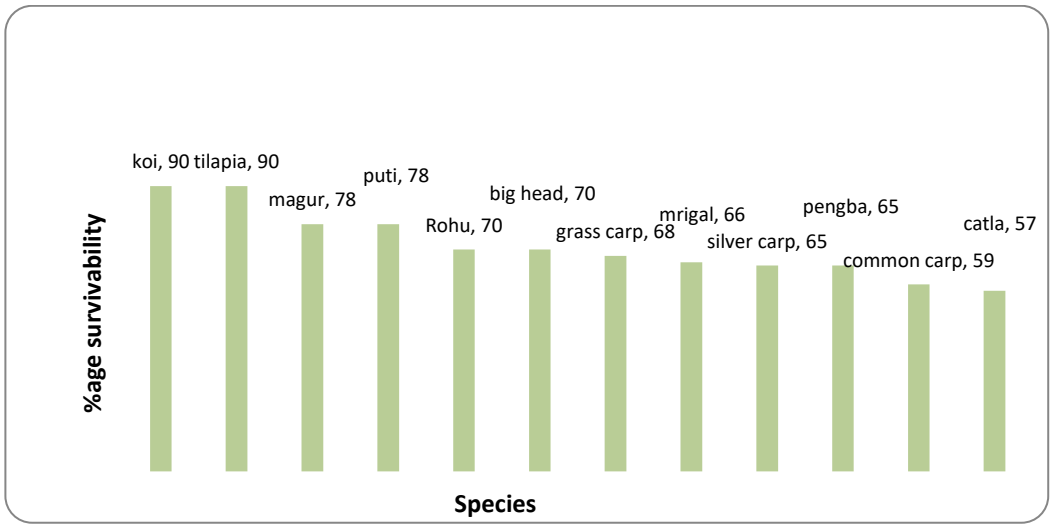


Fig 5.4: Species wise survivability at hatchery level in Manipur

5.2 Type of risk, causes of risks and risk mitigating strategies adopted by supply chain actor

5.2.1 Hatchery level

The primary data of main causes of risks at each stage of the fish seed supply chain was collected and analyzed. The causes of risks at hatchery level are presented in Table.5.1. It is observed from the table that, power supply, disease, price fluctuation, fish and fish-seed handling and aquatic environments were major causes of risks and were ranked into I, II, III, IV, V, respectively. Whereas, poor spawning, poor hatching, poor demand for spawn at the time of selling the seeds were reported to be important causes of risk. Further, mortality during transportation are other risks involved at hatchery level.

Table 5.1: Causes of risks at hatchery seed production in Tripura

S.N.	Causes of Risks	Mean Score	Rank
1.	Power supply	2.000	I
2.	Disease	1.500	II
3.	Low prices	1.429	III
4.	Mass mortality	1.300	IV
5.	Lack of skilled labour	1.300	IV
6.	Aquatic environment	1.273	V
7.	Mortality during transportation	1.250	VI
8.	Poor demand of spawn	1.222	VII
9.	Non availability of inputs	1.222	VII
10.	Non availability of buyers	1.100	VIII
11.	Poor spawning	1.091	IX
12.	Poor hatching	1.091	IX
13.	Poor packing facility	1.000	X
14.	Customer feedback	1.000	X

For different types of risks, hatchery owners adopted different strategies. Hence, information on their risk mitigating strategies were recorded, analyzed and the result is given in table 5.2. It was found that for disease management ,14.28% hatchery owners were using KMn04 and 21.42 % hatchery owners were using CIFAX. For poor water quality about 7% of hatchery owners reported that they use lime to improve water quality. Similarly, about 14% of hatchery owners reported that they were using CCTVs for surveillance and protection from theft of fishes. In order to avoid the risk of uninterrupted power supply mainly required during breeding season 14.28% of hatchery owners have generators, for unsold stock they do nursery seed rearing etc.

Table 5.2 Risk mitigating strategies adopted to minimize the risks by Hatchery owners of Tripura

Risks	Mitigating strategies adopted by Hatchery owners	Percentage of hatchery owners
Disease	KMnO4	14.28
	Cifax	21.42
	Medicine	14.28
	Lime	14.28
	Expert suggestion	7.14
Poor water quality	Lime	7.14
	KMnO4	7.14
	Zeolite	7.14
	Bore water	7.14
	SHET	7.14
Thief& monitoring of labours	CCTV	14.28
Power supply	Generator	14.28
Gas problem in pond	Zeolite	7.14
Unsold stock	Stock up-to fingerling or yearling	7.14
Low quality brooder	Buy from another place	7.14
Labour monitoring	CCTV	7.14

Supply chain risk management (SCRM) is the coordinated efforts of an organization to help identify, monitor, detect and mitigate threats to supply chain continuity and profitability. The supply chain risks have been also classified as a. Supply risks, b. Operational risks, c. Environmental risks, d. financial risks, e. Market risks, f. logistical performances. Each of these risks included four to five components and these components were measured on a five-point scale i.e. most severe, severe, moderate severe, less severe and not important. Then over all mean score for each component as well as for all five dimensions of supply chain risks were calculated for each stakeholder of fish seed supply chain and results are presented below-

Table 5.3: Risks at Hatchery seed production in Tripura

SN.	Dimensions	Component	Mean Score	Rank
C	**Environment risk**		**3.47**	**1**
1.	Events such as rainfall, weather, disaster		3.083	V
2.	Policy uncertainty		3.6	IX
3.	The government support		3.6	IX
4.	Skilled personal		3.6	IX
D	**Financial risks**		**3.32**	**2**
1.	Re-invest		3.1	VI
2.	Payment		3.16	VI
3.	Credit		3.5	VIII
4.	Interest rate		4	
E	**Market Risks**		**3.13**	**3**
1.	Unexpected customers		3.09	V
2.	Reputation risk		3	V
3.	Error in demand		3	V
4.	The information system does not guarantee security		3.1	VI
5.	Infrastructure		3.5	VIII
B.	**Operational risks**		**3.07**	**4**
1.	In consistent inventory/Strategy		2.54	II
2.	Production disruption		2.8	IV
3.	Organizational issues		3	V
4.	Production capacity is not enough		3.18	VI
5.	Not flexible in terms of capacity		3.83	X
F	**Logistical performances**		**2.95**	**5**
1.	Transportation		2.6	III
2.	Delivery on time		3	V
3.	The raw materials are fully met during the production		3	V
4.	Favourable production		3.2	VII
A	**Supply Risks**		**2.5**	**6**
1.	Depends on a single supplier		2	I
2.	Frequent delays in the supply time of materials		2.6	III
3.	Offer(supply) is not flexible		2.6	III
4.	The quantity of the supply was poor		2.8	IV

At hatchery level, supply risks, operational risks, environmental risks, financial risks, market risks and logistical performances is given in table 5.3. It is reflected from the table that environment risks ranked first followed by financial risks, market risk, operational risk, logistical performance and supply risk were ranked II, III, IV, V and VI, respectively. Within each of these risks several components are also ranked and mentioned in the table.

5.2.2 Nursery Seed Grower

In Tripura, causes of risks in nursery seed rearing (spawn to fry/ fry to fingerling) is given in table 5.4. It is observed from the table that, price fluctuation, weather, natural calamities, non-availability of buyers, mortality during transportation were ranked I, II, lII, IV and V. respectively. Whereas other risks like mass mortality due to high stocking, unavailability of spawn on time, mortality due to disease etc. were reported to be important causes of risks. In Tripura as well as in Manipur, weather conditions, natural climates, price fluctuation, mortality during transportation, spawn quality (species) were reported to be potential risk impacting nursery seed production.

Table 5.4: Causes and risk at Nursery seed grower level in Tripura and Manipur

Sl.no.	Risk	Tripura		Manipur	
		Mean Score	Rank	Mean Score	Rank
1.	Price fluctuation	2.750	I	3	I
2.	Weather	2.450	II	3	I
3.	Natural calamities	2.135	III	3	I
4.	Non availability of buyers	1.975	IV	2.92	II
5.	Mortality during transportation to market	1.950	V	3	I
6.	High stocking density	1.806	VI	2.92	II
7.	Unavailability of spawn	1.622	VII	2.33	III
8.	Mortality due to disease	1.605	VIII	3	I
9.	Non availability of inputs	1.350	IX	3	I
10.	Mortality due to pond environment	1.268	X	3	IV
11.	Cheating by hatchery owner for species claim	1.263	XI	3	I
12.	Frequent delays in the supply time of materials	-	-	2	IV
13.	Offer(supply) is not flexible	-	-	2	IV

At nursery seed growers' level, supply risks, operational risks, environmental risks, financial risks, market risks and logistical performances are given in table 5.5. It is reflected from the table that the financial risks, logistical performance, environmental risk, supply risk, market risk and operational risks were ranked I, II, III, IV, V and VI, respectively. Within each of these risks several components are also ranked and mentioned in the table. Similarly, in case of Manipur logistical performance, environmental risk, operational risks, supply risk and market risk were ranked I II, III, IV and IV, respectively.

Table 5.5 Supply chain risk at nursery seed growers

		Tripura		Manipur	
	Dimensions / Component	**Mean Score**	**Rank**	**Mean Score**	**Rank**
D	**Financial risks**	**2.66**	**1**		
1.	Credit	3.35	I		
2	Re-invest	3	II		
3	Interest rate	2.472	III		
4	Payment	2.389	IV		
F	**Logistical performances**	**2.28**	**2**	2.6025	1
1.	Transportation	2.868	I	3	V
2	Delivery on time	2.667	II	2.83	IV
3	Favourable production	2.158	III	2.33	III
4	The raw materials are fully met during the production	2.846	IV	2.25	II
C	**Environment risk**	**2.19**	**3**	2.5	2
1.	The govt support	2.902	I	3	V
2	Events such as rainfall, weather, disaster	2.762	II	2	I
3	Policy uncertainty	2.162	III		
4	Skilled personnel	2.118	IV	2	I
A	**Supply Risks**	**2.0**	**4**	2	4
1.	Offer(supply) is not flexible	2.341	I	2	I
2	The quantity of the supply was poor	2.325	II	2	I
3	Depends on a single supplier	2.1	III	2	I
4	Frequent delays in the supply time of materials	1.975	IV	2	I
E	**Market Risks**	**1.98**	**5**	**2**	4
1.	Infrastructure	2.472	I	2	I
2	Error in demand	2.256	II	2	I
3	Unexpected customers	2.220	III	2	I
4	Reputation risk	2.179	IV	2	I
5	The information system does not guarantee security	2.098	V	2	I

B.	Operational risks	1.8	6	2.125	3
1.	Production capacity is not enough	2.659	I	2.25	II
2	Production disruption	2.205	II		
3	Not flexible in terms of capacity	2.051	III		
4	Organizational issues	2	IV	2	I
5	In consistent inventory/Strategy	1.564	V		

5.2.3 Market Functionaries

At market level in Tripura, causes of risks are depicted in table 5.6. In the market, based on mean score, risk of unsold seed, non-availability of transport, high mortality, non-availability of seed, lack of water exchange, price fluctuation were major causes of risks in seed market and these causes Ranked I, II, III, IV and V, respectively.

Table 5.6: Causes and risk at market level

Causes of Risk	Mean Score	Rank
Non sale of seed	4	I
Non availability of transport	4	I
High mortality	3.5	II
Non availability of seed	3	III
Non availability of water exchanges	2.75	IV
Fluctuation in price	2.25	V

5.2.4 Wholesaler cum commission agent/seed traders

The causes of risk at wholesalers cum commission agent and seed traders' level is depicted in table 5.7. The causes of risks in order are: non availability of transportation facilities (I), mortality during transport (Il), high mortalities (III), non-availability of seed (IV), non-availability of water exchanges (IV), price fluctuations(V) and non-sale of seed (VI), respectively in Tripura. Similarly, order of risk in Manipur are high mortality (I), mortality during transportation to market (II), non-availability of transport (III), fluctuation in price (IV), non-availability of water exchanges (IV), non-sale of seed(V), non-availability of seed (V), respectively.

Table 5.7 Risk involved at Wholesale cum commission agent/Traders

Causes of Risk	Tripura		Manipur	
	Mean Score	Rank	Mean Score	Rank
Non availability of transport	4	I	2	III
Mortality during transportation to market	3.56	II	3	II
High mortality	3.11	III	4	I
Non availability of seed	2.67	IV	1.07	V
Fluctuation in price	2.93	V	1.13	IV
Non availability of water exchanges	3.1	IV	1.13	IV
Non sale of seed	2.66	VI	1.07	V

It is observed from table 5.8 that financial risks, operational risks, environmental risks, market risks, supply risk and logistical performance were ranked I, II, III, IV, V, VI, respectively in Tripura. Whereas, in case of Manipur, financial risks, market risks, logistical performances, operational risks, supply risks and environment risks were ranked I, II,III, IV VI and VI, respectively.

Table 5.8Supply chain risk at different stages wholesalers

SN.	Dimensions/ Components	Tripura		Manipur	
		Mean Score	Rank	Mean Score	Rank
D	**Financial risks**	3.6	1	3.79	1
1.	Re-invest	4	I	3.8	II
2.	Credit	3.9	II	2.86	III
3.	Payment	3.8	III	3.8	II
4.	Interest rate	2.8	IV	4.7	I
B.	**Operational risks**	3.58	2	3.24	4
1.	Production disruption	4	I	2.87	III
2.	Not flexible in terms of capacity	3.7	II	2.86	IV
3.	Production capacity is not enough	3.5	III	4.73	I
4.	In consistent inventory/Strategy	3.4	IV	3.8	II
5.	Organizational issues	3.4	IV	2.86	IV
C	**Environment risk**	3.18	3	2.66	6
1.	The govt support	3.8	I	2.86	II
2.	Policy uncertainty	3.6	II	2.86	II

3.	Skilled personnel	3	III	2	III
4.	Events such as rainfall, weather, disaster	2.3	IV	2.93	I
E	**Market Risks**	3.02	4	3.62	2
1.	Infrastructure	3.5	I	3.8	II
2.	Error in demand	3.3	II	3.8	II
3.	Reputation risk	3	III	2.86	III
4.	The information system does not guarantee security	2.8	IV	3.8	II
5.	Unexpected customers	2.5	V	3.86	I
A	**Supply Risks**	2.2	5	2.67	5
1.	Frequent delays in the supply time of materials	2.6	I	2.93	I
2.	Offer(supply) is not flexible	2	II	2.87	II
3.	Depends on a single supplier	2	II	2	IV
4.	The quantity of the supply was poor	-	-	2.86	III
F	**Logistical performances**	2.0	6	3.38	3
1.	Delivery on time	2	I	3.06	II
2.	The raw materials are fully met during the production	2	I	2.86	III
3.	Favourable production	-	-	3.8	I
4.	Transportation	-	-	3.8	I

5.2.5Causes of risk at seed vendor level:

It is evident from table 5.9 that the non-availability of transportation is reported to be the most important cause of risk at vendor level and it is ranked I. Further, causes of risks like non availability of water exchange facility, non-sale of seed, high mortality, price fluctuation, mortality during transportation and non-availability of seed were ranked I, II, III, IV and V, respectively. As a seed is kept in handi with water in which level of oxygen declines with the passing of time, hence any delay in transportation leads to increase in mortality of seed.

The supply chain risk for seed vendors is presented in table 5.10. It is indicated from the table that market risk is ranked first, logistical performance second and financial risk third, supply risk fourth, environmental risk fifth and operational risk ranked sixth. Within market risk, infrastructure, market information, unexpected customers, etc. were found to be important components. Whereas, in logistical performance, unavailability of packaging material, packaging facility, favorable production, transport are the important components.

