ZOO-Journal **5**: 7-15, 2019 **Research Article** ***ISSN: 2631-2204***

SURVEY ON CARP SEED PRODUCTION IN PRIVATE FISH HATCHERIES OF NEPAL

Dilip K. Jha[1], Ram C. Bhujel[2] and Anil K. Anal[3]

[1]Department of Aquatic Resources, Agriculture and Forestry University, Rampur, Chitwan, Nepal

[2,3] Department of Food, Agriculture and Bioresources, Asian Institute of Technology, Thailand

E-mail: dkjha.ait@gmail.com

ABSTRACT

Aquaculture is rapidly expanding in Nepal as a result demand for fish seed is increasing. Access to adequate high quality seed is the basis for sustainable aquaculture development. Due to quick and high profitability, and encouraging government policy, a number of private hatcheries are increasing especially in southern parts of the country. A survey of 40 private fish hatcheries was conducted from different regions (Eastern-9; Central-19, Western-6, Midwestern-3 and Farwestern-3) representing 15 districts (Morang, Sunsari, Saptari, Siraha, Dhanusha, Mahottari, Bara, Chitwan, Nawalparasi, Rupandehi, Kapilvastu, Banke, Bardiya, Kailali and Kanchanpur) of Terai and inner Terai to assess the status of different stages of seed production within five year from March 2009 to April 2014. The survey revealed that total production of hatchlings, fry and advanced fry within five years were 15852.6, 879.5 and 259.5 million respectively. All these development regions showed increasing trend of their own contribution within a total of five years. The percentage of eggs fertility and hatchability was more (78.3 and 71.7) in mid western development region followed by eastern (68.9 and 61.7), central (68.3 and 61.7), far western (68.3 and 61.7) and western (68.3 and 60.0). Though private hatcheries played important role in seed production, improving their efficiency are imperative, further studies are recommended to overcome constraints on carp seed production.

Key words: Private hatcheries, seed production, cultivated carps.

INTRODUCTION

Aquaculture in Nepal is speedily increasing and access to adequate high quality seed is the basis for sustainable development. Further, availability of required quantities of high quality seed of the desired species during the stocking season is one of the major factors that lead to success of aquaculture operation. Fish seed production in Nepal is mostly limited to seven species of indigenous and exotic cultivated carps. The carps are major fishes, which occupied around 95% of total fish production in Nepal, has the potential to expand in rural areas including mid-hills and generate income upto four times (Bhujel, 2012; Mishra and Kunwar, 2014; DoFD, 2014). The seven fish species of cultivated carps including three indigenous major carps such as rohu, *Labeo rohita* (Hamilton-Buchanan), mrigal, *Cirrhinus mrigala* (Hamilton-Buchanan) and bhakur, *Catla catla* (Hamilton-Buchanan), and three Chinese major carps such as silver carp, *Hypophthalmichthys molitrix* (Valenciennes), grass carp, *Ctenopharyngodon idella* (Valenciennes), and bighead carp, *Aristichthys nobilis* (Richardson) along with common carp, *Cyprinus carpio* (Linnaeus) are grown under polyculture system for the best possible exploitation of usual foodstuff achieving highest yield. Though very recently,

DOI: https://doi.org/10.3126/zooj.v5i0.34776

tilapia, sahar and pangas have been tried other than cultivated carps, but their contribution are negligible. Generally, carp seeds become available to the farmers by public and private hatcheries. There are 14 government and 67 private hatcheries, and 222 nurseries in Nepal (Mishra and Kunwar, 2014). Government hatcheries produced fish seed in the form of 127645000 hatchlings, 16612000 fry and 5797000 fingerlings in the fiscal year 2016-17 (DoFD, 2017). In recent years, there is a trend that the private sector has dominated over the public sector in terms of seed supply, which supplied fish seed in 2013-2014 amounting to 116519000, which increased to 171444000 in 2016-2017 (DoFD, 2017). Regarding nurseries, they rear hatchlings to fry and fingerlings and supplied them to local farmers. Earlier record indicated that private sector supplied about 75% of all fingerlings while 25% comes from government sector (Gurung, 2003). Moreover, current record indicated that private sector is supplying about 80% of the total fry/advanced fry (Jha *et al*., 2015).

