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Fish seed transportation losses, its causes and good aquaculture practices (GAP) for fish seed transportation in Nepal

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Abstract
This study has attempted to access the fish seed transport losses, its causes and way forward the Good Aquaculture Practices (GAP'S) for fish seed trasportation in Nepal. Survey of hatchery owners, nurseries owners, fry traders and fish farmers selected from five districts (Bara, Dhanusha, Mahottari, Sunsari and Kaski) of Nepal were completed from August, 2017-April, 2018. The present survey showed that recommended practices such as conditioning, handling, packing, and acclimatization of fish seed have been not followed by hatchery/nursery owner, fish traders and farmers. Fish seed mortality was found increased with increased duration of transportation times and its ranges between 5-30%. Standard protocol of safe fish seed transportation from carefully handling of fish seed in netting and collection, conditioning before transport, optimum packing density, care during transportation and acclimatization before stocking in ponds as described in this paper should be followed by hatchery owner, nursery owner, fish seed traders, and farmers to reduce the fish seed mortality during and after transportation, and to stock healthy fish seed in ponds.

Keywords: fish seed, transportation, stress, mortality, nursery, hatchery

Introduction
Aquaculture was started in late 1950 in Nepal and it is now fast growing sector (Gurung, 2016) [7]. At present, aquaculture is expanded in the 55 districts out of 77 districts. Polyculture of carp fish in semi-intensive farming in ponds is dominants in the terai regions of Nepal. Seven species of commercially valuable carps are being cultured in Nepal. These include three indigenous species: rohu (*Labeo rohita*), naini (*Cirrhinus mrigala*), bhakur (*Catla catla*) and four exotic species: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idella*). Pond fish farming produces alone 67.52% (70,832 t) of the total aquaculture production in 2017/18 (CFPCC, 2018/19) [2]. In Nepal, fish seed are distributed in three forms: hatchlings: 4-5 days old, fry: 2-3 cm or ~1 g and fingerlings: 2-7 g body weight each in average. Both public and private sector are contributing for seed supply. There are 14 Governments (CFPCC & NARC) and 83 private hatcheries, 235 nurseries and thousands of fish seed traders working in Nepal (Rijal and Jha 219&20) [22].

Fish transport is one of the most stressful procedures in aquaculture facilities (Inoue *et al.* 2005) [15]. Transportation procedures consist of several potential stressors, such as capture, on-loading, confinement, transport, unloading, temperature differences, water quality changes and stocking (Svobodová *et al*. 1999, Iversen *et al*. 2005, Dobšíková *et al*. 2006; 2009) [25, 17,5, 6]. Mortality rates of fish seed depends on the time scale and loading density and water medium (Islam and Hussain 2013; Pakhira *et al*. 2015) [16, 21]. It was reported that the mortality in carp's fry/fingerlings was as high as 90% depending on the type of transport containers used (Lewis *et al*. 1996) [19]. Mortality of fish seeds recorded to 22.5- 82% in traditional transportation system (Islam and Hussain 2013) [16]. Fish stress and mortality can cause significant losses of resources and productivity in both capture and culture systems (Husen and Sharma 2014) [11]. Significance mortality during and post transportation of fish seed (up to 70%) experience by farmers in Nepal (Wagle *et al*. 2012) [26]. Due to expansion of aquaculture in Nepal, supply of quality and healthy fish seed for stocking in ponds is the urgent issue. Therefore, this study was aimed to explore the fish seed transportation protocol used by hatchery/nursery owners, traders, and farmers and to access the mortality rate (%) during transportation, its causes and recommend the possible ways to reduce the mortality of fish seed.

Methodology
Purposive sampling technique was used to collect data and information during the period of August 2017 to April, 2018. Five hatchery owner, five nurseries owner, five fry traders and twenty pond fish farmers were selected from each five districts (Bara, Dhanusha, Mahottari, Sunsari and Kaski) of Nepal. These respondents were interviewed using pre-tested structured questionnaire. Secondary informations were gathered from published article, journals, and proceedings. Data were summarized in Microsoft excel 2013.

