PRODUCTION COST & MARKETING OF RAINBOW TROUT IN NEPAL

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Harihar Bhawan, Lalitpur
www.mrsmp.gov.np

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FOREWORD

The lower price of agro products has been discouraging factor for most of the farmers in their production planning. The lower the price received by the farms means low income, which results in de-motivation, low investment and lower productivity. They are less aware in marketing than the traders and are unable to take appropriate benefit of the price rise over time. Mainly the presence of middlemen in marketing is likely to swab a large share of the consumer's investments however their facilitation for the smooth functioning of the market cannot be ignored. If farmers are aware in the pricing mechanism ahead in the time of the planning and know better about the marketing system, they can better plan and perform for selling their product.

To help farmers in production planning, resource mobilization and utilization, it is essential to understand production conditions and marketing system under which they are operating. Such, important information is useful from growers, entrepreneurs, extension worker, policy makers and researchers to make the business more prosperous and profitable. Keeping these views in mind the Market Research and Statistics Management Program under the Agribusiness Promotion and Market Development Directorate of Department of Agriculture has taken an initiative to "Study on Cost of Production of Rainbow Trout in Nepal" using primary and secondary data through household surveys, retail markets for the year 2015/2016. The field level information was collected by the staffs of this program.

This study would import some lights to analyze different aspects of production and marketing of the rainbow trout. The cost and benefit of the fish production has been assessed including the profit margin. To some extent the market channels, marketing system and the value chain market function along with the SWOT analysis has been observed. Based on the information some future actions for fish production and marketing can be recommended. This could help farmers in rectifying the weakness and make effective plans for production and marketing of the rainbow trout.

I would like to thank all the staffs involved directly and indirectly in this study. Also I would like to thank Directorate of Fish for their cooperation and Department of Agriculture for inspiring this work. Lastly, I would like to thank the farmers, markets and all stakeholders for providing necessary information. Constructive and critical comments and suggestions on this report are always welcome

Thanking You!

Netra Bahadur Bhandari
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1. Background

1.1. Introduction

Fish production in Nepal is confined to inland waters including ponds, lakes, reservoirs and rivers. The southern Terai region of the country is the main area for warm water aquaculture. Aquaculture of common carp, Chinese carps and Indian major carps substantially however, cold water fish culture in the mid hills is at the very beginnings although a few ventures show that it is a profitable enterprise. Rainbow trout is the best suited exotic fish for growing commercially in mid-hills of Nepal. The culture technology and seed of rainbow trout are available in the country.

Rainbow trout (*Oncorhynchus mykiss*) was introduced to Nepal for the first time in the late 1960s and early 1970s from UK, Japan and India. It could not survive due to the lack of technical know-how and was re-introduced from Japan in 1988. During this period, the Nepal Agricultural Research Council developed the breeding and culture technology for this species. Rainbow trout is a carnivorous species which requires high protein feed and well oxygenated water. In nature it feeds on aquatic insects, small crustaceans and small fish. It can be cultured using artificial feed of no less than 20 to 30 percent of animal protein.

Rainbow trout is able to live within a temperature range of 0-25°C and it grows at the water temperature range of 10-20°C. The fish reaches commercial size (200-300 g) during the second year (Huet, 1975). In Trishuli, Nepal, it reaches 200-300 g within 14-months from the free-swimming larval stage (FRS, Trishuli), depending on the quality of the feed, and adequate supply of water of suitable quality, including a suitable temperature and dissolved oxygen concentration.

Rainbow trout was bred for the first time in Nepal in 1990 and its culture was initiated experimentally in 1993. Present trout production is more than 10 metric tons annually from two government stations, and about 300 metric tons from the private sector. Mr. Purna Bahadur Lama from Kakani Village Development Committee-4 of Nuwakot District is the first private trout culturist in Nepal. He started rainbow trout culture in 1998 on a trial basis. Presently, he has been growing 16 000-18 000 fingerlings of rainbow trout each year in an area of 150 m^2.

Aquaculture diversification and commercialization have drawn attention of the planners and policy makers in terms of generating more income, employment opportunities and biodiversity conservation. The farming on high–value low–volume fishes and optimum utilization of the available resources for production, processing, and marketing operations has been conceived for the sustainable development of nation.

Government of Nepal from the Directorate of Fisheries Development and Two Fisheries Research Stations, Godawari and Trishuli, under the Nepal Agricultural Research Council (NARC) are raising rainbow trout from eggs to adults and vice versa. Both of the organizations with its stations are culturing the fish in concrete raceway ponds. As a source of water, spring water at Godawari and river (glacier and snow melt) water at Trishuli are used. The total area of ponds for trout culture at Godawari is nearly 300 m^2. Trishuli station has about 2 000 m^2 surface water area for trout farming of which about 1200 m^2 has been used for grow-out fish and the rest for brood stock of trout as well as for native fish species.

Presently, many private farmers in many districts are indulged in this sector of culture trout and new farms are being constructed in the mid hilly districts along the highways and trekking trails. Some new areas are being surveyed to find out suitable sites for trout aquaculture. This is a positive sign in the development of trout aquaculture entrepreneurship. They can produce 4-5 tons of trout annually under present conditions which naturally generates the income and employments in the rural areas. Water of the many rivers and rivulets of various mid-hill districts have been found suitable, but sites for raceway construction still need to be identified.

Present Scenario

The productivity of fish in Nepal is very low as compared to neighboring countries in cultured and captured fisheries. Unavailability of quality breeds in time, weak technical knowhow, low care and management practices to incidence diseases and pest, low and declining nutrients and feed, poor adoption of improved management practices, higher cost of fry, fingerling are main causes of low productivity of fish (Fish Development Directorate, 2015).

As the scope of expanding land area for cultivation is favorable for the rainbow trout in mid hills, increase in the production can only be achieved by increasing

race course area, productivity per unit area, which can be obtained by the use of improved technology with improved management practices, by intensifying the farming system and by reducing the cost of production through appropriate technology and knowledge. The actual present scenario of the rainbow trout fish in the country is presented which depicts the area, production and yields are ever increasing that can be inferred. There are numerous farms that are been established in recent days along the high ways and trekking trails of the mid hills in Nepal that's contributing to the increasing number of water surface areas of the racecourse and ultimately to the production and yield that can been seen from the table 1 below.

Table 1: Area, Production and Yield of Fish of Rainbow Trout

Fiscal Year	Water Surface Area (Ha)	Production (MT)	Yield (Kg/Ha)
2011/12	12360	871045	1560
2012/13	13160	986000	180
2013/14	14275	1428000	229
2014/15	18677	2087000	291
2015/16	20723	2259625	317

Source: Fisheries Research Center, NARC, Godawari, 20015/16

1.2. Statement of the Problem

Due to the rapid urbanization, growth of the population and the awareness of the people about and the government's emphasis of the fish promoting income generating activities, both the marginal as well as the fertile fields covered by other crops have been converted into fish race course particularly for the rainbow trout farming in the mid hilly districts. Various districts of mid hills of eastern, central and western region was selected to know the status of the cost of production of fish, its value chain and impart some lights in the marketing system. Nevertheless, the expected rate of growth in terms of area and production has not yet been achieved as per the investments in this sector been made. This is an outstanding issue often associated with several problems, as for e.g.; inconsistency in internal as well as external demand and lack of co–ordination between production and marketing of the rainbow trout chain.

The depleting price of fresh and frozen fish has been found discouraging factor for most farmers and entrepreneurs. The lower profit margin received by the farmers means low income, which eventually emphasizes in low investment in the

racecourse area and management again resulting reduced income. This has caused to deteriorate the productivity and the farmers are bound to fall in the vicious cycle of mismanagement due to reduction in the investments.

Farmers and entrepreneurs are forced to distress selling of their produce at low price due to the lack of adequate knowledge of marketing system. This has not only affected the producer but also the consumers. Some of the entrepreneurs are selling the fish in their own restaurants and small scale village resorts cashing the value addition however majority are forced to sell to the assemblers that have been resulting lower returns in farmers' smaller share. Often most producers' final a prior contract before harvesting a safe way to dispose their produce in weekly and fortnightly basis. Farmers take decisions on when to sell, whom to sell and how to sell tend to take place under the availability of limited market information on the demand of the rainbow trout. This confusing situation led the traders' environment not the farmers or the entrepreneurs. This confusion led the traders, it is said that who are more knowledgeable of market mechanism, to exploit the opportunity created due to asymmetry in information between traders and farmers. Different types of contractual systems were found in the different farm sites.

Although various policy and programs have targeted to increase the rainbow trout farm income, and generate income through generation of employments, they have not been well trickled down to farm level. Considering this in mind, this study was designed to address the following research questions.

- How are the average cost of production and the gross margin of rainbow trout fish in selected different location?
- How is the efficient of fish marketing systems in the study areas?
- How is the value chain functioning and the interventions to be made in the chain?
- What are the major problems of production and marketing of fish?

1.3. Rationale

To increase an urgent need of improving economic status of people by raising income through generation of employment, rainbow trout farming has been well considered as one of the viable option in the mid hill districts that have access to the fresh spring water or the molten glacial watercourse.

Producers are bound to sell their produce for the price offered by the traders, which is not based on the competitive market mechanism. Farmers and entrepreneurs are less aware of the marketing than the traders and are unable to take benefit of competitive market price of the rainbow trout over time. The presence of assemblers and retailers in the fish marketing is likely to wipe a large share of the consumer expenditure. If farmers are aware of the pricing mechanism and they know better about the marketing system, they can better plan for the disposal of their produce either fresh or frozen.

Programs like OVOP (One Village One Product) and long term agriculture strategy plans has emphasized on the commercialization of rainbow trout fish in the identified pocket areas throughout the mid hills (GoN, 2012).

Various types of buying and selling arrangements between the producer farmers, assemblers and retailers are prevailing but which mode of transaction is beneficial to farmers and other actors has not been well explored This gap signals out the need of this whether to stick on particular contract or go for another alternatives. So diversification is needed to think on long–term perspective.

This study helps the farmers to seek support from the different financial institutions in investing the fund for production rainbow trout.

Such study is deemed necessary to identify both the problems and prospects of cost of production, its value chain and marketing of rainbow trout. This could help farmers in rectifying the weakness and make effective plans for production and marketing of fish that would ultimately help to increase the living standards by increasing farm income on a sustainable basis.

1.4. Objectives

The main objective of this paper is to provide information on the cost of production, value chain and marketing of trout production in Nepal and its potential for future expansion in the private sector. The specific objectives are:

- To compare cost and benefit of the rainbow trout.
- To study marketing margin of rainbow trout.
- To observe and identify market channels, marketing system, and value chain market function.
- To identify the strength, weaknesses, opportunities and threats of the pond aquaculture.

- To identify bottleneck areas in production and marketing and recommend strategic planning for future action.
- To ascertain the problems and remedial measures of rainbow trout.

1.5. Constraints and Prospects

The reasons for the past failures of rainbow trout in Nepalese waters are not clearly known. Management of trout farms is labor intensive and requires considerable skill, therefore a lack of experience (management failure) might have led to failure of trout rearing in past. Fish are also susceptible to disease when reared under intensive conditions. Commercial trout farming requires good hygienic to prevent epidemics.

Rainbow trout can also be reared extensively, but its farming is mostly characterized by intensive feeding with high protein content feed for higher production. The fish in such systems become more susceptible to many diseases. Among many diseases encountered the most difficult seems to be hepatoma a disease is well studied these days.

Most of the diseases can be controlled, if proper management and hygienic measures could be taken. To prevent hepatoma, artificial feeds must be protected from contamination by aflatoxin which is often related to poor storage and handling of feed.

Fin rot was seen in large fish. This might have resulted due to overcrowding or associated with vitamin deficiency. Most diseases might be associated with the quality of feed stuffs and quality and quantity of water input in raceways.

The introduction of exotic fish may cause both positive and negative effects in a particular ecosystem but trout introduction in Nepal was not as controversial as for other fish. This might be due to lack of indigenous cold water fishes for commercial farming in Nepal. Before the introduction of trout in Nepalese waters, populations of a cold water native fish Asala (Schizothorax sp.) was considered to be severely impacted due to trout predation. However, in Indian cold water Asala was not affected much by the presence of trout in natural waters. In Japan, trout are commercially cultivated from north to south throughout the country, but trout could breed naturally only in Northern Province, Hokkaido. This implies that trout are not prolific breeder but need a specific habitat to spawn in the natural

environment. If this would be true in Nepalese conditions it is probable that trout populations can be regulating by stocking manipulation. These experiences also showed that trout and Asala can co-exist in same environment even if trout are stocked and succeeded to reproduce naturally in cold waters.

Considering vast water resources flowing through glaciers, pristine mountainous rivers; and market potential to substitute imported fish to meet tourists' demands rainbow trout has been introduced in Nepal. The success of trout breeding, rearing and production, over more than two decade shows gradual development of technological packages of practices, technological feasibility and perspective in Nepal. Although some diseases and management problems related to hygienic feed storage were seen this easily remedied. For wider adoption of trout farming further investment and extension activities are desirable.

1.6. Scope and Limitations of the Study

The present study would impart some lights to analyze different aspects of production and marketing of rainbow trout in various districts. Therefore, the findings of this study may be helpful to policy markers, researchers, and entrepreneurs to make this business more prosperous and profitable.

Due to limited human resource, the study couldn't be conducted as a national study however; the Lalitpur, Nuwakot, Makwanpur and Rasuwa districts were covered in Central Region and Myagdi, Kaski in Western Region along with the Panchthar and Illam in the Eastern Region that would represent all the fish growing areas of Nepal. This study was based on purposive sampling of commercial entrepreneur rainbow trout farmers and the data was acquired through the structured questionnaire based on the Survey Manual of the Market Research and Statistics Management Program and the respondents reported mainly on recall basis, so there may be some response errors. This study couldn't cover up the size and quality despite focuses on the quantity of fish, as there was no mechanism to acquire the data about the size and quality, as the respondent only had the data of quantity, which also affects the marketing systems.

2. Materials and Methods

The methodology consists of conceptual framework, selection of the study area sample size, sampling procedure, source of information and data collection techniques, survey design, data collection procedure and methods and techniques of data analysis. Description of each of these sections is as follows.

2.1. Conceptual Framework for Methodology

The conceptual framework outlines briefly about the theoretical background for the analysis of production system, gross margin, marketing systems and marketing margin.

Gross Margin

The per-unit cost of production and profitability of fish is important in most of the study. In this regarded the main issue may be that whether the current price of concerned fish enterprise is sufficient enough to give the farmers an adequate income or not. The issue can be solved directly from farm survey data, if available in this farming enterprise of a farm. Though there are some limitations the enterprise gross margin is a useful tool for this purpose (Dillon and Hardaker 1993).

The gross margin of any enterprise is defined as the difference between enterprise gross income and the variable expenses attributable to the enterprise (Dillon and Hardaker, 1993). The estimation of gross margin is essential to obtain optimum through maximizing the gross margin (Upton, 1996). The variable expenses used in the calculation of gross margin may be defined as expenses that vary more or less in direct proportion to the level of the enterprise. The gross margin is usually expressed on a per unit basis that is per unit area and/or per unit of production. Gross margin gives an idea about farm planning as it helps to decide, whether or not to continue existing farm practices or substitute by others.

Farm size or the scale of production is most important in studying the fish farm enterprises, because all the activities connected with fish farm depend on the size of the farm. Farm size is measured in terms of area coverage. But, it depends of situations such as; area of fish farm, nature of farming, location of the farm, capital employed and volume of output. As compared to small scale fish farming, large

scale fish farming is expected to have certain advantages such as, efficiencies of division of labour, reduction in average overhead costs, economies in guying, economies in selling, economies in skill, better bargaining power and flexible profit making opportunities because of relative economies of scale of fish production (Lekhi and Sing, 1996). Thus larger fish farm enterprises/farmers take higher per unit gross margin than the smaller. This suggests the importance of differences in the scale of production enterprises.

