Inspiring story of aquaculture in Sikkim: A journey from conservation to farming

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We, the authors, both scientists from Directorate of Coldwater Fisheries Research (DCFR Bhimtal), headed for Sikkim, India, in the month of December for collection of samples and data under various projects of the DCFR, reaching Gangtok in its chilly evening hours. In the early hours of the next day we visited the Directorate of Fisheries (DOF), Government of Sikkim and met the Director Mr I.P. Chettri, the Additional Director Mr. Sunil Pradhan and the Joint Director Mr D.B. Rai to discuss our visit, projects and other tour related matters. The DOF officers welcomed us with immense hospitality and assured to lend all possible assistance throughout our stay in the state. The Additional Director and the Block Officer, Mr Surendra Bhandari made arrangements for deputing at least one fisheries officer to guide us in their respective working places. We started our activity on this day itself by visiting carp farmers in the vicinity of Gangtok.

Throughout our tour program, we were assisted uncondition-ally by the Director, Additional Director, Deputy Director, Mr R.P. Subba and Mr Sonam Lepcha (Range Officers), Mr Surendra Bhandari, Mr Naresh Sunwar (Block Officer) and Mr Sonam Bhutia (Block Officer), and we wish to express our sincere thanks to them.

Team of scientists and fisheries officers interracting with farmer.

Sikkim at a glance

Sikkim is a small Himalayan state of India with total area of 7,096 square kilometers. It is surrounded by Nepal on the west, Bhutan in the east, China (Tibet) in the north and rest of India in the south. Although small, it is the most beautiful state for its natural Himalayan landscape and scenic beauty of snow-capped mountains, including mountain peaks such as Khangchendzonga, Kabru, Siniolchu, Thingchinkhang, Jopuno, Pandim, Rathong (online information, Tourism and Civil Aviation department, Government of Sikkim). The state has three climatic zones, ranging from tropical to temperature and alpine. The climate remains overall cold and humid throughout the year (State of Forest Report 2009 - ENVIS Centre Sikkim; online information). Rainfall occurs almost round the year combining pre-monsoon (April-May) and monsoon (May-October). The average rainfall from the months of May-October goes beyond 200 mm, and from June to September exceeds 400 mm at different places and altitude (online information, Meteorological Centre, Gangtok). There are three agro-climatic zones in Sikkim, namely cool type (< 10°C; 2000 m altitude and above), moderate cool type (10-20°C; 1000-2000 m altitude) and warm type (> 20°C; <1000 m altitude) (online information, Meteorological Centre, Gangtok). For aquaculture purposes, we can utilise moderate cool type and warm type agro-climatic zones for farming rainbow trout and exotic carps (grass carp; *Ctenopharyn-godon idella,* silver carp; *Hypophthalmichthys molitrix* and common carp; *Cyprinus carpio*) respectively. In the cool type agro-climatic zone breeding seed rearing and ranching of brown trout can be carried out for promoting sport fisheries and ecotourism.

Biointegration of rainbow trout and cardamom farming.

Brief background

Originally the Sikkimese population had little to do with fish consumption and fish farming. However at present time, with emerging knowledge of fish as a functional food and superior protein compared to other animal meat, fish consumption is becoming popular. As a result of this, the demand for fish in the state has reached 550 MT but the present production is only 160 MT (120 MT from capture and 40 MT from cultured; data obtained from DOF, Sikkim). Therefore, it would not be misleading to say that most of the demand for fish is being

Carp farm visit by team of scientists and fisheries officers and interaction with farmer at Tintek, East Sikkim.

met largely through import from other states, mainly Andhra Pradesh, West Bengal and Bihar. However, nature has gifted Sikkim with ample water bodies suitable for farming exotic carp species in the lower belt and rainbow trout in higher. Prior to 2008-2009, the development program for fisheries was confined to conservation of riverine fisheries, production and stocking of brown trout seed in the cold water streams and lakes for promoting angling but not for generation of livelihood for the farmers. However after 2008-2009, DOF has been moving with all possible speed in promoting fish farming to provide additional livelihood options for farmers, along with the technical and research support from DCFR. Down the line, DOF and DCFR are working hand-in-hand to harness the available water resources for the development of profitable aquaculture ventures. In doing so, DOF has started running-water exotic carp culture (2008-09) and introduced raceway systems for trout culture (2009-10) with the financial support of Rashtriya Krishi Vikas Yojana (RKVY), National Fisheries Development Board (NFDB) and the Fisheries Developmental Plan of the state government (FDP). Although the fisheries office was created in the late 1970s as a wing under Forest Department, it became a Directorate in 1995.

