

7. Livestock Improvement

The livestock sector provides livelihood and nutritional security to about 70% rural masses. Moreover consumption of livestock products is growing at a faster rate in urban population. Considering the importance of livestock, various livestock improvement programmes for different species, viz. cattle, buffaloes, goat, sheep, pig and poultry were undertaken for production and dissemination of superior germplasm under farm/field conditions.

Cattle

Genetic aspects of Holstein-Sahiwal crossbreds

The national milch breed “Frieswal”, is being evolved by *inter-se* mating of Holstein-Sahiwal crossbreds with the target to produce 4,000 kg milk in a mature lactation of 300 days with 4% butter fat. The number of Frieswal cows has increased to 18,047 with 951 elite cows declared on the basis of milk yield of more than 4,000 kg in first or 4,500 kg in second or 5,000 kg or more in third lactation. Bull calves (100) born to elite cows were received at the Bull Rearing Unit of the centre for future germplasm production. The average of service period, dry period, calving interval and 300 days milk yield of Frieswal cows were 148.45 days, 107.59 days, 426.64 days and 3,262.90 kg, respectively, during 2013–14 as compared to 171.20 days, 125.16 days and 445.20 days and 3,240.81 kg in 2009–10. The total milk yield, peak yield and lactation length were 3,307.09 kg, 15.06 kg and 328.36 days, respectively. A total of 105 Frieswal bulls have been evaluated since inception of the project based on their daughters’ first lactation milk yield.

Improvement of indigenous cattle through selection

This project was conceptualized for the genetic improvement of some important native cattle breeds in their home tracts. The programme covers Gir, Kankrej and Sahiwal breeds.

Gir: In second set 8 Gir bulls were introduced for progeny testing. The artificial insemination carried out in farmers’ herd resulted in overall conception rate of 49.75%. The average age at first calving, first lactation milk yield, lactation length and service period in the germplasm units were 1,698.5 days, 1,736.6 kg, 348.6 days and 244.0 days, respectively; whereas in data recording units the corresponding values were 1,391.7 days, 2,205.9 kg, 259.5 days and 217.0 days.

Kankrej: In farmers’ herd artificial insemination resulted in overall conception rate of 51.21%. The average total lactation milk yield and lactation length in germplasm unit were 2,634 kg and 295.05 days, respectively; whereas in data recording units the average first lactation milk yield, total lactation milk yield and

‘Lalima’, cloned female calf of an elite Murrah buffalo

Female cloned buffalo calf named ‘Lalima’, produced through ‘Hand-guided Cloning’, born on 2 May 2014, weighed 36 kg at birth, at NDRI Livestock Farm. The donor cell was taken from the ear of MU-5345, an elite Murrah buffalo, which produced 2,713 kg milk in standard lactation period of 305 days, and 3,494 kg in total lactation period of 471 days during her third lactation.



Cloned calf named ‘Lalima’, produced through ‘Hand-guided Cloning’ on 2 May 2014

Rajat: Cloned male buffalo produced from frozen thawed semen

A male cloned calf named ‘Rajat’ produced through ‘Hand-guided Cloning’ was born on 23rd July 2014 by normal parturition. Its weight at the time of birth was 32 kg. The calf is a clone of a highly ranked progeny-tested Murrah buffalo bull (MU-4393), which had died many years back. The donor cell was isolated from the frozen-thawed semen of this bull, which was born on 10 December 1995. The bull ranked ‘first’ in fifth set of all India progeny-testing program and had 22.29% superiority. This technology could be very useful in multiplying the number of best bulls and meet the demand in the country.

first lactation length were 2,209.90 kg, 2,348.31 kg and 290.83 days, respectively. This breed seems to have good potential for higher milk production.

Sahiwal: Progeny testing programme on Sahiwal is being carried out at NDRI Karnal (Germplasm unit);



Progeny testing programme on Sahiwal is being carried out as associated herd programme involving organized Sahiwal herds at different locations



GLF Hisar; Gaushala Bhiwani; GBPUA&T Pantnagar; GADVASU Farm at Kaljharani; and Veterinary College Durg. All the bulls for progeny testing were provided by NDRI with dam's milk yield exceeding 2,500 kg/lactation. In first set 8 bulls and in the second set 6 bulls were introduced under the programme. During the period 1,216 inseminations were carried out resulting in an overall average conception rate of 37.10%. Semen doses from each bull were provided evenly at all centres to get performance records of the test bulls at different locations.

