

## 6. Livestock Improvement

### AICRP on Cattle

**Frieswal project:** The number of Frieswal females was the highest at military farms Ambala (2,039) followed by Pimpri (1,633) and Meerut (1,141). The strength of elite cows at various military farms was 1,111 as compared to 951 in previous years. During the reported year, 337,485 doses of semen were frozen and 67,323 doses were distributed to military farms. The overall mean of age at first calving (AFC) in Frieswal cows was  $973.25 \pm 2.64$  days. The least squares means of service period (SP), dry period (DP) and calving interval (CI) were  $145.47 \pm 1.70$ ,  $104.43 \pm 1.31$  and  $424.29 \pm 1.68$  days, respectively. The overall least squares means of 300 days milk yield (MY300), total milk yield (TMY), peak yield (PY) and lactation length (LL) were  $3,284.78 \pm 17.73$  kg,  $3,320.47 \pm 16.29$  kg,  $15.11 \pm 0.07$  kg and  $326.56 \pm 0.88$  days, respectively.

### Genetic improvement of crossbred cattle under field conditions

**Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana:** Female progeny (4,098) born from different sets have reached age at first calving. During the reported year, 6,188 artificial inseminations were carried out and the overall conception rate was 46.4%. Average first lactation 305 days milk yield of cows was  $3,703.6 \pm 31.3$  kg and average age at first calving was  $1,036.6 \pm 10.20$  days.

**Kerala Veterinary and Animal Sciences University, Thrissur:** From the female progeny born out of different sets, 1,733 have reached age at first calving. During the reported year, 4,408 artificial inseminations were carried out and the overall conception rate was 37%. Average first lactation 305 days milk yield of cows was  $2,678.3 \pm 64.27$  kg, while average age at first calving was  $1,133.9 \pm 31.38$  days. The milk yield showed an increasing trend among the progeny of different sets and average 305 days milk yield increased from 1,958 kg in first set to 2,604 kg in 10<sup>th</sup> set.

**BAIF Research Development Foundation, Uruli-Kanchan, Pune:** From the female progeny born out of different sets, 4,126 have reached age at first calving. During the reported year, 5,771 artificial inseminations were carried out and the overall conception rate was 43.04%. Average first lactation 305 days milk yield of cows was  $3,206.64 \pm 60.98$  kg, while average age at first calving was recorded as  $956.88 \pm 0.49$  days.

**GBPUA&T, Pantnagar:** From the female progeny born out of different sets, 192 have reached age at first calving. During the reported year, 3,310 artificial inseminations were carried out and the overall conception rate was 56.7%. Average first lactation 305 days milk yield of cows was  $2,587.3 \pm 72.59$  kg, while average age

at first calving was recorded as  $1,044 \pm 44$  days.

### Conservation and genetic improvement of indigenous cattle breeds

**Gir breed:** The Germplasm (GP) unit has 67 breedable females (including 28 heifers); and 15 Gir bulls were inducted in two sets. At the start of the reporting year, 14,676 doses were in stock and during the year 10,097 semen doses were produced out of which 3,928 doses were utilized for insemination and 758 doses were sold. During the year the conception rate was 46.12%;



and 587 daughters were born, taking the total to 3,346 daughters. The average first lactation length and first peak yield were recorded as  $374.30 \pm 20.60$  days and



$13.90 \pm 0.60$  kg, respectively. The overall age at first calving, first service period, first dry period and calving interval were  $1,284.50 \pm 31.30$ ,  $139.10 \pm 9.30$ ,  $200.20 \pm 33.70$  and  $552.00 \pm 46.80$  days, respectively. The wet and overall averages of the GP unit were estimated as  $7.40 \pm 0.60$  and  $4.70 \pm 0.50$  kg, respectively.