Results and Discussions
Fish seed transportation system
The present survey showed that five fish seed marketing channel have been practiced for fish seed distribution in Nepal. Mostly, the small farmers have been purchasing fry/ fingerlings from traders (mallah/beyapari). However, the commercial farmers have been purchasing hatchlings and fry directly from fish hatchery (Box-1).

Box-1. Fish seed marketing Channel

1. Fish hatchery cum nursery– fish nursery – fish seed traders (Mallah/Beyapari) – fish growing farmers
2. Fish nursery – fish seed traders (Mallah/Beyapari) – fish growing farmers
3. Fish seed traders (Mallah/Beyapari) - fish growing farmers
4. Fish nursery– Fish growing farmers
5. Fish hatchery cum nursery - Fish growing farmers

The present findings of survey showed that recommended practices such as conditioning, handling, and acclimatization of fish seed have been not followed by hatchery/nursery worker in Nepal (Fig.1, 2). About 26% of fish hatchery/nursery workers were found to sell their fish seed immediately after collection from the ponds without conditioning. This is the main reason for the fish seed mortality during transportation. Conditioning (the acclimatization of fish prior to transport), plays an important role in increasing survival of fish (Ross and Ross 2008; Hasan, 2008) [23,15]. by emptying their stomach during conditioning to accustomed in the crowded condition. The period of conditioning is 24-72 hours depending on the size and health of post larvae, fry and fingerlings (Jhingran and Pullin, 1985) [18]. The unconditioned fingerlings had 5-folds higher mortality (32.30 ± 2.96%) than the conditioned ones (6.41 ± 0.88%) (Hasan, 2008) [9].

The fish seed traders and farmers have been using taxi, tanga, bus, pickup/minitruck, rickshaw etc. for the transportation of fish seed. In general, 1-2 pack of fish seed is transported by cycles and motorcycles in Nepal (Fig. 3). Taxi usually used in Kaski districts and Tamtam/tanga in the terai districts of Nepal for fish seed transportation.

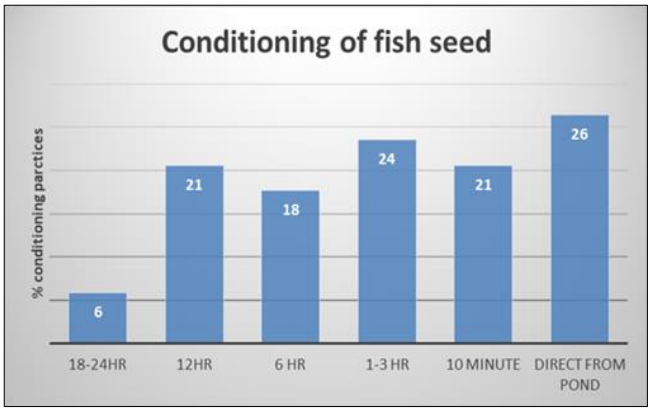

Fig 1: Percentage of conditioning practices applied by hatchery//nursery owner

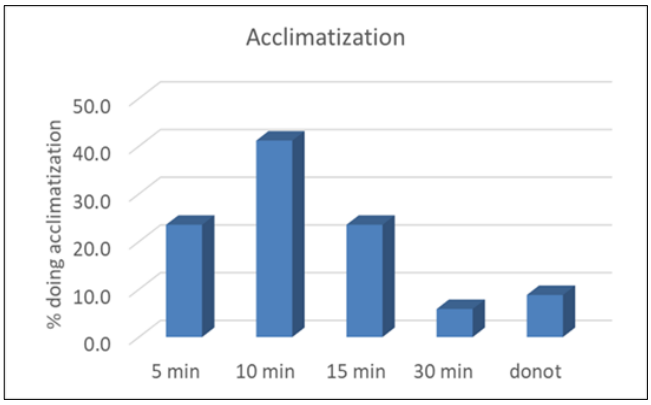

Fig 2: Percentage of acclimatization practices applied by farmers.