Field recording of performance data for large scale progeny testing: Progeny testing of Frieswal (HF×Sahiwal) bulls was done under field conditions at four different agro-climatic locations in India having large concentration of HF crosses. The overall conception rates in GADVASU (Ludhiana), KVASU (Thrissur), BAIF (Urulikanchan) and newly introduced Centre GBPUA&T (Pantnagar) were 43.60, 45.60, 47.30 and 56.20%, respectively. The average first lactation 305 days milk yield showed an increasing trend in the three field centres as it increased from 2,449 to 3,699 kg in GADVASU, 1,958 to 2,725 kg in KVASU and 2,848 to 3,094 kg in BAIF since inception. Bulls of fifth and sixth set were evaluated independently in BAIF, GADVASU and KVASU units. The overall least squares means of first lactation milk yield of daughters of fifth set of bulls in BAIF, GADVASU and KVASU were 2,985.75, 2,941.06 and 2,288.29 kg, respectively; while the corresponding values in the sixth set were 3,073.50, 3,165.59 and 2,494.67 kg, respectively. A consistent increase in productivity at all units was achieved.

Buffalo

Genetic resource improvement: The fifth set of Nili-Ravi bulls was used, and performance of the progeny is being recorded. Best ever average standard lactation (305 or less days) milk yield of Nili Ravi was 2,297 kg. The overall conception rate in Murrah herd during the year was 51.2%, a significant

improvement over the previous year.

Under the Network Project on Buffalo Improvement, the wet average of Murrah herds at various centres increased from 5.29 at the start of the project (1992–93) to 7.15 during 2012–13 and further to 7.73 in the year under report. There is also an improvement in average standard lactation yield from 1,602 kg in 1992–93 to 2,351 kg in 2013–14 across all Murrah centres.

Semen conservation and dissemination: A total of 110,844 frozen semen doses of Murrah bulls were produced, 18,805 doses were used for test matings and 75,500 doses were sold to farmers and other agencies. Pedigreed Murrah bulls were sold to livestock development boards and other developmental agencies of Haryana, Madhya Pradesh and Rajasthan for breeding and improvement of buffaloes. Increased interest in Nili Ravi breed is evident by sudden surge in frozen semen demand by farmers leading to sale of 27,875 doses of frozen semen of elite bulls. Institute's initiative to collect semen from champion Murrah bulls, available with Haryana's progressive farmers, was immensely popular; and 15,158 doses of semen were preserved from these bulls after stringent quality and disease tests, and made available to the farmers for breed improvement.

Field progeny testing programme: Artificial inseminations (16,394) with the semen of 10 test Murrah bulls of 14th set were performed and 6,934 pregnancies were confirmed. A total of 5,286 calvings were recorded and milk recording was completed in 363 daughters under various field unit centres.

Sheep

Increasing productivity of sheep through introgression of fecundity gene: A flock of 384 prolific sheep (GMM × P) by crossing crossbreds of Garole × Malpura (GMM) with Pattanwadi sheep (P) was developed and its evaluation under organized feeding and management is being done. The GMM × P lambs

Performance of CIRB Buffalo Herds

Indicator	Murrah (N)	Nili-Ravi (N)
Standard lactation yield (kg)	2,291±58 (98)	2,297±46 (109)
Age at first calving (months)	45.6±10.8 (37)	39.8±25.3 (42)
Service period (days)	190±11 (87)	127±11 (67)
Calving interval (days)	495±12 (87)	446±8 (97)
Conception rate (%)	51.2 (167/326)	34.2 (152/445)
Wet average (kg)	8.01 (105)	8.25 (94)
Herd average (kg)	4.95 (170)	5.32 (146)
Calf mortality (%)	5.4 (9/166)	2.5 (4/158)



Prolific sheep (GMM × P) was developed and its evaluation under organised feeding and management is continuing



Mega Sheep Seed Project

The broad objective of Mega Sheep Seed Project is improvement of indigenous sheep breeds by propagation of superior germplasm in the farmers' flock. Superior rams were distributed to cover breeding ewes of the registered farmers for improvement of their flock.