**Kankrej breed:** The number of breedable females in GP and Data Recording (DR) units was 67 and 3,058 (includes organized farm and field units), respectively. Seventeen bulls in two sets have been inducted so far. At the start of the year, 66,623 semen doses were available under the project and during the year 33,670 doses of frozen semen were produced and 3,975 doses of semen of second set of bulls were utilized for insemination and 2,410 were sold. During the reporting period 2,286 animals were inseminated, and conception rate was estimated as 39.06% against overall conception rate of 46.45%. The overall average estimates for age at first calving, first service period, first dry period, calving interval in GP unit were  $1,398.75 \pm 80.40$ ,  $187.00 \pm 75.99$ ,  $299.25 \pm 56.17$  and  $431.35 \pm 21.42$  days, respectively; while average estimates for first lactation milk yield, all lactation milk yield and first peak yield were recorded as  $2,136.04 \pm 195.61$ ,  $2,760.71 \pm 134.67$  and  $10.59 \pm$



0.33 kg, respectively. The average first lactation length of the herd was estimated as  $288.20 \pm 15.96$  days, while the wet and overall averages were 9.14 and 6.86 kg, respectively.

**Sahiwal breed:** The number of breedable females above two years of age in the GP unit was 214 and the corresponding number in the DR unit was 599. Fifteen Sahiwal bulls in two sets have been inducted so far. At the start of the reporting year 49,236 of semen doses were in stock and 23,840 doses of semen were produced. During the year, 1,406 inseminations were carried with an overall conception rate of 41.18%. The overall average estimates for age at first calving, first service period, first dry period, calving interval of Sahiwal cows maintained at GP unit were  $1,238.22 \pm 27.55$ ,  $138.75 \pm 24.48$ ,  $123.13 \pm 33.27$  and  $425.38 \pm 25.41$  days, respectively; while average estimates for first lactation 305-day milk yield, total first lactation milk yield and first peak yield were recorded as  $2,054.92 \pm 229.49$ ,  $2,437.79 \pm 379.27$  and  $11.41 \pm 0.69$  kg, respectively. The average first lactation length of the herd was  $316.53 \pm 31.69$  days; while the wet and overall averages were 7.17 and 3.47 kg, respectively.

#### Garima produced second calf Karishma

Garima, a cloned buffalo, earlier born at NDRI produced second female calf named "Karishma" through normal parturition. The weight of the calf at the time of birth was 35 kg and the newborn calf is keeping good health. Garima, born on 22 August 2010 through hand guided cloning technique using embryonic stem cells as donor cells, was inseminated and conceived with frozen-thawed semen.

#### Buffalo

Under field progeny testing programme (FPT), 4,129 AI with the 6 test bulls of XV set were performed in adopted villages. Monthly test day milk yield was recorded for 138 daughters, recording of 66 daughters is in progress.

Milk production performance of Murrah buffalo herd relating to overall wet average (8.25 kg) and herd average

#### Clone of Endangered Wild-buffalo of Chhattisgarh

A clone of the only alive wild-buffalo in Chhattisgarh in semi-captivity was born on 12 December 2014 through the 'Hand-guided Cloning Technique' at ICAR-National Dairy Research Institute, Karnal. The female calf named "Deepasha" weighed 32 kg at birth. This novel achievement of producing cloned calf from endangered species has opened up new windows of applications of cloning technology. Scientists are of the opinion that besides multiplication of superior



germplasm through cloning, conservation of endangered species should also be initiated.

#### Buffalo cloning

A female cloned calf named 'Apurva' was born on 5 February 2015 by normal parturition with birth weight of 37 kg. The calf is a clone of an elite Murrah buffalo (MU-5345) of NDRI Livestock Farm. Earlier, another cloned calf 'Lalima' was produced from the same buffalo. In this case the donor cell was isolated from urine of the donor animal. This is the first report in the world across the species of cloned embryos produced using somatic cells isolated from urine.



(5.77 kg) were the highest since inception of the project and revealed an improvement of 3.0 and 16.15%, respectively, as compared to the earlier records. Overall wet average and herd average were 8.48 kg and 5.98 kg, respectively, for Nili Ravi herd, which revealed an improvement of 2.79 and 12.41%, respectively, over the earlier performance.