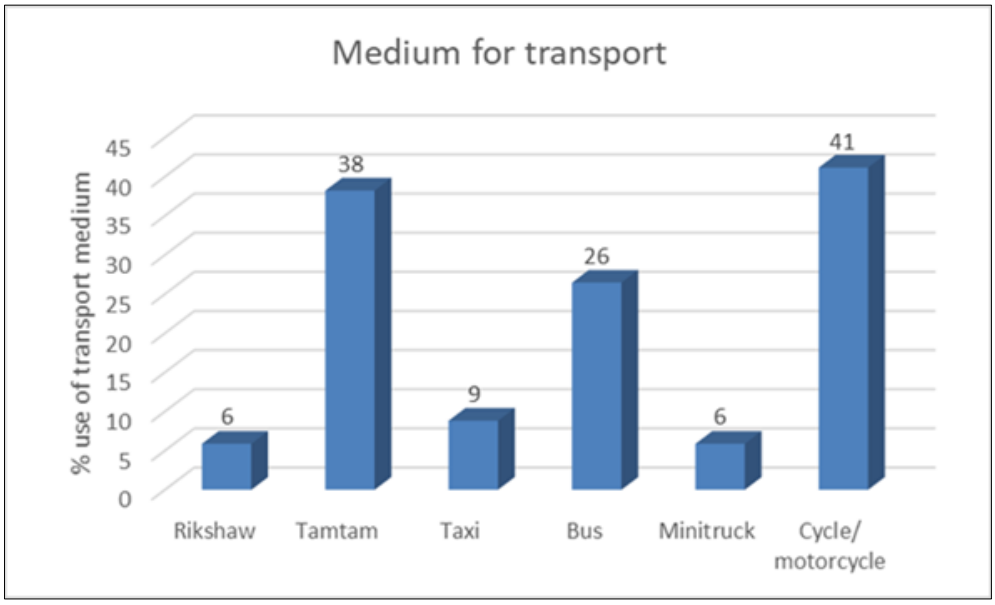

Fig 3: Medium of transport used by farmers to transport fish seed.

Fish seed transportation in traditional ways is still existing practices in Nepal, using different types of containers (Aluminum hundies, plastic container with water in open system) for short distance. Oxygenation is done by frequent splashing of water. However, for long distance transportation, packing of fish seed in the polythene bag with oxygen (closed system) have been practiced. Hatchery owner /nursery owner generally used to pack fish fry in polythene bag with oxygen at packing density of (Mean ±SD) 290±110 / L of fry size 0.5-2.0 g and its rages between 100-500 numbers/ L of water. This packing density of fish seed is within the range of previous recommendation by Jhingran and Pullin (1985) [18]. However, present findings of packing density is higher than the optimum packing density recommendations for rohu fry 40g/L of water for 24 hr duration (~80 fry(0.5g)/L) (Chatterjee *et al.* 2010) [3]. The

farmers didn't acclimatize properly and in proper time fish seed before stocking in the ponds. Only about 25% of farmers acclimatize above 10 minutes (Fig.2).

Fish seed mortality

This study revealed that the hardiness of fish species to tolerate the transportation stress at fry stage could be sequence as hardier fish from Common carp > Bhakur > Mrigal) >Rohu>Bighead carp> Grass carp > Silver carp. Fish seed mortality due to transport stress depends on the duration of transportation and fish species. Fish seed mortality (%) was found increased with increased duration of transportation times. In Nepal, hatcheries / fish seed production units are generally located far away from fish rearing ponds/farms. Therefore, transport of fish seed in stages fry-fingerlings from hatchery to culture units/farms is compulsory that often link to the problem of transport stress and mortality (Husen and Sharma, 2015a) [12]. In the present's findings, carp fish seed mortality were ranges from 5 to 30% (Fig. 4 and Table 1) and it is varies species to species. 30-37% mortality rate were observed in the Indian major carps when confined in polyethylene bags for 48 h (Singh *et al*. 2004) [24]. Higher mortality rate (30%) has been reported during transportation of rohu fingerlings in open aluminium vessels (Hasan and Bart 2007) [8]. The immediate fish mortality usually varies from 5-25% in carp fish seed as found in the survey of farmers and fish traders in Bangladesh (Hasan, 2009) [10].

