



Current Status of Rainbow Trout Culture in Sikkim: A Sustainable Farming System in the Hills

Kul Bahadur Chettri

Department of Economics, Nar Bahadur Bhandari Government College, Tadong

ARTICLE INFO

Article history:

Received: 18 November, 2020

Revision Received: 4 December, 2020

Accepted : 5th January 2020

Key words: Trout farming, Trout infrastructure,
Trout production, Sikkim.

ABSTRACT

Sikkim has various water resources in the form of rivers, lakes, streams and perennial springs which support development for both capture and culture inland fisheries. Rainbow trout is one of the major species that are cultured at high altitudinal zones. Trout fishery has been expanded for the promotion of sustainable fish culture as a suitable income-generating activity in the rural areas, augmenting nutritious food production, generating a supplementary source of income to fish farmers and fishermen, promoting fishery for tourism and conservation of riverine fish germplasm etc. In this paper, some basic requirements for trout farming, trout infrastructure, trout production and Sikkim's status at the national level have been discussed. West district has the largest number of trout raceways followed by East, South and North districts. Over the periods, trout production in the state has been slowly increasing from 10 tonnes to 50 tonnes, 90 tonnes, 110 tonnes and 120 tonnes during the year 2011-12, 2012-13, 2013-14 and 2015-16 respectively. Sikkim stood 3rd position in trout production in India contributing 14% to total production during 2015-16. On average farmers are earning profit of more than ₹2.7 lakhs from one raceway of 51m³ water area. Hence, this farming system is being promoted among the rural people living in the upland areas of the state as per feasibility. The major problems faced by the trout farmers are non-availability of fish feeds and seeds on time and high cost of feeds. Therefore, it is suggested to the concerned authority to solve the problems at the earliest so that production could rise rapidly.

1. Introduction

Sikkim is a landlocked state situated in the laps of the Eastern Himalayan Region. The total geographical area of Sikkim is 7,29,900 hectares out of which 74,343 hectares (10.20%) is cultivable whereas the remaining land areas are forest, cultivable waste and barren and uncultivable land. Sikkim is blessed with beautiful natural resources and rich in biodiversity hotspots. Mixed farming is practiced in Sikkim where agriculture and allied activities go in hand to hand for

supplementing and complementing each other for income generation and livelihood of the farming communities. Among the major allied activities undertaken by Sikkimese farmers are cattle, buffaloes, sheep, goats, pigs, poultry, yak rearing and fish farming etc. Because of the limited landholding in Sikkim, livestock and fisheries have emerged as the sole solution to provide sustainable economic upliftment of the rural masses (Animal Husbandry, Livestock, fisheries and Veterinary Services (AHLFVs) 2018).

Correspondence author: kulchettri33@gmail.com

Nature has endowed Sikkim with an abundance of coldwater resources and varied aquatic life. The state has various water resources in the form of rivers, lakes, streams and perennial springs which provides immense scope for the development of inland fisheries. It has potential in the fishery sector both for capture and culture fisheries due to the abundance of coldwater resources. Trout farming has become an important source of livelihood for the rural people in the upland areas due to the hilly terrain, agriculture and other allied activities are not sufficient for the development of the rural economy (Chettri and Kundu 2020). Initially, the development programme of trout fishery in the state was mainly on conservation of aquatic life and encouraged sport fisheries. But now trout fishery has been expanded for the promotion of sustainable fish culture as a suitable income-generating activity in the rural areas, augmenting nutritious food production, generating a supplementary source of income to fish farmers and fishermen, promoting fishery for tourism and conservation of riverine fish germplasm. The fisheries activity is linked with tourism and the educated unemployed youth are motivated towards fish culture practices which help them to uplift the economic condition of the people in the rural area. It has become an important enterprise for livelihood security to the rural people of Sikkim (AHLFVs 2011).