Marketing Systems and Marketing Margin

The marketing system involves wide range of activities, firms and mechanism of delivering goods one hand to other band, with a view for providing efficient services in the continuum of production-consumption chain. It is because; an efficient marketing system minimizes cost, and benefits all the section of the society (Acharya and Agarwal, 1999).

Marketing system creates time, space, and form utilities of the farm produce for the consumers. Marketing system operates to transport produce to where consumers wish to take delivery of it, at time they find more convenient and in the forms desirable. There functions add values of the farm produce for the consumers and reflected in marketing margin. If these marketing functions are performed in an efficient way, there are low marketing costs resulting into lower marketing margin and higher producers'' share on consumers' rupee. Thus, the prices farmers receive and the quantities they can sell very much dependent upon the performance of functionaries in marketing chain.

As marketing margin provides an indication of the efficiency of existing marketing systems consideration of it in economic analysis of marketing systems of fish enterprises is sensible. The marketing margin also known as retail-farm-gate margin is the difference between the retail price of a product and the price received by farmers for its fishery product (Colman and Young, 1995).

Gross Margin Analysis

The gross margin provides simple and quick method of analyzing a farm business. For any enterprises gross margin is the difference between the gross return and the

variables cost incurred. For the analysis of gross margin, only the variables costs were considered. The variable cost must be specific to single enterprise and vary approximately in proportion to the size of the enterprise (Sankhyan, 1983). The estimation of gross margin is essential to obtain economic optimization (Upton, 1996). The gross margin of the pond fish producers in this study was calculated as;

Gross margin = Gross return – Total variable cost.

Gross margin = Summation of gross return of fish and its integration.

Total variable cost = Summation of cost of all variable item.

The Net Profit Analysis

The net profit is the difference between total revenue and total cost incurred. Thus, the net profit for any farm business can be written as;

TT = TR – TC

TT = TR – (TFC + TVC)

TT = Summation PY × Y – Summation P × I × X – K, K if fixed cost

Where,

TT = Net profit. TR = Total revenue.

TC = Total cost. TFC = Total fixed cost.

TVC = Total variable cost. Y = Quantity of output.

Xi = Quantity of input. Py = Price of output.

Pxi = Price of it input. K = Fixed cost.

Benefit / Cost Analysis

Benefit cost (B/C) analysis was done after calculation of the total cost and Gross return from production. Cost of production was calculated by summing the variable as well as fixed cost items in the production process, while for calculation of gross return, income from fish and its integration. So using following formula was carried out benefit – cost analysis;

$$\text{B/C ratio} = \frac{\text{Gross return}}{\text{Total cost}}$$

Marketing Margin Analysis

Marketing margin is the difference between the retailer's price and the farm-gate price, which was calculated as follows:-

Marketing margin = Retailers price (Pr) - Farm gate price (Pf).

2.2. Selection of the Study Area

The sites were selected as per the nature of the study. Lalitpur, Nuwakot, Makwanpur, and Rasuwa districts were covered in Central Region and Myagdi, Kaski in Western Region along with the Panchthar and Illam in the Eastern Region that would represent all the rainbow trout fish growing areas of Nepal. These district shares the relatively higher percentage of area coverage and production of rainbow trout in the country.

2.3. Sample Size and Sampling Procedure

Sampling process plays an important role in research work as it is very tedious, time consuming and costly to do survey. It is very essential to determine the target population, determination of the sampling procedure and deciding the rational sample size for research work, and the same have been described in the following subheadings.

Sampling Population and Sample Size

The sampling population for the present study included all the purposive rainbow trout farmers of the study area who owned at least 50 square meters of the racecourse water area. The list of all the fish growers of the study area was obtained from Fisheries Research Station of Godawari of Nepal Agriculture Research Council. Altogether 20 farmers were selected randomly from the list of farmers and entrepreneurs of all the districts and were interviewed through pre structured questionnaire.

2.4. Selection of Traders

List of fish marketing traders and assemblers were contacted through the farmers and randomly 10 stakeholders were selected and interviewed according to the checklist.

For the selection of retailers to study the marketing system of the trout, fish markets were purposively selected as been reported by the farmers where they sell their product. As a whole, 5 assemblers/middlemen and 5 retailers were selected randomly and altogether 10 traders were interviewed altogether.

2.5. Source of Information and Collection Techniques

Various sources and techniques were used for collection of the necessary information. In this study, both the primary and secondary data were collected and analyzed. Primary Information obtained through pre tested questionnaire, observation and discussion however the secondary data were obtained through various districts, departmental and ministerial publications for the study.

The sources of secondary data were the DADO office profile, Fisheries Development Directorate of DOA, Fishery Research Station (NARC), related documents, publications, and research paper, etc from the DOA and MoAD.

2.6. Techniques of Data Collection

Different techniques such as: Interview and observation were employed for the collection of necessary information. A brief description of each technique is given here under

Interview

The farmers were interviewed through the structured questionnaire for the collection of primary data. A pre-tested and structured interview schedule was administered to them. The information on cost of production, fish production, prevailing marketing system, acceptance of technology and input use, marketing channels and problems of production and marketing of fish in the study area were collected from the farmers and traders by interview. Different identified traders were also interviewed by using checklist to collect information on marketing system, market price and marketing problems.

Observation

A number of visits were made to the study sites by the office staffs during the survey times and direct observation were made on pond water quality, marketing systems and different farm activities. Furthermore, market visit was also done to observe different activities in the market.

Survey Design and Data Collection Procedure

This section deals with the designing of interview schedule and data collection procedures followed during the field works in various districts.

Interview Schedule Design

Two set of interview schedules were prepared for primary data collection. One set of interview schedule was prepared to collect information from farmers and another set was prepared to collect information from different traders. For this construction of interview schedule, a coordination scheme was prepared to help facilitate the identification of concepts and further level of abstraction to different dimension based on the objectives of the study. Based on which, different variables were included in the interview schedule. In the interview schedule different questions about respondent's family, pond and its production, cost of production, marketing and marketing problems of borrowers and non-borrowers were included. A brief description of each of these sections is given hereunder.

Information on Farmer's Family

In this section, questionnaire was designed to address farmers, family size, educational level, castes of people engaged in aquaculture, causes of encouragement on the business, etc. Similarly, question related to information on membership of different financial institutions and organizations was included.

Information on Pond Aquaculture, Inputs and Technology

In this section, questions were designed to collect data for pond aquaculture on own or, lease ponds, inputs used, fish seed availability, stocking density of fingerlings, size of fish seed used by farmers, feed used in fish culture, and other input used, direction of ponds, fingerling-stocking time, average fish culture duration of different fish species, culture system, fish farming system, water quality parameters, types of pond soil, etc.

2.7. Information on Cost of Production

In this section, questions were designed to collect data on cost associated with production and return of the farmers.

Information on Marketing

In this section, questions were designed to collect data on number of markets, fish selling price, fish selling places, and fish selling to the consumers or, traders, marketing channels, etc.

Information on Production and Marketing Problems

In this section, questions were designed to collect data on different problems of production and marketing systems of fish were recorded.

Pre-Testing

Pre-testing is the most important method for checking the reliability and validity of schedule. The pre-testing interview was done with a rainbow trout farmer and a trader from market. Interview schedule was finalized by incorporating rectifications made during per-testing.

Field Survey

The study was undertaken for eight months from November 2015 to June 2016 during fish harvesting and re-stocking season. Farmers were interviewed by visiting their home and traders were interviewed by visiting in the markers. Regular checking and editing was done. Interview was conducted generally in the morning and day times.

2.8 Report Draft and Publication

The data from the field were compiled and processed in the MS Excel and draft report was prepared and presented to the one of the official for the review of the Fish Development Directorate and necessary amendments were made. There after the reports abstract was presented before the Technical Committee of the Director General of the Department of Agriculture and rectifications were again made before sending to print. Yet the report might not be completed and the fruitful comments and suggestions are soughed from the valuable readers.

2.9 Major Stakeholders of Rainbow Trout

Production and trade of fish is less organized in Nepal compared to other important agricultural products such as dairy, fruits and vegetables. Rainbow trout being comparatively new and its production concentrated in few specific pockets, its trade is concentrated to major towns like Kathmandu and Pokhara and

hotel/restaurants near production sites. In the supply side also very few people/ organizations are involved in its value chain. The major stakeholders involved in rainbow trout value chains are listed as follows.

Input Suppliers

Rainbow trout being specific commodity there are limited stakeholders that supply inputs. Breeder/hatchery and feed producers are the most important among them. Sixteen of the 73 farmers produce and supply fry/fingerlings to other rainbow trout farmers after meeting their own requirement. Other inputs like, construction materials, pipes, polythene sheets, nets etc. are bought from local shops. Similar is the case with feed production.

Primary Traders

Unlike in other agricultural products there are fewer numbers of intermediaries engaged in rainbow trout trade for three reasons. First, its demand is higher than supply that prompts retailers to approach the producers directly, second, there is demand in production areas itself and third there is high risk of quality deterioration during transport and storage. Therefore those intermediaries are involved only when the buyer assures him of specific quantity. Those intermediaries are involved in supply of feed and fingerlings to farmers and fish to traders. There are only a few wholesalers engaged in rainbow trout market.

Retailers

Rainbow trout is relatively new commodity. It is nutritious and easy to eat. Internal tourists and locals like to buy it from the farm itself. Many farmers sell their products to those visiting the farm. They also sell directly to retailers and also restaurants nearby the farm. Retail outlets including department store such as Bhatbhateni super store and Saleways along with fresh houses with proper refrigeration facility either order the product from the farm or receive through primary traders and assemblers.

Restaurants

Restaurants are main bulk buyers of trout fish. They buy fish directly from farmers as well as primary traders and assemblers. Restaurants nearby the production site normally have agreement with producer that supply mutually agreed quantity

at agreed price, while restaurants in major towns receive the product through assemblers. Some of the farms have been running their own restaurants where rainbow trout fish together other food/drink items are served.

Department of Agriculture

The Department of Agriculture (DOA) is a public extension organization with organized network throughout the country. Under the DOA, there are several organizations and programs responsible in development. Among them District Agriculture Development Offices (DADOs) are the most important organizations. Public extension services, including dissemination of technology, information; and training for increasing agricultural production, income generation and sustainability, are conducted by DADOs and agricultural sub-centers under them. Extension activities get technical supports from Nepal Agricultural Research Council (NARC) and also from regional and national level programs. DADOs have collaboration with public, private and nongovernment organizations. The district level extension programs are supervised, monitored and evaluated at regional level by the Regional Agriculture Directorate (RAD) and at national level by the Department of Agriculture (DOA).

There are altogether nine fish development centers and one fish development training center under the department of agriculture that provide technical services to fish farmers, though not specific to rainbow trout.

Fisheries Development Directorate

The Fisheries Development Directorate (FDD) plays a key role in policy formulation, regulation and facilitation for fisheries in Nepal. National Inland Fisheries and Aquaculture Development Program (NIFAND) and Central Fish Laboratory (CFL) located within the directorate at Balaju are responsible to promote fish including rainbow trout for pilot initiatives and execution, database management and feasibility assessment, monitoring and coordination.

Nepal Agricultural Research Council

NARC has been pioneer in introduction and development of rainbow trout fish in Nepal from its first introduction from Japan in 1988. Fisheries Research Division (FRD) of NARC is located in Godawari, Lalitpur district. The objective of this division is to enhance research, capacity, linkage and partnership in fisheries.

To fulfill this objective Fisheries Research Division is conducting participatory research on cold and warm water aquaculture. The FRD of NARC performed its research and development of rainbow trout from its research sites in Godavari and Trisuli in the past. Due to lack of sufficient running water it has stopped rainbow trout in Godavari and has continued research and development (R&D) in Fisheries Research Center (FRC), Trisuli of Nuwakot district and Rainbow Trout Genetic Resource Center (RTGRC), Dhunche of Rasuwa district. Raceway facility available with NARC research centers and seed production/ distribution by them is their main program activity. The centers provide technical support, quality rainbow trout brooder stocks, fertilized ova and fingerlings to farmers and also maintains its demonstration farms in those two districts. In addition, NARC research stations located in different parts of the country provide technical services as per demand.

Japan International Cooperation Agency (JICA)

The JICA assisted for the development of trout in Nepal. Fisheries Research Division, Godawari and Fisheries Research Center Trishuli received a grant of NRs 1.67 million from JICA for scaling up of trout farming, during 2006/07 .The main objective of this grant was to enhance the trout production in Nepal especially from Rasuwa and Nuwakot districts through community participation. Under this project various stakeholders associated with trout farming were trained for better technological, managerial, and marketing aspects. Part of the fund of the JICA project was also used to supply hatchery tool/equipment/technologies to farmers, conduct demonstration program, prepare training materials and also encourage women participation in trout farming.

One Village One Product (OVOP) Program

OVOP is a program designed to enhance the capacity of different districts by focusing on market led production of single product that has a comparative edge there. It is a Public Private Partnership (PPP) based program officially launched in July 17, 2006 for 5 years as a pilot project. By the end of five year of its operation, 8 products in 11 districts have been extended. Among them Rasuwa and Nuwakot Districts are prioritized as rainbow trout growing district. The products have specific natural taste being produced in the Himalayan water and can be competitive in international market as "Himalayan Trout". The program implementation part is divided into production and marketing sectors. Federation

of Nepalese Chambers of Commerce and Industry (FNCCI) as a private sector takes care of market promotion activities whereas the government sector looks after production side.

Recognizing the role of the FNCCI in the promotion of agribusiness in Nepal and its capacity to play a facilitative/coordination role, the secretariat for the OVOP program is entrusted to the Agro Enterprise Center (AEC) the technical wing of the FNCCI. The Secretariat is solely responsible for the implementation and monitoring and evaluation of the whole program.

The following organizations are the members for planning the annual program, policy designing and decision making for promotion of rainbow trout under OVOP.

- Local farmers and companies
- Local chamber of commerce and industry
- Local District Development Committee
- Directorate of Fisheries Development, DoA, MoAD
- Fisheries Research Division, NARC
- Fisheries Research Station, Trishuli
- Agro Enterprise Centre, FNCCI
- National Planning Commission
- Ministry of Industry Commerce and Suppliers
- Nepal Rastra Bank, and
- Ministry of Finance.

3. Literature Review

3.1 Biology of Rainbow Trout

Rainbow trout (Oncorhynchus mykiss) are members of the coldwater-dwelling family Salmonidae, and while their origins lie in Pacific North America, they have since been transplanted to most suitable regions around the world for both sport-fishing and aquaculture purposes. Domestication of rainbow trout has proven to be one of the most successful endeavors in aquaculture's history, undoubtedly attributed to their fast growth rate, ease of spawning and the large size at which they hatch from eggs. While they can withstand large variations in water temperature (0-27°C), they grow and reproduce best within smaller ranges and require a high concentration of dissolved oxygen to be present in the water. Adults spawn in gravel-bottom rivers and streams, with females depositing demersal eggs at a rate of 2000 eggs/kg (FAO, 2011) to 3500 eggs/kg (Rai et al., 2008) of bodyweight and males releasing milt to complete the external fertilization. Because rainbow trout will not spawn naturally in a tank environment, aquaculture operations must rely either on the collection of juveniles from the wild or, more frequently, manual strip-spawning techniques, in which the eggs of a female and the milt of a male are mixed in a container and then placed in hatching trays. Larvae are well developed at hatching and in an aquaculture setting, can be fed a formulated diet upon complete absorption of the yolk sac. These aquaculture feeds mimic the carnivorous diet that wild rainbow trout consume, including the pigment-producing compound astaxanthin (FAO, 2011). In Nepal, market size is typically 200-300 g, which can be attained in 14-20 months (Swar, 2007). 3.2. History and Current Status in Nepal

Rainbow trout were first introduced in Nepal, from the United Kingdom, in 1971. Upon import, the fish were housed at the Godawari and Trishuli government research stations with the eventual goal of stocking surrounding natural water bodies for the establishment of a rainbow trout sport-fishing industry. Shortly after arrival however, mass mortalities rendered the project unsuccessful. A government-issued investigation was ordered and upon identification of the major contributing factors to the project's failure (human resources, water resources, rearing unit design and feed), the resulting consensus was that Nepal's current

conditions deemed it unfit for successful rainbow trout culture. Subsequently, the facilities returned to their prior carp culture operations (Gurung and Basnet, 2003; Nepal et al., 2002; Swar, 2007). However, in the late 1980s and early 1990s, the Nepal Agricultural Research Council (NARC) cooperated with the Japan International Cooperative Agency (JICA), gaining valuable technical assistance and training. The first attempt at culture began with the import of 50,000 eggs, an 80% hatch rate and a successful growout, paving the way for future rainbow trout culture in Nepal. Since then, research efforts have allowed for the establishment of a small commercial rainbow trout industry (Gurung et al., 2006; Rai et al., 2008; Swar, 2007).