Table 5.9 Cases of risk at Vendors level Tripura

Sl.No	Causes Risk in wholesale Tripura	Mean Score	Rank
1.	Non availability of transport	3.6	I
2.	Non availability of water exchanges	2.9	II
3.	Non sale of seed	2.9	II
4.	High mortality	2.8	III
5.	Fluctuation in price	2.8	III
6.	Mortality during transportation to farm	2.6	IV
7.	Non availability of seed	2.5	V

Table 5.10 Supply chain risk at seed vendor level in Tripura

SN.	Dimensions/ Component	Mean Score	Rank
A	**Supply Risks**	2.58	4
	1. Frequent delays in the supply time of materials	2.6	II
	2. Offer(supply) is not flexible	2.9	I
	3. Depends on a single supplier	2.3	IV
	4. The quantity of the supply was poor	2.5	II
B.	**Operational risks**	1.64	6
	1. Production disruption	2.3	III
	2. Production capacity is not enough	2.9	II
	3. In consistent inventory/Strategy	3	I
	4. Organizational issues	0	
	5. Not flexible in terms of capacity	0	
C	**Environment risk**	2.33	5
	1.Events such as rainfall, weather, disaster	2.5	III
	2. Policy uncertainty	3.1	II
	3.The govt support	3.7	I
	4. Skilled personnel	0	
D	**Financial risks**	2.72	3
	1.Credit	3.7	I
	2.Re-invest	3.7	I
	3.Payment	3.5	II
	4.Interest rate	0	

E	**Market Risks**	2.94	1
	1. The information system does not guarantee security	3	II
	2. Unexpected customers	2.9	III
	3. Reputation risk	2.7	V
	4. Infrastructure	3.3	I
	5. Error in demand	2.8	IV
F	**Logistical performances**	2.85	2
	1.Delivery on time	2.7	IV
	2.The raw materials are fully met during the production	3	I
	3.Favourable production	2.9	II
	4.Transportation	2.8	III

5.2.6 Risk at farmer's level:

The cause of risk at farmers level is presented in table 5.11. It is found that in Manipur, weather uncertainty is the most important cause of risk, followed by credit, technology, availability of labour, input availability and input prices, seed availability and seed prices. The risk mitigating strategies adopted by farmers is given in table 5.12. It was found that most of the farmers used CIFAX (48.98%) for disease management followed by KMn04 (12.24%), lime (19.39%). For avoiding risk related to the aquatic environment of the pond, the majority of farmers use lime (28.51%) and KMn04 (26.53%). To avoid the risk of seed unavailability they adopt several strategies such as the purchase of seeds from multiple sources (18.37%), followed by keeping in contact with vendors (6.12%), keeping their own seed in the pond (5.1%), and prior order for next stocking (2.04%). Hence, the farmers were adopting different strategies to mitigate risks related to fish seed supply and fish farming.

Table 5.11Risk involved at Farmers Manipur

Causes Risk in Farmers Manipur	Manipur	
	Mean Score	Rank
1. Weather	11.96	I
2. Credit facilities	10	II
3. Technical know how	8.90	III
4. Labour cost	8	IV
5. Availability of labour	7.01	V
6. Cost of NPK	6.02	VI
7. NPK availability	5.07	VII
8. Feed cost	3.97	VIII
9. Availability of feed	3.02	IX
10. Seed availability	1.02	XI
11. Seed cost	1.979	X

Table 5.12 Risk mitigating measures adopted by the fish farmers

Cause	Measure	Percentage of farmers
Mortality due to Disease	CIFAX	48.98
	KMno4	12.24
	Lime	19.39
	Turmeric	4.08
	Netting	1.02
	Others	18.37
Mortality due to pond environment	Aeration	9.18
	Banana leaf use	5.10
	KMnO4	26.53
	Lime	28.57
	Netting	18.37
	NaCl	1.02
	Others	8.16
	Water exchange	3.06
High stocking density	Sale	13.27
	Transfer to another pond	3.06
Unavailability of spawn	Purchase from other source	18.37
	Contact to vendors	6.12
	Contact to Fisheries Dept	1.02
	Prior order for next stocking	2.04
	Stock only whatever available	1.02
	Own farm production for next season/ stocking	5.10
	Wait for availability	1.02
Non availability of buyers	Sale at lower price	14.29
	Stock and sale later	26.53
	Contact to commission agent	2.04
Non availability of Inputs	Buy from other source	6.12
	Buy at high price	6.12
	Prior order	7.14
Price fluctuation	Sale at low price	1.02
	Sale later	14.29

Supply chain risks of farmers is given in Table 5.13. It is reflected from table that the financial risk was ranked first followed by logistic performance (rank 2), environmental risk (rank 3), market risk (rank 4), supply risk (rank 5) and operational risk (rank 6), respectively at farm level In Tripura. Fish farming is both labour intensive and capital-intensive enterprise. Hence, financing is reported to be the major impediment in fish farming.

Table5.13: Supply chain risk at Fish farmer level in Tripura

			Tripura	
	Dimensions	Component	Mean Score	Rank
A	**Supply Risks**		2.28	5
	1. Frequent delays in the supply time of materials		2.6	I
	2. Offer(supply) is not flexible		2.1	III
	3. Depends on a single supplier		2.2	II
	4. The quantity of the supply was poor		2.10	III
B.	**Operational risks**		2.18	6
	1. Production disruption		2.2	II
	2. Production capacity is not enough		2.5	I
	3. In consistent inventory/Strategy		2.12	III
	4. Organizational issues		2.03	V
	5. Not flexible in terms of capacity		2.08	IV
C	**Environment risk**		2.93	3
	1.Events such as rainfall, weather, disaster		2.6	IV
	2. Policy uncertainty		3.04	II
	3.The govt support		2.9	III
	4. Skilled personal		3.2	I
D	**Financial risks**		3.38	1
	1.Credit		3.6	I
	2.Re-invest		3.4	II
	3.Payment		3.11	III
	4.Interest rate		3.08	IV
E	**Market Risks**		2.78	4
	1. The information system does not guarantee security		2.32	IV
	2. Unexpected customers		2.40	III
	3. Reputation risk		3.39	I

	4. Infrastructure	2.6	V
	5. Error in demand	3.19	II
F	**Logistical performances**	3.28	2
	1.Delivery on time	3.30	II
	2.The raw materials are fully met during the production	3.23	III
	3.Favourable production	3.03	IV
	4.Transportation	3.57	I

6.0 Impact of seed supply chain

The ultimate aim of this research study was to find out the impact of fish seed supply chain at farm level output because timely availability of quality fish seed and other inputs to the fish farmers is supposed to have a significant impact on productivity level, overall production, total revenue and profitability of fish production. Hence, to achieve fourth objective of this study i.e. to analyze the impact of fish seed supply on farm level fish production, impact of fish seed supply at farm level were analyzed. Further apart from the impact of fish seed supply at farm production, financial inclusion of fish seed supply chain actors including fish farmers and usage of ICTs by the supply chain actors for the purpose of their business were also analyzed and these results are presented in this section.

6.1 Impact of seed supply chain on fish production

The farm level data on sources of supply of fish seed to farm level in Tripura and their performance in terms of final weight of fishes of different species at the time of harvest were analyzed and it is presented in table 6.1 and figure 6.1. It was found that the average weight (kg) was high at the time of harvesting of Rohu, Catia, Mrigal, Grass carp, Silver carp, when seeds were procured from seed vendor and market. Hence, these two supply chains have better performance at farm level output. Seed available in market are of mixed type i.e. comprising both stunted fingerlings (yearlings) and fingerlings produced during the same year. Whereas, nursery seed grower mostly provides seed produced during the same year. It is well stated that stunted fingerlings perform better and attain higher body weight in the same duration of culture. This clearly emphasizes the role of seed supply chain to encourage raising stunted fingerlings and enhancing aquaculture productivity. Due to better performance of the seed procured from the seed markets and seed vendors, about 37 % farmers purchased seed from seed vendors and 36% of farmers purchased seed from the market because of availability of desired species and of desired size of fish seed.

The impact of stocking size of seed on average weight of fishes at the time of harvest were also analyzed for Tripura and Manipur and results are presented in Table 6.2. and Table 6.3. It is observed from table 6.2 that mean weight at harvest for all the species in Manipur were higher in case of stocking size of fingerlings as compared to stocking size of fry. The percentage increase in mean weight at harvest of fishes ranged from 11.9% in case of koi species to 326.67% in case of grass carp. Further, the survivability was also found better (96.10%) in case of stocking of fingerling as compared to the stocking of fry in which survivability was only 56.47%. It shows better performance of stocking fingerlings at farm level and farm level production can be significantly increased by ensuring timely supply of fingerlings to the fish farmers of Manipur. In case of Tripura results were presented in table 6.3. It is observed from that table that average weight at the time of harvesting of fishes were higher in case of fingerlings as compared to the fry. The increase was recorded between minimum 5.26 % and maximum 80 %. Further, the survivability was recorded 80.48% in fingerlings and 68.68% in fry. The standard deviation of final weight of fishes

also indicates that the variation in weight and size of fishes at the time of harvest was less in case of stocking of fingerlings as compared to stocking of fry at farm level. These results show that the supply chain supplying fingerlings to the farmers have better outcomes at farm level. Hence, the production and distribution of appropriate size(fingerlings) seed is crucial to increase at the farm level production of fishes in Tripura and Manipur.

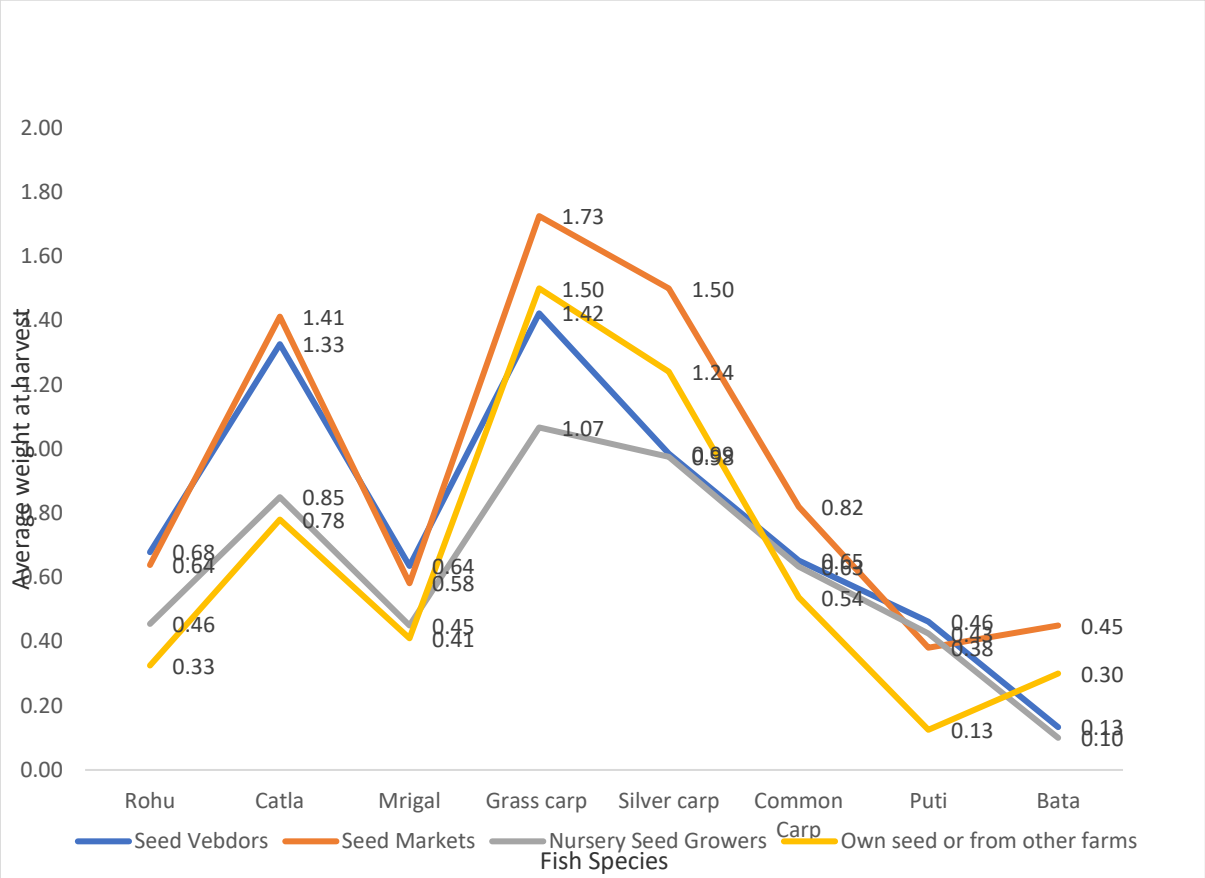


Fig 6.1: Performance of fish Seed at farm level supplied through different supply chain

Table 6.1: Performance of fish seed purchased from different sources by the fish farmers in Tripura

Fish species	Sources wise mean weight (kg) and standard deviation of fishes at the time of final harvest							
	Seed Vendors	Sd	Seed Markets	Sd	Nursery Seed Growers	SD	Own seed /other farms	SD
Rohu	0.68	0.43	0.64	0.34	0.46	0.36	0.33	0.23
Catla	1.33	0.81	1.41	0.59	0.85	0.80	0.78	0.50
Mrigal	0.64	0.32	0.58	0.26	0.45	0.28	0.41	0.23
Grass carp	1.42	0.92	1.73	0.93	1.07	0.81	1.50	0.82
Silver carp	0.99	0.58	1.50	0.61	0.98	0.38	1.24	0.75
Common Carp	0.65	0.39	0.82	0.41	0.63	0.40	0.54	0.34
Puti	0.46	0.33	0.38	0.31	0.43	0.25	0.13	0.04

Bata	0.13	0.06	0.45	0.21	0.10	0.00	2.00	
Bighead	0.95	0.30			0.70	0.00	0.80	
Calbasu			0.50				0.30	
Pabda	0.05	0.00						
Magur								
Tilapia	0.47	0.29			0.30	0.00		
Kanla	0.20							
Chito								
Gonia	0.25		0.50					
Survivability	70.56		81.61		81.33		81.29	
SD	12.43		12.72		10.61		7.29	
% of Farmers	37.00		36.00		11		16	

Table 6.2: Effect of Stocking size on final weight of fish and survivability in Manipur

Sl.No	Species	Stocking size and Average weight at harvest (kg)				Percentage of weight gain due stocking of fingerling
		Fry		Fingerlings		
		Mean	Sd	Mean	Sd	
1.	Rohu	0.525	0.1	0.8629	0.0669	64.35
2.	Catla	0.629	0.0488	0.8477	0.1089	34.87
3.	Mirgal	0.533	0.1	0.7816	0.0875	46.55
4.	Silver carp	0.688	0.1088	0.9541	0.0706	38.78
5.	Common carp	0.26	0.1352	0.3447	0.1036	32.56
6.	Grass carp	0.619	0.1721	2.6400	0.4644	326.67
7.	koi	0.14	0.0894	0.1567	0.0751	11.90
8.	Puntius			0.0400	0.0000	
9.	Tilapia	0.1		0.1953	0.0486	95.35
10.	Bighead	0.733	0.0577	0.9571	0.0535	30.52
11.	Wallago attu			1.0000		
12.	Amul carp			0.7000		
13.	Pangasius			1.3750	0.1500	
14.	Pengba	0.35	0.1			
15.	Murrel	0.1				
16.	SIF	0.525	0.1	0.0100	0.0000	
	Survivability (%)	56.47	4.93	96.10	6.12	

Table 6.3: Effect of Stocking size on final weight of fish and survivability in Tripura

Sl.No	Species	Stocking size and Average weight at harvest (gms)				Percentage of weight gain due stocking of fingerling
		Fry		Fingerlings		
		Mean	Sd	Mean	Sd	
1.	Rohu	0.49	0.23	0.64	0.37	29.61
2.	Catla	1.00	0.41	1.30	0.71	30.16
3.	Mrigal	0.55	0.31	0.62	0.35	14.51
4.	Grass carp	1.50	1.09	2.07	0.90	38.00
5.	Silver carp	0.91	0.56	1.30	0.71	42.67
6.	Common Carp	0.58	0.39	0.76	0.37	31.67
7.	Puti	0.38	0.26	0.40	0.29	5.26
8.	Bata	0.28	0.11	0.49	0.69	76.62
9.	Bighead	1.00		1.06	0.37	6.25
10.	Calbasu			1.25	1.06	
11.	Pabda			0.05	0.00	
12.	Magur					
13.	Tilapia			0.47	0.29	
14.	Kanla			0.20	0.00	
15.	Chitol	2.00				
16.	Gonia	0.25	0.07	0.45		80.00
	Survivability (%)	68.68	11.88	80.48	10.56	

6.2 Impact of supply chain on financial inclusion of fish seed supply chain actors:

In this research study the impact of seed supply chain is analyzed in terms of financial inclusion of different supply chain actors. The results are presented in figure 6.2. It reflects from the figure that 71% of hatchery owners, 92% nursery seed growers, 95% of wholesalers, 63% of seed vendors, 81% of fish farmers and 70% of labourers engaged in the fish seed supply chain in Tripura were found to maintain savings accounts in banks. On an average 50% of them were using ATM services, except in case of wholesalers in which 90% were using ATMs. Credit facilities availed by supply chain actors was about 21%. In case of hatchery owner, 27% nursery seed grower and 25% wholesalers, 2% seed vendors, 11% fish farmers and 3% labourers. Insurance was taken by 21% of hatchery owners, 24% nursery seed growers, 30% wholesalers, 6% seed vendors, 74% fish farmers and 27% laborers. Except labourers, all the stakeholders: 54% nursery seed growers, 36% hatchery owners, 40% farmers, 15% wholesalers and 8% of seed vendors received benefits /financial support from government schemes.