Rainbow Trout (*Oncorhynchus mykiss*) is a species of salmonid native to coldwater tributaries of Pacific Ocean in Asia and North America (Sultan 2016, Singh *et al.*, 2017). It is preferred in diet over other fishes not only for its higher protein content and better taste but also for its health benefits. Trout fish contain higher quantity of omega 3 fatty acids, consumption of which is linked to decreased risk of cardiovascular disease, hypertension and high blood cholesterol. Omega 3 fatty acid consumption may also prevent neurological disorders like dementia, depression, bipolar disorders and Alzheimer's disease.

Trout farming is an ideal option for sustainable use of water resources in mountainous regions because here both surface and underground waters are suitable for this purpose. In regions where income-generating and employment opportunities are scarce, trout farming could help to ensure employment and steady incomes. In addition to the production, trout farming could also ensure increased income and employment through angling tourism restaurants and related services (Woynarovich *et al.* 2011; Singh 2015). Rainbow trout was introduced in Sikkim very recently for

culture purpose. Farming rainbow trout is a profitable alternative to conventional agriculture that can be practiced with very limited land. Realising the benefits of this farming system the Directorate of Fisheries, Government of Sikkim has been promoting trout farming among the rural masses as an income generating activity. The directorate has been providing financial as well as technical assistance for trout farming under the scheme named "Trout culture in raceways". Each year certain numbers of farmers are given financial assistance under the scheme for starting up trout farming in their private landholding. These fish farmers are also given training on trout culture technology. Apart from that the Directorate is regularly organising awareness campaign and training programme to make farmers aware about the benefits of adopting modern culture technology (Sharma *et al.*, 2018).

2. Brief History of Trout Fishery in Sikkim

The establishment of fisheries in the state came into existence in 1974 as a wing in the Forest Department was a great milestone and it was the primary driving force for realising the high potential of fisheries development mainly on conservation of riverine fish species and development of sport fishing. While, the fisheries activities in a real sense started later than 1979 under the direction of Mr. S.B. Raizada, Mr. K.P. Bhutia, Mr. P.W. Bhutia, Mr. D.K. Pradhan and many others. From 1976 to 1992, a lot of major developments have been taken in the Directorate of Fisheries (DOF) for the promotion of trout fisheries in Sikkim.

During 1976-80, trout farm and hatchery at Memencho and trout rearing unit at Yumthang have been constructed. The development that took place during 1980-85 includes the construction of trout rearing unit at Uttarey and trout farm at Yuksum. At the same pace of development, the trout rearing unit at Lachung was constructed in 1985-90. Then from 1991-92, a major initiative took by the DOF with the formation of the Fish Farmers Development Agency (FFDA). After the formation of FFDA, the concept of fish farming in the state started quickly. Under this activity, a major initiative has been taken by the DOF to boost the culture of fish farming by identifying the physicochemical and environmental suitability conditions and potential fish farmers, providing them financial assistance for the construction of ponds, providing them seed and technical know-how along with giving them the training and skills in the science and art of fish farming.

Since 1995, the new direction has been taken place in the approaches to fisheries development and the conventional programme was revised with the following directive.

- Enhancement of fish production and productivity from the available water resources.
- Protection and conservation of riverine fisheries resources in the mid and high altitudes.
- The breeding programme of mahseer, carp and trout fish for stocking in ponds rivers, lakes raceways and reservoirs in different altitudinal zones.
- Promotion of game fishing for sustainable ecotourism.
- Encouragement of commercial trout farming in high and low altitude zones.
- Development of aquaculture with the help of technical and financial assistance to the farmers and unemployed youths in rural areas through various government schemes.