Contributions of DOF

Fish farming in Sikkim is in initial stage although the fisheries related activities were carried out date back from the inception of Fisheries Development Wing under Forest Department, but the activities of those times were mainly the propagation and conservation of trout (both rainbow and brown) and other naturally available hill stream fishes in rivers and lakes. But only very recently, the DOF has started promoting farming of exotic carps in mid hills and rainbow trout at higher altitudes for food security, farm income and sustainable rural livelihoods. They initiated the construction of concrete tanks (50 x 20 x 4 cubic feet) and raceways (45 x 6 x 5 cubic feet) for farming exotic carps and trout respectively, in farmers' land. The numbers of carp farming beneficiaries are increasing rapidly year after year and reached more than 1,200 at the end of 2014-2015 because of the site suitability, water availability and other operational feasibility. The growth rate of trout farming (in terms of number of beneficiaries) was not as fast as compared to carp farming. In the very first year, they were able to construct total of fifty three raceways for same number of beneficiaries. In 2010-2011, with the help of financial assistance from NFDB, RKVY and FDP, the DOF constructed additional one hundred and sixsuch trout raceways in all four districts of the state. By 2013-14, the DOF could increase the number of beneficiaries up to two hundred and forty (data obtained from DOF, Sikkim).

To date, state of Sikkim has more than 1,200 exotic carp farmers and 240 trout farmers with at least one growout tank each (data obtained from DOF, Sikkim). Recently, DOF have installed two fish feed mills in the state to meet the growing feed demand within the state. In addition to that, they

have nine carp and eight trout farms under DOF for seed rearing with total capacity of around 2 million carp seed and 500,000 – 1,00,000 trout seed per year (this is a rough figure taking mortality into consideration). In this way, the DOF is promoting fish farming to achieve production that can meet the half of the demand by 2016-17.

Despite of shortage of manpower, they are working in all aspects for promotion of fish farming, starting from selection of sites (based on water availability in terms of volume and perenniality, temperature assessment round the year), availing funds for construction of raceways, healthy stocking material (bred and reared in government farms of DOF) and feeds (procured from outside of state until now), and providing training and exposure visits to farmers, etc. They are also working on formation of fish farmers' cooperatives and creation of domestic fish markets in each of four district headquarters within these cooperatives. According to them, the cooperatives are formed in fish farming pockets that can help in collecting the fish from respective locations and bring it to the markets. The involvement of these fish growers' cooperatives in marketing activities can rule out the middlemen and maximise the margins for fish growers.

Status of exotic carp farming in Sikkim

We visited the different villages where they do carp farming, those includes Namchebung (Pakyong, East Sikkim), Rakdong-Tintek (East Sikkim), Ranka (East Sikkim) and South Regu (East Sikkim). There, we interacted with farmers about the farm management, feed and feeding and the challenges they face down the line in running a fish farming operation. Most of the farmers, at present, are farming grass carp in majority (more numbers) and common carp in minority (less numbers). According to them, grass carp grows faster than silver and common carp. In addition to this, feeding of grass carp is easier than rest two carps. The growth of this fish, based on their experience falls between 300-1000 grams in 10-12 months culture period. They complained about the size variation, slow growth specifically in common carp and high mortality in temperature extremes in case of silver carp.

Based on our survey, we came to know that the stocking time, density and variety are not uniform. Some farmers' stock seeds in the months of March-April, and this probably prove to be the best stocking time because in doing so, fish can be cultured in long high-temperature period that is from March-April to October-November (7-9 months). Otherwise, if they stock in July-August (most of them they follow this), they either have to harvest in October-November (that will be very short time for producing marketable size) or hold them through winter without any growth. Therefore, stocking in July-August is not recommended, however farmers are forced to practice this because of easy availability of seed in July-August than in March-April, and also due to the lack of the knowledge on slow winter growth. They may need proper guidelines and training on seed rearing technology, stunted seed rearing technology for raising fingerlings through winter

Carp farm visit by team of scientists and fisheries officers at Tintek, East Sikkim.

period (this can even prove as an effective two-cropping aquaculture activity for better profit) so that the stunted advanced fingerlings will be available for stocking at the onset of high-temperature period (March-April to October-November (7-9 months). If followed so it can be beneficial in following different ways:

1. Some interested farmers (who want to go for seed rearing of carp) get one additional crop (one grow-out and other seed rearing) which can prove to be the climate smart aquaculture operation.

2. Availing stunted fingerlings for grow-out may prove to be beneficial because these fingerlings if fed appropriately, in terms of nutrition and feed, can grow faster and reach marketable size in a short time.

3. Ultimately farmers can earn more profit through multi cropping (winter/monsoon) and short (mainly at the time of water availability and high temperature) farming and may help them to earn a better livelihood.

During our interaction with farmers we observed some of problems such as shortage of feed, good quality of seed, mortality at stocking and marketing issues. To meet the feed requirement they used to feed grass carp and common carp with kitchen waste, a mix of mustard oil cake, wheat flour, maize flour and rice bran in different combinations and proportions based on availability. Sometimes they feed

Rainbow trout farm of progressive farmer at Sreebadam, West Sikkim.

grass carp exclusively with grasses such as chayote/is-kush/ squash; *Sechium edule*, bamboo leaves, banana leaves, vegetable leaves, napier grass; *Pennisetum purpureum* and doob/durva; *Cynodon dactylon*.