A reliable system that can produce sufficient fish seed is necessary and is one of the key factors for further aquaculture development. Nursing involves caring of one-week old hatchlings, which have just begun to eat and continues for a period of 20-30 days. These fry are further reared for a period of 2-3 months to produce fingerlings. It generally takes 3-4 months for rearing post larvae to fingerlings in the same ponds continuously (Jha *et al*., 2015). Information about the location of fish hatcheries and seasonal availability of fish seed is essential to meet local and national demand. Seed production systems of private fish hatcheries are very crucial and less studied. So far, no field surveys have been conducted scientifically at the private fish hatchery level on the status of seed production, it has become vital to address this problem so to develop aquaculture as an industry. This paper describes the status of carp seed production systems and their performances in the private hatcheries situated in different parts of Nepal, especially in Terai and inner Terai regions.

MATERIALS AND METHODS

Study area

A survey of 40 private fish hatcheries from different regions of Nepal from Terai and inner Terai was conducted from March 2009 to April 2014 to collect detailed information on carp seed production and management practices (Figure 1).

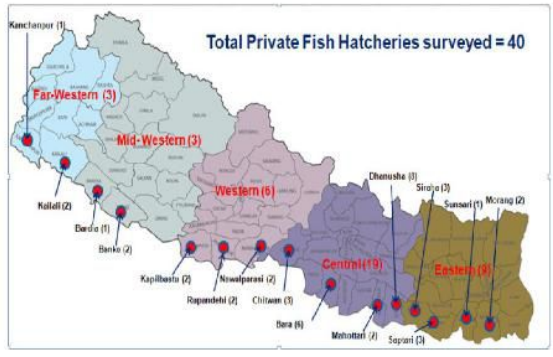

Figure 1. Map of Nepal showing study area.

Data collection

Primary data were collected using Semi-structured questionnaire which was prepared expecting the detailed information on the production and management practices of carp seed. It was pre-tested through a field visit before finalizing it. The questions were precise and free from any kind of influence. Hatchery owners were interviewed face-to-face in their own farms. In order to minimize errors, data were collected in local units and subsequently converted into appropriate entities. Systematic procedure was adopted for the selection of respondents of the survey site.

The secondary data related to the study were collected from Fisheries Development Centers (FDC) under the Directorate of Fisheries Development (DoFD), Kathmandu, Nepal and Fisheries Research Centers (FRC) under the National Agricultural Research Council (NARC). All of these centers were also visited during this study to find real field problems. Data were also collected through other Non-government organizations, journals and websites.

Breeding techniques

The synthetic hormone Ovaprim for indigenous major carps and analogues of luteinizing realesasing hormone (LRHa2) for Chinese major carps are commonly used for induced breeding. Some hatchery owners used Ovaprim only.

Ovaprim® (Syndel Laboratories Ltd., Canada) is a commercial product that contains salmon gonadotropin releasing hormone analogue (sGnRha; D-Arg6-Pro9-Net) and a dopamine anatagonist used as a spawning aid in fishes.

The Luteinizing Releasing Hormone analogue (LRHa) is a peptide (Des-Gly10,[D-Ala6]LRH Ethylamide) is similar in structure to native luteinizing releasing hormone (LRH). The LRHa2 available in the market is in the form of white powder made in China.

Healthy, parasite-free, well-formed and properly matured brood were selected. Synthetic hormone Ovaprim at a rate of 0.5ml kg^{-1}b.w and 0.3ml kg^{-1}b.w. were given to female and male breeders respectively. Similarly, LRHa2 was used @ 6-8 μg kg^{-1}b.w. Generally, male brood of all cultivated major carps given 40-50% less quantity of hormone. Injections were given intramuscularly, just behind the dorsal fin.

