Introduction of rainbow trout *Onchorynchus mykiss* in Nepal: Constraints and prospects

Tek Bahadur Gurung*, Sadhu Ram Basnet**

**Corresponding author: Agriculture Research Station (Fisheries), Pokhara, PO Box 274, e-mail: fishres@fewanet.com.np*
*** Fisheries Research Station, Nuwakot, Trishuli, Nepal*

The introduction of trout to Nepal

The first origins of salmonid fish in Nepal is not known. On the Indian sub-continent, Francis Day was the first to introduce salmonids in 1983[1]. India, Pakistan and Bhutan had successful introduction of trout[2]. In Nepal, two earlier attempts were made to introduce trout for sports and aquaculture development before 1988, however on both occasions the trout could not survive[2]. We are currently making a third attempt and there are indications that this time trout can be promoted successfully.

Nepal is a narrow country with a tremendous variation in both elevation and climate across its 200km width, ranging from tropical southern plains (terai) to the alpine northern Himalayas[3].

Inland water resources are abundant in Nepal[4]. There are approximately 6,000 rivers which flow from north to south[5]. Most of these rivers are turbid during the monsoon due to silt loads from glaciers. This has been suggested as the reason that the earlier introductions of trout failed. However, there are many rivulets where such high turbidity does not exist. The current success of trout cultivation in the Trishuli and Godwary areas suggests that turbidity is not the major issue and instead technological knowledge of trout farming is more important.

At present annual fish production in Nepal is estimated to be around 35, 000 tonnes (2002)[6], mainly from rivers, lakes, ponds, and rice field in Nepal. Anecdotally the aquaculture of carps seems to contribute more than 95% of total fish production in Nepal, although there are no authoritative estimates. Most production comes from the warm southern Terai region.

Trout raceways at Godawari

Trout prefer clean, cold and high oxygen water for their growth and survival, which are abundant in Nepal, particularly in the hill and mountain areas.

At present the technology for farming Nepal's native coldwater fish is not well developed and few species are economically viable to farm. The introduction of an economically viable coldwater species could allow the coldwater resources of Nepal to be used more effectively. Salmonids are well suited to commercial cultivation in cold waters and the technology is well developed[7,8,9]. There are many examples where introduction and aquaculture of trout is important source of income[9,10,11].

The first attempt to introduce salmonids in Nepal was made in 1969 by importing Atlantic salmon (*Salmo salar*) and brown trout (*S. trutta*) from Kashmir, India, and rainbow trout (*Onchorynchus mykiss*) from the United Kingdom, and sockeye salmon (*O. nerka*) from Japan in 1979-80 without success. In the third attempt to introduce rainbow trout into Nepal, 50,000-eyed eggs were brought in from Japan[12,13]. Since then rainbow trout has been bred and reared for more than a last decade[14,15].

Trout was introduced in Nepal to meet many needs including substitution of fish imported in hotels catering for tourists, use of cold-water resources for aquaculture and promotion of fishing tourism in hill streams. We have evaluated the performance of technological management of trout

under Nepal's prevailing socioeconomic conditions. Here we review and briefly analyze the introduction, and possible constraints to farming rainbow trout in Nepal.

The third introduction of rainbow trout to Nepal

Approximately 50,000-eyed eggs were received at the Godawary Fish Farm in Lalitpur, Kathmandu Valley on 28 December 1988 from the Kobayashi Fisheries Experimental Station, Miyazaki Prefecture, Japan. More than 99% of the eggs survived transport and were successfully hatched and reared at Godawary, when water temperature ranged 8.0 to 10.5C. Hatching was completed after 18 days. Some of the fingerlings were sent to the Fisheries Research Centre, Trishuli. The first fish spawned after two years[7,8]. Fry were initially fed with powdered feeds obtained from Japan but later with locally available chicken yolk powder, buff liver and pellet crumble. The fish were subject to intensive health examinations.

The farms

The Godawary Fisheries Research Centre was established in 1962. This station is situated in central Nepal in the Kathmandu Valley, some 1,700 metres above the sea level and about 16 Km southeast of Kathmandu. The climate is sub-tropical and cool with water temperature falling to 8C in winter. Pond waters reach about 26-27C in summer but not more than 20C in streams. The farm is fed by small streams from surrounding hills. The discharge rate of the stream is approximately 30 litres/second.

The Trishuli Fisheries Research Centre is some 70km north-east of Kathmandu, supplied by the Trishuli River. Water temperature never exceeds above 19-20C making Trishuli suitable for trout cultivation. The elevation of the farm is approximately 600 metres from sea level.

