PROJECT DOCUMENT

Program Categories: Departmental Programs
Project Title: Quality Seed for Sustainable Aquaculture
Responsible Department: Aquaculture Department
Total Duration: 2016-2020
Funding Sources: AQD
Estimated Budget for 2020: USD 686,627

1. INTRODUCTION

A sustainable supply of good quality seedstock is key to a successful aquaculture enterprise. Rearing quality seedstock to commercial sizes require efficient husbandry techniques and suitable farm conditions to achieve increased yield. With the intensification of aquaculture systems in several Southeast Asian countries and the environmental challenges such as those resulting from climate change, development and use of quality farmed broodstock and adoption of optimal culture management methods are equally important in ensuring a steady production of seeds and later, marketable aquaculture products.

2. PROJECT

1.1 Goal /Overall Objectives

Generate, verify and promote technologies to ensure the sustainable production of quality seed stock for aquaculture as well as for stock enhancement.

The specific objectives are to:

(1) develop good quality broodstock for both traditional and emerging species
(2) improve quality and production of seedstock through the refinement of hatchery and nursery management methods;
(3) develop schemes for the production, management, maintenance and dissemination of genetically selected and improved stocks; and
(4) produce sufficient seedstock through the adoption of economically viable seed production systems

1.2 Outcomes and Expected Outputs

The program is expected to achieve the following:

(1) production of good quality broodstock;
(2) increased seed stock production through the availability and adoption of refined and efficient hatchery and nursery protocols
(3) if available, promote genetically selected and improved stocks and apply techniques to optimize their use to improve on-farm aquaculture production
(4) enough supply of seeds from major aquaculture commodities through the adoption of technically- and economically-viable breeding and seed production schemes

1.3 Project Description/Framework **(***for total duration of the project*)

The program focuses on studies and activities that determine optimal conditions and cost-effective, science-based methods for the production of quality seedstock. Conventional methods of enhancement of breeding performance, from (a) stock improvement *e.g.* domestication, broodstock management, strain evaluation and selective breeding or genetic improvement; (b) nutritional interventions such as formulation of broodstock diets and larval nutrition schemes; and (c) other non-genetic/environmental interventions *e.g.* hormone application, temperature and water depth in manipulation for shrimp broodstock for traditional and emerging freshwater and marine species are approaches being adopted. Studies using biotechnological tools such as DNA markers have been completed in the previous year

while some were used in screening newly domesticated aquaculture species such as Anguillid eels. In the case of Anguillid eels, genetic markers have been utilized to simply identify species and characterize genetic stocks with the ultimate objective of later on understanding genetic connectivity in wild stocks of Anguillid eels both in the Philippines and Indonesia (part of phase 2 proposal to JAIF).

As mentioned, suitable hatchery and nursery protocols are being developed and refined depending on the level of technology for each species. These technologies are verified and are packaged into the most viable or cost-effective method for broodstock and seed production. Once ready for dissemination, industry stakeholders or primarily the fish farmers shall be informed of advances in seed production methods through training and the production of information, education and communication or (IEC) materials such as technical manuals.

Activity 1: *Broodstoock development*
To achieve the main objective of developing and managing quality broodstock for use in either commercial fish farming and/or stock repopulation, stock characterization using molecular markers were utilized in previous years to aid in determining genetic quality in wild and hatchery stocks. This year, information on the reproductive biology, mating/breeding behavior, and production traits in traditional and emerging aquaculture species (giant grouper), help formulate suitable broodstock management protocols. Nutritional intervention is being done as well to improve reproductive traits. Abalone, mangrove crab, tiger shrimp, Indian prawn, sandfish, tilapia, native catfish, silver perch, giant grouper and Anguillid eels are the species being studied for the development of better breeding stocks.

Activity 2: *Refinement of hatchery and nursery protocols*
To increase production and rearing of larval and juvenile stages of important aquaculture species, mechanisms that: (a) enhance laboratory production of natural food organisms, *e.g.* algal paste production, and alternative food items, *e.g.* polychaetes, which serve as early stage diets; as well as (b) improved rearing conditions and interventions that allow the aquatic organisms to adapt and survive well during larval development, are evaluated.