The growth of rainbow trout culture in Nepal has been large. Production in 1993, when research on full-scale operation initiated, amounted to 0.318 Mt, and by 2006, production reports ranged from 12-17 Mt (Rai et al., 2008; Swar, 2007). While Swar (2007) attributes 60% of current rainbow trout production to private operations, Thakur et al. (2008) argues that this figure is closer to 75%. The first private operation was conducted on a trial basis by a single farmer in 1998 (Swar, 2007). As of Rai et al.'s 2008 report, there were 12 rainbow trout operations in the private sector; of which, ten were deemed profitable. A total rearing unit surface area of 1270 m2, with an average of 15-20 kg/m2/year, resulted in a total production of 12 Mt in 2006 (Rai et al., 2008). Though still considered limited, the private sector's contribution to the Nepalese rainbow trout's industry is expected to grow (Swar, 2007).

3.2. Potenetial to expand RT

The rainbow trout (*Oncorhynchus mykiss*) is a trout and species of salmonid native to cold-water tributaries of the Pacific Ocean in Asia and North America. The steelhead (sometimes called "steelhead trout") is an anadromous (sea-run) form of the coastal rainbow trout(*O. m. irideus*) or Columbia River redband trout (*O. m. gairdneri*) that usually returns to fresh water to spawn after living two to three years in the ocean. Freshwater forms that have been introduced into the Great Lakes and migrate into tributaries to spawn are also called steelhead.

Adult freshwater stream rainbow trout average between 1 and 5 lb (0.5 and 2.3 kg), while lake-dwelling and anadromous forms may reach 20 lb (9 kg). Coloration

varies widely based on subspecies, forms and habitat. Adult fish are distinguished by a broad reddish stripe along the lateral line, from gills to the tail, which is most vivid in breeding males.

Wild-caught and hatchery-reared forms of this species have been transplanted and introduced for food or sport in at least 45 countries and every continent except Antarctica. Introductions to locations outside their native range in the United States (U.S.), Southern Europe, Australia, New Zealand and South America have damaged native fish species.

Resident freshwater rainbow trout adults average between 1 and 5 lb (0.5 and 2.3 kg) in riverine environments, while lake-dwelling and anadromous forms may reach 20 lb (9 kg). Coloration varies widely between regions and subspecies. Adult freshwater forms are generally blue-green or olive green with heavy black spotting over the length of the body. Adult fish have a broad reddish stripe along the lateral line, from gills to the tail, which is most pronounced in breeding males. The caudal fin is squarish and only mildly forked. Lake-dwelling and anadromous forms are usually more silvery in color with the reddish stripe almost completely gone. Juvenile rainbow trout display parr marks (dark vertical bars) typical of most salmonid juveniles. In some redband and golden trout forms parr marks are typically retained into adulthood.Some coastal rainbow trout(*O. m. irideus*) and Columbia River redband trout (*O. m. gairdneri*) populations and cutbow hybrids may also display reddish or pink throat markings similar to cutthroat trout. In many jurisdictions, hatchery-bred trout can be distinguished from native trout via fin clips, typically placed on the adipose fin.

Rainbow trout, including steelhead forms, generally spawn in early to late spring (January to June in the Northern Hemisphere and September to November in the Southern Hemisphere) when water temperatures reach at least 42 to 44 °F (6 to 7 °C). The maximum recorded lifespan for a rainbow trout is 11 years.

Freshwater resident rainbow trout usually inhabit and spawn in small to moderately large, well oxygenated, shallow rivers with gravel bottoms. They are native to the alluvial or freestone streams that are typical tributaries of the Pacific basin, but introduced rainbow trout have established wild, self-sustaining populations in other river types such asbedrock and spring creeks. Lake resident rainbow

trout are usually found in moderately deep, cool lakes with adequate shallows and vegetation to support production of sufficient food sources. Lake populations generally require access to gravelly bottomed streams to be self-sustaining.

Spawning sites are usually a bed of fine gravel in a riffle above a pool. A female trout clears a redd in the gravel by turning on her side and beating her tail up and down. Female rainbow trout usually produce 2000 to 3000 4-to-5-millimetre (0.16 to 0.20 in) eggs per kilogram of weight. During spawning, the eggs fall into spaces between the gravel, and immediately the female begins digging at the upstream edge of the nest, covering the eggs with the displaced gravel. As eggs are released by the female, male moves alongside and deposits milt (sperm) over the eggs to fertilize them. The eggs usually hatch in about four to seven weeks although the time of hatching varies greatly with region and habitat. Newly hatched trout are called sac fry or alevin. In approximately two weeks, the yolk sac is completely consumed and fry commence feeding mainly on zooplankton. The growth rate of rainbow trout is variable with area, habitat, life history and quality and quantity of food. As fry grow, they begin to develop "parr" marks or dark vertical bars on their sides. In this juvenile stage, immature trout are often called "parr" because of the marks. These small juvenile trout are sometimes called fingerlings because they are approximately the size of a human finger. In streams where rainbow trout are stocked for sport fishing but no natural reproduction occurs some of the stocked trout may survive and grow or "carryover" for several seasons before they are caught or perish.

The oceangoing (anadromous) form, including those returning for spawning, are known as steelhead in Canada and the U.S. In Tasmaniathey are commercially propagated in sea cages and are known as ocean trout, although they are the same species.

Like salmon, steelhead return to their original hatching grounds to spawn. Similar to Atlantic salmon, but unlike their Pacific *Oncorhynchus*salmonid kin, steelhead are iteroparous (able to spawn several times, each time separated by months) and make several spawning trips between fresh and salt water, although fewer than 10 percent of native spawning adults survive from one spawning to another. The survival rate for introduced populations in the Great Lakes is as high as

70 percent. As young steelhead transition from freshwater to saltwater, a process called "smoltification" occurs where the trout undergoes physiological changes to allow it to survive in sea water..There are genetic differences between freshwater and steelhead populations that may account for the smoltification in steelheads.

Juvenile steelhead may remain in the river for one to three years before smolting and migrating to sea. Individual steelhead populations leave the ocean and migrate into their freshwater spawning tributaries at different times of the year. Two general forms exist—"summer-run steelhead" and "winter-run steelhead". Summer-run fish leave the ocean between May and October, before their reproductive organs are fully mature. They mature in fresh water while en route to spawning grounds where they spawn in the spring. Summer-run fish generally spawn in longer, more inland rivers such as the Columbia River. Winter-run fish are ready to spawn when they leave the ocean, typically between November and April, and spawn shortly after returning to fresh water. Winter-run fish generally spawn in shorter, coastal rivers typically found along the Olympic Peninsula and British Columbia coastline, and summer-run fish are found in some shorter, coastal streams. Once steelhead enter riverine systems and reach suitable spawning grounds, they spawn just like resident freshwater rainbow trout.

Rainbow trout are predators with a varied diet and will eat nearly anything they can capture. They are not as piscivorous or aggressive as brown trout or chars. Rainbow trout, including juvenile steelhead in fresh water, routinely feed on larval, pupal and adult forms of aquatic insects (typically caddisflies, stoneflies, mayflies and aquatic diptera). They also eat fish eggs and adult forms of terrestrial insects (typically ants, beetles, grasshoppers and crickets) that fall into the water. Other prey includes small fish up to one-third of their length, crayfish, shrimp, and other crustaceans. As rainbow trout grow, the proportion of fish consumed increases in most populations. Some lake-dwelling forms may become planktonic feeders. In rivers and streams populated with other salmonid species, rainbow trout eat varied fish eggs, including those of salmon, brown and cutthroat trout,mountain whitefish and the eggs of other rainbow trout. Rainbows also consume decomposing flesh from carcasses of other fish. Adult steelhead in the ocean feed primarily on other fish, squid and amphipods.

Since 1870, rainbow trout have been artificially propagated in fish hatcheries to restock streams and to introduce them into non-native waters. The first rainbow trout hatchery was established on San Leandro Creek, a tributary of San Francisco Bay, in 1870, and trout production began in 1871. The hatchery was stocked with the locally native rainbow trout, and likely steelhead of the coastal rainbow trout subspecies (*O. m. irideus*). The fish raised in this hatchery were shipped to hatcheries out of state for the first time in 1875, to Caledonia, New York, and then in 1876 to Northville, Michigan. In 1877, another California rainbow trout hatchery, the first federal fish hatchery in theNational Fish Hatchery System, was established on Campbell Creek, a McCloud River tributary.The McCloud River hatchery indiscriminately mixed coastal rainbow trout eggs with the eggs of local McCloud River redband trout (*O. m. stonei*). Eggs from the McCloud hatchery were also provided to the San Leandro hatchery, thus making the origin and genetic history of hatchery-bred rainbow trout somewhat diverse and complex. In the U.S., there are hundreds of hatcheries operated by the U.S. Fish and Wildlife Service and various state agencies and tribal governments propagating rainbow trout for conservation and recreational sport fishing.Six of ten Canadian provinces have rainbow trout farms, with Ontario leading production.

Rainbow trout are commercially farmed in many countries throughout the world. The practice began in the late 19th century, and since the 1950s commercial production has grown dramatically. Worldwide, in 2007, 604,695 tonnes (595,145 long tons; 666,562 short tons) of farmed rainbow trout were harvested with a value of about US $2.6 billion. The largest producer is Chile. In Chile and Norway, sea cage production of steelhead has expanded to supply export markets. Inland production of rainbow trout to supply domestic markets has increased in countries such as Italy, France, Germany, Denmark and Spain. Other significant trout-producing countries include the U.S., Iran, the United Kingdom, and Lesotho. While the U.S. rainbow trout industry as a whole is viewed as ecologically responsible, trout raised elsewhere are not necessarily farmed with the same methods.

About three-quarters of U.S. production comes from Idaho, particularly the Snake River area, due in part to the quality and temperature of the water available there. California and Washington also produce significant amounts of farmed trout. In the east, Pennsylvania,North Carolina and West Virginia have farming

operations. Rainbow trout farming is one of the largest finfish aquaculture industries in the U.S. They are raised inland in facilities where raceways or ponds have continuously flowing water with little pollution and a low risk of escape. The U.S. industry is noted for using best management practices. Imports constitute only about 15 percent of farmed rainbows sold in the U.S., and nearly all domestic production is consumed within the country; very little is exported. The U.S. produces about 7 percent of the world's farmed trout. Rainbow trout, especially those raised in farms and hatcheries, are susceptible to enteric redmouth disease. A considerable amount of research has been conducted on redmouth disease, given its serious implications for rainbow trout farming. The disease does not infect humans.

Rainbow trout, primarily hatchery-raised fish of the coastal rainbow trout subspecies (*O. m. irideus*) introduced into waters inhabited with cutthroat trout, will breed with cutthroats and produce fertile hybrids called cutbows. In the case of the westslope cutthroat trout (*O. clarki lewisi*), hybridization with introduced rainbow and Yellowstone cutthroat trout(*O. clarki bouvieri*) is threatening the westslope cutthroat trout with genomic extinction. Such introductions into the ranges of redband trout(*O. m. gairdneri, newberrii*, and *stonei*) have severely reduced the range of pure stocks of these subspecies, making them "species of concern" in their respective ranges.

Within the range of the Kern River golden trout of Southern California, hatchery-bred rainbows introduced into the Kern River have diluted the genetic purity of the Kern River rainbow trout *(O. m. gilberti)* and golden trout *(O. m. aguabonita)* through intraspecific breeding. The Beardslee trout, (*O. m. irideus* var. *beardsleei*), a genetically unique lake-dwelling variety of the coastal rainbow trout that is isolated in Lake Crescent (Washington), is threatened by the loss of its only spawning grounds in the Lyre River to siltationand other types of habitat degradation.

3.3. Policy Guidelines for District Level Fish Production

Each and every nation has the policy regarding the cultivation of the commercial and subsistence crops. Similarly, GoN also has the policy guidelines regarding the production of fish in general farmers level, commercial and hatchling, fry

production which is been discussed below as per the publication of National Fish Development Program, 2064/65. Under it the fishery development programs has been emphasized on the OVOP (One Village One Product Program), Fish Mission Program and Agriculture Perspective Plan.

Commercial Fish Production Program

- Emphasis on commercial fish production in the areas that has approach to roads and irrigation facilities.
- Technological development and extension of promoting productivity rather than giving emphasis on area increment.
- Zonation of the fish production areas and pockets within the district and find out the problems with immediate remedies through DADO.

General Fish Production Program

- Uplifting of the fish producers to the commercial production system giving and due emphasis on the infrastructure and technological support.
- Continuation pond maintenance programs (upto 40 thousands NRs.) for Fish Production.
- Emphasis on technology in participatory and cluster approach.
- Continuation of direct investments in construction of pond construction (upto 1 lakh NRs.) to promote production and distribution at local level.
- Continuation of promotional programs and activities like farmer's trainings, subsidy on fish net, production demonstration programs of use of limes, health check up camps of fishes to raise fish production and productivity.
- Subsidy in tool and implements.
- Develop the quality control system and mechanism within the district level to control and regulate the quality incorporating the other governing local bodies like farmers groups and cooperatives.
- Coordinating the fish producers groups through DADO.
- Publication of cost of production of fishes in district level through DADO for the information of the stakeholders in each and every district.

- Coordination with the other line agencies like Women Development Office, DDC, NGO's and INGO's for uplifting the fishery production and productivity.

Hatchery and Breeding Program

- Infrastructure development for hatchery and distribution.
- Establishing hatchery resource center to self suffice the district level in the areas that has high potential of fish production.
- Uplifting and support the hatchery owners to produce a healthy hygienic fry, hatchlings and fingerlings.
- Continuation of transport subsidy for the hatchlings, fry and fingerlings.
- Coordinating the fish hatchery through DADO.
- Running of IPM schools kinds of packages to produce healthy fingerlings at farmers' level.

4. Result and Discussion

Commercialization of the agricultural sector is a theme in all the major agricultural policies including the Agriculture Perspective Plan, Agro-Business Promotion Policy and long-term Agriculture Development Strategy (ADS), which has just been handed over to the Government of Nepal for approval. All of those plans and policies highlight on product diversification, service delivery and private sector involvement in transforming traditional subsistence farming system to commercial. Various projects like Agriculture Commercialization and Trade was initiated with the overall project development objective of improving the competitiveness of smallholder farmers and the agribusiness sector in selected commodity amongst one was the rainbow trout as well.

Government of Nepal has various policy guidelines regarding different commodities. One of the key strategies of the government is to accelerate agriculture commercialization with the provision of matching grant assistance to farmer organizations, cooperatives, producer associations and agro-entrepreneurs through a transparent competitive process for actively engaging in profitable market oriented production and strengthening partnership and market linkages with other value chain participants and agribusinesses in selected value chains. Rainbow trout has been one of the value chains being considered for competitive matching grant financing by the government of Nepal and majority of the respondents were benefited from the various programs of the District Agriculture Development Offices and various projects like PACT.

To promote commercialization of potential high value agricultural products in the country, rainbow trout can be one of the prime subsectors that is expected to provide an opportunity to develop common understanding among public sector, non-governmental organization, private sector and donors regarding commercialization and promotion of rainbow trout.

4.1 Locale and the water source

The rainbow trout farms are majorly located in the areas that has ample natural water course either from streams, rivers or rivulets. The farm needs ample amount of water that flows in natural course and trapped in the constructed raceways with

natural flow through elevation without major contamination. Thus almost all the farms are located in the midhills with ample elevation and free water course and the dams along with the raceways are constructed to exploit the natural resource to an optimum level to rise the income and employment generation.