Rearing Systems

Trout are reared in raceways at Trishuli and Godawary Farms and fed with dry pellet feed (32-40% of crude protein) and sometimes with fresh minced water buffalo meat. The rate of feeding is 2-3% of total fish biomass for production purpose.

Disease

The main diseases observed are as follows:

Fin Rot: One of most predominant diseases. This occurred among fish of greater than 1kg body weight. Fish less than 1kg were less vulnerable but not free of this disease. Fin rot was most predominant in caudal fin though occasionally pectoral and pelvic fins were also affected although fish seldom died. In newly infected parts a white streak appears near the caudal fin[16] broadening later on as the muscle and rays start to degenerate slowly. Usually, such affected fins can heal and regenerate.

Hepatoma: This was generally seen in fish bigger than 1kg body weight. This is a cancerous disease found in the liver. About 30% of fish examined had the hepatoma disease. This has also been reported from Trishuli Fisheries Research Station. The infected liver becomes enlarged and pale to white[17]. Seriously infected fish lose balance. This disease is caused by feed contamination with aflotoxin produced from mold, *Aspergillus* flavus[8,17]. Hepatoma arises after 4-6 months of exposure18. A dose of 0.1 to 0.5 ppb of aflatoxin-B1 in feed can cause the liver cancer[17,18].

Fungal diseases

Fungus is mostly a problem in fertilized eggs during incubation, and in post-spawning fish. This might be due to bruises caused by handling. In grown out fingerlings fungal diseases were hardly seen as they are not subjected to stressful handling. The most prominent fungus is *Saprolegnia* sp. This appears as 'cotton' and rapidly spreads to cover the whole body, initially attacking open wounds in adult fish[16]. Severe cases can kill the infested fish.

Intestinal disorders

Some intestinal disorders were seen during the study period. The most common occurrence was carcasses with a swollen stomach. Often in such specimens a hemorrhage and presence of watery fluid in the stomach were observed. In such cases the stomach was totally empty indicating that the fish had not consumed any feed for several days before death. The swollen stomach was also associated with redness of anal opening. Such specimens often discharged dark yellow fluid if pressed gently at proximate end of the opening.

Physical disorders

- *Blunt snout:* Some individuals had blunt or asymmetrical snout. It seemed that the lower jaw grew normally but upper jaw remained undeveloped during the course of growth and development.
- *Twisted alevins:* In 1992 some abnormal twisting occurred in under-developed alevins. These were segregated from the healthy ones but did not survive long.
- *Abnormal gills:* Abnormal gills were fringed and not properly developed. Such gills lacked compactness and redness in appearance.
- *Degenerated operculum:* In some fry the rear part of operculum was missing and gills were not completely covered with the operculum. The reasons of the degenerated operculum were not known.
- *Blindness:* Sometimes one of the eyes was absent due to unknown reasons. In the beginning the lost eyes were opaque but ultimately led to complete degeneration. Such fish were found to lose their balance. Trout are delicate and demand highly oxygenated waters[7,8].

Past failures

The reasons for the past failures of salmonids 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[8].

Rainbow trout can also be reared extensively, but its farming is mostly characterized by intensive feeding with high protein content feed for higher production[7]. The fish in such systems become more susceptible to many diseases. Among many diseases we encountered the most difficult seems to be hepatoma. This disease is well studied and illustrated by Wales[17]. 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[1,19,20] 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[9]. In Japan, trout are commercially cultivated from north to south throughout the country, but trout could breed naturally only in Northern Province, Hokkaido[10]. 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.

Conclusion

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 one 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.

Acknowledgment

We express our gratitude to the Governor of Miyazaki Prefecture for offering 50,000 of rainbow trout eggs for experimentation in Nepal. Mr. Utaka Nakagawa is also thankful for proving kind support and training to the first author during 1987-88. Thanks to Dr. M. K. Shrestha for kindly reviewing the paper. We wish to thank Dr. T. Yamazaki for providing the disease identification format and guiding us to identify the trout diseases.

References

De Silva, S. S. (1989) Exotics-a global perspective with special reference to finfish introductions to Asia. In: Exotic Aquatic Organisms. Edited by de Silva SS. Proceedings of a Workshop on Introduction of Exotic Aquatic Organisms in

Shrestha, B. C. (1997) Cold water fish culture potentialities (in Nepali). In: Krishi (bimonthly magazine) 34:5 (2054) Push-Magh, Fish Culture Special. HMG, Department of Agriculture, Nepal.