Young Murrah bulls (15) were tentatively selected as future breeding bulls and 6 superior males were selected for test mating in 15<sup>th</sup> set. A total 127,209 and 31,474 semen doses of Murrah and Nili-Ravi bulls, respectively, were frozen.

#### Sheep

**Increasing prolificacy in sheep:** Prolific sheep strain developed at the Institute is being evaluated for its overall performance. GMM × P (Garole-Malpura-Malpura × Patanwadi) sheep at birth, 3, 6 and 12 months attained body weights of 3.35, 17.53, 27.51 and 36.01 kg, respectively. Topping rate and lambing per cent on available basis in GMM × P ewes was 100.0 and 92.50%, respectively. Multiple births were 40.54% with litter size of 1.43. In field condition, the lambs born from GMM × P ewes at birth, 3, 6 and 12 months attained body weights of 3.18, 14.42, 24.00 and 28.20 kg, respectively. In total, 15 lambs were born out of 10 lambing from 5 prolific ewes till date with a multiple birth of 50%.



Prolific (GMM × P) sheep

#### Network Project on Sheep Improvement

Presently, there are six ongoing cooperating centres of NWPSI in the country with its coordinating unit at



**Performance of sheep breeds under the Network Project**

Breed	Average body weights (kg)					Annual GFY (kg)	Tupping (%)	Annual lambing (%)	Survivability (%)	Sale of rams
	Birth	3 m	6 m	9 m	12 m					
Marwari	3.19	16.45	23.03	28.33	31.09	1.48	97.5	87.2	97.7	77
Muzaffarnagari	3.60	17.03	26.84	33.34	38.34	1.29	97.3	88.3	97.2	125
Deccani	3.47	16.13	24.54	25.83	28.69	1.03	97.1	90.1	97.9	66
Nellore	3.01	15.20	21.03	25.21	29.01	-	95.2	84.1	96.1	70
Madras Red (field)	2.58	11.53	15.59	-	20.53	-	-	85.5	-	85
Magra (field)	2.45	16.29	23.19	-	30.34	-	-	79.7	-	98

GFY, Greany fleece yield.

ICAR-CSWRI, Avikanagar. Four of these units are farm based while two are field based.

Marwari, Muzaffarnagari, Deccani and Nellore sheep are maintained under Farm Units for improvement through selection and production of superior germplasm. Average fibre diameter, medullation and staple length of Marwari sheep wool were 37.28µ, 55.76% and 4.59 cm, respectively, whereas average fibre diameter, medullation and staple length of fibre in Magra wool were 36.17µ, 47.27% and 5.66 cm, respectively. Under field project, 11,296 Madras Red sheep and 8,212 Magra sheep were registered for performance recording and improvement. Identification and performance recording of progeny was strengthened and 810 Madras Red lambs were individually identified by tagging/tattooing during the year. In Madras Red field flock 85.50% lambing was observed. Artificial insemination (AI) with oestrous synchronization was implemented to accelerate superior germplasm dissemination and enhanced ewe coverage. AI Units were established at Magra and Madras Red Sheep Units.

**Mega Sheep Seed Project**

The major objective of the project is improvement of indigenous sheep breeds in their respective breeding tracts by providing genetically superior germplasm to the farmers in terms of distribution of elite rams as well as estrus synchronization coupled with artificial insemination of the ewes with freshly diluted liquid semen; the project has five cooperating units.

Chhotanagpuri Sheep Unit, BAU, Ranchi (715 Chhotanagpuri sheep; including 433 breeding females),

Mandya Sheep Unit, KVAFSU, Bidar (440 Mandya sheep including 257 breeding females); Mecheri Sheep Unit, TANUVAS, Chennai (nucleus flock of 749 Mecheri sheep; including 392 breeding females); Sonadi Sheep Unit, RAJUVAS, Bikaner (487 Sonadi sheep including 256 breeding females); Malpura Sheep Unit, ICAR-CSWRI, Avikanagar (730 Malpura sheep including 353 breeding females) were built up for production of high performing sheep seed. Superior rams were distributed to registered farmers for improvement of their flock.