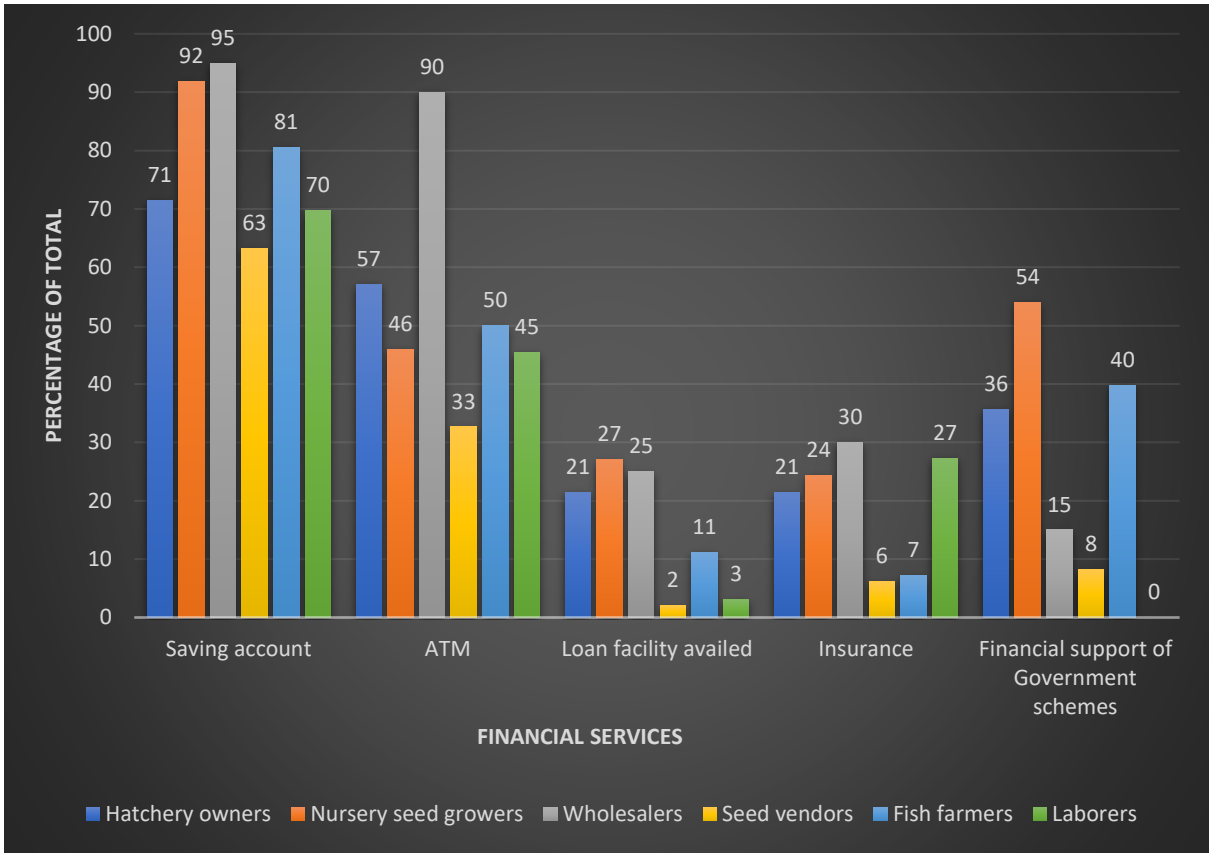


Fig 6.2: Financial inclusion of fish seed supply chain actors in Tripura

6.3 Usage of ICT in fish seed supply chain and its effectiveness

Nowadays, ICT has revolutionized the business environment in all sectors including aquaculture. ICT facilitates business in many ways. Keeping this in view, level of ICT usage by different fish seed supply chain actors were analyzed and presented below-

6.3.1 Usage of ICT by hatchery owner

The results of usage of ICT by hatchery owners are given in figure 6.3. It is observed from the figure that 92.8% of hatchery owners of Tripura and 88.80% of Manipur have smartphones. It is interesting to note that about 28.5% of hatchery owners of Tripura and 44.4% of Manipur use smartphones for digital payment. Majority of hatchery owners of Tripura (92.8%) and Manipur (55.3%) were using smart phones for hatchery business communication and they reported it is effective (77.7%) in Manipur and most effective (92.8%) in Tripura, respectively. Several uses of phone in fish seed business like taking order over phone (28.5% in Tripura and 77.7% in Manipur), order through WhatsApp (71.4% in Tripura and 22.2% in Manipur), applications and social media for information (57.1% in Tripura and 44.4% in Manipur.)

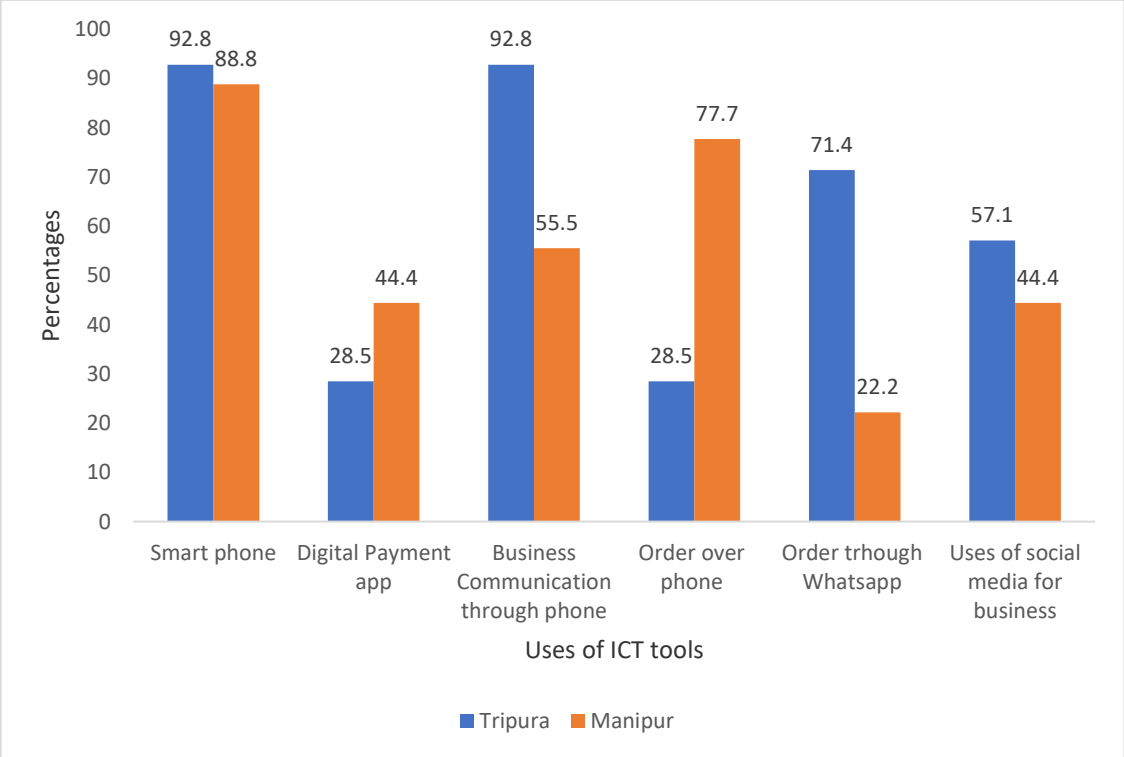


Fig. 6.3: Uses of ICT tools by hatchery owners of Tripura and Manipur

6.3.2 Usage of ICT by Nursery Seed Growers

In case of nursery seed growers about 67.5% in Tripura and 64.2% in Manipur used smartphone (Figure 6.4). In Tripura 18.9% nursery seed grower uses smart phone for digital payment. The majority of seed growers in Tripura (75.6%) and Manipur (92.8%) were using phone for seed business purposes and they reported to be effective to most effective tools for business communications. About 59.4 % in Tripura and 71.4 % in Manipur use phones to take orders over the phone. These supply chain actors also use phone, internet and social media to get technical and other business-related information.

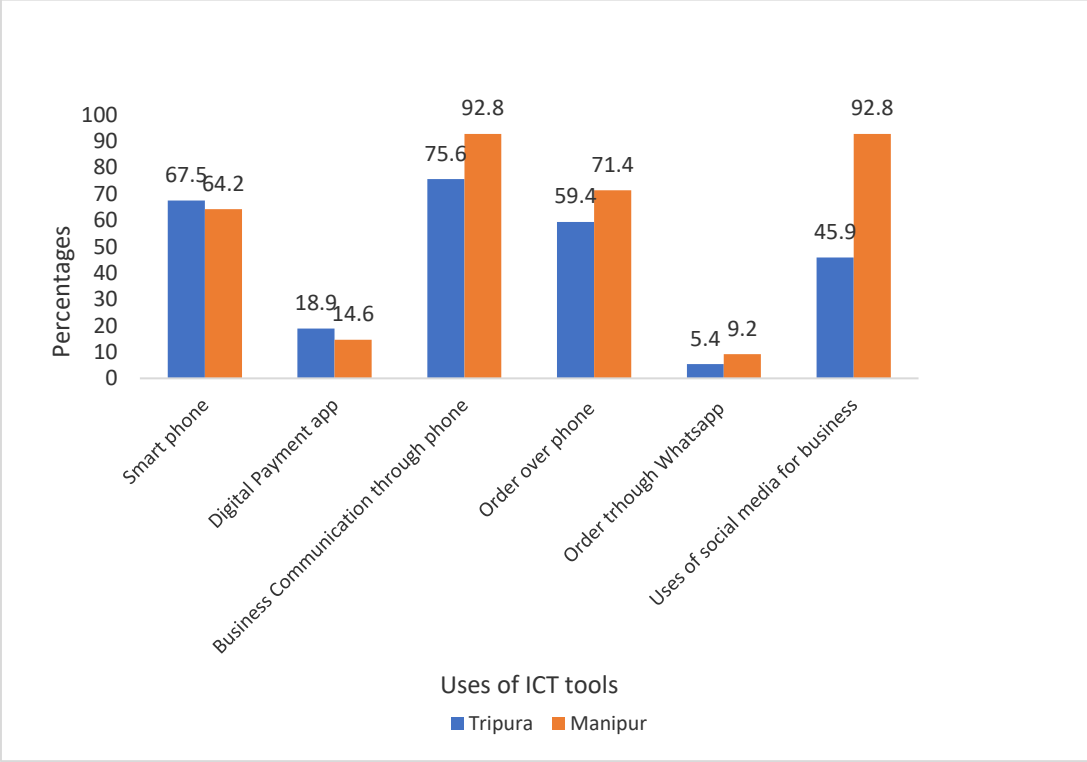


Fig 6.4: Usage of ICT tools by the Nursery seed Growers of Tripura and Manipur

6.3.3 Usage of ICT by wholesalers in fish seed supply chain

70% of wholesaler cum commission agents of Tripura and 56% of fish seed traders of Manipur use smartphones (Figure 6.5). ln Manipur most of them used applications for digital payment. Almost all the wholesalers cum commission agent of Tripura use phone for business communication and taking orders for seed supply. Whereas, only 56 % in Manipur, 20% in Tripura and 62 % in Manipur wholesales /traders were using WhatsApp to take order for supply. 20% in Tripura, 50% in the case of Manipur and 30% in Tripura use social media to get information.

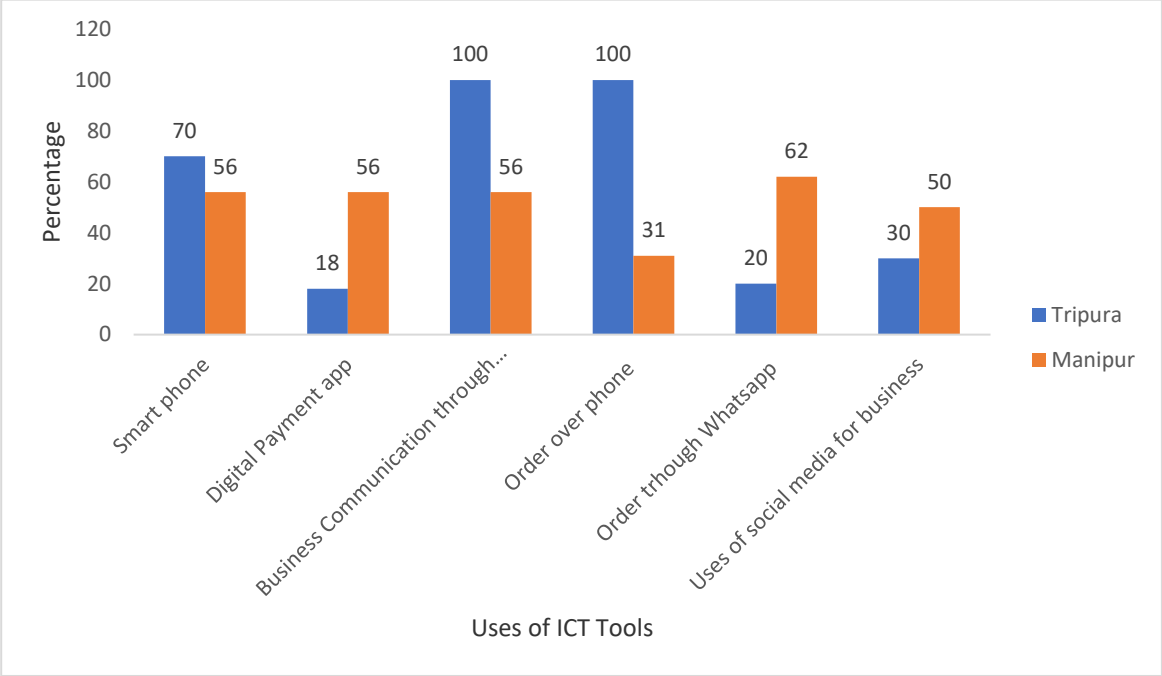


Fig 6.5: Usage of ICT tools by the wholesalers of fish seed in Tripura and Manipur

6.3.4 Usage of ICT by Seed Vendors

The details of ICT usage by seed vendors in Tripura are presented in figure 6.6. It is observed that in case of seed vendors only 14.2% were using smart phones. They never use digital payment apps. Though the majority of seed vendors (87.75%) were doing business communication through the phone, they reported it to be effective (2%) to most effective (14.28%). They also use phones to take supplies of orders (79.59%). However, only 22.44% of seed vendors use social media. It is evident from above result is that phone is used to get orders of seed hence help them in decision making for supplying seeds to the farmers.

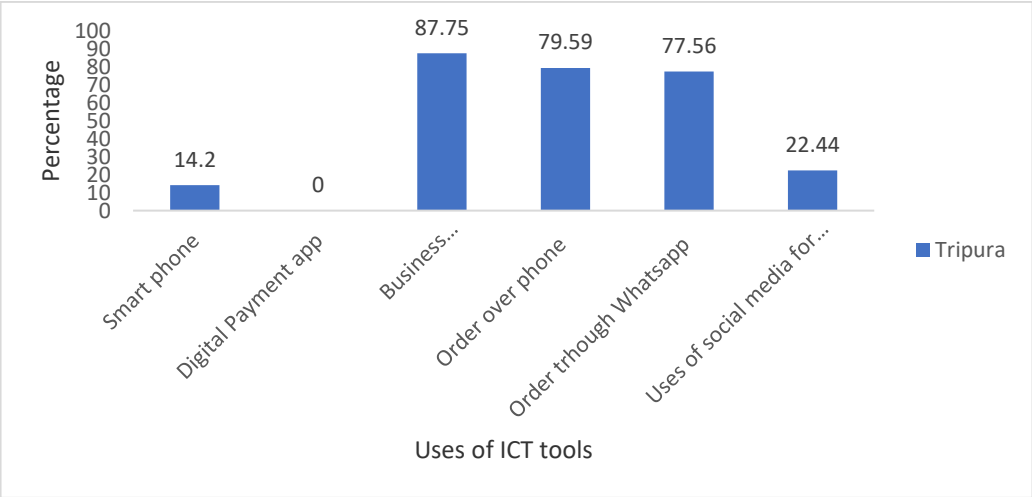


Fig. 6.6: Usage of ICT tools by the fish seed Vendors in Tripura

6.3.5 Usage of ICT by Fish Farmers

The details of ICT used by fish farmers is given in Figure 6.7. It is observed from figure that 59.5% farmers of Tripura and 83.3% farmer of Manipur use smart phones and they have reported that it is effective and useful in their farm business. However, only 11.57% used smartphones for digital payment. Hence digital literacy is important for them to secure digital transaction of money. Majority of farmers of Tripura (69.42%) and Manipur (86.8%) were reported that they were using phone for fish farm business communication. It is interestingly to note that 3.33% of fish farmers are taking order for fish through WhatsApp. 55.37% of farmers of Tripura were using internet and social media to get technical information related to fish farming.