Gorkhali, P. P and J. C. Gautam (1991) Agriculture and fisheries development. In: Background Papers. National Conservation Strategy Implementation Program. National Planning Commission, HMG, Nepal, in collaboration with the World Conservation Union (IUCN). Edited by Baker S et al. 1:211-238.

Bhatt, C. D. (1991) Surface and ground water development for irrigation. Reviewer: C. K. Sharma. In: Background Papers. National Conservation Strategy Implementation Program. National Planning Commission, HMG, Nepal, in collaboration with the World Conservation Union (IUCN). Edited by Baker S et al. 1:239-258.

Shrestha, H. M. (1983) Rivers of Nepal. A preliminary introduction. A glimpse of water resource development in Nepal. Nepal Digest.

Gurung, T. B. and S. K. Wagle (2000) Importance of water quality for optimizing fish yield in Nepal: a review. Paper presented in technical seminar on information sharing in aquaculture 2-3 Kartik, 2057, Fisheries Development Directorate, Balaju, Kathmandu, organized by Fisheries Training Centre Janakpur, Nepal.

Bardach, J. H., W. O. Ryther and Mc Larney (1972) Commercial culture of freshwater salmonids, genera Salmo, Thymallus, and Hucho. In: The farming and husbandry of freshwater and marine organisms. John Willey and Sons. pp. 397-449.

Huet, M. (1975) Breeding and cultivation of salmonids or fish culture in cold water. In: Textbook of fish culture, breeding and cultivation of fish. Fishing news books ltd. 23 Rosemount Avenue, West Byfleet, Surray, England. pp. 59-112.

Shetty, H. P. C., M. C. Nandeesha and A. G. Jhingaran (1989) Impact of exotic aquatic species in Indian waters. In: Exotic Aquatic Organisms. Edited by de Silva SS. Proceedings of a Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fisheries Society, Special Publication No. 3. pp. 45-55.

Chiba, K., Y. Taki., K. Sakai and Y. Oozeki (1989) Present status of aquatic organisms introduced to Japan. In: Exotic Aquatic Organisms. Edited by de Silva SS. Proceedings of a Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fisheries Society, Special Publication No. 3.

Estay, F., N. F. Díaz (1994) Analysis of reproductive performance of rainbow trout in a hatchery in Chile. The progressive fish-culturist. 56: 244-249.

Nakagwa, U. (1998) Rainbow trout introduction in Nepal (in Japanese). In: Aquaculture 6:84-86.

Yamada, T., M. K. Karna and K. R. Bastola (1998) Comparative studies on hatchability, abnormality and advance rate of rainbow trout, Onchorynchus mykiss alevins. In: Present status of fisheries research development and education in Nepal. Edited by: B. R. Pradhan et al 1998. Natural water fisheries development project, Nepal Agriculture Research Council, Japan International Cooperation

Gurung, T. B. and L. S. Lama (1994) A preliminary study on the occurrence of parasites and disease in rainbow trout (Onchorynchus mykiss). In: Annual Report, Fisheries Research Centre, Godawary, Nepal. pp. 26-37.

T.F.R.C (2000) Annual Technical Report, published by Trishuli Fisheries Research Centre, Trishuli, Nuwakot, Nepal.

Davis, H. S. (1961) Culture and diseases of game fishes. University of California Press. Berkeley and Los Angeles, California.

Wales, J. H. (1961) Hepatoma in rainbow trout. In: A symposium on diseases of fishes and shellfishes prepared by the Symposium Committee: Stanislas F. Snieszko, Chairmen and editor. Special Publication No. 5. American Fisheries Society Washington D.C

Halver, J. E. (1972) Fish Nutrition, Academic Press, London Ltd.

Thia-Eng, C. (1989) Address of Dr. Chua Thia-Eng, President of the Asian Fisheries Society. In: Exotic Aquatic Organisms. Edited by de Silva, S. S. Proceedings of a Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fisheries Society, Special Publication No. 3. pp. vii-viii.

Waples, R. S. (1995) Genetic effects of stock transfer of fish. In: Protection of Aquatic Biodiversity. Philipp DP, JM Epifanio, JE Marsden, JE Claussen, RJ Wolotira (editors). Proceedings of the World Fisheries Congress, Theme 3. Oxford and IBH Publishing Co. Pvt. Ltd; New Delhi, India.