In the early time, the trout fish culture was not popular in the private farm although the farmers are culturing other fish species in the marginal amount. The DOF used to produce trout seeds mainly of brown trout for ranching in Memencho, Bethang Tsho, Rongchhu 1, Tshongmu lake, Rore chhu etc. for the breeding of brown trout and production of fry. During the 1980s and 1990s, the activities carried out by the DOF were to collect brooder from Memencho lake to breed brown trout at Memencho trout hatchery and to produce fry. For further rearing to fingerlings and ranching in high altitude lakes and springs, fry produced from Memencho lake were carried to different trout farms of Uttarey, Yoksum, Lachung, Lachen etc. During the early 1980s, they started to bring rainbow trout seed in the form of eyed-ova from Himachal Pradesh; and these were then transported to hatcheries of Uttarey, Yoksum, Lachung and Lachen for final hatching, larval rearing to fry and fingerlingsize. During that time, the seeds were not used to distribute to the farmers for growing in their private lands, instead of giving to them, seeds were taken for ranching in high altitudinal lakes and streams and the rest were used to rise in government farms for breeding in subsequent years. The activity of breeding seeds and fry production is still practiced by the DOF for the aforesaid purposes and to distribute seeds to the local private growers at a very minimal rate (Sharma *et al.*, 2018).

1. *Basics of Trout Farming*

a) *Site Selection and Construction of Raceways*

The two basic considerations which are very essential for site selection are (a) sufficient supply of clean water and (b) water temperature should remain below 20°C. site should be reasonably accessible. Construction of raceways with proper design is one of the most important factors for the success of trout farming. Totally cemented minimum size of 17m x 2m x 1.5m should be constructed for trout farming.

b) *Water flow and Stocking Density*

The amount of water required for a raceway depends upon the quantity of fish being reared. A typical raceway should have available water supply of 300 litres per minute. It would be sufficient to rear one tonne of fish. If the water temperature is below 15°C the flow could be reduced to 180 litres/minute per tonne of fish. A standard raceway of 51m³ water volume could be stocked with 2000 number of trout fingerlings subject to availability of sufficient water.

c) *Feed and Feeding*

Farmed Rainbow trout are fed with formulated floating feed with variable protein concentration. Trout fry and fingerlings require a high protein and energy contain in their diets than a larger fish. The crude protein level ranging between 40-50% in the feed for grow out fish is suitable. Higher quantity of protein from animal origin should be used. The fat content in trout feed should be around 10%. The feeding practice consists of broadcasting the feed from the edge of the pond. Since trout is a sight feeder it quickly takes the feed flatting on the surface. Fish should be feed at the rate of 2-4% body weight per day in a grow out raceways. The feeding may be done two to three times in a day after sunrise and before sunset.

d) *Common Diseases and its Remedies*

The appearance of any disease in a stocked fish is usually shown by changes in behaviour and or body function. The most common diseases occurring in farmed trout in Sikkim are fungal and bacterial diseases. The most common fungal disease is Saprolegniasis. It is caused by the Saprolegnia species "water molds". It is often first noticed by observing fluffy tufts of cotton like materials coloured white to shades of grey and brown on skin, fins and gills of fish or on fish eggs. Poor water quality (for example water with low circulation, low dissolved oxygen, or high ammonia) and

¹ In Sikkim, water is commonly called as chhu or Tsho. Tsho or Chhu means water in Bhutia Language.

high organic loads are often associated with Saprolegnia infections. Common treatment includes bath treatment in KMnO₄ (1g in 100 litres of water for 30-90 minutes), Malachite Green (1: 15,000 solution of malachite green used as a 10 to 60 seconds dip for two or three treatments), salt bath (3% solution).