Activity 3: *Increase awareness on available genetically selected/improved stocks and optimize their use for improved on-farm aquaculture production*
This is done either through the development and evaluation of selected breeds commercially available or otherwise. Once such stock or strains are noted as superior then the same can be promoted to farmers for use with the end-goal of being able to increase on-farm fish yield.

Activity 4: *Promotion of technically and economically-viable breeding and seed production schemes*
It is not enough to disseminate information on innovative and technically feasible breeding and seedstock production methods. One has to ensure that such methods are cost effective thus can generate increased profit for the hatchery/nursery farm operator. The objectives for this activity can be achieved if the technologies that are based on science are verified on farm and will in the process, demonstrate economic viability.

3. PROGRESS/ACHIEVEMENTS OF ACTIVITIES IN THE YEAR 2019

Project/Activity Title	Duration	Remarks
Broodstock development		
<u>*Domestication and strain evaluation*</u> **Catfish** Philippine native catfish (*Clarias macrocephalus*/*C. batrachus*) Broodstock Development and Management A. Evaluation of reproductive traits for selection and propagation	**2018-2019**	Another stock either from Kidapawan or Aparri, Cagayan will be collected to

of quality catfish broodstock B. Development of least cost catfish broodstock maturation diet A study on the Philippine native Clariid catfishes (mainly *Clariid macrocephalus* and *C. batrachus*) that focuses on broodstock development and management continued in 2019. Renewed interest on the propagation of the native catfishes was due to the fact that they are disease resistant, can be stocked at high densities and thrive in areas where water quality is not optimal. As such, the native catfish can be said to be an ideal culture species especially at a time when climate change has posed numerous challenges to freshwater fish farming. Stocks from three sources, namely Zambales, Quezon and Iloilo collected in 2018 are being maintained for use in broodstock development and broodstock diet trials. Of the three founder stocks, only catfish breeders from Zambales spawned successfully. The broodstock diets that have been tested initially on the Zambales founder stocks contained 0.5% mango peel, 0.5% paprika and a combination of both. Preliminary results using mature *C. batrachus* from Iba, Zambales showed higher relative fecundity (28.3 and 28.6 eggs/g BW female, respectively) from those fed feeds containing either 0.5% mango peel or the combination of mango peel and paprika. However, hatching rate was noted to be higher (86.3%) in the treatment fed the diet with paprika alone. Meanwhile, the stock from Quezon was subjected to induced spawning trials thrice but did not result to any spawns, nor surviving hatchlings (for one trial). On the other hand, the stock from Iloilo are growing very sluggishly, hence are not large enough nor mature for spawning. Offspring from the Zambales stock (now with known ages) are being reared for use later in stock evaluation/comparison looking at breeding efficiency and response to broodstock diets. To optimize use of the Zambales F1 stocks which are currently being on-grown to mature sizes, some of the juveniles were set up for a grow-out feeding experiment using an invasive alien species (black mussel) as feed attractant and as an additional source of crude protein. The formulated diets tested consisted of the following: diet 1-fishmeal based catfish diet (Coniza, et al., 2003) as control; diet 2-okara (soy pulp) based diet without black mussel and; diet 3-okara (soy pulp) based diet with 10% dried black mussel. Dried black mussel is known to have a high crude protein content at 69% (CA, SEAFDEC/AQD). Results of this feeding trial (Sayco and Romana-Eguia, unpublished) showed that stocks that were fed diet 3 gave the highest specific growth rate (1.32±0.18%/day) while the lowest (0.92±0.18 %/day) was that of the stock fed the okara-based diet.		enable strain comparison/ evaluation
<u>*Environmental and nutritional intervention to improve broodstock performance*</u> **Silver therapon (*Leiopotherapon plumbeus*)** Domestication of silver therapon (*Leiopotherapon plumbeus*) A. Nutritional evaluation of wild-sourced and hatchery-bred stocks for feed development B. Reproductive performance of wild- and hatchery-bred silver therapon In 2019, the effect of dried thraustochytrid biomass supplementation on reproductive performance of 3-year old broodstock of the silver therapon was examined in a tank-based feeding trial. The treatment groups having three replicates each consisted of: (1) control [basal diet;	**mid-2015 to 2019**	