The Lactogen-1 and chicken eggs are commonly used to feed the spawn after 4 days. Some hatcheries also used cow milk, buffalo milk, soymilk and goat milk along with egg. Generally 1-2 chicken eggs were used for 100000 hatchlings.

Data analysis

The data collected from private fish hatcheries were compiled and analyzed for descriptive statistics using Microsoft Excel.

RESULTS

Almost all hatcheries in the study area involved in producing different stages of seeds of carps, mainly indigenous major carps, Chinese major carps and common carp. Generally, hatcheries begin their activities from February and continued upto September each year. There was specieswise sequence in carp breeding starting from common carp to other carps, namely; grass carp, silver carp, bighead carp, catla, mrigal and rohu. Demand for seed of these carps starts from March and ends in September. Highest demand of seed was observed during April - May as most of the growers follow carp polyculture. Generally, duration of hatchling cycle in most of the hatcheries was about 4-5 days and number of cycles per year varies between 20 and 40 depending on facilities of each hatchery.

The percentage of eggs fertility and hatchability was more (78.33 and 71.67) in mid western development region followed by eastern (68.89 and 61.67), central (68.33 and 61.67), far western (68.33 and 61.7) and western (68. 61.60) (Table 1).

Table 1. Fertility and hatchability of eggs (%).

Region	Eggs Fertility	Hatchability
Eastern	68.89	61.67
Central	68.33	61.67
Western	68.33	60.00
Mid western	78.33	71.67
Far western	68.33	61.67

Production and contribution of hatchlings from private hatcheries

Yearly production of hatchlings from different development regions indicated that central development region played important role. Production of hatchlings in 2009 was 58.2, 512.9, 157.5, 39.2, and 16.5 million in eastern, central, western, mid western and far western respectively. It was in increasing trend and production in 2013 was 172.5, 4951.6, 1520.1, 65.5 and 19.8 in eastern, central, western, mid western and far western respectively (Table 2). Total production of hatchlings in 5 years indicated that central development region was leading with highest score (Figure 2).

Table 2. Yearly production of hatchlings (million).

Year	Eastern	Central	Western	Mid-Western	Far Western	Total Overall
2009	58.20	512.90	157.50	39.20	16.50	784.30
2010	82.40	632.70	183.60	42.50	17.80	959.00
2011	114.30	2763.00	209.40	48.20	16.20	3151.10
2012	140.50	3789.10	224.60	57.50	17.00	4228.70
2013	172.50	4951.60	1520.10	65.50	19.80	6729.50
Total	**567.90**	**12649.30**	**2295.20**	**252.90**	**87.30**	**15852.60**

Similarly contribution from the central development region was more (65.4% in 2009 and 73.6 in 2013) and it was always leading in the production of hatchlings though western development region suddenly enhanced production from 5.2% in 2012 to 22.6% in 2013(Table 3). Mid western and far-western development region showed slightly decreasing trend (Table 3).

Table 3. Contribution of hatchlings from private fish hatcheries (%).

Year	Eastern	Central	Western	Mid- Western	Far Western	Total
2009	7.4	65.4	20.1	5.0	2.1	100.0
2010	9.0	66.0	19.1	4.4	1.9	100.0
2011	4.0	87.7	6.6	1.5	0.5	100.0
2012	3.0	89.6	5.3	1.4	0.4	100.0
2013	3.0	73.6	22.6	1.0	0.3	100.0

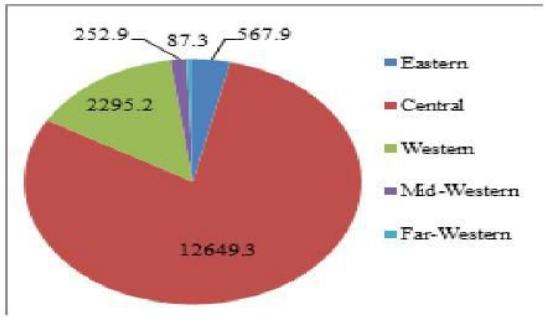

Figure 2. Total hatchling production (million) in five years from different regions.