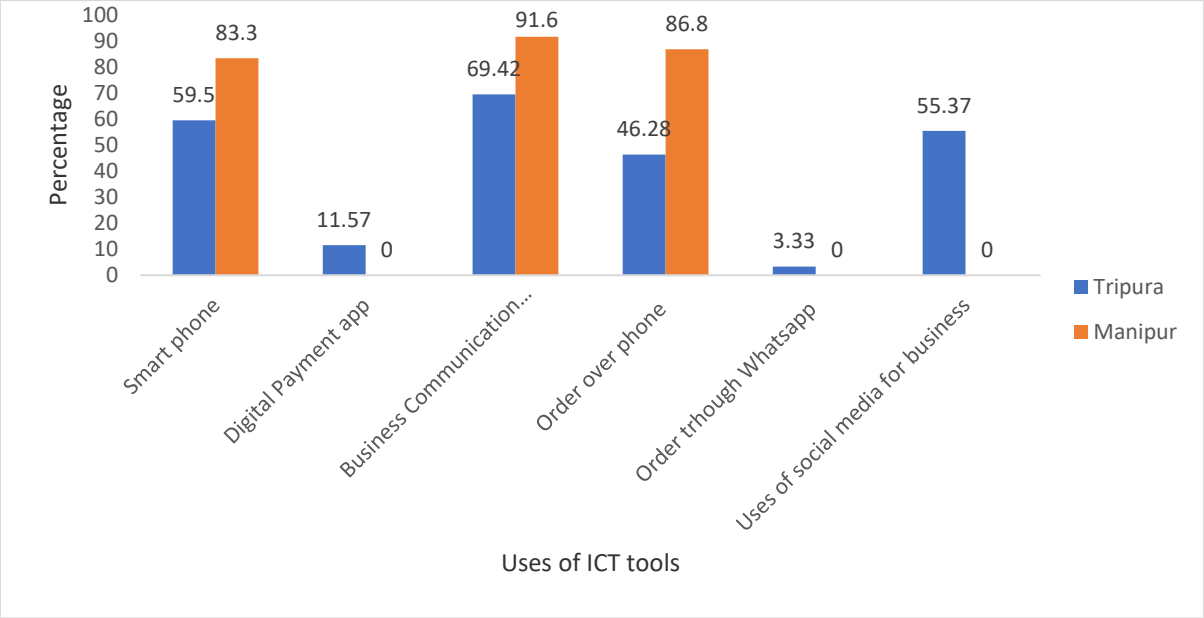


Fig 6.7: Uses of ICT tools by Fish Farmers in Tripura and Manipur

6.3.6 Usage of ICT by Labourers of Seed Supply Chain

In the case of labourers, about 21% in Tripura and 84% in Manipur used smartphones (Figure 6.8). In Tripura 18.9% labourers uses smart phone for digital payment. The majority of labourers (90.9%) use phones for business communication whereas, in Manipur 45% labourers were reported to be using phone for business communications.

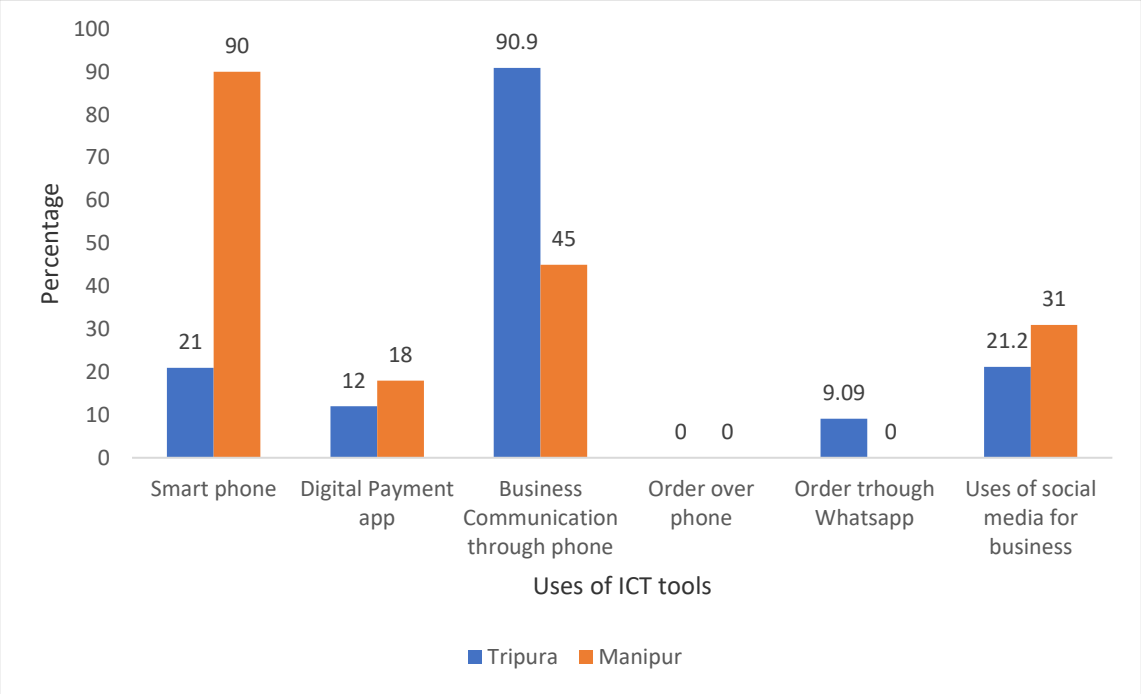


Fig 6.8: Usage of ICT tools by the labourers in Tripura and Manipur

7.1 Model Bankable Project on Establishment of Carps Hatchery (Eco/Chinese Hatchery) in Manipur

Based on the primary data on cost and returns of hatchery units of Manipur, a Bankable Model Project for Establishment of Carps Hatchery (Eco/Chinese Hatchery) in Manipur was developed and it is presented in Tables 7.1 to 7.4. By assuming economic life of the project for 10 years and discount factor 0.15, present value of cost and returns was calculated. The net present value of the project (NPV) was Rs. 6007845.0/-, Benefit-Cost Ratio (B-C Ratio) was 2.029 and Internal Rate of Return was 68.05%. All these financial Indicators shows that the investment in establishment of Hatchery Units in Manipur was economically viable.

Table 7.1: Cost and Return of a hatchery unit in Manipur

Sl. No.	Head	Total Cost (Rs)
A.	**Capital Cost of Establishment of Hatchery**	
1	Construction of brooder and nursery ponds	266206.08
2	Construction of Hatchery (overhead tank, breeding pool, hatching pool, shed, water pipe electricity etc.)	1000040.0
3.	Cost of Machineries (Tubewell, Pump, Generator, oxygen cylinder etc)	700555.5
4.	Brood stock	1066668.0
	Total capital cost	3033470.0
B.	**Operational cost**	
1.	Preparation of brooder ponds (ha)	235220.18
2.	Manuring	12000.0
3.	Fertilization	1440.0
4.	Lime	10240.0
5.	Disease management	10000.0
6.	Feed	211500.0
7.	Netting	23750.0
8.	Feed cost	95000.0
9.	Additional labour for hatchery (per days)	168000.0
10.	Packaging cost	90000.0
11.	Electricity	16000
12.	Mic. cost for pituitary gland	16600.0
	Total Operational Cost	**771000.2**
C.	**Returns**	
	Net spawn production (no in Lakh) (70% survivability)	4215.225
	Gross Return (Rs)	2854688.0

Table 7.2: Distributed cost and returns over 10 year of a Hatchery unit in Manipur (project period is assumed 10 years)

Year	Capital cost	Operational Cost	Gross Return
1	3033470	0	0
2	0	771000	2854688
3	0	771000	2854688
4	0	771000	2854688
5	0	771000	2854688
6	0	771000	2854688
7	0	771000	2854688
8	0	771000	2854688
9	0	771000	2854688
10	0	771000	2854688

Table 7.3: Present worth of cost and returns of a Hatchery unit in Manipur

Year	Capital cost	Operational Cost	Total cost	Gross Return	Discounted Cost (DF=15%)	Discounted Return (DF=15%)	Net Discounted Benefit
1	3033470	0	3033470	0	2637800	0	-2637800
2	0	771000	771000	2854688	582987	2158554	1575567
3	0	771000	771000	2854688	506945	1877004	1370059
4	0	771000	771000	2854688	440822	1632177	1191355
5	0	771000	771000	2854688	383323	1419284	1035961
6	0	771000	771000	2854688	333325	1234160	900836
7	0	771000	771000	2854688	289847	1073183	783335.4
8	0	771000	771000	2854688	252041	933203	681161
9	0	771000	771000	2854688	219166	811480	592314
10	0	771000	771000	2854688	190579	705635	515056

Table 7.4: Financial indicators showing economic viability of project and Bankability for a Hatchery unit in Manipur

Sl.No.	Financial indicators of project	Value
1.	NPV	6007845.0
2.	BCR	2.029298
3.	IRR	68.05
4.	Capital cost	3033470.0
5.	Margin Money (10%)	303347

6.	Bank Loan	2730123.0
7.	Rate of interest	12%
8.	Repayment period	10 years

7.2 Model Bankable Project on Establishment of Carps Hatchery (Eco/Chinese Hatchery) in Tripura

Using data on cost and returns of Hatchery units of Tripura, a Bankable Model Project for Establishment of Carps Hatchery (Eco/Chinese Hatchery) in Tripura has been developed and it is presented in Tables 7.5 to 7.8. By assuming economic life of the project for 10 years and discount factor 0.15, present value of cost and returns were calculated. The net present value of the project (NPV) was Rs. 8048214.0/-, Benefit-cost Ratio (B-C Ratio) 2.58 and Internal Rate of Return was 114.44%. All these financial indicators shows that the investment in establishment of Hatchery Units in Tripura is financially sound and economically viable.

Table 7.5: Cost and Return of a hatchery unit in Tripura

Sl. No.	Head	Unit	Total Cost
A.	Capital Cost		
1.	Construction of brooder ponds	Ha.	791250.0
3.	Hatchery shed		45000.0
4.	Overhead tank (in liter)	Liter	80000.0
5.	Circular breeding pool	meter (diameter)	31400.0
6.	Hatching pool	meter (diameter)	33750.0
7.	Guard shed and office room (in ft.)	Sq. feet	103333.0
8.	Water supply pipe	Inch (diameter)	8625.0
10.	Shallow tube well	Inch (diameter)	19214.0
11.	Water pump	H.P.	42125.0
12.	Generator cost	Kw.	41500.0
13.	Brood stock (ha)	Kg	800000.0
14.	Oxygen cylinder (year)	D type	22466.0
15.	Electricity fittings and other equipment, nets etc etc.	Misc	53745.0
	Total capital cost		2072408.0
B	Operational Cost		
	Preparation of brooder ponds (ha)	Ha.	14000.0
	Manuring	Kg	18500.0
	Fertilization	Kg	3666.0
	Lime	Kg.	19600.0
	Disease management	LS	6625.0

	Feed	Kg.	415600.0
	Netting	no	17833.0
	Additional labour for hatchery (per days)	Man-days	68000.0
	Packaging cost	LS	132900.0
	Electricity	RS	25500.0
	Mic. cost for pituitary gland	No.	68030.0
	Total Operational Cost		790254.0
C	**Returns**		
	Net spawn production (no in Lakh) (75% survivability)	Liter	591.81
	Gross Return (Rs)	Rs.	31,64,277.94

Table 7.6: Distributed cost and returns over 10 year of a Hatchery unit in Tripura (project period is assumed 10 years)

Year	Capital cost	Operational Cost	Gross Return
1	2072408	0	0
2	0	790254	3164278
3	0	790254	3164278
4	0	790254	3164278
5	0	790254	3164278
6	0	790254	3164278
7	0	790254	3164278
8	0	790254	3164278
9	0	790254	3164278
10	0	790254	3164278

Table 7.7: Present worth of cost and returns a Hatchery unit in Tripura

Year	Capital cost	Operational Cost	Total cost	Gross Return	Discounted Cost (DF=15%)	Discounted Return (DF=15%)	Net Discounted Benefit
1	2072408	0	2072408		1802094	0	-1802094
2	0	790254	790254	3164278	597546	2392649	1795103
3	0	790254	790254	3164278	519605	2080564	1560959
4	0	790254	790254	3164278	451830	1809186	1357356
5	0	790254	790254	3164278	392896	1573205	1180309
6	0	790254	790254	3164278	341649	1368005	1026356
7	0	790254	790254	3164278	29709	1189569	892484
8	0	790254	790254	3164278	258335	1034408	776073
9	0	790254	790254	3164278	224640	899485	674846
10	0	790254	790254	3164278	195339	782161	586822

Table 7.8: Financial indicators showing economic viability of project and bankability for a Hatchery unit in Tripura

Sl.No.	Financial indicators of project	Value
1.	NPV	8048214
2.	BCR	2.583977
3.	IRR	114.44
4.	Capital cost	2072408.0
5.	Margin Maney (10%)	207240.8
6.	Bank Loan	1865167.0
7.	Rate of interest	12%
8.	Repayment period	10 years

8.0 Summary and conclusions:

8.1 Summary

Fish production in North Eastern states of the country is mainly dependent on rain water which restricts the culture period for fish to about 9 months (June to February) in seasonal ponds. Hence, timely availability of quality seed of appropriate size of desired fish species to the fish farmers is the key factor that determines final weight of the fishes at the time of harvesting and market price realization. Due to undulated topography, accessibility of the farmers for fish seed is poor in the whole North Eastern Region. It also increases risks of mortality, low survivability and price instability for seed, etc. To fill the gap between demand and supply of quality seeds remains a big challenge in development of aquaculture in Tripura and Manipur. Hence, this study was undertaken for systematic mapping of the seed supply chain of Tripura and Manipur states. The specific objectives of the study were:

1. To map the fish seed supply chain of Tripura and Manipur
2. To analyze cost and return structure for different chain actors operating at different stages of seed supply chain
3. To assess risks involved in seed supply chain activities
4. To analyze impact of seed supply on farm level fish production
5. To develop bankable projects in fish seed supply chain of Tripura and Manipur

In order to achieve the objectives of the research study two states viz Tripura and Manipur of North Eastern Region of India, were selected purposely because of higher area and production of fish these two states. The fish seed production and distribution involves a series of stakeholders, including input suppliers, hatchery owners, nursery seed growers, seed market functionaries, seed vendors, fish farmers and labourers, etc. Hence, for mapping of the whole fish seed supply chain, multistage stratified random sampling design was used to identify a representative sample including respondents of all category stakeholders, to select districts, RD Blocks, villages and finally respondents for collection of primary data. In Tripura state, Gomati, Sepahijala, West Tripura, Dhalai and North Tripura districts were selected, whereas, in Manipur state, lmphal East and lmphal West, Bishnupur, Thoubal and Chandel districts were selected based on area and production of fish. Further, from each district of Tripura two RD Block were selected such as Gomati district-Matabari RD Block, Kakrabon RD Block; Sepahijala district-Bishalgharh Block, Nalcher RD Block; West Tripura district - Mohanpur RD Block, Jirania; Dhalai district - Ambassa, Durgachowmuhani RD Block; North Tripura district-Kalacharra Rd Block, Laljuri Rd Block have been selected. Similarly, in Manipur from each of the selected district two RD blocks were chosen based on fish culture area and fish production. Selected blocks are in lmphal East & West lmphal: Wangoi , Sawombung, Bishnupur: Moirang, Nambol RD block, Thoubal district: Thoubal, Lilong district, Chandel district: Chandel, Chakpikarong RD block. From the selected blocks a representative number of respondents were selected in each category of stakeholders. In Tripura, Hatchery (Chinese/Low-

cost/Pvt/ Govt)-14 Nursery seed growers-46 Seed markets-4 Fish seed vendors-50 Commission Agent-cum Wholesalers-20, Fish farmers-121, and labourers-31. Similarly, from Manipur number of respondents are, hatchery (Chinese/Low cost/Pvt/Govt)-9, nursery seed growers-12, traders-16, fishfarmers-157, and labourers-44. Therefore, altogether 524 respondents were selected for personal interview and data collection. Separate survey schedule was developed and used for collecting data from each category of respondents.