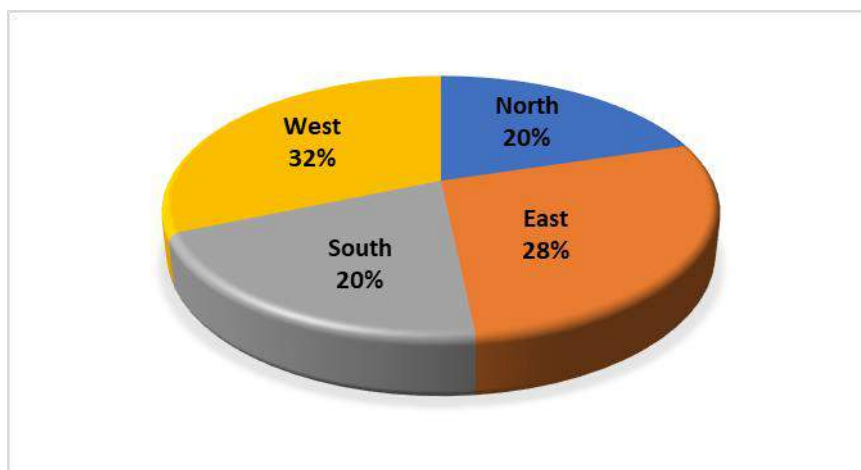
Common diseases are best prevented by good management practices such as good water quality and circulation, avoidance of crowding to minimise injury and good nutrition and regular cleaning the raceways with 3% salt solution or KMnO₄ or Malachite Green

e) Trout Infrastructure and Trout Production in Sikkim

Earlier, in Sikkim, trout fishery was confined to production

and stocking of brown trout fish seed in the coldwater streams and lakes for promoting angling and later it was extended to rainbow trout farming as an economic activity in the private sector due to the growing population and demand of trout fish in the state. Farming rainbow trout is a profitable alternative to conventional agriculture that can be practiced within very limited land. Due to its taste and medicinal value, trout is highly preferred over other locally available fishes; hence, the total demand for trout is very high. Realising the benefits of this farming system, the government is promoting trout farming among the rural masses as an income-generating activity. The government is providing financial as well as technical assistance for trout farming under the scheme named “Trout Culture in Raceways.”

Figure 1: District wise Percentage of Rainbow Trout Raceways in Sikkim as on 2016-17



Source: Directorate of Fisheries, Government of Sikkim.

As of 2016-17, there is a total of 349 units of raceways had been constructed, the highest being in the West district 32% followed by East district (28%), North district (20%) and South district (20%) respectively. Figure 1 illustrates the number of trout raceways constructed during 2009-10 to 2016-17 in all four districts of Sikkim. In the beginning, i.e., 2009-10, the larger number of raceways had been built in the West district and lowest in the South districts with a total of fifty-three raceways all over the state. In the subsequent year, the total unit rose to one hundred and six. But unfortunately, during the three annual periods, i.e., 2011-12, 2012-13 and 2013-14, very fewer units were able to construct because the state had got very less financial support from the central schemes and between the years 2014-15 to 2015-16, the DOF was unable to provide financial support to the farmers; as a result, not a single unit had been constructed because DOF

had not been granted any funds from the centrally sponsored schemes. Again, in the year 2016-17, the number of raceways increased by one hundred and more with the initiation of the Blue Revolution Mission in the country.

There is total eight trout farm along with the hatcheries had been set up in Sikkim for brown and rainbow trout seed production. Two trout farms were located in the West district, four in the North district and two in the East district. Although, there are trout growers in some places of South district but not a single government trout farm had been located so far because there are fewer suitability areas in the district. The west district has the largest number of rearing tanks than the others. The district wise trout farm is discussed as follows:

Table 1: Government Trout Farm in Sikkim

Name of the Trout Farm	District	Hatchery Capacity (lakhs)	Rearing Tank (No.)	Area (ha)	Annual Seed Production (lakhs)
Men-Moi-Tso Farm (Brown Trout)	East	5	4	1	5
Kyongnosla trout Farm	East	2	4	-	-
Yuksom Trout Farm	West	2	24	0.50	0.50
Uttarey Trout Farm	West	2	8	0.10	0.50
Sharchok Trout Farm	North	1	4	0.70	0.50
Lachen Trout Farm	North	0.50	4	0.50	0.50
Rabum Trout Farm	North	3	-	-	-
Denga Trout Farm	North	5	-	-	-

Source: Directorate of Fisheries, Government of Sikkim.