**Goat**

**Increasing production performance:** Selective breeding of Jamunapari, Barbari, and Jakhrana goats



showed significant improvement in body weights, milk yield and wool production. The average body weights at birth, 3, 6, 9 and 12 month age in Jamunapari were 3.29±0.04, 12.78±0.14, 18.12±0.30, 23.55±0.38 and



Mandya sheep flock





### Improving goat productivity in Farmers' flock

The implementation of goat husbandry technologies in the farmers' flock across country through AICRP on Goat Improvement significantly affected conservation and improvement of goat genetic resources, as it increased population of goats true to the breed and productivity amongst 13 descriptive breeds and 3 lesser known genetic resources. Significant improvement in body weights (19 to 43%) at different ages, in milk yield (12 to 31%) and in prolificacy (8-17%) was observed in different breeds. Considerable improvement in survival rate due to adoption of health and management practices at farmers flock (e.g. mortality in Bengal kids at Ranchi Unit was reduced from 69 to 12.5% and in adults from 35 to 8.5% over the years) resulted in higher population growth. Annual income from sale of Black Bengal goats has increased from ₹ 8,000 to 14,500 (small flock <10 goats) and ₹ 15,000 to 28,000 (large flock >15 goats). Project has contributed significantly to biodiversity conservation.

28.31±0.48 kg and in Barbari goats 1.54±0.02, 8.55±0.09, 13.40±0.16, 19.14±0.33 and 22.69±0.41 kg, respectively. In Jamunapari goats 90 and 140-days milk yields were 78.08±2.376 and 110.68±3.79 litre and in Barbari goats 140 days milk yield was 85.16±2.32 litre. The body weights in Jakhirana goats were 2.74±0.09, 9.93±0.56, 15.80±0.18, 20.24±0.69 and 22.75±0.75 kg at birth, 3, 6, 9 and 12 months, respectively. The overall mortality in the institute flocks was less than 4%.

### Pig

**Pig for fattening purpose:** Pure parental lines of Hampshire and Duroc (male), and Ghungroo (female) pigs were used as exotic and indigenous germplasm, respectively, for producing the triple cross (D<sub>50</sub>H<sub>25</sub>G<sub>25</sub>). The productive, reproductive and adaptive characters of developed population of Variety-I (H<sub>50</sub>G<sub>50</sub>) were stabilized by few generations of *inter-se*-mating. Subsequently, selected Variety-I female pigs were crossed with Duroc males, which was used as terminal sire due to its high potential of lean meat production with superior growth rate. The crossbred animals showed significantly higher body weight and pre-weaning and post-weaning growth rate. Mass scale production of these animals was initiated at the institute farm for supply to farmers.



Triple cross pig variety developed at ICAR-NRC on Pig

### Poultry

**Rural poultry:** Pure lines, viz. PD-1 (Vanaraja male line), PD-2 (Vanaraja female line) and PD-3 (brown egg layer line) were maintained for use in developing rural chicken varieties. In PD-1 line, the shank length and body weight increased considerably in the present generation. In PD-2 line, the egg production up to 52 weeks in S-12 generation showed an improvement of 1 egg over previous generation on phenotypic scale. In PD-3 line, the body weight at 4 and 6 weeks of age was 178.3±0.05 and 276.6±0.04 g, respectively. The shank length at 6 weeks of age was 54.0±0.5 mm. The ASM was 159.0±0.03 d and body weight at 20 weeks of age was 1,349.6±64 g. In the SL-4 generation of Gramapriya Male Line (GML), the shank length at 6 weeks improved by 3.23 mm over the previous generation.