50% crude protein], (2) basal diet + 0.5% dried thraustochytrid biomass, and (3) basal diet + 1.0% dried thraustochytrid biomass). Hatchery-reared silver therapon broodstock (16.9-17.7 g) were stocked at 30 individuals per cage (1F:2M sex ratio) in three replicate suspended net cages (1 m length × 1 m width × 1.5 m depth) per treatment. Broodstock were fed diets at 2% of body weight for 14 weeks. Fish were sampled every 2 weeks to monitor weight gain and adjust the feed ration. After 14 weeks of feeding, females and males were paired at a sex ratio of 1F:2M per spawning tank of 60-L capacity for hormone-induced spawning trials using a mixture of 10 IU hCG g^{-1} BW and 0.5 mL ovaprim kg^{-1} BW. The effect of dried thraustochytrid biomass supplementation were examined on the basis of growth, survival, and reproductive performance (spawning success, fecundity, gonadosomatic index, fertilization and hatching rates). Female silver therapon broodstock fed 0.25% thraustochytrid biomass and control diets had higher spawning success than those fed 0.5% thraustochytrid biomass diet. Although results did not show significant differences among the treatment groups, those fed the diet with 0.25% thraustochytrid biomass had higher gonadosomatic index (GSI), fertilization and hatching rates compared to those fed 0.5% thraustochytrid biomass and control diets. These results suggest that supplementation of thraustochytrid biomass at 0.25% could enhance the reproductive performance of female silver therapon broodstock.		
Tiger shrimp (*Penaeus monodon*) Effects of water depth, temperature and methyl farnesoate on the mating behavior and reproductive performance of black tiger shrimp (*Penaeus monodon*) broodstock To best understand conditions that encourage and facilitate mating in the tiger shrimp, experiments that would determine differences and problems in breeding performance of male and female spawners from captive and wild environments (stocked separately and/or their combination as mates) were conducted. Video documentation on the reproductive behavior (pursuit of females by males and vice versa and number of mating episodes) of adult *Penaeus monodon* during trials separately exposing spawners to varying depths (1 m vs 1.5 m) and temperature (fluctuating ambient and 32°C) were done. Use of methyl farnesoate (a hormone that could induce female crustacean molting and reproduction) on captive shrimps, was done in 2019. Based on the video recordings, molted females were observed to be pursued by males. Wild males spent more time near females than captive males. Captive females were noted to molt longer than wild females in ambient temperature. Wild and captive stocks exit the molt or shell almost at the same time. There is no significant difference in the courtship behavior among the four trial combinations (wild F x wild M, wild F x captive M, captive F x wild M and captive F x captive M) in the fluctuating ambient and 32°C temperature levels for the 1 m depth experiments. On the other hand, there is a significant difference in the courtship behavior of *P. monodon* between the two temperature levels at 1.5 m depth.	**2019**	Trials on the effect of methyl farnesoate are yet to be completed and requires 3-6 more months to finish the experiments
<u>*Broodstock management, breeding protocol development for other species (for stock management and enhancement)*</u> **Giant grouper** Breeding and seed production of giant grouper (*Epinephelus*	**2015-2019**	