East Sikkim

Mememcho trout farm is located in the East district and it is the oldest trout farm of the state constructed in 1975. The farm has four raceways of standard size which are being used for rainbow trout fry rearing. Hatchery unit with a capacity of 5 lakhs green ova is used for breeding and seed rearing of brown trout for which brooders are being collected from Mememcho lake. The area of this farm is about 1 ha with a capacity of 5 lakhs seed production. Brown trout seeds are used for ranching in suitable high altitudinal lakes and rivers. The feeding river is Mememcho which feeds the Mememcho lake as well. Kyongnosla trout farm was constructed in 2013 with a hatchery unit of 2 lakhs green ova. This farm has two units of fry rearing fibre tanks and seven feeding trays. Currently, water line to feed this farm has been damaged and the farm is under renovation and development. However, this farm is the nearest to the capital city.

West Sikkim

Uttarey trout farm was constructed in the 1980s, later it was renovated in 2012. It has an area of about 0.10 ha with 8 numbers of rearing tanks. The seed production capacity of the farm is 0.50 lakhs. The farm has a hatchery unit of 2 lakh green ova. It also has 4 fry rearing units with a capacity of 1 lakh fry in each tank and four brooder rearing units with a capacity of rearing 200 kg brooders. This is the most active farm in the state and it is catering to all seeds required by the farmers of the west district.

The farm receives water from the nearest stream which is perennial. Uttarey river flows through its vicinity towards its downhill, within a distance of approximately 100 m. Yoksum trout farm was constructed in 1984. This farm has a hatchery capacity of 2 lakhs, 24 rearing tanks with an area of 0.50 ha. The seeds production of this farm comes around 0.50 lakh annually.

North Sikkim

Sharchok trout farm is located in Lachung and it was built in 1990 and its hatchery was constructed in 2012. The hatchery unit has a capacity incubating 1 lakhs green ova. It has 4 rearing tanks of area 0.70 ha. The annual seed production capacity of this farm is about 0.50 lakhs. Lachen trout farm is located in Lachen with the hatchery capacity of 0.50 lakh green ova. This farm also has 4 functional tanks with an area of 0.50 ha. The annual seed production capacity is 0.50 lakhs. Rabum trout farm was constructed in 2014. The farm has the hatchery unit with a capacity of 3 lakh green ova. It also has multiple numbers of standard raceways for brooder rearing with a capacity of 400 kg brooders.

Denga trout farm and its hatchery were constructed recently. Its hatchery unit has a capacity incubating of 5 lakh green ova. All these trout farms were established for seed production and demonstration purposes. The fingerlings are distributed free of cost in the initial periods and at a very minimal rate in the subsequent periods to the fish farmers to encourage them for aquaculture.

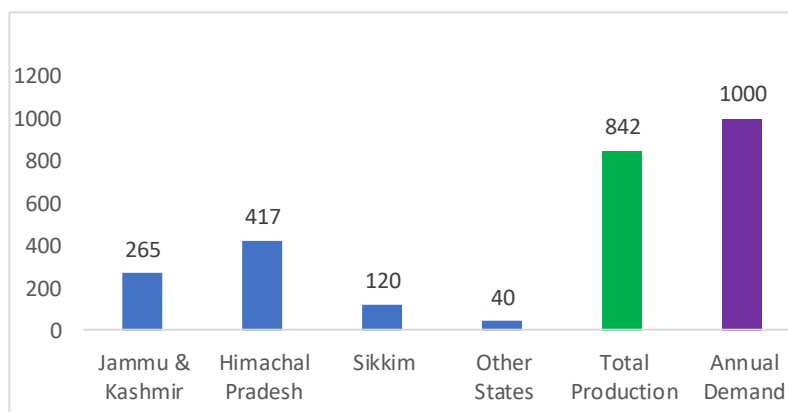
Himachal Pradesh, Jammu & Kashmir and Sikkim are the leading states where trout farming is undertaken in both private and public sectors. During 2015-16, Himachal Pradesh was the largest trout producer in the country which stood at 417.23 tonnes followed by Jammu and Kashmir (265 tonnes), Sikkim (120 tonnes) and Uttarakhand and Arunachal Pradesh (40 tonnes). The north-western Himalayan region (Jammu & Kashmir and Himachal Pradesh) remained the centre of trout production in India. These two states contribute the bulk of India's trout production of about 81% (50% from Himachal Pradesh and 31% from Jammu and Kashmir), Sikkim contribute 14% and other states contribute 5 % of total production in India (see Figure 4).