Adult pair of PD-2 line

### AICRP on Poultry Breeding

Under the AICRP on Poultry Breeding, ICAR Research Complex for NEH Region, Agartala; NDVSU, Jabalpur; AAU, Guwahati; BAU, Ranchi; CSKHPKV, Palampur and MPUAT, Udaipur are involved in rural poultry production. At Agartala centre, the body weight at 8 weeks in Tripura Black, Dahlem Red and ND cross [(Tripura black × CSFL) × DR], egg production up to 40 weeks of age were studied. Hen housed egg production in Jabalpur color (JBC) and 40 weeks egg weight and egg production in Kadaknath (Kd) were studied at Jabalpur centre. Three-way cross, Kamrupa [(PB-2 × Indigenous) × Dahlem Red female] besides the native, Dahlem Red and PB-2 populations were evaluated at Guwahati centre. Annual hen housed egg production in the native population and BN (broiler × native) cross were studied at Ranchi centre. Native (G-2), Dahlem Red (DR), 2-way (DR × Native) and 3-way [(Native × Dahlem Red) × Dahlem Red] crosses were evaluated at the CSKHPKV, Palampur centre. The egg weight was 59.0 and 45.8 g in Dahlem Red and native population, respectively, at 40

### Poultry Seed Project

Improved poultry germplasm for rural poultry was supplied through six centres located across the country. Chicks (259,086) of improved germplasm were distributed to the farmers by the centres in their respective regions. The Patna centre distributed 45,864 improved germplasm; Kolkata centre 61,835 chicks; Durg centre, 16,996 improved chicken germplasm; and Jharnapani centre supplied 63,210 germplasm to the farmers. Gangtok centre distributed 36,401 improved chicken germplasm to the farmers across Sikkim. At Imphal centre, 34,780 improved rural chicks were distributed to the farmers in Manipur. The Seed Project has been strengthened during the XII plan with addition of five more centres.



weeks. The Dahlem Red produced 67 eggs up to 40 weeks of age, whereas native population recorded 40 eggs. The hen housed egg production in D×N cross was 54 eggs in farm.

At the MPUAT, Udaipur centre, G-4 generation of native germplasm was evaluated for body weight at 8 weeks of age, hen housed and hen day egg production up to 40 weeks. During the third evaluation (E-3), Pratapdhan was evaluated up to 72 weeks of age. The pullets matured 4 days earlier as compared to last generation. The hen housed egg production up to 72 weeks of age was 97 eggs in E-3 generation.

**Poultry for eggs:** Pure lines of White Leghorn chicken (IWD, IWF, IWN, IWP, IWH and IWI) were improved through intra-population selection under the AICRP on Poultry Breeding. At KVASU, Mannuthy centre, the egg production up to 40 weeks of age on hen-housed basis was 122 in IWN and 123 in IWP strains. The S-12 generation of IWN and IWP strains was evaluated at AAU, Anand. The egg production up to 40 weeks of age increased by 8.1 and 4.6 eggs, respectively, in IWN and IWP strains. The egg weights at 40 weeks of age increased by 1.36, 1.39 and 3.26 g as compared to previous generation in IWN, IWP and control populations, respectively.

The egg production up to 64 weeks of age was 230 eggs each in IWD and IWF strains during S-31 generation at SVVU, Hyderabad and up to 72 weeks of age it was 276 and 280 eggs, respectively. Egg weights at 64 weeks of age in IWD and IWF strains were 56.5 and 56.1g, respectively.

At DPR, four layer chicken lines (G-3 generation of IWH and IWI lines, S-11 generation of IWK line, and layer control population) were evaluated for the performance up to 52 weeks of age. As compared to previous generation, egg production up to 40 and 52 weeks increased in IWH population by 10 and 12 eggs, respectively. In IWI population, these increased by 8 and 1.5 eggs, respectively.