The methodology for supply chain mapping was used as recommended by the researchers in which the supply chain mapping involved mapping of six dimensions of supply chain such as a) supply chain entities b) relationship of supply chain entities c) material flow d) information flow e) management policy and f) lead-time. The second objective was achieved through analyzing cost, returns and margin of supply chain actors. Third objective was risk assessment for the fish seed supply chain. The risk at different stages of the fish seed supply chain was measured by calculating survivability and mortality of seed. Further, causes of risks were identified and ranked using Garret ranking technique. Fourth objective of the study was achieved by analyzing data collected on performance of seed supplied through different channels at farm level, stocking size of fish seed and their impact on final weight at the time of harvesting, financial inclusion of supply chain actors and level of ICT usage in their seed production and seed distribution business, etc. In the last objective that was to develop bankable projects in fish seed supply chain of Tripura and Manipur, financial analysis of establishment of hatchery units in Manipur and Tripura were performed and bankable projects for establishment of hatchery units for spawn production were developed as a part of this study.

8.2 The salient findings of the study:

i. The analysis of secondary data on the distribution of aquaculture area, spawn production and fingerlings production across the RD blocks of Tripura revealed that there is a skewed distribution in seed production. It was found that 45% of total spawn production was confined to Sepahijala district and 58.81% of fingerlings production was confined to two districts namely Gomati and Unakoti. It indicates that an efficient fish seed supply chain for distribution of fish seed in the entire state is required.
ii. In Manipur seed production showed increasing trends during 2015-16 to 2020-21 and in total seed production, Indian Minor Carp, and Exotic Carps accounted 92 % and remaining 8 % were catfishes. In Manipur also fish seed productions are confined to valley districts like lmphal east, lmphal West, Thoubol and Bishnupur whereas, water area for fish production is distributed in whole state.
iii. The fish seed supply chain entities in Tripura, are input suppliers, hatchery owners, nursery seed growers, wholesaler/traders, commission agents, seed vendors and fish farmers. Whereas, in Manipur, supply chain entity is input suppliers, hatchery cum nursery seed growers, traders, fish farmers, labourers.
iv. It was found that majority of hatchery owners (71.42%) in Tripura belong to Schedule Castes, in age group above 50 years (57.15%), mainly male, with land holding that was

between 1-5 kani (28.57%). Their family size was 4-6 members (57.14%), education level primary and above, annual income above 5 lakhs, and their sources of information were colleagues and friends (78.57%). Similarly in Manipur, majority of hatchery owners belonged to age group above 50 years (66.67%), OBC caste category (66.66%), with land holding 5-10 kani (22.22%), family size 4-6 members (55.55%), education above primary level. Their annual income was above 5 lakh (100%) and their sources of information was Extension Officer (100%).

v. Among the nursery seed growers of Tripura, majority (72.41%) of them belonged to middle age group (up 15-50years), schedule castes (45.94%), male, land holding 1-5 kani (45.45%), family size 4-6 members (71.73%), education level primary and above, annual income Rs.1-2.5 lakh (37.5%), and their sources of information were colleagues and friends (35.71%), extension officer (26.19%) and internet (21.43%). Similarly in Manipur, majority of nursery seed growers belonged to middle age group (72.41%), OBC caste category (51.72%), land holding 1-5 kani (51.72%), family size 4-6 members (65.51%), and education above primary level, annual income 1-2.5 lakh (34.34%) and their sources of information was extension officer (58.62%).

vi. In case of nursery seed vendors of Tripura, majority (55.10%) of them belonged to middle age group (up 15-50 years), schedule caste (79.59%), male, land less (51.02%), BPL (69.38%), with family size 4-6 members (59.18%), education level primary and above, annual income below Rs. 1 lakh (48.98%), and their sources of information were colleagues and friends (93.88%). Their secondary or off-season occupation was daily paid labourers (40.82%). It shows that majority of poor people are engaged in distribution of seed in Tripura.

vii. It was found that the fish farmers in Tripura belong to schedule castes (37.4%), OBC (24,39%), ST(22.76%). Majority of them belong to middle age group (up 15-50 years), (67.42%), male (98.55%), land holding 1 kani (72.15%), family size 4-6 members (66.66%), education level primary and above, annual income less than 1 lakh (47.06), and their sources of information were colleagues and friends (30.61%), extension officer (13.27%), internet (40.82%). Similarly in Manipur, majority of fish farmers belonged to middle age group (92.45%), OBC caste category (46.54%), male (81%), land holding upto 1 kani (72.15%), family size 4-6 members (83.64%), education above primary level, annual income 1-2.5 lakh (74.21%) and their sources of information is colleagues and friends (95.07%).

viii. The socio-economic conditions of labourers engaged in fish seed supply chain indicates that in Tripura, majority (72.72%) belonged to middle age group (up 15-50 years), Schedule Castes (68.18%), male, land less (86.67%), BPL (72.72%), with family size 4-6 members (63.33 %), education level primary and above, annual income below 1 lakh (68.75%). Their sources of information were colleagues and friends (76.19%) and their secondary or off season occupation was daily paid labourers (48%). It shows that majority of poor people are engaged in distribution of seed in Tripura.

ix. The entity relationship between supply chain actors is three type exclusive, preferred and vendor type. In this study, relationship between input suppliers and hatchery owners was found to be of exclusive type; relationship between hatchery owners and

nursery seed growers was found to be preferred relationship. In case of nursery seed growers and seed vendors at seed farm, seed growers were in better position to bargain hence preferred relationship was found. However, in the seed market seed buyers are in better position to bargain for seed as many sellers are present in the market. In this case, relationship between sellers or nursery seed growers and buyers (seed vendors, farmers) were vendor type. At farm level, farmers are in better position to bargain with seed vendors which indicates preferred relationship.

x. lnter-organizational relationship between supply chain actors in different tiers of supply chain may have horizontal or vertical integration. In fish seed supply chain, hatchery owners are generally involved in spawn production as well as in nursery seed rearing. Similarly, in some cases, nursery seed growers do nursery seed rearing as well as marketing of seed. However, strong integration in fish seed supply chain could not be noticed which can influence the market prices or quality.

xi. Supply chain map showing physical flow of seed for Tripura and Manipur was developed. It was found that 65.2 % of total spawn supply is routed through Hatchery-Nursery Seed Growers in Tripura. Similarly, for fry and fingerlings in Tripura physical flow of seed through sub channels 1) Hatchery -Seed Growers-Market-Vendor-Farmers was 37.62% and 2) Hatchery -Seed Growers-Market-Farmers was 39% of total supply of seed. Hence, these two sub supply chains were identified to be dominant for fish seed delivery in Tripura.

xii. In Manipur it was found that 55.43% fry and 38.69% fingerlings were routed through hatchery cum nursery seed growers to the fish farmers. Hence, in Manipur the hatchery owners were also performing the function of nursery seed growers and they directly supplied seed to farmers in form of spawn, fry as well as fingerlings. Further, about 15.28% fish farmers purchase spawn from the hatchery and they do nursery seed rearing at their own farm. They meet out their requirement of fingerlings and also supplied to the neighbour farmers. 6.49% of total seed requirement of farmers is met by the traders who import seeds from outside the state i.e. Kolkata.

xiii. It was interesting to note that two distinct fish seed supply chain models were found in Tripura and Manipur. In Tripura spawn is produced by hatchery and it is supplied to nursery seed growers for nursery seed rearing (fry and fingerlings production). Then nursery seeds are supplied to the seed markets from where seed is distributed through seed vendors to fish farmers. Whereas, in case of Manipur, no fish seed markets were found. As a result, hatcheries are producing spawn, fry and fingerlings and they directly supply to the farmers. The farmers are also purchasing spawn and doing nursery rearing at their own farms. Hence development of fish seed market is very much required in Manipur for better organized fish seed supply chain activities for seed distribution in the state.

xiv. The flow of information within the supply chain plays a vital role in decision making by the supply chain actors. It was found that the information regarding seed availability and prices flows from upstream to downstream of supply chain. Whereas, information about seed demand in terms of species, size quality, flows from downstream to upstream. Hence information flow was bidirectional in fish seed supply

chain of Tripura. Whereas, in case of monetary flow, it was unidirectional from downstream to upstream. Physical flow of seed is also unidirectional from upstream to downstream.

xv. For the fry/fingerlings lead time for four sub supply chains such as 1. Hatchery-Seed Growers-Farmers, 2. Hatcheries-Seed Growers-Market- Vendor-Farmers 3. Hatchery -Seed Growers-Market-Farmers and 4. Hatchery -Seed Growers-Vendor-Farmers were worked out. In case of sub chain 1, 2, 3 and 4, estimated lead time were 922 hours, 925 hours, 923 hours and 923 hours, respectively.

xvi. In Tripura spawn survivability at hatchery level was found to be 76.36%; at nursery seed rearing, it was 33.19%; and at distribution of fry and fingerlings by seed vendors, survivability was found 93.84%. At farm level, survivability was estimated to be 80.78%. Survivability of seed is one of the most important determinants of economic gain from the seed supply chain. The survivability particularly at nursery level and seed vendor's level required to be increased in order to minimize economic losses in fish seed supply chain.

xvii. In Manipur spawn survivability at hatchery level was found to be 70%; at nursery seed rearing, it was 70%; at distribution of fry fingerlings survivability was found 90%. At farm level, survivability was found different for fry (56.47%) and for fingerlings (96%). Hence, for better survivability of seed at farm level production, nursery seed rearing is to be promoted.

xviii. Further, causes of risks at different stages of supply chain risk mitigating strategies adopted by supply chain actors and dimensions of supply chain risk management (SCRM) were analyzed for both states Tripura and Manipur.

xix. The power supply, occurrence of diseases, price fluctuation, non-availability of buyers at the time of harvest and lack of skilled labourers were the major causes of risks at hatchery level. At nursery seed rearing, price fluctuation, weather condition, mass mortality, mortality during transportation, and non-availability of buyers when crop is ready, unavailability of spawn on time are important causes of risks. At market level, non-sale of seed, non-availability of transport facilities and high mortality are important causes of risks. In case of seed vendors, non-availability of transport, non-availability of water exchange facility and non-sale of seed are major source of risk. The supply chain actors of nursery seed growers adapt different risks mitigating strategies such as uses of medicine (CIFAX) or preventive measures (KMN04), for the disease management, generators for power supply, lime for water quality management, CCTVs for surveillances at hatchery and nursery seed rearing, etc. However, along the distribution channels, appropriate facilities are required to avoid mortality of seed during its distribution.

xx. Analysis of costs and returns at different stages of fish seed supply chain indicated that for establishment of a hatchery unit in Manipur with water area of about 1 hectare, capital cost was Rs.30,28,469/- and operational cost was Rs. 1758827/annum. On an average, a hatchery owner in Manipur earned net return over total cost of Rs. 10,95,861.0/unit/annum. Whereas, in Tripura a hatchery owner with one hectare water invested capital cost of Rs. 2072408/- on establishment of hatchery and his

operation expense was Rs. 1276885/annum. They earned net income of Rs.18,87,393/annum on average. It indicates that establishment and operation of hatchery for spawn production in both states were profitable enterprise.

xxi. Similarly, the cost and return of nursery seed rearing units and fish farm have been analyzed and it was found that nursery seed rearing was also found to be a profitable enterprise. However, the profitability of nursery seed rearing and fish production is highly dependent on professional skill, adoption of technology, level of input use, marketing, etc.

xxii. Majority of farmers of Tripura and Manipur have adopted polyculture system with multiple stocking and multiple harvesting. Farmers are used to rear species combinations including Indian Major Carp (Rohu, Catia, Mrigal), Exotic Carps (Grass Carp, Silver Carp, Common Carps) along with one or two locally available fish species which have high market demand and market prices. The local species are added in culture system to generate additional income from fish farming. However, availability of seed of these local species is very less. Hence, there is a need of promoting breeding, seed production and seed supply of local fish species.

xxiii. The marketing cost margins, marketing efficiency and price spread in different marketing channels of fish seed in Tripura were analyzed and it was found that the price spread in marketing channel I, marketing channel II, marketing channel III and marketing channel IV were Rs. 66000 .0, Rs.124391.6 Rs.104391.6 and Rs. 86000.0 per lakh seed, respectively. Higher price spread in marketing channel II and channel III was because of fish seed routed through the fish seed market in which most of the middlemen are involved.

xxiv. The marketing efficiency was highest (ME=5.30) in marketing channel-I (Hatchery-Nursery seed growers-Fish farmers) followed by Marketing channel IV (Hatchery -Seed Growers-Vendor-Farmers) (ME=2.69), marketing channel III (Hatchery-Nursery seed growers-Wholesalers cum commission agent-Fish farmers) (ME=1.95) and marketing channel II (Hatchery-Nursery seed growers-Wholesalers cum commission agent- Seed Vendors-Fish farmers) (ME= 1.10). Though the marketing efficiency of channel I & Channel IV was higher but physical flow was higher in marketing channel III (39% and Marketing channel II (37%). Hence, marketing efficiency of these two channels needs to be increased.

xxv. The distribution of fish farm price along the sub supply chains of Tripura, value added at different stages, economic loss due to poor survivability of seed (mortality) were calculated. The producers' share in consumers' rupee of fish seed were about 84 % in channel-I, 67.92% in Channel-IV, 58.28% in Channel-II and lowest 48.84% in channel-III.

xxvi. The profit margin of fish seed vendors of Tripura showed that they earned percentage margin of 24.3%. However, every day they lose money amounting about Rs 143.79/- due to mortality of fingerlings during transportation and distribution. This amount is significant as vendors put hardwork in distribution of fish seed. Hence, technology interventions are needed for reducing mortalities of fish seeds during transport.

xxvii. The impact of supply chain in terms of performance of seed supplied through different sources (channels)to the fish farmers was analyzed. It was found that

the seed supplied by seed vendors and seed markets were better as compared to other sources. Hence, these two supply chains have better performance at farm level output. It may be because of the availability of seeds in the market which are of mixed type: stunted fingerlings and normal fingerlings. Whereas, nursery seed grower and own seed mostly provides seed produced during same year. This clearly emphasizes the role of seed supply chain to encourage raising stunted fingerlings and enhancing aquaculture productivity and fish production in Tripura state.

xxviii. The impact of stocking size of seed on average weight of fishes at the time of harvest were also analyzed for Tripura and Manipur. In case of stocking of fingerlings in Manipur, percentage increase in mean weight at harvest of fishes ranged from 11.9% in case of koi species to 326.67% in case of grass carp as compared to the stocking of fry. Further, the survivability was also found better (96.10%) for stocking size of fingerling as compared to the stocking size fry in which survivability was only 56.47%.

xxix. Similarly for Tripura, it was found that the mean weight at the time of harvest of fishes were higher in case of fingerlings as compared to the fry. The percentage increase in mean weight at harvest was recorded between minimum 5.26 % to maximum 80 %. Further, the survivability was recorded 80.48% in fingerlings and 68.68% in fry. The standard deviation calculated for all these changes showed better stability in size and weight of fishes at the time of harvest in case of stocking of fingerlings as compared to stocking of fry. Hence, price realization to the farmer for big size fishes are more as compared to small size fishes. These results clearly indicate that fish farmers can benefit by stocking stunted fingerlings/fingerlings rather than stocking fry. It will increase farm level fish production as well as fish production in the state.

xxx. The uses of ICT for getting information regarding fish production system was encouraging in whole seed supply chain in Tripura as well as in Manipur. However, digital literacy on secured digital payments and use of social media are crucial for making fish seed supply chain more efficient.

xxxi. Financial inclusion of core supply chain actor was found medium level but it was very poor in case of supporting supply chain actors such as seed vendors and labourers.

xxxii. A Bankable Model Project for Establishment of Carps Hatchery (Eco/ Chinese Hatchery) in Manipur was developed and the net present value of the project (NPV) was Rs. 6007845.0/-, Benefit-Cost Ratio (B-C Ratio) 2.03 and Internal Rate of Return was 68.05. Period of project was taken 10 years and discount factor 0.15. All these financial indicators show that the investment in establishment of Hatchery Unit in Manipur is economically viable.

xxxiii. A Bankable Model Project for Establishment of Carps Hatchery (Eco/ Chinese Hatchery) in Tripura was developed by assuming economic life of the project for 10 year and discount factor 0.15, net present value of the project (NPV) was Rs. 8048214.0/-, Benefit-cost Ratio (B-C Ratio) 2.59 and Internal Rate of Return was 114.44. All these financial indicators show that the investment in establishment of hatchery unit in Tripura is financially sound and economically viable.