	Flock strength (breeding females)	Rams distributed
Chhotanagpuri sheep unit, BAU, Ranchi	809 (501)	89
Mandya sheep unit, KVAFSU, Bidar	536 (291)	55
Mecheri sheep unit, TANUVAS, Chennai	625 (354)	52
Sonadi sheep unit, RAJUVAS, Bikaner	674 (364)	58
Malpura sheep unit, CSWRI, Avikanagar	643 (312)	-

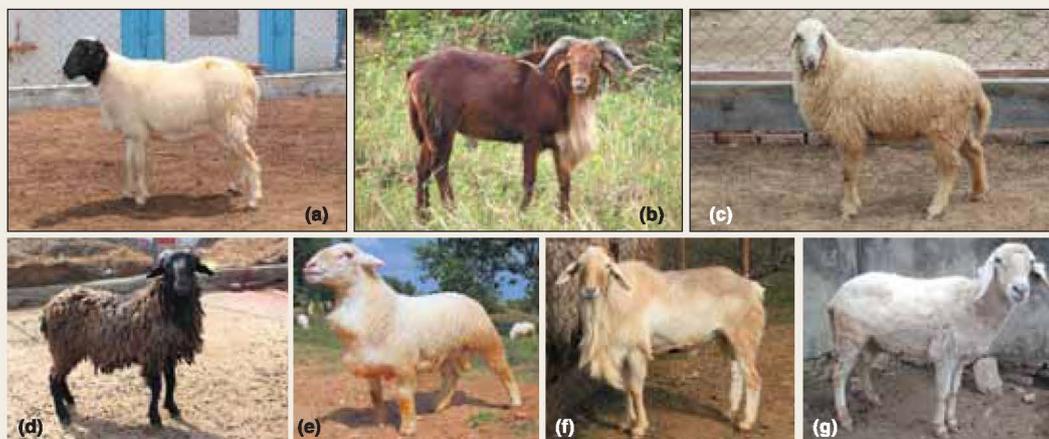
attained 3.58 ± 0.08 , 15.90 ± 0.47 , 23.39 ± 0.68 , 26.85 ± 0.80 and 32.35 ± 1.01 kg, body weights at birth, 3, 6, 9 and 12 months of age, respectively, and GFY of 712 g at first 6 months of age. A total of 25.71% GMM × P ewes produced multiple births with ewe productivity efficiency (live weight of litter at 3 month of age) of 17.92 kg. Prolific sheep (GMM × P) produced 25% more lamb and 13% more litter weight at 3 months over Malpura sheep. Overall survivability rate of this prolific sheep during 0–3, 3–12 months and adult stage was 99, 95 and 100% respectively.

Goat

Genetic Improvement Programme: Use of better management practices and technologies reduced morbidity and mortality, increased fecundity and population growth in most of the 13 goat breeds covered under the project. In Marwari breed, mortality was reduced to 3.5% in the year 2013–14 from 7% during 2009–10. In Ganjam breed, average number of doses per farmer increased from 33 in 2001 to 71 during 2013 and population increased by 500% of Assam

Network Project on Sheep Improvement

The aims of Network Project on Sheep Improvement (NWPSI) are genetic evaluation and improvement of indigenous sheep breeds through selection for growth and wool production. The project includes farm and field based centres located at ICAR Institutes and State Agricultural/Veterinary Universities. Presently, there are six centres of NWPSI in the country with its coordinating unit at CSWRI, Avikanagar (Rajasthan). Four of these units are farm based while two are field based. Survey of Magra sheep was conducted in the breeding tract for identification and selection of centres in the field as well as flocks and for collection of base line data. Kota, Kanaser and Jaalwali centres were identified for this breed. Rams (23) were distributed to farmers.



(a) Overall survivability was 97.08% in Marwari sheep; (b) Lambing rate of 85.62% was recorded in Madras Red sheep; (c) Survey of Magra sheep was conducted in the breeding tract for identification and selection; (d) A flock of Chottanagpuri sheep was built up for production of sheep seed; (e) Mandya breeding rams were distributed to farmers for improvement of the breed; (f) the nucleus flock of Mecheri sheep including breeding females was established; (g) a flock of sonadi sheep was established for production of superior rams

Performance of sheep breeds under the project

	Birth	Average body weight (kg)				Tupping rate (%)	Lambing rate (%)	Overall survivability (%)
		3	6	9	12			
Marwari*	3.03	16.6	25.81	30.15	33.05	93.2	85.86	97.08
Muzaffarnagari	3.78	18.18	26.34	30.78	35.49	93.4	76.9	96.36
Deccani	3.45	16.05	22.66	23.52	25.96	93.84	90.44	94.88
Nellore	3.15	14.37	22.1	26.85	29.1	96.35	85.1	-
Madras Red	2.58	11.62	15.57	19.47	21.13	-	85.62	-

*The wool fibre diameter (μ) was 33.54, medulla (%) 47.15 and annual GFY, 1,582 g.