This is because trout farming in India was started initially in the states of Jammu & Kashmir and Himachal Pradesh having larger water resources as well as larger trout growers. Jammu and Kashmir and Himachal Pradesh are the hubs of coldwater fishery resources and fish species. Sikkim, another Himalayan state of India situated in the northeastern region is also performing well in trout farming and occupies the third position leaving behind Uttarakhand and Arunachal Pradesh. The total trout production in the country stood at 842 tonnes and the demand is around 1000 tonnes in 2015-16. In the present situation, the demand exceeds the supply, therefore, we can infer that there is a scope of trout farming in India.

Under the beneficiaries' scheme 'Trout Culture in Raceways', so far 249 beneficiaries have been given financial

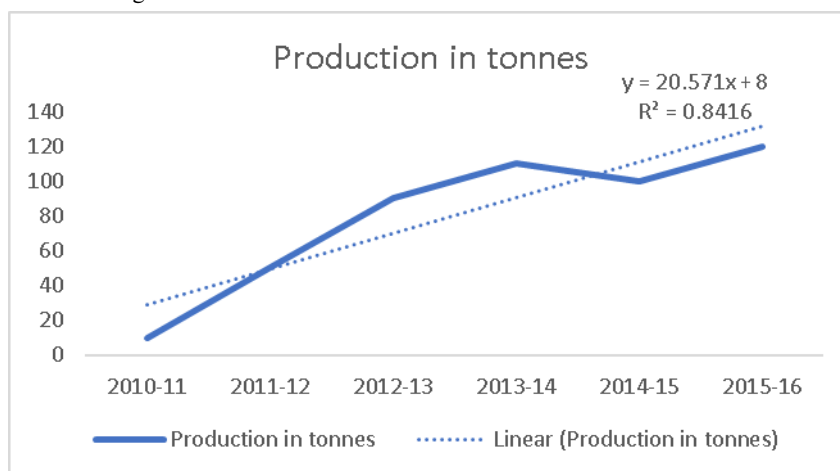
support during the years 2010-11 to 2013-14. Furthermore, with the funding from the central government under the programmed of Blue Revolution 100 new units of trout raceways are being constructed throughout the state. With an increase in the number of trout growers, the total production has risen sharply in the past few years. In the year 2010-11, the total trout production in the state was negligible of about 10 tonnes which had increased to 50 tonnes, 90 tonnes, 110 tonnes and 120 tonnes in the year 2011-12, 2012-13, 2013-14 and 2015-16 respectively. To increase seed production in the state, the government is also implementing the project of community trout hatchery. At present, there are three community hatcheries are being constructed in the three different locations of West district. It is expected to produce around 80,000 numbers of trout fingerlings each year

Figure 2: State-wise Rainbow Trout Production in India 2015-16 (in tonnes)



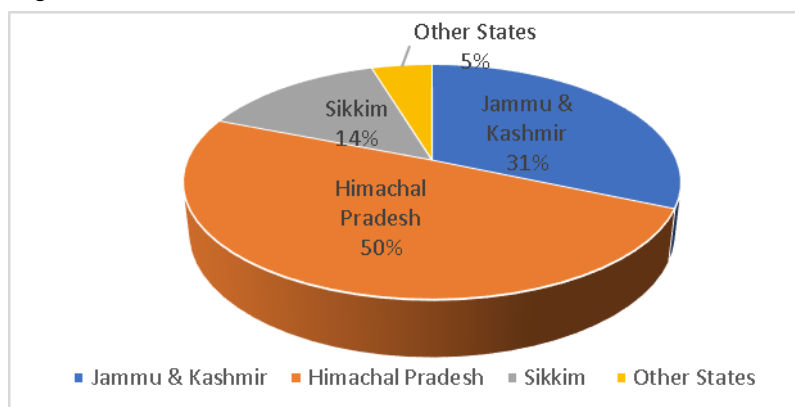
Source: Directorate of Coldwater Fisheries Research, ICAR, Government of India.