4.2. Education status of the farmers

Education plays important role in adoption of improved farm position and the education status of family members of respondent is presented in table 4.

Table 4 Educational Status of Family Members of the Respondent

S.N	Educational Levels of Farmers	Total	
		No	%
1	Illiterate	0	0
2	Primary level (Below Class 10)	6	30
3	Secondary level (Upto Bachelor Level)	10	50
4	University level (Masters Level)	4	20
Grand total		20	100

Source: Field Survey, 2016

From the table it is evident that majority of respondents family members were educated. The 50% of the farmers were having the education up to bachelors level and 20 % were having university degrees and rest under school leaving certificate. Higher the percentage of literacy can be inferred to have a good approach of the farming, trading and marketing of the fishes with more judgmental and optimum utilization of the available resources.

4.3 Motivation for the Rainbow Trout Farming Business

It was found the majority of the respondents were influenced by their own family member and self observation towards the business (60%). Only 15 % of the respondent expressed that they were attracted to fishery business only after receiving training. However, 20 % of the respondent replicated by motivation due to the friends and neighbors successful proliferating business that is been established in their own community or to the similar sites in other districts. The result pertaining to the causes of encouragement towards the business has been presented in table 5.

Table 5: Reasons for Involvement in Rainbow Trout Production and Marketing

S.N	Items	Total	
		No	%
1	Family members / self observation.	12	60
2	By friends	4	20
3	By training	3	15
4	By other	1	5
Grand total		20	100

Source: Field Survey, 2016

However, the reports from DADO ascribes the importance of the training for fish farming, but the motivation and adoption of the farming started more from the observations of the traditional enterprise rather than the training to start the farm. But the training part is very vital in the ongoing production which cannot be ignored that has been provided by the DADO and other stakeholders.

4.4 Credit Sources and Its Uses

Sources of Credit

The investment for any business is eminent. The business starts with self fund to certain extent but for the further extension of the project needs more fund to grasp the risk and cover up the opportunities to make the turn over to the positive. The table no. 6 shows the sources of credit and the interest rates.

Table 6: Source of Credit and Interest Rates

S.N	Items	Credit		Remarks
		%	Interest rate	
1	Self Fund	5	_	
2	ADB/N	6	12.5	Long Term
3	Other Banks	2	10-13	Long Term
4	Cooperatives	2	16-18	Long/Short Term
5	Saving from Group	1	18-36	Short Term
6	Land Lords	1	24-48	Short Term
7	Friends and Family	3	0-12	Short Term
Grand total		20		

Source: Field Survey, 2016

The above table depicts that the farmers approach the institutions for the investments needed as per the need of short and long term needs and decide the institutions as per their need. Only 25% of farmers are non-borrowers. The majority ie. 30 % of the farmers approach Agricultural Development Bank followed by other banks for the long term need with easy installments of repayment of the loan. Majority of borrowers attracted to the ADB/N due to cheaper rate of interest rate, good dealing behaviors and easy access. However, farmers approach cooperatives, saving groups, and friends and families for the short term needs with medium interest rates with a contrast of paying as much as 48% of the interest rate per annum for the local landlords.

Fish farming business was found to be in increasing trend in the mid hill districts. Most of the farmers who couldn't approach with ADB/N were due to the cumbersome paper works for the farmers and had little approach to reach the financial institutions and heavily relied on the saving groups and local land lords repaying higher amount of interest rates for the short term needs as well.

40% of sampled loaners were under the loan range 7.5 lakh to 10 lakh, 30% loan were under 1 lakh to 2.5 lakh, 17.5% loaners were under 2.5 to 5 lakh and 12.5% of loaner were under 5 to 7.5 lakh. Generally 2.5 lakh loans will provide for only working capital, 1 lakh to 2.5 lakh loan was for repairing for of ponds with working capital, or construction of one new pond with working capital. Up to 5 lakh loan ranges showed the construction of new ponds with working capital. 7.5 to 10 lakhs loan range provided fish rearing ponds along with hatchery or land purchase and pond construction along with working capital, etc.

However there were some farmers like Gandaki Rainbow Trout Farm of Sardikhola Kaski who was producing the fish feed were having higher loans upto 1 carod and were excluded in the study as feed producing industry is another sector that has not been included in this study.

Use of Loan

The table below showed 20% of the farmers who had the knowledge and skills about the fish farming and had limited suitable land for pond construction approach the institutions for financial assistance for the land purchase and 28%

approach for the pond construction and maintenance. 30% of the loan was seen to be investment on the feed and 8% on the tools and implements and nets, similarly 5 % for the medicinal purchases. On the contrary only 7% of the loan was used in hiring the manpower and 2% for other utilities.

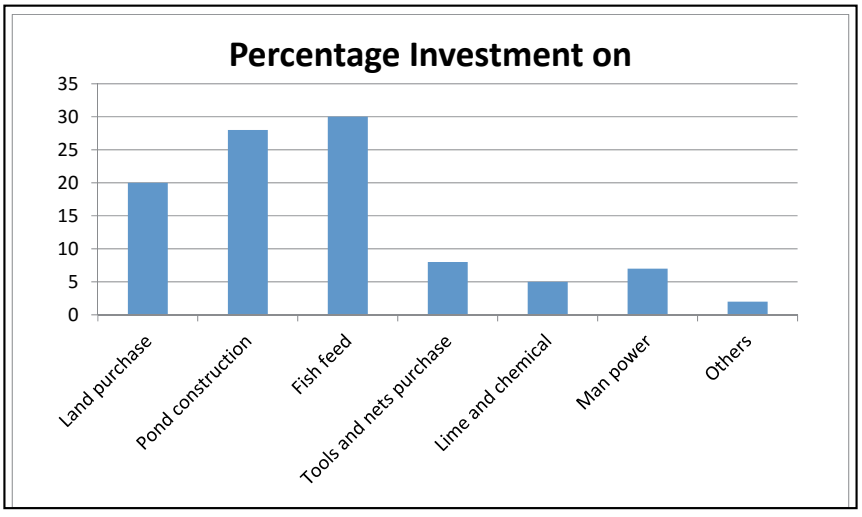
Table 7: Use of Loan and Purposes

S.N	Items	Invested Percent
1	Land purchase	20
2	Pond construction	28
3	Fish feed	30
4	Tools and nets purchase	8
5	Lime and chemical	5
6	Man power	7
7	Others	2
	Total:	100

Source: Field Survey, 2016

According ADB/N loan distribution norms, farmers must spend 60% of their loans on working capital except land purchase. So this above data satisfies the condition for successful fish production.

Graph 1: Percentage Investment On



Source: Field Survey, 2016

4.5. Production And Marketing

Rainbow trout culture is tied with specific agro-climatic conditions (fresh cold running water, low temperature in gentle hill and mountain slopes) and market access. Basically, trout farming is knowledge, input and technology intensive farming. It requires year round dependable source of cold oxygenated unpolluted fresh running water with temperature range of 9-13 degree C for spawning and 14-20 degree C for table fish production.

Production

Production of rainbow trout is comparatively new venture in Nepal. As specified earlier, breeding of rainbow trout was initiated in 1990 and experimental production started in 1993 in research centers. In private sector, it was first demonstrated in 1998 at a farm of Mr. Gopal Lama of Ranipauwa, Nuwakot district. With its popularity growing very fast among producers as well as consumers this activity has spread in 6 districts, number of farmers increased to 36 and production increased to about 55 tons in 2007/08. Number of districts as 23, number of farmers as 114, and volume (mt) of production has increased to 317 respectively, in 2015/16 (Table 8). At present it accounts for about 0. 30% of total fish production in the country. Interactions with concerned stakeholders revealed that the volume of rainbow trout production may reach to about 500 mt by 2020.

Table No 8: Trend of Rainbow Trout (Table Fish) Production in Nepal

Year	Raceway Area (sq. m.)	Stocked Fry (No.)	Production (Mt.)
1197/98	10	500	0.045
1998/99	20	1000	0.08
1999/00	60	4500	0.7
2000/01	280	11200	1.0527
2001/02	546.3	41000	8.965
2002/03	1055.5	79200	16.192
2003/04	1075.5	80900	14.199
2004/05	1317	99000	16.095
2005/06	1571.93	118000	18.23
2006/07	2265.27	170000	25.882
2007/08	7081.45	354100	55.192
2008/09	9128	556500	82.783

2009/10	10800	485900	88.589
2010/11	12230	917250	135.7
2011/12	12360	871045	159.395
2012/13	13160	986000	179.41
2013/14	14275	1428000	228.63
2014/15	18677	2087000	290.78
2015/16	20723	2259625	317.70

Source: Fisheries Research Division, NARC, 2016

4.6. Farms and Raceway Area

The reported number of districts as per the record of the Fisheries Research Center, NARC Godawari is altogether 23 with total number of farmers as 114 with total number of Raceway of 1111 with total area of 20722.8 square meters with the production of 317.7 metric tons. The details of all the districts with respective numbers of farmers, number of raceways, area, trout fry stocks (90-105) per square meter along with production is presented in the table no 9 below :

Table no 9: Inventory of Districts, Raceway Area and Production in Nepal

S.N	Districts	No. of Farms	No. of Raceways	Area (sq.m)	Trout Fry Stock (90-105) No/sq.M	Production (MT)
1	Nuwakot	39	386	5643.6	613000	74.5
2	Rasuwa	12	61	627.2	73200	11.4
3	Sindhupalchock	10	108	2470	256000	42.7
4	Lalitpur	5	78	1560	147000	20.6
5	Kathmandu	3	36	576	60000	8.5
6	Mawakanpur	2	8	575	43125	7.3
7	Dhadhing	6	86	1960	198000	31.3
8	Mustang	1	2	100	7500	1.3
9	Kaski	8	176	4400	608000	83.3
10	Kavrepalanchock	4	21	296	31000	5.7
11	Dolakha	5	33	417	38000	7.4
12	Illam	2	9	162	14000	1.5
13	Panchthar	4	18	396	28000	5.0
14	Therathum	1	4	102	10000	1.2
15	Manang	1	8	120	11800	1.0
16	Syangja	1	6	90	9000	1.0

17	Palpa	1	6	90	9000	1.1
18	Myagdi	2	8	150	16000	2.1
19	Parbat	2	14	232	24000	3.4
20	Solukhumbu	2	15	270	30000	3.5
21	Okhaldhunga	1	6	104	11000	1.4
22	Lamjung	1	10	180	22000	2.5
23	Jumla	1	10	180	0	0.0
	Total	114	1111	20722.8	2259625	317.7

Source: Fisheries Research Division, NARC, 2016

4.7 Hatcheries and Their Production Capacities

Despite of the potential of fish farming in mid-hill districts, there were limited number of Hatchery in operation and none were found registered in the DADO office. As per the record of NARC, several hatcheries were found in operation but without registration. They produce fingerlings and hatchlings in various seasons; however the number of fingerlings or hatchlings they produce couldn't be reported. There is still scope of expansion of these hatcheries as well, as the numbers of fingerlings, fry and hatchlings that produces gets sold within the local area and there is a scope of exporting to other potential areas within and outside the district as well.

4.8 Stocking Density of Rainbow Trout Production

Stocking density is dependent more on the volume of water supply, temperature and oxygen concentration in water than the actual size of pond as been reported by the farmers. Very fast running water is also not desirable. If the current is too fast, fish energy might be used more for swimming instead of growth. On the other hand, slow current results in the accumulation of wastes. Water flow must be increased in summer when water temperature is higher and dissolved oxygen lower than in winter. It was well understood by the farmers that as a rule of thumb water current should be sufficient to provide at least one complete exchange of water per one or two hours in the pond.

A well managed farm should be able to sustain 10 kg/m2 of fingerlings. In general a pond with a flow of 1 m3 of water per minute can support annual production of 1-2 tons of rainbow trout in Nepal. In a pond supplied with sufficient fresh water

and quality feed, enough young fry can be stocked to give production of 20 kg/m2 (200 t/ha). 70 g fish as initial weight, at 15 kg/m2 should be able to produce about 32 kg/m2 of fish 90 days after stocking, with water flow maintained at 2.5 L/sec in an area of 3.5 m2(Nepal et al., 1998). Our recommended rate of stocking is 50-100 fry/m2 depending on conditions, where harvest size would be 200 g. The weight rather than the numbers should be reduced, if water temperature reaches more than 21°C and the flow rate is not sufficient, and dissolved oxygen is less than 6 mg/L. It is believed that ponds with a high degree of aeration can support a stocking density up to five times greater than non-aerated ones.

Ref: Economics of Rainbow Trout in Nepal.

4.9 Fish Feed

Feeding is a very important part of fish culture. Two types of feeding practices are used ie. machine feeding, which is used for well equipped and well managed farm or hand feeding, which needs frequent supervision of the ponds, and is used on fish farms with fewer facilities. In case of hand feeding, young fish must be fed 7-8 times a day at 60-90 minute intervals. As the fish grow over 10 g feeding frequency can be reduced to 3-4 times a day. When the fish reach over 50 g feeding twice a day is sufficient. However, it must be noted that feed and size of pellets control the growth variation of fish among individuals of the same group. Lights off during night's lowers metabolism and preserves energy in the fish.

Trout needs a supply of high protein content feed in pellet form. Generally, more than 35% crude protein (CP) is necessary for trout. Growth of trout has not been satisfactory with feed containing less than 20 percent animal protein. More than 40 percent CP containing feed has been recommended for the newly swim-up young and for brood stock. 35 percent CP containing feed made with 30 percent animal protein (shrimp) has been used in Nepal. We have been supplying buffalo liver to the swim-up fry up to 5-10 g size at a rate of about 0.1 percent of body weight. The fry had a very good survival rate with good growth. The pellets and crumbles should be graded into different sizes suitable for the mouth size of the growing trout. Feeding rate varies on the basis of fish size and the water temperature. Young trout (< 30 g) need to be fed 3-10 percent of body weight per day, but 1-2 percent is sufficient for bigger ones.

Ref: Economics of Rainbow Trout in Nepal.

Response to ready-made feed was very prominent on the fish farms with high production and productivity in response to the rainbow trout fishery training and other technical support from governmental, NGO's and INGo's but only 35% of the respondents adopted for the Ready-made feed. Majority (65%) of farmers of the districts used locally formulated feed for fish.

Those who acquired more training and financial support, use only readymade feed in districts. The productivity was highest in the Ready-made feed with 12.5 kg/10 sq meter so forth with locally formulated feed with 10kg/10 sq meters. Table no. 10 shows the types of feed used and their productivity in the study district.

Table 10: Type of Feed Used

S.N	Types of feed	Total		
		No	%	Prodn /10 Sq m
1	Locally formulated	13	65	10 kg
2	Ready-made feed	7	35	12.5 kg
Grand total		20	100	

Source: Field Survey, 2016

4.10 Market Channels and Marketing Practices

Rainbow trout has a specific niche market that is medium to high income domestic consumers and tourists. Market arrivals generally occur after November until June. Its value chain is small and simple due to small-scale production and consumption. The products are not marketed in general in local market stalls, footpaths and general fish shops. Very limited middlemen are found to exist in marketing of trout fish. Local consumers often visit the farm gate to buy the fresh product. Some of the producers also act as middlemen and these traders have own informal contractual agreements with other local producers for advance buying of trout products. Some of the producers also own restaurant where they offer rainbow trout dish in different tastes and sizes as per demand of consumers.

During field survey it was revealed that Pokhara, one of the major tourist hubs, gets trout from Kathmandu market using their private channel, while there was also

report of Pokhara supplying it to Kathmandu occasionally. It was also reported that there is good export market potentials of dried rainbow trout, but this has been limited by low volume of production and higher demand than supply for fresh consumption. In a nut-cell prevailing marketing options for the producers can be summarized as:

- Cooked products sold to consumers from their own hotels/restaurants,
- Fresh sales to local hotels and restaurants,
- Fresh sales to traders and consumers at farm gate, and
- Fresh sales to hotels, restaurants and department stores in major towns such as Kathmandu and Pokhara.