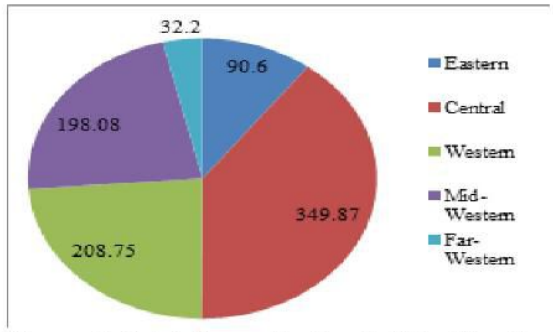

Figure 3. Total fry production (million) in five years from different regions.

Production and contribution of fry from private hatcheries

Yearly production of fry from different development regions indicated that central development region played important role. Production of fry in 2009 was 9.7, 51.4, 27.8, 39.8, and 4.5 million in eastern, central, western, mid western and far western respectively. It was in increasing trend and production in the year 2013 was 27.2, 87.4, 57.7, 41.0 and 8.5 in eastern, central, western, mid western and far western respectively (Table 4). Total production of fry in 5 years indicated that central development region was leading with highest score (Figure 3).

Table 4. Yearly production of fry (million).

Year	Eastern	Central	Western	Mid Western	Far Western	Total Overall
2009	9.70	51.38	27.80	39.80	4.50	133.18
2010	13.50	65.89	31.95	38.75	5.50	155.59
2011	18.00	68.08	43.00	38.93	6.20	174.21
2012	22.20	77.07	48.30	39.60	7.50	194.67
2013	27.20	87.45	57.70	41.00	8.50	221.85
Total	**90.60**	**349.87**	**208.75**	**198.08**	**32.20**	**879.50**

Similarly contribution from the central development region was more (38.6% in 2009 and 39.4 in 2013) and it was always leading in the production of fry. The western development region has maintained steady increment from 20.9% in 2009 to 26% in 2013 (Table 5). Mid western and far-western development region showed slightly decreasing trend while eastern development region revealed gradually increasing trend. It was 7.3, 8.7, 10.3, 11.4 and 12.3% in 2009, 2010, 2011, 2012 and 2013 respectively (Table 5).

Table 5. Contribution of fry from private fish hatcheries in total by region (%).

Year	Eastern	Central	Western	Mid- Western	Far Western	Total Overall
2009	7.3	38.6	20.9	29.9	3.4	100.0
2010	8.7	42.3	20.5	24.9	3.5	100.0
2011	10.3	39.1	24.7	22.3	3.6	100.0
2012	11.4	39.6	24.8	20.3	3.9	100.0
2013	12.3	39.4	26.0	18.5	3.8	100.0

Production and contribution of advanced fry from private hatcheries

Yearly production of advanced fry from different development regions indicated that mid western development region played important role as it produced 23.0, 22.8, 23.0, 23.3, and 30.6 million in 2009, 2010, 2011, 2012 and 2013 respectively (Table 6). Production of advanced fry in 2009 was 2.9, 4.9, 5.2, 23.0, and 1.9 million in eastern, central, western, mid western and far western respectively. It was in increasing trend and production in 2013 was 6.9, 9.9, 18.9, 30.6 and 3.6 million in eastern, central, western, mid western and far western respectively (Table 6). Total production of advanced fry in 5 years indicated that mid-western development region was leading with highest score (Figure 4).

Table 6. Yearly production of advanced fry (million).