Hill and Osmanabadi goat breeds during last 5 years, a significant achievement for meat producing species. The programme also had a significant impact on conservation of Sangemneri goats, a threatened goat breed, as its population in breeding tract increased by 353% during last 5 years. In Surti goats, another threatened goat breed of the country, kidding rate increased from 1.41 to 1.48 since year 2009 impacting four-fold increase in total population in area. The breed improvement programme has significant impact on improvement in production and conservation of threatened goat breeds of the country.

Pig

Suitable pig varieties for farmers' field: The breeding programme includes parental lines of exotic Hampshire and Duroc (male), and indigenous Ghungroo and Niang Megha (female) pigs. Animals of Hampshire-Ghungroo crosses showed better performance with respect to production, reproduction, adaptive and carcass traits than Hampshire-Niang Megha crosses at organized farm as well as farmers' field. Age at first heat and age at first service were 270.52±6.85 and 311.51±7.96 days, respectively. Pre-and post-weaning growth rates were 122.45±6.31 and 240.87±20.35 g/day. Slaughter weight at 8 months age was 57.49±1.62 kg.



Pig varieties developed at NRC on Pig: variety I (H₅₀G₅₀) Variety II (H₅₀M₅₀)

Poultry

Improvement of poultry for eggs: The layer lines IWN and IWP at KVASU, Mannuthy and AAU, Anand, and IWD and IWF strains at SVVU, Hyderabad, were improved through intra-population selection under the AICRP on Poultry Breeding. At KVASU, Mannuthy, hen housed and hen day egg production up to 64 weeks of age increased by 13.4 and 11.4 eggs, respectively, over previous generation in IWN strain. In IWP, hen housed egg production up to 64 weeks of age increased by 1.0 egg over previous generation. At AAU, Anand, egg production up to 64 weeks of age increased by 9.64 eggs in IWN, by 11.05 eggs in IWP and by 21.52



Pullets of three way cross (PD1 × IWI × PD3)

eggs in control over previous generation. Egg weight at 64 weeks of age increased in both selected populations as compared to previous generation. The genetic response of egg production up to 64 weeks of age in IWN and IWP strains was positive over last 11 generations.

At DPR, Hyderabad, egg production up to 64 weeks of age increased by 7, 9 and 19 eggs in IWH, IWI and IWK lines, respectively, over the last generation. There was marginal increase in 64 weeks egg weight in IWH and control lines in S-10 generation. The layer control population was stable for egg production up to 64 weeks of age during last 10 generations.

Improvement of poultry for meat: Under AICRP on Poultry Breeding, five synthetic colour broiler populations were improved through mass selection for 5-week body weight in sire lines (PB-1 and CSML) and 5-week body weight along with egg production in dam lines (PB-2, CSFL and SDL). At Bengaluru centre, the average genetic and phenotypic response for 5-week body weight in PB-2 was 30.6 and 32.1 g, respectively, over last 5 generations. Egg production up to 40 weeks of age increased over previous generation in PB-1 line. At Ludhiana centre, over the last 6 generations, 5-week body weight in PB-2 improved by 15.1 and 61.4 g/generation on phenotypic and genetic scales, respectively. Feed efficiency up to 5 weeks of age improved in this line. At CARI, Izatnagar centre, egg production up to 52 weeks increased by 2.3 eggs in CSFL as compared to previous generation. The genetic response was 13.3 g in CSML and 16.8 g/generation in CSFL for 5-week body weight over last 5 generations. Bengaluru and Izatnagar centres participated in the 40th Random Sample Poultry Performance Test at Gurgaon. The strain cross from Bengaluru centre recorded body weight of 1,532 and 1,988 g, respectively, at 6 and 7 weeks of age with corresponding feed conversion ratio (FCR) of 2.22 and 2.40. CARIBRO-Dhanraja of Izatnagar centre attained body weight of 1,592 and 1,936 g, respectively, at 6 and 7 weeks of age.