The products were not differentiated among sellers except some labeling. The restaurant and hotel owners sell the products in different types of recipes based on the nature of hotels and consumers preferences. The prices were found set based on market negotiation, local contacts, promotion strategies and technique with particular hotels, restaurants and super markets. As rainbow trout is a high value perishable product, it requires good care and handling in post harvest use and marketing.

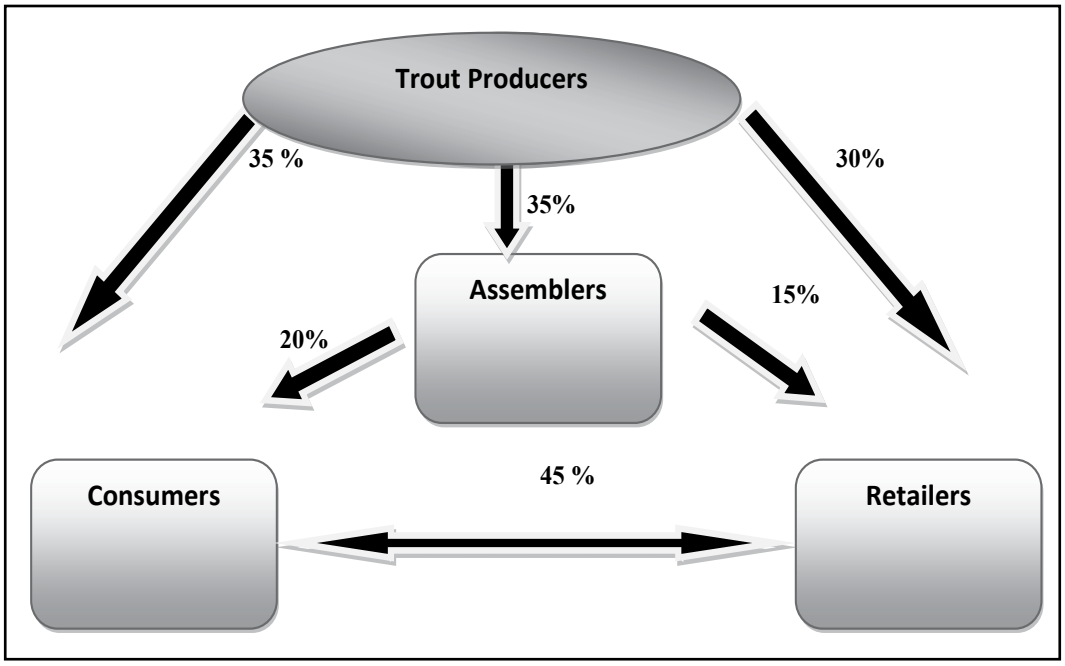
Current transport system and production sites are reasonably good for a quick distribution of perishable products. However, such a production site close to major market centers and convenient transportation system may not be available in many parts of the hills and mountains.

Direct marketing between producer and consumer is practiced by majority of the farmers. In most cases, producers sell their fish to the visitors of the farms and majority of the producers have the cooking facility and they catch live fish in their farm and serve to the consumers thus giving them value addition of their produce. They too contact the retailer cold stores along with the superstores like Bhatbhateni and Sellways and contact assemblers to channelize their product to the demanding areas of tourist hubs like Pokhara and Kathmandu.

The 35% of the total production is sold directly to the consumers and the 35% is channelized to the destined hubs to fetch high prices and rest of the 30% of the produce is cleaned, frozen and channelized to the retail stores thus reaching the

consumers. Out of the Assemblers Share, 20 % is directly sold to the consumers and 15 % is channelized again to the Retailers. Retailers sold 45% of the production but since it's in frozen form thus resulting lower market price as compared to fresh to the consumers. The fish-marketing channel was shorter, so it can be inferred that they could get more income without depleting income with change in each hands of the handler.

Flow Chart 1: Marketing Channels & Percentage of Trout Flow to Consumers



As far as its export is concerned, few percentage of the rainbow trout is been exported by producers to domestic consumers who live abroad in dried forms to United Kingdom, Hongkong, Japan, Australia and USA. These all exports do not contribute much as it is been taken by the consumer themselves without any initiative of the producer in dried form.

There has been an initiative taken by the private sector recently to export smoked dried rainbow trout abroad. The sample has been sent to the Middle East and if approved by the concerned quarantine authority, there might be the demand of 10 Mt of smoked dried rainbow trout by next year.

4.11 Harvesting and Sizes

Rainbow trout is widely accepted as food fish of high quality. In countries where commercial trout farming is well developed, as in Europe, harvesting size ranges from 170-230 g to 350-450 g for the fresh market and 1.5-3 kg for fillets and smoked trout. 200-300g fish are the most suitable size for harvesting because of higher feed efficiency and low production cost. In Nepal most trout consumers prefer 200-300 g trout.

Ref : Economics of Rainbow Trout

Nepalese consumers believe that the smaller the size the more delicious the fish is. Restaurants and hotels request 200 g, 250 to 350 g and more than 1 000 g fish. Smaller sizes are served as a whole fish and bigger ones are for smoking. The smaller size is more profitable to sell in grow-out fish farms. Old brood stock is another source of income in the seed production or full system farms.

The trout is a perishable but high value food, and should be marketed in good quality. Post harvest handling of the fish therefore becomes very important. The transport system in Nepal is not very convenient for a quick distribution of perishable products like fish. It is believed that trout export has a good future.

4.12 Purchase Price of Fish Species

Marketing is essential part of produced fishes. The purchase price of fish varies on the basis of types of storage and freshness of marketed fish. As it goes on with the handler one after another, the price goes up with each hand of traders. Assemblers were the first step of brokers who purchased the fish from producers at lowest possible rate and sell a large portion to the traders and little amount to the consumers.

The assemblers were the second steps of traders who purchased fish from producers at medium rates. The retailers are the third steps of traders, who directly sold their fishes to the consumers. Because consumers had to pay more money, they purchased fish at higher rates than other traders from the producers.

The purchase price of locally produced rainbow trout table fish was higher, due to its higher demand low quantity of supply. The other cultured and imported

fishes are larger in size and thus fetch very lower prices in the local market due to its freshness and its taste. The market had the high demand for the Rainbow Trout despite of having high price is due to its taste and freshness. Common carps, Indian carps and Chinese carps along with other species of fishes does not compete with the Rainbow Trout as the market along with the consumers are segregated as per the taste and nutrition and willing pay much higher compared to these produces.

4.13 Selling Price of Rainbow Trout

Majority of the farmer's were found satisfied from fish price. Selling price of the producers depended on the cost of production, selling time, demand, and selling condition of the fishes. Because fish is perishable in nature, its selling prices vary. The farmers sell their fresh produce from farm at Rs 750 per kg in average. Some of the farmers have opened up their own retail store and fetching the same price. However the assemblers get the fish at Rs 700 per kg sell them ranging from 750 to 800 Rs per kg and the retailing price for the frozen varies from 800 to 900 Rs per kg at the cold stores and retail markets.

4.14 Farmers' Satisfaction from Fish Prices

On the basis of production, farmers were found satisfied with the return from their enterprises. Although fish is perishable in nature, its demand and price is higher. Farmers of the Pokhara Nuwakot and Kathmandu were found to fetch higher prices as compared to the other districts. Its due to the remoteness of the farm and the transportation cost involved in the marketing. However the margin is much higher as compared to the pond fisheries market price in the local markets. So majority of farmers were satisfied and only 15% farmers were unsatisfied due to unlimited admission and people's expectancy in nature that is been presented in the table no 11 below.

Table 11: Farmers' Satisfaction from Fish Prices

S.N	Items	Total	
		No.	%
1.	Satisfied	17	85
2.	Unsatisfied	3	15
Grand Total:		20	100

Source: Field Survey, 2016

4.15 Supply Situation

From the household and market survey, it can be inferred that the bulk production doesn't enter the formal market. It is either consumed locally in the smaller local markets and some enter the district markets as well. Only about 45% percent of the product reaches bigger market as the demand for the fresh rainbow trout fish in both of the districts is huge and the production cannot meet the demand despite of its high price. The local supply is sometimes so high that almost all the produced rainbow trout are consumed in the local production farm in their own restaurants and sold at their outlets only at farm gate level. It cannot meet the consumers demand at the retail outlets. However, only at the peak harvesting season, the supply in the market would be high and the produce cannot be consumed within the production area and thus it reaches bigger markets like Pokhara and Kathmandu in retail cold stores and organized grocery markets.

4.16 Cost of Production

The fish production in ponds contributes about 62% of total fish production of Nepal where as rest of the production comes from the captured fisheries. The total national production is 56000 Mt. that contributes about 2.11Kg per capita consumption as the national average.

The Cost of production contains two major parts ie. ***Capital costs*** or ***Initial cost*** and the ***Annual Operation Cost.*** The ***Capital costs*** or ***Initial Cost*** contains the costs that are incurred before fish producing activity is done. It is the preliminary costs that has to be invested for the infrastructure development and production management like construction of ponds, water management, making of dikes and water canals, pipes, equipments other associated facilities like stores, fish nets, shade houses, buckets, cages, graders, water pumps, weighing balance, etc. However, these costs are incurred on the first year of the production but is retained for more than a year, so its cost cannot be deducted while calculating the cost of production in that year, whereas has to be distributed for the production years ahead depending upon the investments and its returns on the things that cost has been incurred.

Annual Operation Costs includes two types of costs, ie. ***Variable Costs*** and ***Fixed Costs. Variable Costs*** are those costs, that varies as per the production conditions and capacity of the farm that keeps on changing on day by day or invested once in one production cycle like preparation of the pond, investments on fingerlings, fry or hatchlings, fish feed, daily wage workers, small tools and implements, chemical fertilizers, limes, organic matters, medicines, fuels, electricity, depreciation of seasonal implements, freight costs and others.

Fixed costs are those costs that are incurred for operation and management of the farm on yearly basis like yearly salary of workers, interest on the loans and principle, annual depreciation of farms tools and implements, operation and maintenance costs, farm tax and water taxes, etc.

If there will be a change in Capital or Initial investment costs, it has to be calculated with due emphasis depreciation on the variable cost. The depreciation has to be calculated in each of the investments except on land as it the only resource that will be appreciated not vice versa where as if the pond is constructed on the rented land, then its rent should be calculated as well.

Giving a due account on the above stated situation, the average benefit cost analysis shows that total expenses and total income of both the districts. The average cost of production per hectares were calculated from the farmers of both the districts and presented in the table 12 below.

Costs and Benefits from Rainbow Trout Farming in Mid Hills (Average for 200 sq.m raceway)

Table 12: Capital Costs or Initial Costs

S.N.	Particulars	Costs in Rs.	Expected Life	Depreciation
1	Raceway Construction	672000	20	33600
2	Water Supply System	225000	20	11250
3	Store, Feed House, etc.	185000	20	9250
4	Drag Net	7500	5	1500
5	Netlon, Hapas, Graders	13500	5	2700
6	Small Pumps, Equipments, Balance	15000	5	3000
7	Others (Buckets, Softwoods etc.)	8200	2	4100
		1126200		65400

Source: Field Survey, 2016

Table 13: Annual Operation Costs

S.N	Particulars	Unit	Quantity	Rate	Total Rs
A	**Variable Costs**				
1	Fry (2 gm size)*	No	15000	9	135000
2	Feed for Table Fish	Kg	6000	130	780000
3	Feed for Advanced Fry	Kg	375	170	63750
4	Small Equipments, Glassware, Tools, Chemicals, nets, etc	LS			13500
5	Electricity	LS			12000
6	Telephone & Communication	LS			12500
7	Fuel/Transport Cost	LS			30000
8	Other (Oil, Medicines, etc.)	LS			13000
Total					**1059750**
B	**Fixed Costs**				
1	Salary of Manager	MM	5	15000	75000
2	Salary for Staff/Labor	MM	20	9000	180000
3	Land Rent (1 Ropani per Year)	LS			12000
4	Bank Interest (14% of Capital Cost)	Rs			157668
5	Depreciation	Rs			65400
6	Maintenance (5% of Capital Cost)	Rs			56310
7	Miscellaneous	LS			13000
8	**Total**	Rs			**559378**
	Total Annual Cost (A+B)				**1619128**
C	**Income and Profit Margins**				
	Fish Production**	Kg	2500	750	1875000
	Total Annual Operating Costs				1619128
	Net Profit				255872
	Production Cost Per Kg				**647.65**
	Profit Per Kg Production				**102.35**

Assumptions: *75 fry per sq m and mortality 15%
** Average Harvesting size 200 gram

Source: Field Survey, 2016

The largest cost item in rainbow trout farming is capital cost including construction of raceway, 24 hour running water supply system, store house; and procurement of nets, grader and related equipments. It was estimated that about Rs 897 thousand was required to construct 200 m2 concrete raceways and water supply system. Similarly, construction of store and guard house required Rs 185

thousand. Another about 52 thousand was estimated for procurement of different types of net and related equipments. Among the operating costs, feed is the most important item accounting for about 52 percent of total operating costs. Other major cost items are interest on credit, remuneration of human resources including manager and labor/security guard, depreciation of capital items, procurement of small equipment/utensils and utilities. Estimated capital and operating costs and returns from rainbow trout farming in 200 square meters raceway as elaborated above.

The cost benefit analysis (Table 14) shows that total annual operating cost of an average farm is about Rs 1.61 million whereas value of production is Rs 1.87 million meaning that an average farm of 200 square meter raceway can earn a net profit of Rs 255 thousand per annum. In terms of a per kilogram of fish production, cost was Rs 648 whereas average farm gate price was Rs 750 in April 2016, resulting in to a profit of Rs 102 per kg of rainbow trout production. The question is having so lucrative in nature, why there is no production boom? The major reason given by the stakeholders was that entrepreneurs often hesitate to invest in this business for two reasons: first, initial cost is very high and second, that high fry mortality was experienced in some of the cases in the past.

Table 14: Cost Returns from Rainbow Trout in 200 sq m Raceway

Description	**Unit**	**Quantities**	**Rate**	**Total Rs**
Income from Fish Production	Rs	2500	750	1875000
Total Annual Operating Costs	Rs			1619128
Feed Investment Ratio compared to Annual Operating Cost	Percent			52.11
Net Profit	Rs			255872
Production Cost per Kg	Rs Per Kg			647.65
Profit per Kg Production	Rs Per Kg			102.35
Net Benefit	Percent			15.80%

Source: Field Survey, 2016

Producers are found to have largest share in profit from rainbow trout value chain, followed by retailers and then by assemblers. This is justified as a farmer has to spend as much as Rs 648 per kg production and has to wait 12-14 months for the fish to gain average weight of 200 gram.

Table 15: Share of Major Stakeholders in Profit from Rainbow Trout

Description	Percentage per Kg.
Producers	44.58
Retailers	29.06
Assemblers	26.05
Total	100

Source: Field Survey, 2016

4.17 Price and Payment System

Normally, producers of rainbow trout consult each other and fix price of the product. This leads to a uniform price across single pocket. Prices may differ slightly among locations in different regions due to transportation cost and immediate demand supply situation. There are also some variations in market prices of trout in different seasons and parts of the year.

Market arrival normally occurs during December to June, which has direct impact on prices and also availability. As there is little or no direct sale from the farm during July to early November, small amount available with cold houses gets much higher price. During the field survey the farm gate average price of fresh products in private farm was Rs 750 per kg, while it was Rs 450 per kg in NARC farms. Practice of pre-fixing of the product price and buying the whole lot, which is often practiced in some of the other high value products, is not prevalent in rainbow trout.

Based on the information gathered during focus group discussions it was estimated that the average cost of handling and packaging is Rs 25 per kg, cost of transportation Rs 20 per kg and cost of weight loss & others Rs 25 per kg. This adds up to Rs 820 per kg at urban centers away from farm. However, retail price in Kathmandu and Pokhara during the survey period was recorded from Rs 950 to Rs 1000 per kg, meaning that profit margin to traders was Rs 130 per kilogram of the product.