Figure 3: Trout Production in Sikkim from 2010-11 to 2015-16



Source: Directorate of Fisheries, Government of Sikkim.

Figure 4: State wise Contribution to Total Trout Production in India in 2015-16



Source: Directorate of Coldwater Fisheries Research, ICAR, Government of India.

Note: Other states include Uttarakhand, Arunachal Pradesh

Table 2: Cost and Benefits Analysis of Trout Farming in Raceways (Unit Size 51m³ Water Area)

1	Costs (C) Capital Cost	Construction of Trout Raceways as per design/specification. Size 17m x 2m x 1.5m = 51m ³	Rs 1.20 lakhs
2	Species	Rainbow Trout No. of Stock- 1500 Nos Operating Cost: - (Recurring) (i) Cost of seeds @ Rs 10/- per each for 1500 nos. including transportation cost (ii) Cost of feed including transportation cost	Rs 0.30 lakhs Rs 1.00 lakhs
3	Benefits (B) Production	Trout fish average growth 400-600 grams per year. Mortality 20%. Total production 500kg @ Rs 800 per kg	Rs 4.00
4.	Net Profit B-C	Rs 4.80 lakhs – 1.30 lakhs	2.7 lakhs

Source: Computed from Primary Data

As per the latest specifications and design of DOF, the ideal size of the trout raceway is 51m³ which costs around ₹1.20 lakhs. On average the stocking of 1500 nos. of fingerlings at ₹10 per each cost 0.30 lakhs and the cost of feed including the transportation cost is around ₹1.00 lakh. Therefore, the total operating cost is ₹1.30 lakhs. On average, the production of 500kg fish at ₹800 per kg would give ₹4.00 lakhs of revenue. The net profit from a single raceway would come to ₹2.7 lakhs which is a very venturing and promising profit to the farmers.

Challenges and Prospects of Trout Farming

There are vast water resources in Sikkim which are virgin and unutilised. The perennial springs and streams in the Himalaya are flowing from the uplands to low lands are not properly and fully utilised. In Sikkim, fisheries sector is facing the problems like poor accessibility, difficulty hilly terrain, lack of transportation and improper market, lack of infrastructure for aquaculture etc as a result this sector could not foster to the expected and extensive level. The major problems faced

by the trout farmers in Sikkim are non availability of fish feeds on time, high cost of feeds and lack of required fish seeds on time etc. Even though such problems exist, there is a huge prospect of fisheries and fish farming in the hilly state and can enhance the level of production, if some of the following strategies are taken into consideration.

- The available water resources could be bringing into fish farming and aquaculture development by utilising these resources Efficiently and properly rather than going into waste
- Awareness of the importance and role of fisheries and aquaculture for the rural development and nutritional value can motivate the younger generations that could result in greater participation of people in fish farming.
- Fish is a highly perishable product, proper accessibility, cold storage, proper transportation and marketing facilities in the rural areas could foster this sector so that local fish can be easily available in the market.

- The use of modern technology and training for farmers can increase the level of production and productivity.
- The retail local fish shop should be started at the district level so that the local fishes will be easily available in the market and this will also encourage fish farmers to produce local fishes.
- Although water resources are plentiful, many problems need immediate attention from the government as well as the management teams to get better results in terms of steady growth in production, productivity, profitability and sustainability etc.
- To minimise the major problems faced by the farmers such as non availability of feed on time and high feed cost, the government should frequently monitor or establish at least feed mill plant within the state to redress such problems.