At Directorate of Poultry Research, colour broiler lines namely, PB-1, PB-2 and control broiler were conserved and evaluated. In PB-1 line, age at sexual maturity (ASM) decreased by 2 days, while body weight,



Livestock migration

A study on pastoralism was conducted to explore the coping strategies of herders from five districts of western Rajasthan (Pali, Jodhpur, Nagaur, Barmer and Jalore) with significant migratory cattle or small ruminant populations. Pastoralist communities with flock/herd size ranging from 42 to 250 heads of small ruminants and 35 to 220 cattle in dry lands moved along with their animals in search of better forage and water resources during scarcity periods. The study showed three kinds of livestock migration: (i) local/temporary, (ii) semi-migration in large size flocks, and (iii) permanent migration where animals were permanently moved from the home tract to other districts or states. Observations recorded through GPS showed that if water source is available, animals on an average travel 8.71 km/day and drink water once a day. Sometimes, animals covered 18–22 km to locate a water source. The study helped to understand common property resource (CPR) management in arid Rajasthan, utilization of crop fields after harvest and emphasized on the need for development of fodder resources and creation of watering points at selected sites as a policy.



egg weight and egg production up to 40 weeks of age increased marginally as compared to last generation. In PB-2 line, body weight at 5 weeks of age showed an improvement of 3.5 g/generation over the last 10 generations on genetic scale.

Development of germplasm for rural poultry:

Under AICRP on Poultry Breeding, six centres, namely, ICAR Research Complex for NEH Region, Agartala; JNKVV, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur; and CSKHPKV, Palampur are working for the development of location specific rural poultry germplasm. At Agartala centre, the ND (Tripura black × DR cross) cross produced 59 eggs up to 40 weeks of age where age at first egg was 163 days. The Jabalpur centre developed Kd (Kadakhnath) (25%) × JBC (Jabalpur colour) (75%) cross, which produced 186 eggs up to 72 weeks of age under extensive system of rearing. Guwahati centre evaluated BN (PB-2 × Native) and BND (PB-2 × Native male × Dahlem Red female) cross in farm and field conditions. Palampur centre evaluated ND (Native × Dahlem Red) × D (Dahlem Red) cross up to 52 weeks of age both at farm and under field conditions. MPUAT, Udaipur evaluated G-3 generation of native germplasm up to 40 weeks of age.

PD-1, PD-2, PD-3 and PD-4 purelines were improved. The native breeds such as Ghagus, Nicobari and recently collected Aseel were maintained at this Institute. In PD-1 line, age at sexual maturity (ASM),

egg weight and egg production at 40 weeks were 203.7 ± 0.06 days, 54.72 ± 0.01 g and 38.17 ± 0.04 eggs, respectively; while shank length and body weight at 6 weeks of age decreased slightly as compared to last generation. In PD-2 line, the egg production up to 52 weeks in SL-1 generation showed an improvement of 1 egg over previous generation on phenotypic scale. In PD-3 line, egg mass showed an improvement of 37.75 g as compared to previous generation. In SL-3 generation of Gramapriya male line (GML), shank length at 6 weeks of age, the primary trait of selection improved by 1.55 mm over the previous generation. The egg production up to 40 weeks of age increased marginally by 1 egg as compared to the previous generation. A random bred rural control population evolved for comparing the performance of different rural lines was also evaluated and maintained. In PD-4 line, at farmers' field, average body weight of male and female birds was $2,334 \pm 59.2$ and $1,809 \pm 60.6$ g, respectively, at 40 weeks of age. In G-1 generation of Ghagus breed, body weights at 8 and 16 weeks of age, ASM, egg production up to 40 weeks and egg weight at 40 weeks were 382.2 ± 4.07 g, 956.3 ± 18.9 g, 177.3 ± 1.2 days, 29.6 ± 1.8 eggs and 47.2 ± 1.01 g, respectively. Ghagus and PD-4 breeds were genotyped for LEI0258 and MCW371 microsatellite markers linked to MHC locus, where heterozygosity was higher in Ghagus for both markers as compared to PD-4 line. The PD-1 × PD-4 cross was distributed to the farmers in Warangal, Telangana where egg production up to 72 weeks of age was 148 eggs. Egg production up to 52 weeks of age of 3-way cross (PD-1 × IWI × PD-3) was 150.2 ± 1.85 eggs with egg weight of 60.04 ± 0.47 g at the Institute farm.



Ghagus hen



Ghagus cock

Under the conservation programme, Nicobari fowl eggs collected from CARI, Port Blair were maintained. In G-0 generation, ASM, body weight and shank length at 40 weeks of age were 175.7 ± 6.30 days, $1,480 \pm 50$ g and 83.5 ± 2.1 mm, respectively, in females. Egg production up to 40 and 60 weeks of age was 64.2 ± 4.5 and 146.8 ± 6.3 eggs, respectively; while egg weight at respective age was 46.30 ± 0.78 and 54.08 ± 0.66 g. Body weight of Aseel birds during G-0 generation at 16 and 20 weeks of age was 1,082 and 1,363 g, respectively. The ASM, body weight and shank length at 40 weeks of age were 186 days, 2,203 g and 119.3 mm, respectively.