Spot payment was reported when a buyer is a visitor to the farm site, is unknown person, or one is buying in small quantity. Regular customers including traders, hotels and restaurants pay regularly as per mutual agreements. No delay in

payment was reported as trout is in short supply and supplier may refuse to sell to those that did not pay in time. Advance payment was also reported in few cases, especially by organized caterers and some restaurants and hotels those serving trout on discussing their demand and assuring the supply.

4.18 Value Addition

Rainbow trout being relatively new and unique product there is large demand of this product. As present production is much lower than demand, almost entire product is sold fresh, except hotels/restaurants preparing variety of dishes. Some of the producers and traders reported that they supply dried rainbow trout to local market and also export it on sample basis. However, the quantity they traded was very small and the product was mostly used for souvenir.

Information collected from stakeholders at different level shows that average production cost per kg of rainbow trout is Rs 598. Average farm gate sales price at private sector during the survey period was Rs 750, meaning that farmers earn a net value of Rs 152 per kg of rainbow trout production. Primary traders buy fish at farm gate and deliver it to hotel, restaurant and fresh house (retailer). Their other cost items are packaging (ice, foam, polythene bags) transportation, storage and weight loss accounting for Rs 30 per kg. They make a net profit of Rs 50 per kg. Fresh house that serve as wholesaler cum retailer of rainbow trout sell the product at Rs 950 per kg. Their cost was estimated at Rs 40 per kg in addition to procurement cost. Their net benefit was estimated at Rs 80 per kg as presented in Table 16. The table clearly shows that there is enough space to improve the value chain that would benefit producer as well as consumers.

Table 16: Value Addition in Fresh Rainbow Trout Production and Trade

Activities	Unit	Producer	Assembler	Retailers	Total
1. Production Cost	Rs/Kg	648			648
2. Procurement Cost	Rs/Kg		750	830	
3. Cost Addition	Rs/Kg				
3.1 Packaging	Rs/Kg		10	15	25
3.2 Transportation	Rs/Kg		15	5	20
3.3 Storage (including weight loss)	Rs/Kg		5	20	25
Total Costs (TC)	Rs/Kg	648	780	870	

4. Sales Price (SP)	Rs/Kg	750	830	950	
5. Value Addition	Rs/Kg		50	120	352
6. Profit (SP-TC)	Rs/Kg	102	80	80	282
7. Profit as % of Sales Price	Percent	15.75	10.27	9.20	35.33
8. Share in Profit	Percent	44.58	29.06	26.05	100

Source: Field Survey, 2016

Value Chain

The chain map provides a graphic representation of the structure of the value chain showing how products flow through the primary system as well as alternative channels. The channels are generally vertical chain of enterprises that transforms raw materials and delivers them to consumers as finished goods. The map lists functions vertically along the left hand side with the final market the top. The participants or actors of the value chain are designated by boxes.

In the fish map, the channels have been identified on the basis of core business units, i.e the supply, production and distribution involving physical product flow from supplier to the end-user. In general, the more the units are integrated, the more comparative advantage they gain and more capital intensive they are.

The value chain of rainbow trout starts from suppliers of seed and feed. Initially Nepal Agricultural Research Council (NARC) used to supply brood fish to hatchery as one of the innovative approach to promote hatchery and fry production at private sector. Now those hatcheries have been selecting and maintaining brood stock. They produce and supply fry to their own farm as well as to other farms. Similarly, several rainbow trout farms produce feed for their own farm and also supply to other farmers.

Processing of rainbow trout is limited to preparation of different dishes at restaurants/hotels for immediate consumption and drying only. There are several restaurants established along the road and trekking route near its production area. Some of them also offer dried fish to tourists that are interested to take home the product. The pattern of sales is quite interesting. The Shardikhola pocket of Pokhara reported that as most half of the trout production is sold to local restaurants and consumers visiting the sites. The reason is that this pocket falls

in one of the trekking routes and also that their popular tourist/picnic spot for the local people. The case is different for Nuwakot from where than two third of production enters into the urban markets, mainly Kathmandu. A simplified value chain map of rainbow trout is presented in the Figure 2.

Further value addition is done by restaurants located at production site and also urban centers. Based on information provided by concerned stakeholders it is estimated that local restaurants buy raw fish at the rate of Rs 750 per kg at farm gate. One kg rainbow trout cooked into different types of dishes as demanded by the consumer is sold at Rs 1,200 on an average making a net profit of Rs 179.

Compared to local restaurants urban restaurants make larger profit. It is estimated that urban restaurants spend about Rs 1180 per kg of rainbow trout fish from buying fresh to cooking into desired dishes. The product is sold at about Rs 1500 at the restaurant making an average net benefit of Rs 320 per kg. Details of costs and benefit estimates are presented in table below. Costs might, however, differ significantly if raw fish is bought from urban wholesaler.

Table No 17: Value Addition on Rainbow Trout Fish by Restaurants (Case of Sardikhola)

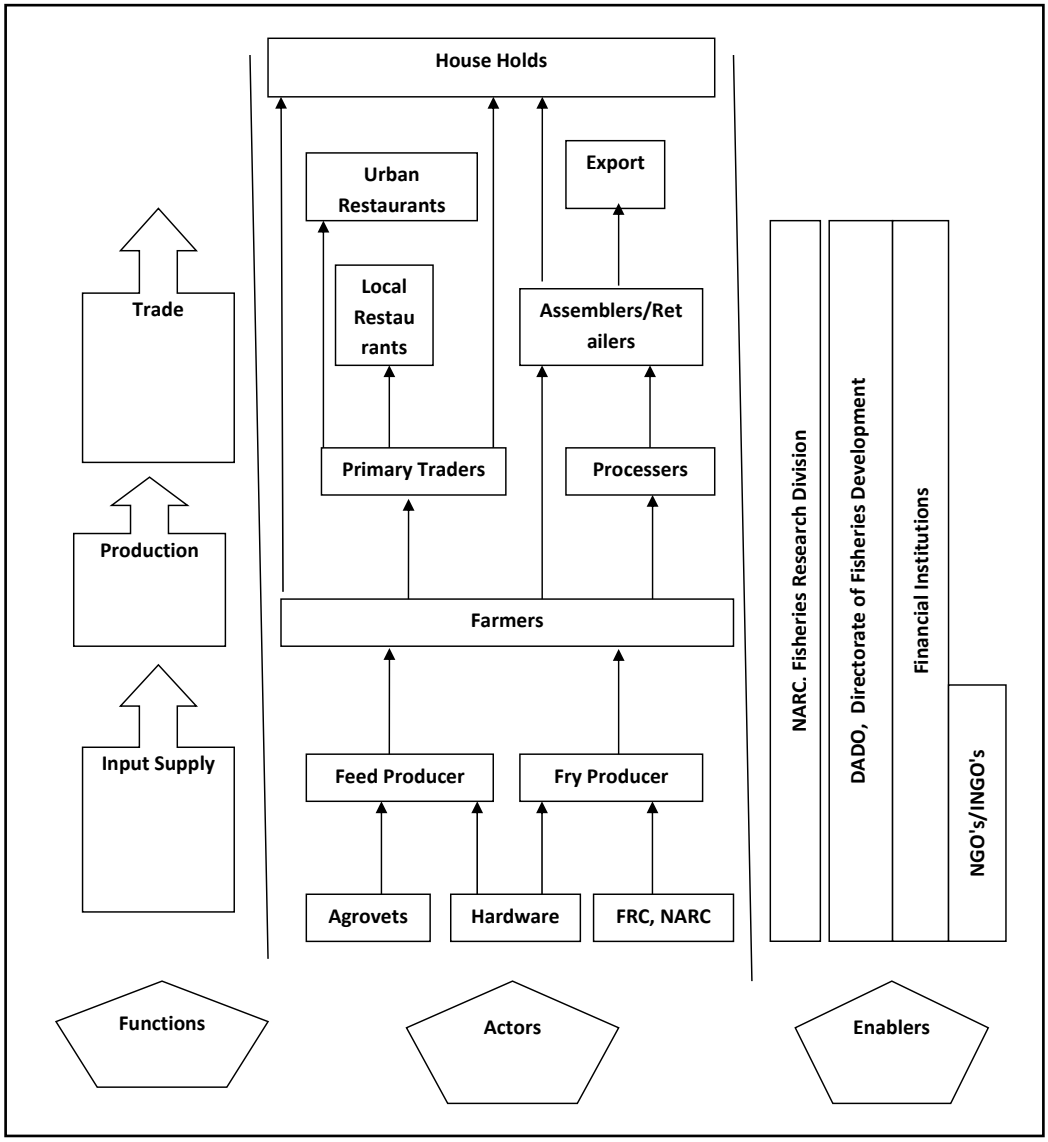
Description	Average Rs/Kg	
	Restaurant at Farm Site	Restaurant at Urban Site
A Costs		
Buying Price	750	750
Transportation		20
Packaging		15
Freezing		10
Cleaning/Dressing	5	5
Wastage (20%)	151	160
Cooking Costs	100	200
Others	15	20
B Benefits		
Ready Product	1200	1500
C Net Profit	179	320

Source: Field Survey, 2016

Institutional Arrangements of Value Chain

The institutional involvements of the value chain when linked with in a big market is presented in the diagram below and the functions, actors and enablers can be categorized as follows;

Figure 2 : Value Chain Map with its Institutional Involvement of Rainbow Trout



4.19 SWOT Analysis

The following SWOT analysis of the producing rainbow trout shows a number of strength and opportunities for boosting value adding interventions. During the designing of the interventions adequate provisions needs to be created for addressing the weaknesses and threats for the growth of the product that is presented blow in the table

Strengths	**Weaknesses**
• Abundance of climatically suitable pockets for rainbow trout production in the hills. • Specific natural taste as it is produced in the natural glacier and spring water • Some of the feed ingredients are locally available. • Very good performance of private sectors in recent past. • OVOP has declared rainbow trout as one of its priority area. • Consumers preference leading to high market price • Good source of attraction to tourists • Employment generation at local level • Road access getting in better surveyed area. • Improved access of communication facilities. • Proactive farmers seeking information and doing insurances of ponds and fishes. • Farmers groups and cooperatives.	• Short supply of hatchlings/fry. • No quality assurance of feed being supplied by different stakeholders • Less knowledge on scientific management practices. • Lack of infrastructure including, feed mills, ice plant, road network and power supply. Underdeveloped marketing channel. • No brand promotion initiated yet. • It is labour intensive and there are slim chances of mechanization • Requires high investment in the initial phase. • Imported feed ingredients and chemicals are not easily available and also are costly. • Limited adoption of improved rearing practice due to low investments. • Unclear policy regarding the insurance of fishes. • High incidences of diseases and pests. • Poor feeder roads. • Weak forward and backward linkage. • Low of investment from public sector.

Opportunities	Threats
• Higher demand than production/ supply in the past. • Demand increasing every year • Local bodies as well as communities are very much enthusiastic. • Possibilities of spreading to other districts. • Private sector has initiated hatchery which will solve the problem of fry availability. • Good prospect of product diversification and export. • Potentiality to increase both area and productivity. • Scope for fish processing industry. • Government policies are supportive as it regards fish as a high value. • Scope of the value added products of the niche'. • Assured return on investment. • Creating jobs and employment opportunities.	• Establishment cost may increase substantially to start in new areas • Cold chain management might be difficult in present power generation system • Biodiversity damage may occur if proper attention is not given. • High risk of landslide and siltation as rainbow trout farming has been using hill slopes. Risk of arising water rights related issues. • Costly power supply for water and aeration management causing high cost. • Disease may pose serious threats to the production and is hard to control in disease favourable weather conditions. • Poisoning of fishes due to personal enmity in neighbourhood.

4.20 Scope for Further Development

Nepal has an area of 147,181 km2, which can be divided into three physiographic regions, from south to north: the Terai plain, the Mid-hills, and the High-hills, also referred as mountains. Hills make 77 percent of the area of Nepal, while the Terai occupies only 23 percent. The Himalayas in the north strongly influence the climate of Nepal. These geographical zones are endowed with many water resources.

Approximately 5% of the total area is in the forms of river, stream, lake, reservoir, pond and swamp. Among these, the rivers represent about 49 percent of the total water area. Cool and cold water streams and rivers in Nepal extending from the Himalayas offer excellent habitat to 76 native and a few exotic cold water species, including Rainbow trout (Swar, 2008). The native cold water fisheries resource offers vast scope for development of cold water aquaculture; however, at present this sector is used for subsistence and recreational fisheries only3. Cold water

native species for their aquaculture promotion is still in its infancy. It is only few indigenous species that have been domesticated and propagated for cultivation purposes. Major potentials and constraints in promotion of rainbow trout farming in Nepal are listed in the following paragraphs.

Potentials

Rainbow trout (Oncorynchus mykiss) is a high value exotic cold water fish. It prefers clean, cold and high oxygen water for its growth and survival (Gurung & Basnet 2003). On-farm testing of rainbow trout at individual farmers' own management conditions and its economic analysis indicates that trout farming is technically feasible and profitable in places where suitable agro ecological conditions prevail. Various studies carried out by Fisheries Research Centre (FRC), Trisuli and Fisheries Research Division (FRD) Godawari revealed that trout farming can be managed by farmers in raceway ponds (Gauchan et al. 2007). Followings are the factors that provide high potentials of increasing rainbow trout fish in Nepal.

Perennial rivers and natural spring water

There are several rivers originating from the Himalayas and flowing through the hills and the Terai. Water from those rivers is found suitable for rainbow trout and other species of fish depending on their locations. At present fisheries research center in Nuwakot is using water from Trisuli, one of the snow-fed river, successfully for growing fisheries. Natural spring water tapped from the forest in the hills is also found be the appropriate water for trout farming. There is no official estimate of the total areas suitable for rainbow trout farming. Interaction with the farmers and professionals working in the sub-sector estimate that about 15 high hills and 40 mid hills districts of Nepal are suitable for rainbow trout farming (Gauchan et.al. 2008) wherever dependable source of fresh cold running water is available. It is also estimated that the present area can be increased by almost 100 times or more, provided technical and policy support are assured.

Sloping land utilization

Sloping lands with poor fertility status, which otherwise could not be used for most of the agricultural crop farming, could be used for constructing race way ponds. Current farming on slopping land in mid and high hills shows good result

on productivity of trout. Similarly, narrow strips along the river sides are found suitable for rainbow trout cultivation, which otherwise would remain unused.

Good return to farmers

Rainbow trout farming and trade is found beneficial to farmers as well as traders, especially to restaurants. A study conducted by NARC in 2006 shows that annual operating cost of rainbow trout on 100 m2 land was NRs 304,079 while income from sales of the product was NRs 461,975 meaning a net profit of NRs 157,896. Further analysis shows that return on capital cost was 45.92 % and return on operating cost was 51.92% (Nepal and Thapa, 2010). There are no other crops that can yield such a high return from marginal land being used for rainbow trout farming.

High demand of rainbow trout fish

High demand and ever increasing prices of the product indicates that there is plenty of scope for scaling up production of rainbow trout. There is very high demand of rainbow trout from urban household and tourism sector. There are several restaurants opened along the rainbow trout producing areas and nearby tourist routes providing employment and income to rural populace, especially to women. This product being specific in nature, departmental stores in Kathmandu and Pokhara have also been supplying the product from their store. Similar is the case of big and small fresh houses. There are no cases reported by farmers about the produce that have not been sold so far. This can also be corroborated from the fact that the farm gate price of raw rainbow trout increased from 425 in 2005 to 750 in 2012, more than 75% rise in seven years.

Product diversification

Nepal receives large number of tourists from different parts of the world. They have different tastes and preferences of food. This provides ample opportunity of increased sale of local products including trout provided that our chefs are trained in preparing western, continental, Japanese and Chinese food in addition to South Asian types. Entrepreneurs that exported samples of dried rainbow trout to Singapore, Hongkong and Korea reported that they received very positive response. According to them this being specialty product there is very high demand from those markets.