Year	Eastern	Central	Western	Mid Western	Far Western	Total Overall
2009	2.90	4.88	5.21	23.00	1.90	37.89
2010	4.05	5.99	6.46	22.80	2.25	41.55
2011	5.50	6.89	14.41	23.09	2.70	52.59
2012	6.35	8.52	16.22	23.33	3.07	57.49
2013	6.90	9.99	18.93	30.60	3.60	70.02
Total	**25.70**	**36.27**	**61.23**	**122.82**	**13.52**	**259.54**

Similarly contribution from the mid western development region was more (60.7% in 2009 and 43.7 in 2013) and it was always leading in the production of advanced fry. The western development region has maintained steady increment from 13.8% in 2009 to 27% in 2013 (Table 7). The central development region showed slightly increasing trend from 12.9% in 2009 to 14.3% in 2013 (Table 7) while far western development region revealed a stable contribution which was 5% in 2009 and 5.1% in 2013. The eastern development region has varied results. It was 7.7, 9.7, 10.5, 11.0 and 9.9% in 2009, 2010, 2011, 2012 and 2013 respectively (Table 7).

Table 7. Contribution of advanced fry from private hatcheries (%).

Year	Eastern	Central	Western	Mid- Western	Far Western	Total
2009	7.7	12.9	13.8	60.7	5.0	100.0
2010	9.7	14.4	15.5	54.9	5.4	100.0
2011	10.5	13.1	27.4	43.9	5.1	100.0
2012	11.0	14.8	28.2	40.6	5.3	100.0
2013	9.9	14.3	27.0	43.7	5.1	100.0

All these development regions showed increasing trend of their own contribution within a total of five year. It was quite interesting that private hatcheries supplied more advanced fry than DoFD and Fisheries centers under NARC.

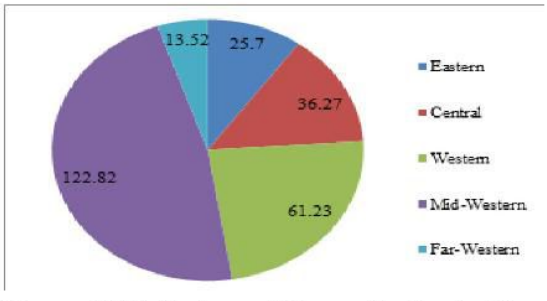

Figure 4. Total advanced fry production (million in five years from different regions

DISCUSSION

Fish farming in Nepal is rapidly expanding and considering its potential in the near future, adequate production and supply of quality fish seed should be the main focus. Present survey clearly indicated that there are some rooms for the improvement in existing private hatcheries to increase productivity and seed supply. It has been reported that collection and incubation of seed can result in high losses due to poor management (Jha *et al.*, 2015). About 70% hatchery owners mentioned that they didn't have practical hands-on knowledge for better management of their hatcheries. Technical

knowledge on better management practices would certainly enhance seed quality.

A number of stress factors - such as low dissolved oxygen, temperature and pH variations; nutritional deficiencies; overcrowding and aggression from other fish; and handling and waste loading occurring especially in artificial confinement result in immunosuppressive fish which are more susceptible to disease organisms and affect seed production. Other than environmental factors, predatory aquatic insects and parasitic diseases are also limiting the growth and survival of juveniles (Jha and Bhujel, 2012). Most of the hatchery owners do not have understanding of health issues in their systems. Some hatcheries stocked different stages of seed three to five times more than those of usual range, which affects survival. It has been reported that low survival and slow growth of fish is due to poor quality seed which create negative impacts for farmers practicing fish culture (Barman *et al.*, 2002; Edwards, 2013). Mohan (2007) reported that the seed which are healthy, full of life and uniform size fit the definition of good quality seed irrespective of the species.

In most of the hatcheries there is no brood replenishment. Continuous use of same broods might have resulted in inbreeding causing low quality of seed affecting the survival as well as the growth of the juveniles. Increased frequency of spawning and off-season production, both of which may increase stress on brood fish result in production of immature gametes and hence fish seed quality (Little *et al.*, 2002). Brood stock improvement should be considered as one of the most important management aspects of all seed production units that lead to good response in breeding, increased fertilization, hatching and larval survival (Routray, 2012). Generally duration of hatchling cycles in most of the hatcheries was about four to five days and number of cycles per year between 20-40 depending on size and facilities of hatcheries. In Jessore district of Bangladesh number of cycles per year was between 30-35 (Samad *et al.*, 2014).