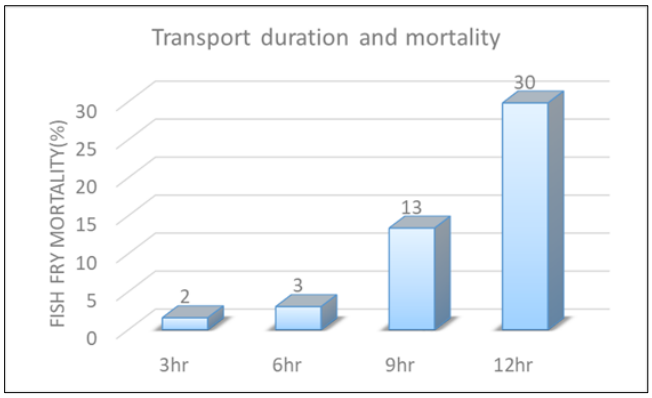

Fig 4: Transport duration and mortality of fish seed

Table 1: Fish seed mortality in carp fish species during transportation

Fish species	Fish seed mortality (%)	
	Mean±SD	Range
Silver carp	24.3±4.6	5.0-30.0
Grass carp	16.5±4.5	20.0-30.0
Bighead carp	16.4±3.2	10.0-20.0
Rohu	15.4±4.5	10.0-25.0
Naini	11.4±1.7	10.0-15.0
Bhakur	10.3±0.8	10.0-12.0
Common carp	8.3±2.3	2.0-10.0
overall	21.1±8.3	5.0-30.

Good aquaculture practices (GAP) for fish seed transportation

Quality of seed and later performance are negatively affects due to poor husbandry practices during production, nursing, holding or transportation. Therefore, harvest and transport of seed should be done carefully with minimum stress. This will ensure good survival rate of seed on stocking into the grow-out ponds (Mohan, 2007) [20]. Carefully handling of fish seed from netting, handling and packing should be followed by hatchery and nursery owner with proper conditioning before transportation and acclimatization before stocking to avoid fish seed stress and mortality.

Netting of fish seed

Fish seed should be netted from nursery ponds in the morning time at low temperature. The fish should be netted by soft drag net with minimum stress. Preferably, knotless nets should be used to net fish, and fish should be handled in low-light environments (Berka 1986, Mohan 2007) [1, 20]. Mechanical abrasion of fish seed during netting and handlings should be avoided.

Conditioning prior to transport

Conditioning (the acclimation of fish prior to transport) will increase the survival rate of fish (Ross and Ross 2008, Hasan 2008) [23, 15]. This process consists of a period of starvation in holding facilities with good water exchange to ensure that all faeces are voided and should become accustomed to the conditions of overcrowding prevailing during transport (Jhingran and Pullin, 1985; Ross and Ross 2008) [18,23]. A cloth hapa or conditioning tank with hapa could be used for the conditioning of fish seed. Feeding should be stopped and water exchange should be continued till conditioning process. The site of conditioning should be arranged in a shaded area during conditioning. The period of conditioning depends on the size and health of post larvae, fry and fingerlings. Generally, fish seed should be conditioned for 12-24 hours.

Packing of fish seed

Open containers is not useful for the transportation of fish seed. Always use closed container with oxygen. Polythene pack of 16-18 liter capacity could be used with oxygen for the transportation. For the transportation of higher number of fish seed, plastic tank with foam lining inside should be used. The packing density depends on size of the fish and duration of transportation. Packing density should be optimized for the specific period of transportation to avoid stress-related mortality both during and/or after transportation (Chatterjee *et al*. 2006; Chatterjee *et al*. 2010). [4, 3].

Table 2: Packing density of carp fry/fingerlings of fish for safe fish transportation in 16-18 liters capacity bag.