Multiple use of water resource

Water after passing through raceway ponds located on sloping lands could be utilized for generating electricity, running Ghatta (local water mill) and irrigation. Farmers responded that micro level electricity generation at farmers' own initiatives is the best way to solve the problem of lower voltage and load shading. Ghatta is used to grind the feed for trout, together with grinding other grains as per requirement of locals. The drained water then can be utilized for irrigating crops. Labor efficiency is also reported to increase as the same person can manage the raceways and other agricultural activities simultaneously.

Constraints

Despite favorable environment for rainbow trout farming in the hills of Nepal and good economic incentive, this activity is not increasing as expected. Reasons of less than expected growth in rainbow trout farming were discussed with stakeholders during the field survey. Followings are the major constraints identified.

Finding appropriate site

Though there are several locations in the hills where running cold water is available, there are other essential conditions for successful farming of rainbow trout. They are: year round supply of clean cold water with high dissolved oxygen levels, easy accessibility, electricity, means of communication and feed source. These conditions often limit expansion of rainbow trout farming in Nepal.

High costs

Cost of construction of raceways and other infrastructures on sloping land is comparatively very high. Cost of machines for feed making and other management make production cost more expensive. Electricity supply system is concentrated near the urban centers and along major highways. Installing supply system up to farm sites on own initiative is expensive. Therefore, micro electricity generation on own initiative is one of the options, but it adds substantial cost to the producers.

Technical aspects

Trout growing needs a thorough technical knowledge. Most of the farmers are facing the technical difficulties. It is inferred that trout growing farmers not only

need great interest in farming but also equally be sensitive and serious in technical matters with risk bearing capacity as well. Trout growers of the study area feel the prevailing technical support are insufficient. In the absence of standard protocol for brood management, breeding practices and nursing and rearing management; quality of fry differs from one to another hatchery and also from one to other batch. High mortality of fry was also reported to be major problem by farmers.

Loan sanctioning and valuation of sloping land

Because of high initial costs and also long gestation period (about 12-14 months) required for rainbow trout to attain commercial size of 200-300 gms, substantial amount of money is required. There are two difficulties farmers are facing. They are: (1) valuation of their slopping land in the hills is very low for collateral that banks require and (2) most of the banking facilities are concentrated in and around urban areas.

Availability of fry (seed)

Fry fish is not available in adequate amount as demanded by farmers at present context. It was reported that almost all trout growers of the area had lower stock of fry than actual capacity of their pond due to unavailability of fry fish.

Availability and cost of feed materials

Feed materials and procedure of pellet making is costly at farmers' level. As feed quality is highly influential in growth of trout, farmers can not compromise with the quality of feed. Some of the farmers have been producing feed on their own, but they also suffer as costs of associated machines are very high to bear by a single farmer. High protein rich feed is required for trout among which dried shrimp is the main component. Availability of shrimp is sometimes difficult as farmers have to rely on traders from Kathmandu valley and other towns in the country.

Possible Areas of Intervention

Studies in the past have indicated that there is high scope of rainbow trout production and marketing in Nepal. However, the potentialities have not been harnessed due to several reasons including social, economic and development related constraints. Overcoming those obstacles to harness full potentials of this

subsector requires multi-dimensional approach. Some of the major possible areas of intervention are discussed as follows.

General

Identification of Potential areas

There is no authentic information on how much area of which pocket is suitable for rainbow trout farming. Many rainbow trout farms were established by farmers on their own judgment without scientific analysis of the sites. This approach is risky as there may arise several problems such as soil erosion, dispute on source of water, poor accessibility etc. This requires following standard norms and practices in selection of proper sites. GIS based assessment of pockets/area for rainbow trout farming conducted by GIS section, MoAD in Nuwakot and Rasuwa district (Rai et al. 2008 and Aryal et.al, 2008) has revealed very positive results. Similar assessment of potential areas in other pockets would be helpful in determining potentiality of rainbow trout farming.

Research and Development Facilities

At present NARC conducts research in its Nuwakot and Rasuwa centers. This is inadequate as every mico-climate has its specific properties and research done in present centers may not be applicable for other areas stretched through Dolakha to Syangja districts. Well equipped research centers are required to be established with major research thrust on identification of suitable conditions for different altitude, aspects and water types. Appropriate method for controlling diseases and pests is also urgently required. Besides, research should be geared towards the cost effective feed and hatchery performance.

Strengthening linkages

In order to expand the market a seasonal and long term contracts among hatcheries, fish producers, primary traders, large traders including fresh house and supermarket chains, retailers and hotels/restaurants is required. In other words, strengthening of value chain is essential for smooth flow of product and avoid any market glut or short supply. Lack of linkage among public sector stakeholders is also seen one of the major problem at present. The government should initiate in promoting coordination among DoA, NARC, Department of Roads (DoR), Nepal Electricity Authority (NEA), AEC and district line agencies.

Branding specialty commodity

Grading, branding and packaging of rainbow trout to specific buyers' requirements would open up existing and new markets for the product. Branding with unique name like trout from Himalaya, organic product etc. will be instrumental for market promotion, add value and secure premium prices in international market. High importance should be given to quality control for which coordination with Department of Food Technology and Quality Control (DFTQC) is essential.

Basic Infrastructure Development

Fish being highly perishable commodity basic infrastructures such as road, electricity and means of communication are important elements. There are several technically feasible sites that do not have those basic infrastructures. The public sector investment is required for infrastructure development. Considering social and environmental safeguards measures rainbow trout farming site should have appropriate drainage facility; hygienic practice in collection, storage (refrigerator, icebox), handling/processing/packaging (packaging materials) and transportation (vehicle operation); and facility of disposal of waste materials. Employment/skill enhancement is another sector where public sector can work together with NGOs and private sector.

Privileged Credit facility

Rainbow trout farming needs high investment from infrastructure development to annual operation. Financial institutions are reluctant to provide loan for two reasons: first, lack of sufficient collateral and second, location. Hill slopes in rural areas are not considered good and safe collateral and their valuation by financial institutions is low, resulting non-lending or lending very small amount. Special arrangements are required to finance them.

Market promotion

Though present production is being marketed without much hassle, the condition will change with increase in scale of production. Consumers need to make aware of the benefits of the products at domestic and international markets. Domestic market promotion can be shouldered by private sector including entrepreneurs, AEC and NGOs. The government should use its normal and diplomatic channels to introduce the specialty products in international markets.

Some Glimpses from the Dairy of Reporters Published in National Broadsheets

Fish of Many Colors

Kathmandu Post

ASH KUMAR RAI

Jun 1, 2014

Rainbow trout (Oncorynchus mykiss) are coldwater fish native to North America and tributaries of the Pacific Ocean in Asia in suitable waters at below 20 degree Celsius and pH 6-8. They are carnivores and feed on the larvae, pupae and adults of aquatic insects, fish eggs and adults of terrestrial insects that fall into the water and small fish, crayfish, shrimp and other crustaceans.

The cultural practice of breeding rainbow trout started in the late 19th century and commercial production has grown dramatically since the 1950s. Rainbow trout are now commercially farmed in many countries as they are rich in Omega-3 polyunsaturated fatty acids that decrease the risk of cardiovascular disease, hypertension, high blood cholesterol and certain types of cancer.

Trout in Nepal

Rainbow trout were first introduced to Nepal in 1969 from India. After this first batch failed, rainbow trout eggs were imported in 1988 from Japan. These were successful. After more than a decade of continuous efforts, a complete technology package for trout culture has now been developed.

Trout farming started in 1998/1999 in the private sector and now, 85 farmers produce about 180 metric tons annually. They are, however, mostly confined to the central and western regions. The private sector started producing fingerlings since 2005 and now produces about 1,100,000 fingerlings annually. Trout farming is yet to extend to the Eastern and the Mid- and Far-Western regions. However, initiatives have been taken since 2013 in the east in Diktel, Khotang by building technical support centers for the Eastern region.

A female trout spawns 2,000-3,000 eggs/kg and spawn once a year from December to March. Favorable water temperatures for breeding and incubation range from 9-14 degree Celsius. The newly hatched sac fries (alevin) take about two weeks to reach the swimming stage and are fed starter feed at two hour intervals till they grow to 5g sizes each. Frozen buffalo liver is often mixed with starter feed for healthy and better growth.

The trout reach a marketable size of 200-300g in 12-16 months with maximum growth from 16-18 degree Celsius. These fish need to progress through the grades of 2-5 g; 10-20 g; 50-60 g; and >100 g for uniform growth and to avoid cannibalism. Two to two and a half kilos of feed can produce one kilo of trout. Shrimp/prawn, soybean, wheat, oil cake, rice bran, vitamin mixture and minerals are the main feed ingredients.

An adequate supply of water below 20 degree Celsius throughout the year, sufficient space, preferably at a one to three percent slope, accessible road, electricity, safety and security are the main criteria for selecting a space for trout farming. Concrete raceways of various shapes and sizes with 0.9 m depth to maintain 0.70 m water level can be constructed in either parallel or linear fashion. Parallel ponds are suitable for sufficient water supply and linear ponds for limited water supply but contamination from one pond to other can occur in linear ones. However, the ponds also need a filter chamber to clean the used water before being sent to other raceways. Earthen ponds/plastic ponds can also be used to raise trout.

Trout in Ilam

There are around 6,000 rivers and streams in Nepal and most of them flow all year round with cold water originating in the Himalayas. So there is enough scope for a trout farming industry in the country, which could also become an important source of income in hilly areas.

Ilam, a district in the eastern hilly region is one such place which holds potential for trout farming. Many streams and rivers—Gitangkhola, Ratekhola, Kangekhola, Khare-khola, Ningwakhola, Phedikhola, Bhote-khola and Maikhola—flow in Barbote, Mabu, Puwamajhuwa and Maima-jhuwa in Illam. The water temperature and pH there is observed to be 9-11 and 7.2-7.6 degree Celsius, respectively. The perennial cold and clean water flow in Kange dobhan, Phedi and Khare dobhan areas hold great potential for rainbow trout farming. Futhermore, going by the available water sources, electricity and road linkages for marketing as well as people's interest, rainbow trout farming has great potential in Ilam district as an income source and moreover, to attract the young generation with job opportunities. The government, therefore, must encourage and provide guarantees for security and the marketing of the fish. It should also provide subsidies for trout farming material, including raw feed.

Rai is a former Chief of the Fisheries Research Division
Published: 01-06-2014

Fishy Business

Nepali Times

PRANAYA SJB RANA in NUWAKOT

Padam Rumba reaches into the water, where hundreds of fish swim in circles, and scoops one out. The fish gasps and struggles in his hand, but Padam maintain his hold on the slippery creature. The fish writhes, and its scales glint blue, gold and red in the bright sunlight. Padam puts the rainbow gently back into the water and the fish swims away with a wet flick of its tail.

Padam started his trout restaurant in Betini six years ago, and it has now grown to be the biggest and most popular in the area. Just 38km from Kathmandu near Kakani, the restaurant is drawing huge hordes of hungry picnickers from the capital.

Barely twenty years ago, were these scenic mountains of Nuwakot just a place you passed through on the ride to Trisuli. Today, it is bustling with restaurants that serve fish reared in quick-flowing local streams. Betini today rivals Malekhu, and in terms of taste outpaces it.

"Raising fish is just like any other job, you need hard work, dedication and a lot of patience," says Rumba who looks after the 17 pools that hold three tons of trout at any given time.

As a customer you can pick out a fish and Rumba's wife will cook it in any way you like. From crispy deep-fried to thick aromatic curry, the trout tastes heavenly. The meat is tender and soft and there are no bones to pick out. But like all good things, it comes at a price. A kilo of rainbow trout, raw, costs Rs 750. Add Rs 150 to that if you want it fried.

When Purna Bahadur Lama first started raising trout back in 1997, he had 400 fish and one pool. Lama used to work for the government fishery in Trisuli and there he saw Japanese rainbow trout for the first time. Supported by the Nepal Agriculture and Resource Centre, Lama raised Rs 60,000 and started his own farm and restaurant. The site in Nuwakot was perfect because of its cool temperature and abundant running water. Proximity to Kathmandu meant a never-ending

stream of customers willing to pay for the rare treat.

"When I told people I was raising fish they all laughed at me," recalls Lama. "They're not laughing anymore, they're eating my fish." In the past 11 years, Lama's business has grown exponentially.

Lama and Rumba's restaurants are small and homely, and surrounded by concrete pools full to the brim with rainbow trout. They are built along the contours of terraces and fed by streams. The higher pools hold the spawn while the lowest ones have the biggest trout, ready to be plucked out and thrown into the frying pan.

Trout restaurants have sprung up all along the roadway, and there are more than 20 fish farms in Nuwakot alone.

Japanese rainbow trout are notoriously finicky and difficult to rise. They require water temperatures between 3 and 20 degree Celsius with regulated oxygen levels. The pools need to be cleaned once a week and older fish need to be kept away from the young.

Most of the trout diseases come from poor feed, but Rumba has eliminated that by making his own and breeding his own fingerlings. Rumba has no qualms selling his feed and spawn to rivals, it just makes the fish pie bigger and everyone benefits.

Rumba sells at least 5kg of fish each day and on weekends, more than 20kg. He also supplies 40kg of trout each month to three hotels in Kathmandu.

FROM ISSUE #393 (28 MARCH 2008 - 03 APRIL 2008) |

Foreign Returnees Make Millions in Fishery

Republica

Manoj Adhikari

Pokhara, Dec 10: At a time when a majority of rural youths are moving overseas to earn a decent income, Lakshin and Amrit Gurung - brothers in law holding permanent residency of the UK and Japan, respectively -- are making millions in their own village by starting a fishery business nearby the lake city.

When the Gurung in-law brothers decided to return, they had little idea of what they would do, but eventually jumped into Rainbow Trout farming in a land owned by their in-laws in a place near Sardikhola of Pokhara.

Their efforts, which materialized in the form of Gandaki Rainbow Trout Farm, required them to invest Rs 8 million for purposes like acquisition of land, development of necessary infrastructure, buying a feed machine and hiring the workers. But just within a year, the investment is fetching them a return of Rs 15 million.

"This year also, we are targeting to sell 18 tons of fish in the very first harvest," said Lakshin, who returned to Nepal despite holding red passport of the UK. As the climate and temperature of the area perfectly suits the farm, we have better production than other areas, he told Republica.

Encouraged by the first year´s turnover, half of which was net profit, Gurung brothers have worked out fresh plans to expand the farm and produce more fish to increase their profits. "Given that Rainbow Trout is high on demand and priced pretty well, we are sure we will earn more profits next year," said Lakshin.

The efforts of Gurung brothers, meanwhile, has helped people in the region to realize that commercial farming would enable them to make more money than what they would in overseas jobs.

Lakshin, who had entered Kathmandu from his native village, Ghandruk, in 1996, initially undertook woolen yarn business and later worked as an importer of

garments, bringing in apparels from Hong Kong and Bangkok.

However, after the prospect of such business doomed, he move to Hong Kong under the status of dependent of his wife Bishnu Kumari, who had Hong Kong ID. After the UK government changed opened residency to the families serving the British government, he eventually landed in London.

Though his wife, having experience of working as a chef, easily adopted in the new setting, Lakshin, however, remained unemployed and could not enjoy there.

"The UK is definitely a developed and prosperous country. But I saw no opportunity except for menial jobs. That constantly compelled me to return to Nepal," he related.

During that period, his brother in law Amrit was settled in Tokyo with his family. He had a permanent residency and was pursuing meat and fish businesses. "I proposed him to return to Nepal and start a business of our own. Though he was reluctant, I compelled him to agree. We agreed to start meat and fish business," said Lakshin.

Thanks to their dedication to do something for themselves, Gurung in-laws have set up a good business and also created employment opportunities for seven persons. "We will soon hire six more people in a restaurant that we are opening shortly nearby the farm," said Lakshin.

The Gurung in-laws had started rearing fingerlings in April by preparing 31 race ways in a land located at Sardikhola-3, Mulkhel, Barahsthan. Now they are constantly harvesting and selling the popular variety of fish.

The farm that started by bringing 80,000 fingerlings from Trishuli has today become a model farm in the district. District Agricultural Development Office (DADO) and Regional Agricultural Directorate always refer the farm to concerned stakeholders with high regard.