Poultry Seed Project: Under Poultry Seed Project, Patna centre distributed 45,706 improved germplasm to the rural farmers. Chicks (64,251) of Vanaraja and



Gramapriya were supplied by Kolkata centre to various parts of West Bengal and adjoining North Eastern states. The average body weight at 19 weeks of age was 1,956 and 1,163 g in female parents of Vanaraja and Gramapriya, respectively. Jharnapani centre distributed 55,912 birds to the farmers of Nagaland, Asom, Meghalaya and Arunachal Pradesh. At Gangtok centre, 2,615 birds were distributed to farmers across Sikkim through self help groups. At Imphal centre, 38,638 Vanaraja birds were distributed to the farmers.

Fisheries

Production of surrogate carp: Surrogate brood fish (host fish that received germ cell transplantation), fry and fingerlings (seed produced from the gametes of transplanted surrogate brood fish) of carp were produced by xenogeneic transplantation of isolated germ cells (GCs) in catla (*Catla catla*), rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*). On attaining maturity the surrogate brooders were bred with normal brooders (without transplant), in different possible combinations. By this method 30 to 40% surrogate carp fry and fingerlings could be produced. This confirmed that donor derived gametes can be produced in a related host species (carp to carp). Surrogate production has the possibility to allow efficient fish-seed production, effective breeding, transfer of biodiversity to an aquaculture strain, conservation and efficient utilization of genetic resources.

Micronutrient enriched fish: Meeting requirements of micronutrients and trace minerals namely, selenium (Se) and iron (Fe) for better human health can be achieved by enriching human food sources. Feeding rohu with feed supplemented with Se and Fe nanoparticles for one month, significantly enhanced fish muscle selenium and iron contents. Further, both nano-Se and nano-Fe supplementation showed a positive impact on growth, innate immune function, haematological parameters and antioxidant activities without any toxic effect on fish. The fish fed with these micronutrients as nanoparticle serves as health food for human beings.

Multiple breeding in pearl spot: Early hatchling separation, a strategy to reduce the breeding interval, was adopted to improve pearl spot breeding in small tanks and recirculatory aquaculture system. In four months same pair was able to breed six times at intervals of 20, 15, 20, 15 and 18 days. Number of larva produced were 1,400, 1,950, 1,050, 950, 1,350 and 1,300, respectively. The average breeding interval was 18 days and number of larva per spawning 1,333.



National Marine Fish Brood Bank: National Marine Fish Brood Bank was established at ICAR-CMFRI Regional Centre, Mandapam to hold broodstock

of commercially important marine finfishes and to supply quality eggs/newly hatched larvae to hatcheries for fingerling production and further rearing. The brood bank maintains broodstock of high value marine finfishes like cobia, silver pompano, groupers, snappers and breams in tanks with continuous bio-filtration system.

Mud crab broodstock development: Mud crab, *Scylla serrata*, broodstock was developed under captivity as a primary step towards its domestication. Ovigerous females were produced after nine months of culture in



the farmer's pond in Sunderban having salinity of 18 to 25 ppt. Females of 500g produced about 1.2 million eggs.

Captive breeding of minor carps: *Labeo dero*, *Labeo dyocheilus* and *Chagunius chagunio*, the minor carps in coldwater regions of the country, were induced bred. The successful captive breeding of these species



uncovers opportunities to produce seeds *en masse* for ranching and aquaculture diversification of coldwater sector.

Hapa culture of rohu in farm ponds: Agriculture in Western Maharashtra, depends on farm ponds for irrigation. Commercial fish culture, as an option for augmenting income was tried on these farm ponds. Hapa based rohu (*Labeo rohita*) culture as a component of integrated agri-aquaculture (IAA) model system with a stocking density 40 fish/m³, was observed as a viable option for nutritional and additional income security.

Fish waste derived bactericidal silver nanoparticles for aquaculture use: A process for synthesis of nano-silver was developed using fish wastes (intestine, gills and liver) collected from freshly sacrificed rohu (*Labeo rohita*). The synthesized nano-silver when incorporated in feed and zeolites showed bactericidal activity against *Aeromonas hydrophilla*, a fish pathogen. Nano-silver formulation from fishery wastes thus has potential to control fish diseases in aquaculture. □