Relatively few hatchery operators reported fish health problem, which might be due to the lack of awareness about the problems. In order to improve seed availability, there should be a collaborative approach and networking among different organizations of seed producers and all stakeholders. Quality feed with supplementation of multi-strain probiotics increases survival and growth of carp hatchlings (Jha *et al.*, 2015). Use of live food enriched with amino acids can also improve growth and survival of fish larvae and in good quality (Phelps, 2010; Horvath *et al.*, 2015).

Hapa nursing of juveniles significantly improves survival because predators such as snakes, insects and frogs found in ponds normally are prevented or reduced. If young fish are in hapas, it is easy to cover by net to protect from birds as well. Therefore, emphasis should be given to manage nursing fry and advanced fry in hapa in pond systems. Hapa or cage nursing has been proved very useful in other countries of Asia such as Bangladesh and Thailand. Specially, spawns in the early hatching period (up to four weeks) should be given more protection from predation, and rearing of such juvenile in hapa made by polyester cloth improved survival of common carp spawn (Chandra *et. al.*, 2011; Sarkar *et. al.*, 2007). Similar results were reported in the hatchlings of *Labeo rohita* when reared in hapas (Jha *et. al.*, 2015).

Fish growers often complain about poor growth of fish procured from hatcheries as not reaching marketable size within the specified period.

Marketing of substandard quality of seed is due to unhealthy competition among the hatcheries. For them quantity is important rather than the quality. There is a growing concern and need to develop standard norms for hatcheries and accreditation of hatcheries based on particular norms to maintain the supply of quality seed. Data recording systems are very poor as most of the hatchery operators are not well trained to keep proper records and manage hatcheries hygienically. There is no certification system for the hatcheries which exist in some countries.

Most of the hatcheries face enormous problems during seed production cycle. There is a need of collaborative approach among different organizations responsible for sustainable fish production in Nepal to take necessary actions to resolve the health and growth related problems in juveniles and table fish.

CONCLUSION

Carps are the major species which occupied around 95% of total production. Carp culture is largely dependent on the seeds produced from private fish hatcheries other than hatcheries from government and NARC. Due to inbreeding and poor management of brood stock, quality of seed is deteriorating, which affected not only survival and growth of the juveniles but also production. Sometimes, mass mortality of hatchlings in rearing unit occurred due to poor management and fish pathogens. It was found that substandard quality of seed due to unhealthy competition among the hatcheries. For them quantity is important rather than the quality. Data recording system was very poor as most of the hatchery operators are not well trained. Monitoring and evaluation practices should be established so that hatchery operators follow the standard procedures.

ACKNOWLEDGMENTS

The authors would like to acknowledge the contribution of the Nepal Local Currency Fund through the Asian Institute of Technology, Thailand, for supporting the research. We also thank the hatchery owners for their warm welcome during the survey.

REFERENCES

Barman, B. K., D. C. Little and Nietes-Sataponvanit (2002). State of the System Report: fish seed quality in Northwest Bangladesh. In: Penman, D.J., M.G. Hussain, B.J. McAndrew and M.A. Mazid (eds.). *Proceedings of a Workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia*, 12-14 February, 2002, Dhaka, Bangladesh. Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh, pp. 69-75.

Bhujel, R. C. (2012). Increasing role and potential of Small-Scale Aquaculture: National, regional and global perspectives. In: Shrestha, M.K. and J. Pant (eds.) *Proceedings of the National Symposium on Small-scale Aquaculture for Increasing Resilience of Rural Livelihoods in Nepal.* Institute of Agriculture and Animal Science, Tribhuvan University, Rampur, Chitwan, Nepal, and The World Fish Center, Penang, Malaysia, p.191.