Recommendations:

i. Fish seed supply chain in Tripura is relatively organized and structured as compared to Manipur because of existence of specialized nursery seed growers and seed markets in the Tripura state. Hence, for the development of aquaculture in Manipur, fish seed supply chain needs to be improved, nursery seed rearing needs to be promoted and nursery seed markets need to be developed as both are missing in Manipur state.

ii. The fish seed supply chain requires some minimum facilities along the supply chain such as oxygen packing, water exchange facilities, aerator facilities, transport facilities etc. because seeds are transported in live conditions in low volume of water and high density of seed which is subject to high risk of mass mortality. Hence, seed markets are to be developed at road side with easy access and with all the required infrastructural facilities.

iii. The spawn production, nursery seed growing and fish production - all are found to be a profitable enterprise in Tripura and Manipur. Hence, institutional financing for these enterprises needs to be strengthened.

iv. The stunted fingerlings (yearlings) and fingerlings have better performance at farm level. Hence, technical and financial support for production and supply of stunted fingerlings (yearlings) and fingerlings to a farmer is crucial.

v. Further research and technology interventions are required to develop fish seed transportation carriers for distribution of live seeds to long distance.

vi. Financial inclusion and digital literacy in particular for financial services are to be strengthened.

vii. The use of ICTs is very crucial for fish seed supply chain. Hence, capacity building programmes for supply chain actors on ICT applications in seed production and seed marketing is needed.

Appendix-1

College of Fisheries
Central Agricultural University
Lembucherra, Tripura-799210

A

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule- Hatchery Owner)

A. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher secondary	Graduate

							and above
	Family members (no.)						

Occupation	Family occupation					
	Type	Primary		Secondary		Tertiary
	Name					
	Engaged family member (no.)					
	Income					
	% Contribution in Family income					
	Self occupation					
	Period	Name	Days in year (No.)	Average sale		Income (Rs.)
				Quantity	Value	
	On season					
	Off season					

	Gross income (from all sources)	Expenditure (total)	Net income

Income and Expenditure (Annual)			
Working experience (years)			
Social participation	No membership/ Member of one organization/ Member of more than one organization/ Office holder/ Wider public leader		
Source of information	T.V./ Newspaper/ Radio/ Social media/ Internet/ colleagues and friends/ Extension officers/ Private agencies		

B. Facilities and assets available for seed production:

Total land holding					
Agricultural land					
Brood stock pond					
Area in kani/ganda	Species	Own/ Leased	Year of construction	Initial cost/Annual Rent for leased in	Mode of construction Self/Govt
Pond-1:					
Pond-2:					
Pond-3:					
Total area-					
Nursery pond					
Pond-1:					
Pond-2:					
Total area-					
Hatchery					
Hatchery 1					
Hatchery 2					
Hatchery 3					
Total area-					

C. Pattern of Spawn production in hatchery

Spawn production in hatchery in last year (Actual)

Period/Month /cycle										Overall for the year
Number of days										
Species										
Total spawn production										

Survivability										
Total spawn sold										
Pricesavg										
Proportion of Spawn sold to nursery growers (%)										
Proportion of Spawn sold traders (%)										
Proportion of Spawn sold farmers (%)										

D. Capital cost for establishment of hatchery:

A. Capital cost of Hatchery (Year of establishment.....)

Sl.no.	Item	Specification (dimension)	Unit	Cost (Rs.) At the time of establishment
i.	Construction of Brooder Ponds			
ii.	Construction of nursery Ponds			
iii.	Hatchery shed			
iv.	Overhead tank			
v.	Circular breeding pool			
vi.	Hatching pools			
vii.	Guard shed and office room			
viii.	Water supply pipe and connectivity			
ix.	Electricity supply and fittings			
x.	Shallow tube well			
xi.	Water Pump			
xii.	Generator set			
xiii.	Brood stock			

xiv.	Oxygen cylinder			
xv.	Contingent expenses for nets, equipment, handi, hapas etc.			
	Total			

E. Recurring cost

I. Cultural cost for preparatory months (Total period: .....)

	Item	Specification	Unit	Duration	Cost(Rs.)
i.	Preparation of brooder ponds				
ii.	Manuring				
iii.	Fertilization				
iv.	Lime				
v.	Disease management				
vi.	Feed				
vii.	netting				
viii.	Salary of guards-cum-labour				
	Other cost (specify)				
	Total				

II. Cultural cost for operating months (Total period: .....)

	Item	Specification	Unit	Cost(Rs.)
i.	Feed cost			
ii.	Guards-cum-labour			
iii.	Additional labour for hatchery operation			
iv.	Misc. cost for pituitary gland/ hormone, equipment			
v.	Packaging cost			
vi.	Electricity cost			
	Total			

III. Cultural cost for post-operatory months (Total period.....)

	Item	Specification	Unit	Cost(Rs.)
i.	Mannuring, feeding, liming and fertilisation			
ii.	Wages for guards-cum-labour			
iii.	Cost of periodical netting			
iv	Other expenses			
	Total			

F. PRODUCTION

		Unit/quantity	Cycle/month	Total duration
i.	Per batch requirement of female brood fish			
ii.	Per batch requirement of male brood fish			
iii.	Per batch requirement of brood fish for single run (male or female)			
iv.	Total number of hatchery runs			
v.	Total requirement of brood fish			
vi.	Number of successful breeding			
vii.	Number of spawns produced per kg body weight of female brood fish			
viii.	Spawn produced from female brood fish in a single run			
ix.	Survivability (in percent)			

G. Gross income/run

I.	Gross income/run	Quantity	Price/unit (bati, lakh etc.)	Total	Name of agencies two whom spawn is sold with proportion (%)
i)	From sale of major carp spawn				
ii)	From sale of exotic carp spawn				
	Sub Total				

Nursery seed rearing (Up to fry) and Seed Production in a year

Cost of production of Nursery seed (Nursery pond area.....kani/ganda)

Inputs		Quantity	Unit price	Total costs	Production	Survivability (%)	Quantity (no.)	Selling Price (Rs.)	Gross Return
Deweeding, bund compaction					Catla				
Lime					Rohu				
Fish spawn	Catla				Common Carp				
	rohu								
	common carp								
	grass carp								
Transportation of inputs					Grass carp				
Feed (Rice bran and ground nut cake in 1:1 ratio					Number of cycle				
Raw cow dung					Total Catla				
Labour for feeding other maintenance					Total Rohu				
Harvesting expanse					Total Common Carp				
Costs involved in selling of seed					Total Grass carp				
Transport									
Marketing etc.									
Watch and ward, Miscellaneous									

H. Nursery seed rearing (Up to Fingerling)

Cost of production of Nursery seed (Nursery pond area.....kani/ganda)

Inputs	Quantity	Unit price	Total costs	Production	Survivability (%)	Quantity (no.)	Selling Price (Rs.)	Gross Return
Deweeding, bund compaction				Catla				
Lime				Rohu				

Fish spawn	Catla				Common Carp				
	rohu								
	common carp								
	grass carp								
Transportation of inputs					Grass carp				
Feed (Rice bran and ground nut cake in 1:1 ratio					Number of cycle				
Raw cow dung					Total Catla				
Labour for feeding other maintenance					Total Rohu				
Harvesting expanse					Total Common Carp				
Costs involved in selling of seed					Total Grass carp				
Transport									
Marketing etc.									
Watch and ward, Miscellaneous									

J. Details of Purchase of inputs and sale

Name of input							
Places of purchase							
Agency							
Quantity							
Quality							
Availability							
Total Price							

Name of output							
Places of sale							
Agency							

Quantity							
Availability							
Total Price							

K. Demand and supply gap at Hatchery level:

Species					
Target production					
Actual production					
Actual demand					
Gap in demand and supply					
Reasons for not fulfill the demand					

Mode of Transport system to transfer inputs from the producing areas to the farm

L. Risks involved at the level of nursery seed growers

Sl.No.	Causes	Occurrence More Frequent, Frequent, Rare	% Loss
i.	Aquatic environments (Water quality)		
ii.	Poor spawning		
iii.	Poor hatching		
iv.	Mass mortality		
v.	Disease		
vi.	Poor demand of spawn		
vii.	Non availability of inputs		
viii.	Non availability of buyers		
ix.	Low prices		
x.	Mortality during transportation to markets		
xi.	Poor packaging facility		
xii.	Lack of skilled laborers		
xiii.	Power supply		
xiv.	Customer feedback		

M. Measures adopted to minimize risks

Sl.No.	Causes	Measures
i.		
ii.		

iii.		

N.Supply chain risk at different stages

Sl.No.		Reason	Occurrence Most severe/Severe/moderate/occasion/Not important
Supply risks			
a.	Frequent delays in the supply time of materials (inputs)		
b.	Offer(Supply) is not flexible		
c.	Depends on a single supplier		
d.	The quality of the supply was poor		
Operational risks			
a.	Production disruption		
b.	Production capacity is not enough		
c.	Inconsistent inventory / inventory handling maintenance strategy		
d.	Organizational issues (operation issues)		
e.	Not flexible in terms of capacity		
Environment risks			
a.	Unexpected events such as rainfall, weather condition, natural disaster		
b.	Policy uncertainty		
c.	The Government support and environment of business		
d.	Skilled personnel are not available		

Financial risks			
a.	Credit		
b.	Ability to re-invest		
c.	Payment		
d.	Interest rate		
Market risks			
a.	The information system does not guarantee security		
b.	Unexpected customers or unstable customers		
c.	Reputation risk		
d.	Broken external / internal infrastructure		
e.	Error in the demand forecaste		
Logistical Performance			
a.	Delivery on time		
b.	The raw materials are fully met during the production process		
c.	Favorable production and inventory planning strategy		
d.	The process of transporting goods takes place smoothly		

O. Training, Skill development

a. Whether previous training received?
b. Name;
c. Organization;
d. Year & number of days:
e. Any training needed? Specify area
    1.

P. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM	Massage received	Credit Facility availed	Insurance service	Benefitted from Government	Digital payment app

				Loan:		schemes (name of schemes)	
				Source:			
				Amount Availed:			
				Purpose:			

Q. Uses of ICT in fish seed supply chain

ICT Tools		Purposes(For Placing Order/ Seeking And Sharing Information	Frequency Of Uses Of ICT (F/O/R)	Effectiveness (ME/E/LE/NE)
Phone	Yes/No			
Type				
Phone Call/SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

R. Supply chain performance matrix

Sl. No	Factors	Information	Low	Medium	High

A.	Efficiency				
a.	Production cost per unit				
b.	Distribution cost per unit				
c.	Transaction cost(cost of searching opportunities)				
d.	Inventory (Associated cost for storages management) a. Raw material b. Unsold seed				
B.	Flexibility				
a.	Backorder (proportion of back order in total orders)				
b.	Lost sale (proportion of lost order in total orders)				
C.	Responsiveness				
a.	Fill rate(actual fill rate/target fill rate)				
b.	Product lateness(delivery date-due date)				
c.	Customer response time (process time(order-delivery))				
d.	Lead time (time required to complete the production)				
e.	Customer complain (number in one season)				
D.	Product quality				
a.	Appearance (at first look) (Good/Average/Poor)				
b.	One species (Yes/No)				
c.	Mixed ((Yes/No)				
d.	Uniformity in age (Yes/No)				
e.	Uniformity in size(Yes/No)				
E.	Product health and safety				
a.	Seed is healthy				
b.	Proper monitoring of seed health(Yes/no)				
c.	Product reliability(Number of complain registered with respect quality of seed)				
d.	Convenience (Number of complain regarding packaging etc.)				

F.	Process quality				
a.	Traceability (information available about its source)(Yes/No)				
b.	Storage and transportation (standard followed) (Yes/No)				
c.	Working conditions (hygiene and health standards) (Yes/No)				
G	Environmental aspects				
a.	Energy uses in production process (electricity)				
b.	Water uses (liter per 1000 seed production/sale)				
c.	Chemical and pesticide used (yeas/no)				
d.	Recycle/reuse(% of material reused/recycled)				
H.	Marketing				
a.	Promotion (Increase in number of customer and sale)				
b.	Customer services				
c.	Display in store (sample demonstration to customers)				

S. Additional constrains faced by the farmer:

Date: Signature of the interviewer

College of Fisheries Central Agricultural University Lembucherra, Tripura-799210	B

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Nursery Seed Growers)

D. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher secondary	Graduate and above
	Family members (no.)						
Occupation	Family occupation						

	Type	Primary		Secondary		Tertiary	
	Name						
	Engaged family member (no.)						
	Income						
	% Contribution in Family income						
	Self occupation						
	Period	Name	Days in year (No.)	Average sale		Income (Rs.)	
				Quantity	Value		
	On season						
	Off season						
Income and Expenditure (Annual)	Gross income (from all sources)		Expenditure (total)		Net income		
Working experience (years)							
Social participation	No membership/ Member of one organization/ Member of more than one organization/ Office holder/ Wider public leader						
Source of information	T.V./ Newspaper/ Radio/ Social media/ Internet/ colleagues and friends/ Extension officers/ Private agencies						

E. Faculties for Nursery seed rearing

Total land holding					
Agricultural land					
Pond area	Area in kani/ganda	Nursery/Fis production/ both	Own/ Leased in	Year constr ion	Initial cost/Annual Rent for leased in
	Pond-1:				
	Pond-2:				
	Pond-3:				
	Pond-4:				

	Total Pond area=				

Other assets

Name of assets	Year of purchase	Cost (Rs)	Economic life
Aerator			
Pump			
Electric supply			
Tanks			
Fishing gear crafts			
Handi and other small farm impalements			
Farm/Store house			
Packaging facilities			

F. Pattern of nursery seed rearing

Period/Month/cycle						Total
Number of days						
Species						
Total stocking						
Total sale Fry(no)						
Total sale fingerling(no)						
Total sale Fry(value)						
Total sale fingerling(value)						
Proportion seed sold at farm						
Proportion seed carried market for sale (%)						
Proportion seed sold to traders who take market(%						
Proportion seed sold to vendors who take it to farmers(%)						
Proportion seed sold to Farmers (%)						
Proportion seed sold at farm (%)						

i. Multiple stocking and harvesting (whether nursery preparation repeated)?

ii. Availability of water for early stocking?

iii. Selective bred/GMO/mono sex seeds?

G. Nursery seed rearing (Up to fingerling) and Seed Production in a year

Cost of production of Nursery seed (Nursery pond) area.....kani/ganda)

Inputs		Quantity	Unit price	Total costs	Production	Survivability (%)	Quantity (no.)	Selling Price (Rs.)	Gross Return
Deweeding, bund compaction					Catla				
Lime					Rohu				
Fish spawn	Catla				Common Carp				
	rohu								
	common carp								
	grass carp								
Feed (Rice bran and ground nut cake in 1:1 ratio					Grass carp				
Labour for feeding other maintenance					Number of cycle				
Raw cow dung					Total Catla				
Harvesting expanse					Total Rohu				
Transportation of inputs					Total Common Carp				
Watch and ward, Miscellaneous					Total Grass carp				
Costs involved in selling of seed									

Transport								
Marketing etc.								

H.Nursery seed rearing (Up to Fry)

Cost of production of Nursery seed (Nursery pond area.....kani/ganda)

Inputs		Quantity	Unit price	Total costs	Production	Survivability (%)	Quantity (no.)	Selling Price (Rs.)	Gross Return
Deweeding, bund compaction					Catla				
Lime					Rohu				
Fish spawn	Catla				Common Carp				
	rohu								
	common carp								
	grass carp								
Feed (Rice bran and ground nut cake in 1:1 ratio					Grass carp				
Labour for feeding other maintenance					Number of cycle				
Raw cow dung					Total Catla				
Harvesting expanse					Total Rohu				
Transportation of inputs					Total Common Carp				
Watch and ward, Miscellaneous					Total Grass carp				
Costs involved in selling of seed									

Transport								
Marketing etc.								