**Poultry for meat:** Under the Project, five synthetic coloured 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). The Bengaluru centre evaluated PB-1 and PB-2 lines. The average 5-week body weight was 1,030 and 948 g in PB-1 and PB-2 lines, respectively. The Ludhiana centre regenerated S-39 generation of PB-2 and S-7 generation of PB-1 line along with control population. Over the last 10 generations, the genetic response for 5-week body weight in PB-2 line was 30.8 g/generation.

The CARI, Izatnagar centre evaluated CSML and CSFL and Control populations. Body weight at 5-week increased in all the populations. The Bhubaneswar centre evaluated CSFL and CSML lines. Body weight at 5-week increased in both the selected populations as compared to previous generation. Colour broiler lines i.e. synthetic colour broiler male line (PB-1), synthetic colour female line (PB-2) and control broiler (CB) populations were maintained and evaluated. Genetic and



Adult pair of PB-1 line

phenotypic responses in 5-week body weight over the last 5 generations were 40.3 and 16.3g, respectively. In PB-2 line, 40 weeks part period egg production showed an improvement of 7 eggs over the last generation. The egg production up to 52 weeks improved by 8 eggs over the last generation.

#### Duck for farmers' field

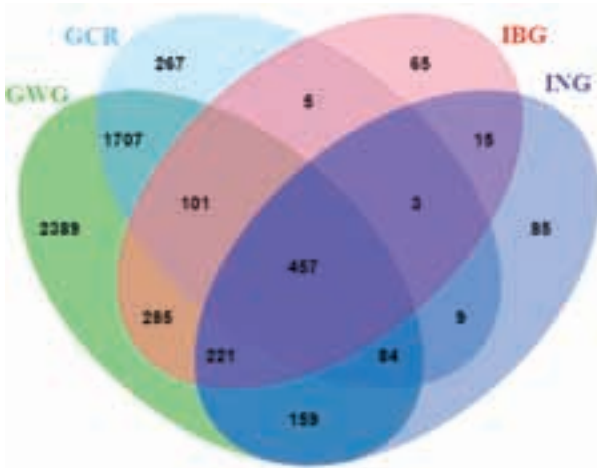
Keeping in view the need of the farmers to have dual purpose (for both egg and meat production) colour plumage ducks with good adaptability and scavenging ability for their propagation in backyard system of rearing, crossbred were developed using males of White Pekin (meat variety) drake and females of Khaki Campbell (egg variety) duck through artificial insemination technology. The production, reproduction, body conformation and egg traits were evaluated in three management conditions, i.e. (i) intensive system (research farm of RC CARI), (ii) farmers' field through KVK, Khurda, and (iii) Integration with rice (CRRI, Cuttack). Crossbred ducks attained 1.60–1.80 kg (female) and 1.80–2.20 kg (male) by fifth month of age, sexual maturity at 18th week and 64 g of egg wt. The birds were best suited due to their colour plumage pattern and low mortality in all the three management situations.



**Guinea fowl:** A total of 33 lactobacilli isolates obtained from guinea fowl gut samples were screened for their probiotic potency through various *in vitro* tests. *L. plantarum* (LGFCP4) was identified as best probiotic candidate and selected for feeding trial in both guinea fowl and broiler chicken. The feeding of LGFCP4 was found effective in improving FCR and cell mediated immunity and showed competitive exclusion of *Salmonella* and *Escherichia coli*.

#### Fish

**Captive breeding of *Rita chrysea*:** *Rita chrysea*, an indigenous catfish endemic to Mahanadi river, Odisha,



Venn diagram showing shared and unique microbial species. GWG, Guinea fowl GIT in intensive system; GCR, guinea fowl crop in intensive system; IBG, broiler GIT in intensive system; ING, CARI-Nirbheek gut in intensive system

has good consumer preference and market demand fetching ₹ 250-300/kg. Captive stocks of *R. chrysea* were successfully induced bred in hatchery conditions. Fishes of 130-150 g were selected for induced breeding. The fecundity was estimated about 9,000-12,000/100 g body weight. The larvae hatched out in 24-26 h of incubation at 26-28 °C. Fertilization ranged between 70 and 80%

#### Modular farming system for mud crab

A three-tier modular farming system comprising three months nursery rearing, four months of mid grow out and three months of final grow out was developed for farming of mud crab. The three tier system is used in dividing the 10-month farming period into three groups, so that income could be generated by the farmer at each stage, in a short period of 3-4 months.