Chandra, K. J., B. Das, and D. R. Das (2011). Effect of nursing methods on survival of Common carp, *Cyprinus carpio* Lin. Spawn. *J. Agrofor. Environ.* **5(1)**: 117-120.

DoFD (2014). ***Annual Progress Report.*** **Government of Nepal, Directorate of Fisheries Development, Balaju, Kathmandu, Nepal.**

DoFD (2017). *Annual Progress Report* 2016-2017. Government of Nepal, Directorate of Fisheries Development, Balaju,

Kathmandu, Nepal.

Edward, P. (2013). Peter Edwards writes on rural aquaculture. Pond aquaculture is taking off in Nepal. *Aquaculture Asia.* **18(4)**: 3-11.

Gurung. T. B. (2003). Fisheries and Aquaculture Activities in Nepal. *Aquaculture Asia.* **8(1)**: 14-19.

Horvath, L., G. Tamas, A. G. Coche, E. Kovacs, T. Moth-Poulsen and E. Wynarovich (2015). *Training Manual on the Advanced Fry and Fingerling Production of Carps in Ponds.* A handout for on –farm training workshop on fish seed production of Common carp and Chinese major carps in Central and Eastern Europe, the Caucasus and Central Asia. Second revised edition. Budapest, FAO-REU, pp. 32.

Jha, D. K. and R. C. Bhujel (2012). Incidence of fish diseases and management practices in Nepal. In: Shrestha, M.K. and J. Pant(eds.) *Proceedings of the National Symposium on Small-scale Aquaculture for Increasing Resilience of Rural Livelihoods in Nepal.* Institute of Agriculture and Animal Science, Tribhuvan University, Rampur, Chitwan, Nepal, and The World Fish Center, Penang, Malaysia.

Jha, D. K., R. C. Bhujel and A. K. Anal (2015). Carp seed survival in private hatcheries of Nepal. *Nepalese Journal of Aquaculture and Fisheries* **2**: 65-75.

Little, D. C., A. Satapornvanit and P. Edwards (2002). Freshwater fish seed quality in Asia. In: P. Edwards, D.C. Little, H. Demaine (eds.), *Rural Aquaculture*. CAB International, Wallingford, 185-195 pp.

Mishra, R. N. and P. S. Kunwar (2014). Status of Aquaculture in Nepal. *Nepalese Journal of Aquaculture and Fisheries* **1**: 1-17.

Mohan, C. V. (2007). Seed quality in freshwater fish production. In: M.G. Bondad-Reantaso (edi.). Assessment of freshwater fish seed resources for sustainable aquaculture. *FAO Fisheries Technical Paper.* No. 501. Rome, FAO. 2007, 499-517 pp.

Phelps, R. P. (2010). Recent advances in fish hatchery management. *Revista Brasileira de Zootecnia* **39**: 95-101.

Routray, P. (2012). Carp brood stock management and quality seed production. In: Das, M. K., P. Routray, N. K. Barik, P. Jayasankar (eds.). *Quality Fish Seed Production Through Brood Fish Management in SAARC Countries*. CIFA, Bhubaneswar, India, 22-39 pp.

Samad, M. A., M. M. Hossain, A. B. M. S. Nima Rahman and M. I. Haidar (2014). Present status of freshwater prawn culture and management system in Abhaynagar Upazila in Jessore of Bangladesh. *Bangladesh Research Publications Journal*, **9(3)**: 182-189.

Sarkar, U. K., P. K. Deepak, R. S. Negi, T.A. Qureshi and W.S. Lakra (2007). Efficacy of different types of live and non conventional diets in endangered clown knife fish *Chitala chitala* (Hamilton Buchanan) during its early life stages. *Aquaculture Research* **38(13)**: 1404-1410.

(Received July 7, 2019; revised accepted September 10, 2019)