Size (g)	Numbers of fry/ fingerlings packed in plastic bag up to 6 hr	Numbers of fry/ fingerlings packed in plastic bag up to 12 hr
0.5	1000-1500	700-1000
1.0	750-900	500-600
2.0	225-300	150-200
3.0	150-225	100-150
4.0	115-150	75-100
5.0	90-115	60-75
6.0	75-110	50-70
7.0	65-90	45-60
8.0	60-75	40-50

Only healthy fish seed should be sorted for the transportation. The packing density/numbers should be at the rate of 40-50g/L or 80-100 fry (0.5g)/L of water for the transportation of fish seed (Chatterjee *et al*. 2006; Chatterjee *et al*. 2010; Husen and Sharma 2015b) [13]. Optimum packing density for Indian major carp fry size (0.5g) was found 100 fry/L of water for transportation up to 6h (Chatterjee *et al*. 2006) [4]. For

short duration, optimum packing density for advanced rohu fingerlings (14.00-15.00 cm) for 2–3 h duration of transport was found 134 g/L of water (Pakhira *et al*. 2015) [21]. On the basis of above findings, the optimum packing density for the safe fish seed transportation is presented in the table 2. The water used for the fish seed packing should be clean with high oxygen level (5-8 mg/L).

Use of therapeutics and herbal anesthetics

The fry bathed with saline water (0.9% NaCl solution) before transportation was found to decrease handling stress and delayed mortality of fish fry (Islam and Hussain 2013) [16]. Addition of 0.3-0.5% sodium chloride (NaCl) to transport water reduces handling stress and later-stage mortality in transported fishes (Berka 1986) [1]. Additionally, use of anesthetics in optimum concentration will mitigate the stress and its related harm in fish, by increasing fish welfare, production, and profitability (Husen and Sharma 2014) [12]. Clove oil is one of the emerging herbal anesthetics for the fish handlings and transportation due its good features like easy to access, environment and human friendly and economics anesthetics. The findings of earlier studies that addition of optimum dose of herbal anesthetic clove oil at the rate of 0.4-0.5µl/L in the transport water was found to reduce the fish seed mortality during transportation (Husen and Sharma, 2015b; Husen and Sharma 2015c) [13, 14]could be applicable for safe fish seed transportation. Addition of zeolite, at 7g/L to the transport water was found to improve the water quality by reducing the concentration of ammonia which increased the survival of fish seed (Singh *et al*. 2004) [24].

Care during transportation

The transportation should be done in the morning hour to avoid the increase of temperature of water. Covering of polythene bag after packing with moist jute bag/cotton cloth and sprinkling of cold water in 1-2 hr interval of time during transportation will make temperature low. Foam cushion should be provided for the polythene bag to avoid jerk during transportation. The packing bag should be checked regularly for leakage.

Acclimatization and stocking

The fish should be acclimatized to pond water temperature before stocking. The bag should be kept in the pond water for at least 15-30 minutes to ensure the matching of temperatures of transport water and pond water. After acclimatization, the bag should be opened and fish seed should be released slowly in the pond.

Conclusions

The Good Aquaculture Practices (GAP'S) for fish seed transportation from carefully handling of fish seed at netting, collection, conditioning, optimum packing density, care during transportation and acclimatization before stocking in ponds should be practically followed in the fields by hatchery and nursery owner, and farmers to reduce pre-transport stress, and mortality during / after transportation and to stock healthy fish seed in aquaculture facilities. Addition of 0.3-0.5% sodium chloride (NaCl) and herbal anesthetic clove oil at the rate of 0.4-0.5µl/L to transport water could be an option to reduce stress related fish seed mortality during fish seed transportation. These practices will helps to stock healthy fish seed, hence enhance the fish productivity, production, and profitability from fish farming. Strategy to promote the farmers/farmers groups for their own nurseries at or near to their farm to avoid long durations of fish seed transportation and to improve quality of fish seed for stocking by government agencies is urgent need. Training to hatchery and nursery owner, farmers should be provided to upgrade the skills on the fish seed handling and transportation.

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