Fish seed Species	Size of fish when sold	Price	Demand	Pattern of harvesting (Partial or full)	Fate of unsold stock (Yearling or grow out)

I. Details of Purchase of inputs and Sale of seed

Details of input						
Places of purchase(L/D)						
Agency(M/D)						
Details of output						
Places of sale (L/D)						
Type of consumer (Vendor/farmer)						
Agency (M/D)						

(L: local, D: Direct; M: Middleman, D: Direct)

Mode of Transport system to procure spawns from the producing areas to the Farm.

a) Pick up van b) Rickshaw c) truck, passenger bus d) CNG e) others

J. Fish Seed Supply and demand gap at Nursery seed grower

Demand	Targeted Species for nursery seed						
	Total quantity of spawn required						
	Are you getting desired quantity of spawn						
	Are you getting desired quality of spawn						
	How much not fulfilled?						
	Possible reasons						
Supply	Are you able meet out demand for seed desired species						
	If not which species						
	Quantity						
	What proportion of demand you could not fulfill						
	Possible reasons						

K. Risks involved at the level of nursery seed growers

Sl.No.	Causes	Occurrence More Frequent, Frequent, Rare	% Loss
xiv.	Mortality due to Diseases		

xv.	Mortality due to pond environment		
xvi.	High stocking density		
xvii.	Availability of spawn		
xviii.	Non availability of buyers		
xix.	Non availability of inputs		
xx.	Low prices		
xxi.	Mortality during transportation to markets		
xxii.	Cheating by hatchery owner for species claim		
x.	Weather		
xi.	Natural calamities		

Supply chain risk at different stages

Sl.No		Reason	Occurrence Most severe/Severe/moderate/occasion/Not important
A.	Supply risks		
e.	Frequent delays in the supply time of materials (inputs)		
f.	Offer(Supply) is not flexible		
g.	Depends on a single supplier		
h.	The quality of the supply was poor		
B	Operational risks		
f.	Production disruption		
g.	Production capacity is not enough		
h.	Inconsistent inventory / inventory handling maintenance strategy		
i.	Organizational issues (operation issues)		
j.	Not flexible in terms of capacity		

C	Environment risks		
e.	Unexpected events such as rainfall, weather condition, natural disaster		
f.	Policy uncertainty		
g.	The Government support and environment of business		
h.	Skilled personnel are not available		
D	Financial risks		
e.	Credit		
f.	Ability to re-invest		
g.	Payment		
h.	Interest rate		
E	Market risks		
f.	The information system does not guarantee security		
g.	Unexpected customers or unstable customers		
h.	Reputation risk		
i.	Broken external / internal infrastructure		
j.	Error in the demand forecast		
F	Logistical Performance		
e.	Delivery on time		
f.	The raw materials are fully met during the production process		
g.	Favorable production and inventory planning strategy		
h.	The process of transporting goods takes place smoothly		

Constrains faced by the farmer:

L. Measures adopted to minimize risks

Sl.No.	Causes	Measures
iv.	Mortality due to Diseases	
v.	Mortality due to pond environment	
vi.	High stocking density	
vii.	Availability of spawn	
viii.	Non availability of buyers	
ix.	Non availability of inputs	
x.	Low prices	
xi.	Mortality during transportation to markets	
	Others	

Training, Skill development

Whether previous training received?
Name;
Organization;
Year & number of days:
Any training needed? Specify area
1.
2.
3.

i. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital payment app
				Loan:			
				Source:			
				Amount Availed:			
				Purpose:			

ii. Uses of ICT in fish seed supply chain

ICT Tools		PURPOSES (For placing order/ seeking and sharing information	FREQUENCY of uses of ICT (F/O/R)	EFFECTIVENESS (ME/E/LE/NE)
Phone	Yes/No			
Type				
Phone Call/SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

M. Possible solution to make supply chain more efficient

Name and signature of person collected data

Date:

Appendix-3

College of Fisheries Central Agricultural University Lembucherra, Tripura-799210	C

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Fish Seed Market)

Date:

1. Name of the Market:
2. Established (YEAR):
3. Name of the Fish seed Market Society:
   Regd. No:
4. Registered under:
5. Market Area:
6. Location:

A. ADMINISTRATION & MANAGEMENT:

Sl.	Designation	Name	Contact Details
1	President		
2	Vice President		
3	Secretary		
4	Vice Secretary		
5	Treasurer		

B. MARKETING REGULATION(General):

Marketing Timing:

Period of operations:
Commission charges: Agency whom it is charged:

C. Type of functionaries available in market :

Sl.	Type	Number
1	Wholesaler cum commission agent	
2	Fish seed Sellers	
3	Fish Seed buyers	

4	Labor for facilitating marketing activities	
5	Transportation Agency	
6	Packaging Agency	
7	Other	
	Total	
	Number of Female if any	

D. AVAILABLE INFRASTRUCTURE:

Sl.	Facilities	Yes/no	Remarks (No/Capacity)
1.	Communication facility		
2.	Financial Institution		
3.	Packaging facility		
4.	Oxygen facility		
5.	Water exchange facility		
6.	Transportation		
7.	Market shed		
8.	Drainage system		
9.	Electricity		
10	Rest house		
11	Vehicle parking space		
12	Storage facility		
13	Auction facilities		

Main criteria for fixing price

Price announced by market	Cost plus price	Competitive pricing	Dynamic price	Ongoing pricing

Price of seed determining factors

Factors	Rank
Species	
Size	
Source	
Appearance	
Seed availability in the market	

How much time it takes to sale the products in the market and losses during waiting time:

Period	Hours/minutes	Physical loss (out of 1000 seeds)	Value loss
Maximum			
Minimum			
Average time			

E. Market arrival Date:

Agency name	species	Quantity of seed(no)	Size (category)	Price Rs/1000	Place of arrival	Mode of transportation	Agency from which seed purchased	Price paid	Transportation cost	Other charges paid	Mortality (number)

F. Type of fish seed available in the market

Sl. No.	Species	Species	Yes/No
i.	Size like spawn, fry, fingerlings, stunted fingerlings		
ii.	Monospecies,		
iii.	Mixed		
iv.	Claim of availability of improved variety and exotic variety of seed		
v.	Availability of high value fish species like		
vi.	Availability of ravine seed in market		
vii.	Major type availability, whether fingerlings of same year Stunted fingerlings		

G. Change in pattern of market arrival of fish seed during the season

Month									
Species									
Size									
Number									
Price									
Places from seed arrival									
Places of seed demand									

H. Information pertaining fish seed trade (Information flow)

i. From where you get information on market prices of seed

ii. From where you get information regarding Market availability

iii. What are the information he give to the farmers

I. Risks involved in fish seed trade

Sl.	Risks in fish seed trade	Rank	Frequent/occasional/rare	Physical loss	Value loss	Measures taken to minimize particular risks
	Non availability of seed					
	Non sale of seed					
	Non availability of transport					
	High mortality					
	Fluctuation in price					
	Non availability water exchanges					

J. Possible suggestions to improvement in market for effective fish seed supply chain

Sl.	Ranking of risks in fish seed trade	Rank

K. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM Card	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital paymen t app

L. Uses of ICT in fish seed supply chain

ICT Tools		PURPOSES (For placing order/ seeking and sharing information	FREQUENCY of uses of ICT (F/O/R)	EFFECTIVENESS (ME/E/LE/NE)
Phone	Yes/No			
Type				
Phone Call/SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

M. Supply chain performance matrix

Sl. No	Factors	Information	Low	Medium	High
A.	Efficiency				
e.	Production cost per unit				
f.	Distribution cost per unit				
g.	Transaction cost(cost of searching opportunities)				

h.	Inventory (Associated cost for storages management) c. Raw material d. Unsold seed				
B.	Flexibility				
c.	Backorder (proportion of back order in total orders)				
d.	Lost sale (proportion of lost order in total orders)				
C.	Responsiveness				
f.	Fill rate(actual fill rate/target fill rate)				
g.	Product lateness(delivery date-due date)				
h.	Customer response time (process time(order-delivery))				
i.	Lead time (time required to complete the production)				
j.	Customer complain (number in one season)				
D.	Product quality				
f.	Appearance (at first look) (Good/Average/Poor)				
g.	One species (Yes/No)				
h.	Mixed ((Yes/No)				
i.	Uniformity in age (Yes/No)				
j.	Uniformity in size(Yes/No)				
E.	Product health and safety				
e.	Seed is healthy				
f.	Proper monitoring of seed health(Yes/no)				
g.	Product reliability(Number of complain registered with respect quality of seed)				
h.	Convenience (Number of complain regarding packaging etc.)				
F.	Process quality				
d.	Traceability (information available about its source)(Yes/No)				
e.	Storage and transportation (standard followed) (Yes/No)				

f.	Working conditions (hygiene and health standards) (Yes/No)				
G	Environmental aspects				
e.	Energy uses in production process (electricity)				
f.	Water uses (liter per 1000 seed production/sale)				
g.	Chemical and pesticide used (yeas/no)				
h.	Recycle/reuse(% of material reused/recycled)				
H.	Marketing				
d.	Promotion (Increase in number of customer and sale)				
e.	Customer services				
f.	Display in store (sample demonstration to customers)				

Additional feedbacks:

Name and signature of person collected data

Date:

Appendix-4

College of Fisheries Central Agricultural University Lembucherra, Tripura-799210	D

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Fish Seed Wholesalers cum commission agent/Traders)

A. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher secondary	Graduate and

							above
	Family members (no.)						

Occupation	Family occupation			
	Type	Primary	Secondary	Tertiary
	Name			
	Engaged family member (no.)			
	Income			
	% Contribution in Family income			

	Self occupation					
	Period	Name	Days in year (No.)	Average sale		Income (Rs.)
				Quantity	Value	
	On season					
	Off season					

Income and Expenditure (Annual)	Gross income (from all sources)	Expenditure (total)	Net income
Working experience (years)			
Social participation	No membership/ Member of one organization/ Member of more than one organization/ Office holder/ Wider public leader		
Source of information	T.V./ Newspaper/ Radio/ Social media/ Internet/ colleagues and friends/ Extension officers/ Private agencies		

B. Assets details of family:

Assets		Vehicles	Animals	House Hold Machinery	Business Related Asset

	Land Property	By Cycle	Motor Cycle	Four Wheeler	Truck	Cattle	Television	Refrigerator	Washing machine	Electric Fan	Computer	Air Conditioner	Grinder	Smoking Chula	Packaging Machine
No./Area															

C. Information pertaining fish seed trade (Physical and monitory flow)

i. If only Commission Agent- Details of fish seed trade

Details of seed transaction (daily)

Sl. No.	Species									Overall
1	Number									
2	size									
3	Value									
4	Commission charge									

ii. If Commission Agent cum wholesalers/traders- details of fish seed purchase &sale (on the day of interview)

Sl. No	Species	Size	Quantity purchased	Purchase price	Place of purchase	Agency from which seed purchased	Commission charge	Place where seed are sold	Agency whom seed sold	Quantity of sale
1.										
2.										
3.										

Sl. No	Species	Sale price	Transportation cost	Other costs incurred in trading of fish seed	Transportation time and duration (Hours)	Seed Delivery time & duration (Hours)	% mortality during trade
1.							
2.							
3.							

D. Seasonal variation trade of seed & price:

Particular	Month												
		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Species													
Size													
Daily trade	Peak												
	Moderate												
	Low												
Prices	Peak												
	Moderate												
	Low												

E. Basis on which seed prices decided

Sl. No.	Criteria	Rank
1.	Seed availability	
2.	Number of buyers	
3.	Species	
4.	Size	
5.	Sorting & Grading	
6.	Season	
7.	Quality of seed/appearance	
8.	Source/place of seed	

F. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM Card	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital payment app

G. Risks involved in fish seed trade

Sl. No.	Risks in fish seed trade	Rank	Frequent/occasional/rare	Physical loss	Value loss	Measures taken to minimize particular risks
1.	Non availability of seed					
2.	Non sale of seed					
3.	Non availability of transport					
4.	High mortality					
5.	Fluctuation in price					
6.	Non availability water exchanges					

Supply chain risk at different stages

Sl.No.		Reason	Occurrence Most severe/Severe/moderate/occasion/Not important
B.	Supply risks		
i.	Frequent delays in the supply time of materials (inputs)		
j.	Offer(Supply) is not flexible		
k.	Depends on a single supplier		
l.	The quality of the supply was poor		
B	Operational risks		
k.	Production disruption		
l.	Production capacity is not enough		
m.	Inconsistent inventory / inventory handling maintenance strategy		
n.	Organizational issues (operation issues)		
o.	Not flexible in terms of capacity		
C	Environment risks		
i.	Unexpected events such as rainfall, weather condition, natural disaster		
j.	Policy uncertainty		
k.	The Government support and environment of business		
l.	Skilled personnel are not available		
D	Financial risks		
i.	Credit		
j.	Ability to re-invest		

k.	Payment		
l.	Interest rate		
E	Market risks		
k.	The information system does not guarantee security		
l.	Unexpected customers or unstable customers		
m.	Reputation risk		
n.	Broken external / internal infrastructure		
o.	Error in the demand forecast		
F	Logistical Performance		
i.	Delivery on time		
j.	The raw materials are fully met during the production process		
k.	Favorable production and inventory planning strategy		
l.	The process of transporting goods takes place smoothly		

Any other constrain faced by the agent:

H. Uses of ICT in fish seed supply chain

ICT Tools		PURPOSES (For placing order/ seeking and sharing information	FREQUENCY of uses of ICT (F/O/R)	EFFECTIVENESS (ME/E/LE/NE)
Phone	Yes/No			
Type				
Phone Call/SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

I. Possible suggestions to improve fish seed supply chain

-
-

Date: Name and signature of Enumerator

Appendix-5

College of Fisheries
Central Agricultural University
Lembucherra, Tripura-799210

E

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Fish Seed Vendors)

J. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher secondary	Graduate and above

	Family members (no.)						
Occupation	Family occupation						
	Type	Primary		Secondary		Tertiary	
	Name						
	Engaged family member (no.)						
	Income						
	% Contribution in Family income						

	Self occupation					
	Period	Name	Days in year (No.)	Average sale		Income (Rs.)
				Quantity	Value	
	On season					
	Off season					
Income and Expenditure (Annual)	Gross income (from all sources)		Expenditure (total)		Net income	
Working experience (years)						
Social participation	No membership/ Member of one organization/ Member of more than one organization/ Office holder/ Wider public leader					
Source of information	T.V./ Newspaper/ Radio/ Social media/ Internet/ colleagues and friends/ Extension officers/ Private agencies					

K. ASSETS DETAILS OF FAMILY:

Assets	Land Property	Vehicles				Animals	House Hold Machinery						Business Related Asset		
		By Cycle	Motor Cycle	Four Wheeler	Truck	Cattle	Television	Refrigerator	Washing machine	Electric Fan	Computer	Air Conditioner	Grinder	Smoking Chula	Packaging Machine
No./Area															

Mode of distribution of fish seeds to the farmers:
a) Pick up van b) Rickshaw c) truck, passenger bus d) by walks e) others

L. Information pertaining fish seed trade(Physical and monitory flow)

i. Details of fish seed purchase &sale (on the day of interview)

Sl. No	Species	Size	Quantity purchased	Purchase price	Place of purchase	Agency from which seed purchased	Commission charge paid	Place where seed are sold	Agency to whom seed is sold	Quantity of sale
a)										
b)										

ii. Details of fish seed purchase &sale (on the day of interview)

Sl.no	Sale price	Transportation cost	Other costs incurred in trading of fish seed	Transportation time and duration (Hours)	Seed Delivery time & duration (Hours)	% mortality during trade
a)						
b)						
c)						

M. Seasonal variation demand, supply, price

Particular	Month	April	May	June	July	Aug	Sep	Oct
Species								
Size (cm)								
Supply (number)	Peak							
	Moderate							
	Low							
Demand (number)	Peak							
	Moderate							
	Low							
Price (Rs/1000)	Peak							
	Moderate							

	Low							
Is your demand fulfilled Can you meet farmer requirement (Quality)								
Can you meet farmer requirement (Quantity)								
Reasons for not fulfilling demand								

Do you buy fish seed (Variety and size) whichever available on market or according to farmers demand?

N. Information labourers migration

Particulars	Details
Native place	
Temporary or permanent migration	
Address (place)	
With family or without family	
If temporary period	
How far he travelled for labour daily:	
What is the mode of travel	
Daily expense of travel	
Whether he could get regular work or not:	
How many day in a month he could not get work:	

O. Information pertaining fish seed trade (Information flow)

iv. From where you get information on market prices of seed?
v. From where you get information regarding Market availability?
vi. From where you get information regarding which place fish seed is in demand?
vii. On what basis farmers fixed the price of seed?
viii. What is the information he give to the farmers?

P. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM Card	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital payment app

Q. Risks involved in fish seed trade

Sl.No.	Risks in fish seed trade	Rank	Frequent/occasional/rare	Physical loss	Value loss	Measures taken to minimize particular risks
1.	Non availability of seed					
2.	Non sale of seed					
3.	Non availability of transport					
4.	High mortality					
5.	Fluctuation in price					
6.	No rainfall					

R. Supply chain risk at different stages

Sl.No.		Reason	Occurrence Most severe/Severe/moderate/occasion/Not important
Supply risks			
m.	Frequent delays in the supply time of materials (inputs)		
n.	Offer (Supply) is not flexible		
o.	Depends on a single supplier		
p.	The quality of the supply was poor		
Operational risks			
p.	Production disruption		
q.	Production capacity is not enough		
r.	Inconsistent inventory / inventory handling maintenance strategy		

s.	Organizational issues (operation issues)		
t.	Not flexible in terms of capacity		
Environment risks			
m.	Unexpected events such as rainfall, weather condition, natural disaster		
n.	Policy uncertainty		
o.	The Government support and environment of business		
p.	Skilled personnel are not available		
Financial risks			
m.	Credit		
n.	Ability to re-invest		
o.	Payment		
p.	Interest rate		
Market risks			
p.	The information system does not guarantee security		
q.	Unexpected customers or unstable customers		
r.	Reputation risk		
s.	Broken external / internal infrastructure		
t.	Error in the demand forecast		
Logistical Performance			
m.	Delivery on time		
n.	The raw materials are fully met during the production process		
o.	Favourable production and		

	inventory planning strategy		
p.	The process of transporting goods takes place smoothly		

Any other constrain faced by the farmer:

S. Uses of ICT in fish seed supply chain

ICT Tools		Purposes (For placing order/ seeking and sharing information	Frequency of uses of ICT (F/O/R)	Effectiveness (ME/E/LE/NE)
Phone	Yes/No			
Type				
Phone Call/SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

T. Training, Skill development

Whether previous training received?
Name;
Organization;
Year & number of days:
Any training needed? Specify area
1.
2.
3.

L. Supply chain performance matrix

Sl. No	Factors	Information	Low	Medium	High
A.	Efficiency				
i.	Production cost per unit				
j.	Distribution cost per unit				
k.	Transaction cost(cost of searching opportunities)				
l.	Inventory (Associated cost for storages management) e. Raw material f. Unsold seed				
B.	Flexibility				
e.	Backorder (proportion of back order in total orders)				
f.	Lost sale (proportion of lost order in total orders)				
C.	Responsiveness				
k.	Fill rate(actual fill rate/target fill rate)				
l.	Product lateness(delivery date-due date)				
m.	Customer response time (process time(order-delivery))				
n.	Lead time (time required to complete the production)				
o.	Customer complain (number in one season)				
D.	Product quality				
k.	Appearance (at first look) (Good/Average/Poor)				
l.	One species (Yes/No)				

m.	Mixed ((Yes/No)				
n.	Uniformity in age (Yes/No)				
o.	Uniformity in size(Yes/No)				
E.	Product health and safety				
i.	Seed is healthy				
j.	Proper monitoring of seed health(Yes/no)				
k.	Product reliability(Number of complain registered with respect quality of seed)				
l.	Convenience (Number of complain regarding packaging etc.)				
F.	Process quality				
g.	Traceability (information available about its source)(Yes/No)				
h.	Storage and transportation (standard followed) (Yes/No)				
i.	Working conditions (hygiene and health standards) (Yes/No)				
G	Environmental aspects				
i.	Energy uses in production process (electricity)				
j.	Water uses (liter per 1000 seed production/sale)				
k.	Chemical and pesticide used (yeas/no)				
l.	Recycle/reuse(% of material reused/recycled)				
H.	Marketing				
g.	Promotion (Increase in number of customer and sale)				
h.	Customer services				
i.	Display in store (sample demonstration to customers)				

M. Possible suggestions to improve fish seed supply chain

Additional feedback

Date: Name and signature of Enumerator:

Appendix-6

College of Fisheries
Central Agricultural University
Lembucherra, Tripura-799210

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Fish Farmers)

A. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher seco	Graduate and above

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>nd ar y</td><td></td></tr>
<tr><td></td><td>Family member s (no.)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="13">Occupation</td><td colspan="7">Family occupation</td></tr>
<tr><td>Type</td><td colspan="2">Primary</td><td>Secondary</td><td colspan="2">Tertiary</td></tr>
<tr><td>Name</td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
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<tr><td>Income</td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td>% Contribution in Family income</td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="7">Self occupation</td></tr>
<tr><td rowspan="2">Period</td><td rowspan="2">Name</td><td rowspan="2">Days in year (No.)</td><td colspan="2">Average sale</td><td rowspan="2">Income (Rs.)</td></tr>
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<tr><td>Source of information</td><td colspan="7">T.V./ Newspaper/ Radio/ Social media/ Internet/ colleagues and friends/ Extension officers/ Private agencies</td></tr>
</table>

B. Land holding/water area (kani)

Own land	Leased in land	Total land	Agri cult ural land	Own Pond area	Leased in pond area	Total water area	Number of pond and size

C. Culture period: From ..... To..... Months.....

D. Fish production practice adopted (Tick)

Single stocking - single harvesting	Single stocking - Multiple harvesting	Multiple stocking - Multiple harvesting	Multiple stocking- Single Harvesting

E. Water depth: Max..... (cm) Min.....(cm)

F. Species and stocking ratio

Sl.No.	1	2	3	4	5	6	7	overall
Name species								
Number of seeds								
Stocking size								
Period of stocking								
Source of seed								
Purchased price								
Average weight at harvesting								
Survivability (out of 1000)								

G. Existing practice of fish production

Sl. No.	Management practice	Present Status	Remark Good /moderate / Poor
A.	Pre stocking management		
i.	Soil and water pH management		
ii.	Removing weed fishes		
iii.	Application of lime		
iv.	Application of Cow dung as basal dose		

v.	Application of N,P,K as basal dose		
vi.	Time and interval of application of these inputs		
vii.	Desired water colour		
viii.	Desired water depth		
B.	Stocking Management		
i.	Stocking density		
ii.	Month of stocking		
iii.	Species		
iv.	Stocking ratio		
v.	Size seed at the time stocking(length/weight)		
H.	Post stocking Management		
i.	Fertilization		
ii.	Organic Fertilizer		
iii.	Inorganic Fertilizer		
iv.	Type fish feed		
v.	Doses of feed		
vi.	Feeding methods		
vii.	Feeding Time		
viii.	Quantity of Lime, cow dung and NKP application during post stocking period		
ix.	Interval of Lime, cow dung and NKP application during post stocking period		
x.	Monitoring Fish growth		
xi.	Disease occurrence		
xii.	Prophylactic measures		
xiii.	Treatment of disease		

I. Existing management practice and input uses

Sl. No.	Management practice/Inputs	Quantity	Price	Total cost	Source of inputs	Timely availability
Pre stocking						
i.	Cleaning of weeds					
ii.	Dewatering					
iii.	Removing of weed fishes					
iv.	Filling of water					
v.	Quantity Lime basal dos					
vi.	Quantity Cow dung ba dose					
vii.	Quantity N,P,K Basal do					

viii.	Total hired labour					
ix.	Total family labour used					
Stocking Management						
i.	Species wise number fingerling stocked 1 2 3 Total					
ii.	Total hired labour					
iii	Total family labour used					
Post stocking						
i.	Source of Feed (Market/Homemade)					
ii.	Type of Feed (Pelleted/sinking/floatir					
iii.	Total quantity of feed					
iv.	Quantity of Lime					
v.	Quantity of cow dung					
vi.	Quantity of NKP					
vii.	Quantity any prophylac of disease cont medicines used					
viii.	Regular Netting					
ix.	Harvesting					
x.	Total hired labour					
xi.	Total family labour used					

J. Production Level:

Species				
Total harvest (Kg)				

K. Marketing of fish:

Place of sale of fish:
Total sale (kg):
Transportation cost if any (Rs):
Whether fishes are sold in mixed or after species wise segregation:
What is selling price (species wise):

L. Any prior training received?

Name:

Organization:

Year & Number of day:

M. Specific areas in which farmers need training and skill development programme

1.

2.

3.

N. Major Constraints in increase in Fish production

Sl. No.	Constraints	Rank
1.	Technical know how	
2.	Seed availability	
3.	Seed Cost	
4.	Availability of Feed	
5.	Feed cost	
6.	Availability of Lime, N,P,K	
7.	Cost on N,P,K	
8.	Availability of labour	
9.	Labour cost	
10.	Credit facilities for fish production by bank	
11.	If any others pl specify	
12.	Weather	

O. Sources of Information

Sl.No.	Information	Source
1	Related to Fish seed availability	
2	Related to Fish feed and other inputs availabilit	
3	Level of input use	
4	Fish production technologies	
5	Disease management	
6	Market price of inputs including seed	
7	Market price of fish	
8	Market demand for fish	
9	Stocking of any new species	

P. Financial inclusion

Bank account (Yes/no									

Q. Household Fish Consumption

Species harvested by Farmer	

Size of the fish	
Number of the fish species harvest (Monthly)	
Harvesting duration (Monthly)	

R. Measures adopted to minimize the risks of fish farming

Sl. No.	Causes	Measures
i.	Mortality due to Diseases	
ii.	Mortality due to pond environment	
iii.	High stocking density	
iv.	Availability of spawn	
v.	Non availability of buyers	
vi.	Non availability of inputs	
vii.	Prices fluctuation	
	Others	

S. Fish Seed Supply and demand gap at Farmer level

Demand	Targeted Species for grow out						
	Total quantity of seed required						
	Are you getting desired quantity of seed						
	Are you getting desired quality of seed (in terms size, health etc.)						
	Gap in demand and supply (number)						
	Possible reasons for not getting desired seed						

T. Supply chain risk at different stages

Sl. No.		Reason	Occurrence Most severe/Severe/moderate/occasion/Not important
Supply risks			
q.	Frequent delays in the supply time of materials (inputs)		
r.	Offer(Supply) is not flexible		
s.	Depends on a single supplier		
t.	The quality of the supply was poor		
Operational risks			
u.	Production disruption		
v.	Production capacity is not enough		
w.	Inconsistent inventory / inventory handling maintenance strategy		
x.	Organizational issues (operation issues)		
y.	Not flexible in terms of capacity		
Environment risks			
q.	Unexpected events such as rainfall, weather condition, natural disaster		
r.	Policy uncertainty		
s.	The Government support and environment of business		
t.	Skilled personnel are not available		

Financial risks			
q.	Credit		
r.	Ability to re-invest		
s.	Payment		
t.	Interest rate		
Market risks			
u.	The information system does not guarantee security		
v.	Unexpected customers or unstable customers		
w.	Reputation risk		
x.	Broken external / internal infrastructure		
y.	Error in the demand forecast		
Logistical Performance			
q.	Delivery on time		
r.	The raw materials are fully met during the production process		
s.	Favorable production and inventory planning strategy		
t.	The process of transporting goods takes place smoothly		

U. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM Card	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital payment app
				Loan: Source: Amount availed: Purpose:			

V. Uses of ICT in fish seed supply chain

ICT Tools		Purpose For placing order/ seeking and sharing information	Frequency of uses of ICT (F/O/R)	Effectiveness(ME/E/ LE/NE)
Phone	Yes/ No			
Type				
Phone call/ SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash/			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

W. Supply chain performance matrix

Sl. No	Factors	Information	Low	Medium	High
A.	Efficiency				
m	Production cost per unit				
n.	Distribution cost per unit				
o.	Transaction cost(cost of searching opportunities)				
p.	Inventory (Associated cost for storages management) g. Raw material				

	h. Unsold seed				
B.	Flexibility				
g.	Backorder (proportion of back order in total orders)				
h.	Lost sale (proportion of lost order in total orders)				
C.	Responsiveness				
p.	Fill rate(actual fill rate/target fill rate)				
q.	Product lateness(delivery date-due date)				
r.	Customer response time (process time(order-delivery))				
s.	Lead time (time required to complete the production)				
t.	Customer complain (number in one season)				
D.	Product quality				
p.	Appearance (at first look) (Good/Average/Poor)				
q.	One species (Yes/No)				
r.	Mixed ((Yes/No)				
s.	Uniformity in age (Yes/No)				
t.	Uniformity in size(Yes/No)				
E.	Product health and safety				
m	Seed is healthy				
n.	Proper monitoring of seed health(Yes/no)				
o.	Product reliability(Number of complain registered with respect quality of seed)				
p.	Convenience (Number of complain regarding packaging etc.)				
F.	Process quality				
j.	Traceability (information available about its source)(Yes/No)				
k.	Storage and transportation (standard followed) (Yes/No)				
l.	Working conditions (hygiene and health standards) (Yes/No)				

G	Environmental aspects				
m	Energy uses in production process (electricity)				
n.	Water uses (liter per 1000 seed production/sale)				
o.	Chemical and pesticide used (yeas/no)				
p.	Recycle/reuse(% of material reused/recycled)				
H.	Marketing				
j.	Promotion (Increase in number of customer and sale)				
k.	Customer services				
l.	Display in store (sample demonstration to customers)				

Additional feedback:

Date:

Name and signature of Interviewer

Appendix-7

College of Fisheries
Central Agricultural University
Lembucherra, Tripura-799210

(NABARD Funded project Study on freshwater fish seed supply chain for development of Aquaculture in Tripura & Manipur States of North Eastern Region)

(Survey Schedule-Labourers in Fish Seed Supply Chain)

I. General Information

Name							
Contact address	Village	Block		District		Mobile no.	
Age							
Caste	General/ OBC/ SC/ ST						
Gender	Male/ Female/ Other						
Religion	Hindu/Muslim/Christian/Buddhist/Others						
Residential status	Resident area	House			Area of house (ha)		
	Rural/ Urban	Ownership	Owned	Rental			
		Type	Katcha	Pucca (RCC)			
Agricultural land holding size (ha)							
Economic status instruction	APL/ BPL						
Marital status	Single/ Married/ Divorced/ Separated/ Widowed						
Family type	Nuclear/ Joint						
Family size	Male	Female	Total	Children (< 14 years)			
Education	Level	Illiterate	Primary	Upper primary	Secondary	Higher secondary	Graduate and above
	Family members (no.)						

<table>
<tr><td rowspan="11">Occupation</td><td colspan="6">Family occupation</td></tr>
<tr><td>Type</td><td colspan="2">Primary</td><td>Secondary</td><td colspan="2">Tertiary</td></tr>
<tr><td>Name</td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
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</table>

II. ASSETS DETAILS OF FAMILY:

Assets	Land Property	Vehicles	Animals	House Hold Machinery	Business Related Asset

		By Cycle	Motor Cycle	Four Wheeler	Truck	Cattle	Television	Refrigerator	Washing	Electric Fan	Computer	Air Conditioner	Grinder	Smoking Chula	Packaging Machine
No./Area															

III. Monthly Expenditure Pattern:

Heads of Expenses	Food	Clothing	Medicine	Education	Insurance	Other	Total
Amount (Rs)							

IV. Monthly Expenditure on Animal Protein:

Animal Protein	Meat	Fish	Egg	Dry Fish
Qty (Kg/No)				
Amount (Rs.)				

V. Monthly Savings:

Particulars	Income	Expenses	Savings
Amount (Rs)			

VI. Details of work performed?

Season	Type of work he performed	Skilled/Semi skilled/unskilled	Number days in year	Average daily income
On season				
Off season				

VII. Labourers' migration information

Particulars	Details
Native place	
Temporary or permanent migration	
Address (place)	
With family or without family	
If temporary period	
How far he traveled for labour daily:	

What is mode of travel	
Daily expense of travel	
Whether he could get regular work or not:	
How many day in a month he could not get work:	

VIII. Financial Inclusion in fish seed supply chain

Bank saving account	Year	ATM Card	Massage received	Credit Facility availed	Insurance service	Benefitted from Government schemes (name of schemes)	Digital payment app
				Loan: Amount availed: Purpose:			

IX. Uses of ICT in fish seed supply chain

ICT Tools		Purpose For placing order/ seeking and sharing information	Frequency of uses of ICT (F/O/R)	Effectiveness (ME/E/LE/ NE)
Phone	Yes/ No			
Type				
Phone call/ SMS				
Social Media platforms	WhatsApp			
	Facebook			
	Instagram			
	YouTube			
	E-Mail			
Payment	By cash/			
	Digital Pay (UPI/BHIM/Other App)			
	Net banking			

X. Supply chain performance matrix

Sl. No.	Factors	Information	Low	Medium	High
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q.	Production cost per unit				
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t.	Inventory (Associated cost for storages management) i. Raw material j. Unsold seed				
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m.	Traceability (information available about its source)(Yes/No)				
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t.	Recycle/reuse(% of material reused/recycled)				
H.	Marketing				
m.	Promotion (Increase in number of customer and sale)				
n.	Customer services				
o.	Display in store (sample demonstration to customers)				

XI. Possible suggestions to improve fish seed supply chain

XII. Any constrains faced by the labourer

Additional feedback

Date:

Name & Signature

College of Fisheries
Central Agricultural University (Imphal)
Lembucherra, Tripura- 799210

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