lanceolatus) Activities continue to be implemented for a giant grouper study focused on developing technologies for giant grouper aquaculture. Through this study, giant groupers were observed to directly undergo male sexual maturity from juvenile phase, and through sex change from functional females, as diandric protogynous hermaphrodites. Furthermore, females were noted to mature at an average of 23.5 kg body weight (BW) while males mature at 17.5kg BW compared to stocks in Vietnam where female giant groupers were observed to mature at an average size of 33.5kg and male giant groupers at 34.3 kg. Induced ovarian development was performed in the giant grouper juveniles through intramuscular injection and oral administration of rgg FSH (follicle stimulating hormone). However, this was possible only until the cortical alveolar stage and after this, sex reversal would ensue. The reproductive cycle of giant groupers peaks during full moon, thus induced spawning activity is best performed at this time. Spawning induction in giant groupers in the floating sea cage was achieved using SEAFDEC/AQD protocols where slow-release GnRH was implanted four days before full moon and then HCG injection was performed two days before full moon. This study likewise looked at the appropriate larval food for giant groupers. Inclusion of *Proales* during the first 10 days of rearing results in significantly higher larval survival rate. Another component of the study looked at sperm cryopreservation. The viability of grouper sperm can be prolonged through cryopreservation in liquid nitrogen or in a -80°C biofreezer. In terms of sperm motility, motility is better retained in cryopreserved tiger grouper sperm while long-term fertilization capacity was only confirmed in giant groupers. Generally, viability remains despite a total loss in sperm motility. Initial results in evaluating suitability of Ficoll 70 as additive to the MPRS-DMSO (9:1 v/v) sperm extender at -80°C storage showed a dose-dependent effect in terms preserving viability. However, addition of Ficoll 70 does not positively affect motility conservation, which only lasted up to one month of cryopreservation. This project also successfully developed hybrids which are known to have improved growth and disease resistance. The project also plans to use sterile hybrids to apply surrogate technology in giant grouper production.		
<u>*Production of nonconventional feed ingredients for use in broodstock diets*</u> **Mudworm** Economic viability of tank based polychaete culture technology In the study "Economic viability of tank based polychaete culture technology," aimed to produce uniformly sized polychaetes in tanks using optimal nursery and grow-out protocols. Polychaete production facilities have been improved. Production is on-going using 500 broodstock in each 1 m^2 tank. Once achieved, the economic viability of indoor tank-based polychaete culture will be demonstrated.	**2016-2019**	Other species (*Perinereis* and *Composetia* sp) are currently being maintained.
Refinement of Hatchery and Nursery Protocols		

Anguillid eel (*Anguilla marmorata* and *A. bicolor pacifica*) Domestication of the Philippine native eel *Anguilla* sp. (Teleostei: Anguillidae) A study to determine the feasibility of nursing Philippine native glass eels in captivity was started in late 2017 and continued until July 2019. In addition to developing an appropriate rearing protocol of this fish species through provision of suitable feeding scheme and/or formulated diets for nursing glass eels and young elvers, identification of anguillid eels based on morphological and genetic characterization and potential pathogens in nursery eel systems were conducted. Experiments involving the assessment of pre-weaning diet for glass eels showed that *Tubifex* sp. or bloodworm was better than both *Artemia nauplii* and artificial diets. Meanwhile in terms of diet form, a moist paste diet gave high glass eel survival compared to those given dry and semi-moist diets. The stocks used for the feeding trials which came from batches of glass eels collected in 2017 and 2018 were morphologically and genetically identified. Analysis of 2018 Aparri samples enabled the identification of 96 pcs of *Anguilla marmorata* among the stock, aside from four (4) *A. luzonensis*. Samples from General Santos City in Mindanao which were pre-sorted as *A. bicolor pacifica* based on visual examination from source, were validated as 100% *A. bicolor pacifica* based on cytB sequence alignments. Apart from mtDNA sequence analysis, seven microsatellite primers used in Anguillid species were successfully tried on the Philippine Anguillid eel samples and the protocols for cross-amplification and microsatellite analysis were optimized. The glass eels and the rearing water from surveyed eel nursery farms were monitored for the presence of pathogens. Bacterial analysis of the water samples as well as parasite identification and load in the fish samples were also conducted. The pathogens identified were ectoparasites (*Trichodina* spp.), monogeneans (*Ichthyophthirius multifilis*) and bacteria (*Aeromonas* spp., *Pseudomonas* spp., and *Vibrio* spp.). Risk factors were noted and prevention, control and treatment measures were recommended.	**mid-2017 to mid-2019**	
<u>*Improvement of rearing protocols*</u> **Mangrove crab (*Scylla serrata*)** Use of algal paste in the larval rearing of mangrove crab *Scylla serrata* For ease in the hatchery rearing of mangrove crab seedstock, the use of algal paste in rotifer cultures for mangrove crab seed production was evaluated. Higher rotifer counts were noted when live *Nanochlorum* was used as feed. When live *Tetraselmis*, *Tetraselmis* algal paste from AQD and a commercial *Tetraselmis* algal paste were compared, the number of rotifers produced were highest in those fed the *Tetraselmis* algal paste from AQD. Meanwhile, when crabs were fed rotifers that subsisted on *Nanochlorum* culture, *Tetraselmis* culture, *Tetraselmis* paste from SEAFDEC/AQD and commercial *Tetraselmis* paste, growth was highest in those that were fed rotifers that were given *Nanochlorum* batch cultures.	**2018-2019**	
Sandfish *Holothuria scabra* Optimizing hatchery production of early juvenile sandfish *Holothuria scabra* The sandfish hatchery facility was improved, that is aeration filters were installed, sandfilter system was upgraded, autoheating system was installed. Broodstock were acquired from three sources, namely Concepcion, San Lorenzo, Sagay and Igang. Sixteen spawning episodes	**2018-2019**	