As mentioned earlier, some of them stock seed in August-September and culture the fish with slow-to-no growth over the chill winter months and face the winter driven mortality (some of them were complaining about winter mortality). We had a thorough discussion regarding the stocking related mortality, and we could draw a hypothetical reason behind the same that pond might not have matured enough in terms of

Rainbow trout breeding and seed rearing facility of DOF, Uttarey, West Sikkim.

plankton availability, formation of natural biofiltration systems, etc. Others are not encountering such problems of mortality possibly because of stocking the seeds when the colour of tank turns green with plankton (following all protocols of pond preparation such as manuring with cow dung, liming, etc). We will discuss the marketing issue at the end collectively for both carps and trout.

Status of trout farming

To gather the information regarding trout farming, we visited the villages that are involved, which include Pangthang, Tumin, Zuluk, Phadamchen (East Sikkim) and Uttarey (in and around government trout farm, West Sikkim). We got enough opportunity to interact one-on-one with farmers, and the best thing we observed among them was that they were very much interested to expand their operations provided that feed and seed were readily available throughout the year. The motivation behind their interest in expansion of trout farming is maximum margin (currently selling @ Rs. 500-800/kg), more than they earn than any other existing farming they are involved with. We discussed feed and feeding management, the need for sorting and grading, size-specific harvesting (harvesting bigger fish earlier and letting the smaller to grow and harvest subsequently, so that all the fish in the tank get enough opportunity to grow more than 500 grams) and marketing. Because of the lack of sufficient raceways, they have insufficient space for sorting and grading; instead, some of them follow size-specific sequential harvesting.

Trout farm at panthang, East Sikkim.

Differential growth and size variation is common problem in trout farming, possibly induced by improper feed and feeding management. According to them, when feed and feeding, in terms of optimum nutrition and feeding strategy is not an issue, they get satisfactory growth of about 500-1,000 grams in 10-12 months of rearing. The raceways of beneficiaries were built in such a place where the farmers have access to optimum water source even in the months of December, and the temperature in winter and summer does not cross

Carp farm at Namchebung, East Sikkim.

the lethal value (based on the mortality information obtained from farmers), as DOF had guided each farmer in a very appropriate manner for the same.

Among the farmers we interacted with, the majority of them follow stocking @ 300-500 fingerlings per raceway but some are stocking @ 1,000-1,200 per raceway at their best management efforts. In general, they feed trout with feed supplied by DOF, but some farmers feed cooked beef liver at the very early stage of stocking to ensure better survival. We observed variation in feeding strategy from farmers to farmers; progressive farmers follow size-specific feeding strategies, feeding 4-6 times per day at early stages and twice daily at later stages. That may be the reason why they are practicing multiple cropping and getting best possible profit out of small tanks.

Overall the scope for the expansion of trout farming is more promising than with carp because of the high price of the fish and the high margins. If we can increase the raceway holding from one or two per farmer at present to at least five based on the suitability of site and the current performance of the farmers, by any means of public funding, we can ensure a best possible sustainable livelihood for the farmers.

Conclusion

Overall the aquaculture in the state is growing, although at a slow pace but the possibilities and perspectives are promising in ensuring new and better means of livelihood to the farmers. However, down the line there are many constraints, which if not addressed in time may impede the growth of the sector. Some of the common problems associated with carp and trout farming, in an ascending order of intricacy in addressing, and with their possible solutions include:

- **Mortality at the time of stocking:** This can be easily mitigated by following better pond preparation practices considering all water quality related issues prior to stocking.

- **Non availability of feed:** To address this issue, a detailed study involving the survey of availability of local ingredients is needed to be carried out for formulating and manufacturing cost effective feeds for both carp and trout so that the farmers may procure feeds easily as and when they require it.

- **Insufficient seed:** DOF is working hand-in-hand with ICAR-DCFR for breeding and seed rearing related activities. To some extent the state is becoming self-sufficient in trout seed production. However, the breeding and seed production of grass carp within the state needs serious attention and if not addressed, the farmers need to depend on seed supplied from outside the state where quality and availability is not certain.

Carp farm visit by team of scientists and fisheries officers and interaction with progressive farmer at Tintek, East Sikkim.

- **Marketing issues:** DOF has taken initiatives to form fish farmers cooperatives, these cooperatives in turn can run and regulate cold storage equipped fish markets in each district. By doing this, the influx of middlemen can be reduced that in turn can ensure best margin for farmers and lowest possible price for the consumers. Even cooperative personals can operate the feed manufacturing and distribution side-by-side the marketing of farm products that can ensure even better flow of farm input and output.

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