"It is a model farm. I always take business people and other stakeholders to the farm to show them how fish farming should be done," said Beni Bahadur Basnet, chief of Kaski DADO. He disclosed he is also planning to organize a Rainbow

Trout Festival in the city.

Amrit, meanwhile, said that they were also thinking of breeding fingerlings at the farm in a bid to be self-dependent on all aspects of fish farming.

However, the Gurung in-laws expressed they will decide on the plan only after they get a clear picture of the market. "For now we are facing difficulty in fulfilling the demands we are getting," Amrit stated. The farm currently is receiving orders for hundreds of kilograms everyday from restaurants. Individual customers too are approaching the farm.

"We are selling at least 20 kg of fish to individuals from the farm itself," said Amrit.

Likewise, as the cost of fish feed is expensive in the market, Gurung inlaws have also bought a machine to produce the feed themselves investing Rs 1 million. "We must feed 3 kg of pellet feed to a fish to enable it gain a weight of 1 kg. Given such huge requirement of feed, we thought it is better to produce it ourselves than rely on expensive supply, which costs Rs 200 per kg," said they.

Normally, trout is ready for harvest within a year. But because of suitable climatic conditions, the farm has been able to harvest it in 7-8 months.

Because of high nutritional value, trout is expensive the world over. In Nepal too, retailers in different cities are selling it at more than Rs 1,000 per kg. However, Gurung in-laws are presently selling them at Rs 800 per kg.

"Trout is expensive in the market because it is imported from India. This has rendered it unaffordable for general consumers. We want to change this situation. Every Nepalis should be able to afford it," said Amrit.

If the farm managed to produce as much trout as they have planned, he said they will further lower the price.

December 13, 2011, Republica.

Rainbow Trout Farming in Kaligandaki River

Republica

Rudra Pangeni

JOMSOM, Dec 5: Five people here in Ghasa VDC have ventured into commercial rainbow trout farming by utilizing perennial freshwater of the Kaligandaki river basin.

Nabin Bhattachan, a local hotelier, in partnership with four other investors, has leased six ropanis of land to construct raceway for fishes. The group has already invested Rs 2.9 million for the construction of infrastructure.

Bhattachan said they would invest an additional Rs 5 million for purchasing fingerlings and financing operational cost for 14 months, the time required for the fingerlings to mature.

Talking to Republica, Bhatachan said his group came up with the idea after High Mountain Agribusiness & Livelihood Improvement Project (HIMALI) Project called for new agri-business idea about a year ago. Bhattachan leads the group of four-- Bishal Sherchan, Rajan Gauchan, Punit Gauchan and Bikram Gauchan -- but all of them have equal investment in the project.

HIMALI has decided to provide a grant of about Rs 5.03 million for the project. The project funded by Asian Development Bank supports agribusiness in the high hills and mountains to improve the livelihood of the locals.

"We will bring some 74,750 fingerlings of rainbow trout from Shardi Khola of Kaski and release them in the raceway by the second week of January next year," Bhattachan said. "After 14 months we expect to sell about 7,480 kg of trout at Rs 1,000 per kg," added Bhattachan. Bhattachan said that the hotels in the area are frequented by foreign as well as domestic tourists. Fish is a good source of protein and is easy to eat as it lacks intra muscular bones. "Moreover, trout traders in Kaski have assured that they would purchase our fish," added Bhattachan.

President of Mustang Chamber of Commerce and Industry Khagendra Tulachan,

also a hotel entrepreneur, said there are 140 hotels in Jomsom, Ghasa, Lete, Muktinath and Kagbeni. "The trout produced in the farm would be supplied to these hotels. We bring trout from Pokhara but we are not able to fulfill the demand," added Tulachan.

Kenneth E. Neils, fish culture expert of HIMALI project, said that similar rainbow trout farming is already in operation in Solukhumbu. "The rainbow trout farm will fulfill the demand for trout in the area," Claimed Neils. The village lies at an altitude of 2070 meters.

Amar Bahadur Shah, chief of HIMALI, said the project provided financial support to Bhattachan to introduce the concept of agri-business in the area. Bhattachan also said half a dozen local youths will be employed in their farm. Two of them are to head to Kathmandu for two-month training. Over 100,000 tourists visit Jomsom and Kagbeni, Kagbeni and upper Mustang annually.

Rainbow trout was first introduced in Nepal some five decades ago from United Kingdom, Japan and India.

Published on 2013-12-05

Rainbow Trout: New Taste in Towns from Hills

Setopati

Ramesh Lamsal, kathmandu

Nepal is quite appropriate for fisheries of rainbow trout fish as we have plenty of cold water and slopes.

Although farmers have been attracted to it in recent times, it has not been moved ahead for lack of government investment and awareness among farmers.

The Ministry of Agriculture Development had recently undertaken feasibility study of rainbow trout fish keeping in 54 districts of the country and had thought of forwarding it as a 'one village one product' scheme.

Nepal Agriculture Research Council (NARC) had forwarded a program to run 'mission rainbow trout' campaign but it has not reached to the farmers as expected.

Recently, it has been started in Sindhupalchok, Kavrepalanchok, Dolakha, Solukhumbu, Kathmandu, Lalitpur, Baglung, Rasuwa, Dhading, Makwanpur, Gorkha, Kaski, Manang, and Mustang districts commercially.

As it gives enough income and is easy to keep, farmers are attracted, but there is no necessary grant and guidelines from the government, complain fish keepers.

Undertaking rainbow trout fisheries for long in Okharpauwa of Nuwakot, a farmer Padam Bahadur Lama says no government cooperation has been received even if it gives good income.

The government's 'mission rainbow trout' in Nuwakot has not received necessary cooperation.

Trout Association of Nepal Vice Chairman Mahendra Ghorasaini said 300 tonnes of fish was produced in 2069-070 BS in the country, but in the current FY, only five tonnes is expected.

If government increases grant and utilizes waste lands, we can produce more than 30,000 tonnes of fish, said Ghorasaini.

It can be produced in most of the Himalayan and hilly districts as it is kept only in cold water. If produced properly, it can be exported to Gulf countries, South East Asia and Mid-East. Fish from cold is healthier than in warm water, and trout is effective for heart patients as well.

Farmers themselves have produced 1,900,000 fingerlings. Rainbow Trout Association says fingerlings were produced commercially in Nuwakot and Kaski districts.

If government provides technical and economic cooperation, we can produce more than 10 million fingerlings annually, says Ghorasaini.

When fish catch diseases, foreign medicines do not work and they have been using only livestock medicines, said fisheries expert of Fish Research Division, Trishuli, Rajman Mulmi.

NARC Director Tek Bahadur Gurung says we can make the country self-reliant in five years in rainbow trout if government provides financial help. Trout is now sold for Rs.800 to Rs.850, whereas it was sold at Rs.1,300 per kg three years ago.

It was started from Kakani of Nuwakot and Rs.four billion has been invested so far. General Secretary of the Association Jayaram Aryal says one farmer can earn Rs.300,000 to Rs. one million from it annually.

It is now consumed mainly in large hotels and restaurants of Kathmandu and Pokhara. Started in 1989 in Trishuli with Japan's gift of 50,000 fingerlings to Nepal, its first test production in private sector was by Sadhuram Basnet, Purna Bahadur Lama and others in Sisneri of Nuwakot in 1998.

Published on: Monday, March 31, 2014

5. Conclusion and Recommendations

5.1 Conclusion

To make the expansion of commercial rainbow trout aquaculture in the mid- and high-hills of Nepal, there needs to be a significant input of funds, and they must address all issues plaguing the potential. Funding may come in the way of government grants and subsidies for potential trout farmers, workshops and demonstrations for hands-on training, and industry-dependant infrastructure (transport roads, proper feed and harvest fish storage, etc.), or from private investors looking to pledge money toward a development project, to assist in the same improvements. Though rainbow trout aquaculture requires higher capital and operational costs than most species currently cultured in Nepal, the high market price and high demand can certainly make investment a worthwhile enterprise. It is at the recommendation of the author to seriously and carefully consider expanding the industry. Collaboration between researchers, both domestic and international, farmers, government and investors should continue so that the industry remains moving forward, and in such a way that production, efficiency and success is maximized. It is believed that Nepal can become a valued, respected, coveted contributor to the local and global markets of rainbow trout.

5.2 Recommendations:

Based on the assessment and analysis of the findings especially the constraints faced by the actors of the rainbow trout fish production and marketing following major recommendation have been made.

Hatchling & Fry Production

Improvement in productivity and cost reduction should be the major intervention in the value chain. Attention should be paid in improving the access to good quality appropriate quantity and quality of hatchling and fry production combined with good price along with integrated disease and pest management, production infrastructure, storage, handling, packaging, transportation and etc. Some of the major innervations recommended for improvement of production system have been stated below.

Support Farmers in Hatchling & Fry Production

Availability of quality hatchling and fry combined with quantity as per the demand at reasonable price is the most pre-requisite in fish production. The DADO programs and projects should support the resource mobilization in establishing improved production and flow. Such system should address various aspects of hatchling and fry production with particular emphasis on:

- Improve the quality through the adoption of negative and positive selection.
- Establishment of production pocket areas in Mid hill areas for high quality rainbow trout production.
- Training and mobilization of hatcheries groups for the higher hatchling and fry production.
- Adoption of quality control mechanism.
- Raising awareness amongst farmers on need for quality and fish species through field demonstration, workshops, campaigns, farmers' field days and observation tours.
- Provide trainings for adoption of new technologies and practices for quality maintenance and to raise the quantity of production system.
- Replacement of old de-generated technologies and spreading of the new fresh water trout species that are profitable in nature that adopts with the prevailing production system.

Assist Farmers in the Selection and Adoption of Appropriate Species

Access to appropriate species is the key to boost the production and productivity and thus should facilitate the producers in identification and adoption of other species of fresh water trout to fully harness the market opportunities.

- Study for the prominent fish species currently adopted by farmers in other countries.
- Identify a pool of recommended trout species that are compatible with the market demand and requirements.
- Support farmers in the field testing and verification through farmer-led experimentation.
- Assist farmers in the diffusion of verified technologies and species through farmers' to farmers' technology diffusion practices.

The selection of the species should be done as per the market requirements of nation as well as of other export potential countries. Generally, trout are supplied from the Mid hills, and the concentration should be done towards production timings as per the requirement of the domestic as well as the international markets.

Innovative tools like Participatory Species Selection (PSS) are recommended to enhance the adoption rate of the varieties and improvement of seed.

Promote Integrated Disease and Pest Management Practices

The incidence of disease and pest seems to be quite severe causing high losses. The losses are also due to deterioration of quality of management practices. The program in the collaboration with the Fish Development Directorate and Fish Research should Division support farmers in adopting integrated management practices. The problems that need immediate attention are:

- Bacterial Diseases like Columnaris, Tail & Fin Rot and Gill Diseases.
- Fungal Diseases like Water Mold & Haptoma Diseases.
- Protozoan Diseases like Trichodianiasis

The disease and pest management practice should also include the adoption of seeds resistant to prevailing diseases n the production areas. Priority should also receive the replacement of susceptible seed lot by higher generation seed.

Reduce Cost of Production

Program should assist fish growers in reducing their cost of production and achieve competitive and comparative advantage over the import substitution.

As discussed earlier the hatchling and fry management has the biggest impact on the cost followed by nutrient and disease management. Reduction in the cost of production can be achieved through:

- Adoption of appropriate seeds suitable to location specific conditions
- Use of quality hatchlings and fries with appropriate sizes.
- Adoption of improved production management practices.
- Mechanization of production operation like use of excavators for pond making, dike maintenance, inlet and outlet management for water if possible.

- Development of rural infrastructure including farm to market link roads, collection points, temporary sheds for short term storage, grading and packaging etc.

Production Programs

Production programs should assist the farmers in competitive production with lower investments with technology transfer through District Agriculture Development Offices and Service Centers. The extension approach should be focused to all strata of farmers despite of the economic condition and approaches. The production can be raised by continuation of the following programs that is being conducted till now with more innovative and proactive thrusts.

- Programs like subsidy in tools and implements should be continued.
- Insurance programs on fish should be promoted with incentives should be continued.
- Water quality maintenance set should be on indivisiual farmer's basis.
- Subsidy on pump sets should be provided.
- Maintenance the ponds and dike should be promoted.
- Segregation canal improvement programs should be introduced.
- Promotion of programs like Exit canal of water in case of flood should endorsed.
- Training on commercial intensive rainbow trout farming, hatchling and fry production should be introduced to the farmers having investment potentials.
- Programs like Fish disease laboratory from Fish Training Centers should be continued.
- Programs like surveillance reporting should be continued for disease and pests incidences

Marketing

The programs should work with the value chain actors in improving the efficiency of marketing. The capacity of the market functionaries at the current situation is not enough to cope with the increased supply from the Nepalese producers like if the production is doubled by any means, the supply market functionaries will not be in a position to absorb the increased supply especially at the current level of handling capacity of the market stakeholders.

This is related to investment capacity of market stakeholders, market infrastructures like short term cold storage, cold storage, collection, grading, packing and transportation. At present some of the market function is being carried out by the local stakeholders and the export potential is not possible only by eliminating the bottlenecks in production part, but it will also require to address the constraints in marketing part of the chain. Following major activities are recommended to remove those constraints:

Ensure Efficient Collection and Delivery System

The program should work with the producers to manage supply based on demand situation. The farmers should be facilitated in the preparation Production Plan as per the market demand. In the commercial production areas the producers will require facilities for the post harvest operations like curing, grading and packaging. Improved short term storage facilities are required in the collection points and wholesale markets. The current capacity of cold storage is very nominal and cannot support any increase in supply and this bottleneck has to be removed.

The cost of cold storage is very high as compared to India and supportive programs should identify the ways to reduce the cost like lobbying for lower the electricity cost by government or seeking subsidy. The capacity of collectors and traders should be enhanced in post harvest management practices. The approaches to facilitate for increased private sector investments in developing marketing infrastructures are needed.

Promote Institutional Development and Improve Marketing Chain

The majority of the production units are very small with poor investment capacity and the marketable volume of these units is also small. Such production units should be very susceptible to production and marketing problems and institutional development is necessary to provide such units for increasing efficiency. The different chain actors or market inter-mediators possess different strength, expertise and comparative advantage over others for specific market function and the promoted institutional development must consider this fact. Marketing cooperatives should play a greater role in helping the farmers receive a greater portion of the benefits by increasing the efficiency of the cooperative marketing. Following improvement measures are recommended:

- Greater involvement and integration of hatchlings and fingerlings producers and fish producers in value chain operation:
- Promotion of marketing operations.
- Adoption of quality control mechanism in seed and feed.
- To analyse the strength, weakness, expertise and comparative advantage of the market functionaries.
- Strengthen the chain workshops can be organized with the active participation of the concerned functionaries.

Research & Development Sector

To ensure reduced cost of production and greater profits, research agencies like NARC should carry out innovative and adoptive researches. The outcomes and the findings of the researches should be disseminated to the potential farmers who are engaged in the production sector to increase their gross margin. Similarly, the new investor farmers can also be lured to make investments by luring through assured margin and profit. The following measures are recommended to the research organizations:

- Expand trout farming in feasible areas and explore market for trout in country and abroad, establish trout hatcheries in private sector
- Public-private partnership (farmers' cooperatives, I/NGOs) approach to promote research and development along with commercialization of trout
- Develop curriculum for farmer training, develop human resources, infrastructure, facilities required for the rapid expansion of trout.
- Develop/strengthen feedback mechanism and communication system for all stakeholders in newly adopted technologies.
- Research on year round supply of trout seed, quality feed based on local ingredients, fish health management, reproductive performance.
- Feasibility study in different development regions from commercial and livelihood perspective, participatory trout farming research in new locations.
- Technology on low-cost pond/raceway construction.
- Establishment and study on different strains of rainbow trout, maintenance of genetic variation, genetic purity.
- Study on socioeconomic and environmental impact with trout establishment in reservoirs.

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