Mud crab instars on three months of nursery rearing attained weight of about 85g with survival rate of 45%. During mid-grow out of four months the crabs attained weight of about 280g with a production of 1,110 kg/ha. In three month final rearing, production was about 1,168 kg/ha with a survival rate of 80%. This form of modular production system enhances survival rate and production efficiency, and farmers are able to generate income at each stage of three to four months.



#### Success Story

##### Integrated multi-trophic aquaculture (IMTA) system

Integrated farming of cobia, *Rachycentron canadum* in cages along with raft culture of sea weed, *Kappaphycus alvarezii* was successfully accomplished at Mandapam, Tamil Nadu. The practice proved effective in increasing fish production in cages and alleviating adverse impact of organic load on the environment. Integration of seaweed rafts with cobia cages doubled the seaweed yield to 290 kg/raft. Cobia attained an average weight of 3.25 kg during culture period of six months. This is an initial step in developing an ecologically sustainable integrated marine fish farming system, where seaweed, mussel/oyster, lobsters, high value marine food and ornamental fishes could be farmed together.



Cobia sea cage farming along with seaweeds rafts; (inset) seaweed

and hatching rates 60 to 70%. Successful induced breeding would lead to hatchery seed production and grow out culture of this species.

**Induced breeding of giant snakehead:** Broodstock of giant snakehead, *Channa marulius* was raised in concrete cisterns and fishes of 700-950g were induced bred under hatchery conditions by hormonal treatment. Fishes spawned after 16-18 h. Eggs were floating, non-adhesive and light yellow. Its fecundity was about 2,000-6,000 eggs/kg body weight. Larvae hatched out in 40-44 h at 25-27°C water temperature. Fertilization rate ranged from 75 to 85% and hatching 60 to 70%.

**Induced breeding of milkfish:** Milkfish has the ability to grow in brackishwater, seawater and even adapt



Milkfish (*Chanos chanos*)



to freshwater conditions. Fish consumes low protein formulated feed and grows up to 500-700 g size in 5-6 months. Fish were bred for the first time by ICAR-CIBA through hormonal manipulation. The fertilized eggs were hatched and reared to fingerling stage, which are suitable for farming. Milkfish with its ability to grow with other fishes and shrimp and also being disease resistant is an ideal fish suitable for polyculture, including pokkali farming practiced in Kerala.

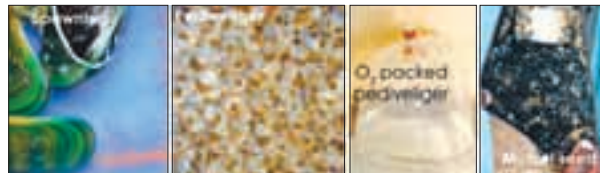
**Cost-effective feed:** Pacific white shrimp, *Litopenaeus vannamei* covers almost 90% of the shrimp



*Litopenaeus vannamei* produced using ICAR-CIBA developed feed

farming area in the country. The growth of *L. vannamei* was significant with the cost effective feed prepared by ICAR-CIBA. The feed gave FCR of 1.68 when tested in farmers' pond.

**Seed production of green mussel:** Mussel farming is practiced by collecting seed from natural habitat. ICAR-CMFRI developed commercial seed production



Various stages of green mussel seed production

technology to overcome the short supply of quality seeds for mussels and for expansion of mussel farming. Under this package of practice, about 1 lakh mussel spat can be produced in 1 tonne capacity FRP tank in 30-40 days and the same number can be nursery reared to seed size in small meshed nursery cages within 40-60 days with survival rate of more than 95%.