There is a huge potential to increase fish production in the state. Besides private tanks and ponds, currently there are eight government trout farms where 48 tanks are owned by DOF. But all these government farms were established for seed production to distribute to the farmers and demonstration purposes. The farms are not producing fishes on a large scale for selling purpose, therefore it is suggested to the government that these farms can do production on a large scale and sell fishes in the market as a result the revenue of the DOF will increase.

2. Conclusion

The study found that the coldwater fisheries have been steadily progressing in the Himalayas for the last two decades. There was an increment in fish production in all the five Himalayan Indian states. Although there have been fluctuations in production over the years, the production of rainbow trout has progressed gradually during the last few decades in the Indian Himalayas. The total rainbow trout production in India has increased from a mere 147.0 tonnes in 2004-05 to 602.0 tonnes in 2013-2014 to 755 tonnes in 2014-15 and 842 tonnes in 2015-16. The total annual supply of trout in the country is about 842 tonnes whereas the demand is about 1000 tonnes. This implies that demand exceeds supply, therefore, there is a great scope and potential in this sector. The annual growth rate of trout production in this duration has remained at 25.42% in 2014-15 and 11.52 % in 2015-16. Himachal Pradesh, Jammu and Kashmir and Sikkim were the leading trout producers in India which contributed 50%, 30% and 14% respectively to total production in India during 2015-16

The trout production infrastructure has also been developed.

steadily in the state during the last 10 years and around 8 trout farms are under the Government sector with 349 units of raceways had been constructed, highest being in the West district 32% followed by East district (28%), North district (20%) and South district (20%) respectively. The rainbow trout production in Sikkim is also growing steadily with an increase in the number of trout growers. The total production has risen sharply in the past few years. In the year 2010-11, the total trout production in the state was negligible of about 10 tonnes which had increased to 50 tonnes, 90 tonnes, 110 tonnes and 120 tonnes in the year 2011-12, 2012-13, 2013-14 and 2015-16 respectively. On average farmers are earning profits of more than 2.7 lakhs rupees from one raceway of 34 sq. m water area. Hence this farming system is being promoted among the rural people living in the upland areas of the state as per feasibility. On the other hand, problems and constraints such as poor accessibility, poor transportation, lack of required fish seeds and feeds and high cost of feeds need to be redressed at the earliest to encourage the local fish farmers and to increase the production in the hills of Sikkim.

3. References

- Animal Husbandry, Livestock, fisheries and Veterinary Services (2011, 2018). Annual Report 2017-2018. Department of Animal Husbandry, Livestock, fisheries and Veterinary Services, Government of Sikkim. http://www.sikkim-ahvs.gov.in/fisheries_development.html
- Bose S and Bala N (2020). The rainbow trout farming in the foothills of Himalayas with special reference to Uttaraey, Sikkim, 11(5): 698-701
- Chettri KB and Kundu R (2020). Evaluation of Socio-Economic Conditions of Coldwater Fish Farmers: A Case Study of Sikkim. *Indian Journal of Economics and Development*, 16(1): 62-71.
- Sharma P, Pandey NN, Haldar RS and Sarma D. (2018) Trout farming in Sikkim: a glimpse at present status and way forward, *Bulletin No 31*, 1-79
- Singh AK (2015). Advances in Indian coldwater fisheries and aquaculture. *Journal of Fisheries Sciences*. com, 9(3): 48-54
- Singh AK, Pandey NN and Ali S (2017). Current status and strategies of rainbow trout *Oncorhynchus mykiss* farming in India. *International Journal of Aquaculture*, 7: 23-30
- Sultan S (2016). India a unique opportunity for rainbow trout farming. <https://www.aquaculturealliance.org/india-a-unique-opportunity-for-rainbow-trout-farming/>
- Woyrnarovich, A., Hoitsy, G., & Moth-Poulsen, T. (2011). Small-scale rainbow trout farming. *FAO fisheries and aquaculture technical paper*, (561), I