(from February to September) were recorded. The target production of 20,000 early juveniles per batch was achieved, one in February and the next, in June. Low sandfish juvenile survival noted in the hatchery production was attributable to fluctuating temperature, lack of larval food and low salinity. Technology brochures on sandfish hatchery and nursery operations have been published. An updated hatchery manual is under preparation. Collation of best protocols and practices is being done.		
Sandfish *Holothuria scabra* Assessment of tank-based nursery system of sandfish *Holothuria scabra* To optimize growth and survival of sandfish juveniles to 20 g fingerling size, rearing is divided into two nursery phases: primary nursery phase for early juveniles (3 g) and secondary nursery phase for late juveniles (3 g to > 20 g). This study aims determine the optimal rearing conditions for primary nursery system for early juvenile sandfish in tank-based floating *hapas* and evaluation of the rearing performance of secondary nursery system for late juvenile sandfish in tank-based floating *hapas*. Survival of sandfish juveniles was noted to be 56% after one month rearing in *hapa* in tanks at 250 sandfish/*hapa* stocking rate. Growth was about 0.02 g/day. For the second nursery phase, a preliminary experiment focused on the adoption of supplemental feeding was conducted. This study was done using three feed types: milkfish fry mash, shrimp PL feed, *Sargassum* powder (SP), and a control with no supplemental feed. Three replicate bins with sediments were used for each treatment and control. The best supplemental feed was the milkfish fry mash where the growth of sandfish was 0.1 g/day.	**2017-2019**	
***Tigriopus* sp.** Development of techniques for sustainable mass production of harpacticoid copepods for marine fish and crustacean larviculture This study aimed to investigate and describe the life cycle of *Tigriopus* sp., determine and establish optimal culture conditions for *Tigriopus* mass production. The life cycle of *Tigriopus* wasnsuccessfully monitored and described. Meanwhile, the conditions for *Tigriopus* mass production have yet to be optimized.	**2019**	
Pompano Utilization of artificial illumination in floating net cages on the nursery culture of pompano *Trachinotus blochii*: Effects on the growth and survival of pompano and its added economic value This study was conducted to (a) develop alternative and cost-effective nursery rearing techniques for the pompano, (b) determine the effect of artificial illumination on prey selectivity of pompano and subsequently, on pompano growth and survival and (c) determine the effect of artificial illumination on the abundance of zooplankton in floating net cages. Results showed that artificial lighting at night improved pompano growth in the nursery. Reduction of feeding by 75% with formulated diets was possible in the first 75 days of culture and up to 50% feed reduction can be done until 95 to 105 days of culture.	**2017-2019**	
Seaweed (*Kappaphycus* sp.) Production of *Kappaphycus* plantlets This study aims to demonstrate the production of *Kappaphycus* propagules in land-based nursery laboratory and in sea based nursery cages. In 2019, the production target was achieved with 44 batches of	**2017-2019**	

propagules produced/ year. The seasonality of on-grown tissue plantlets have been defined. The characteristics (especially carrageenan quality) of plantlets grown at different pH and salinity levels have been noted.		
Production of alternative natural food organisms for hatchery and nursery rearing of commercially important aquatic species **Algal paste** Optimization of electrolytic flocculator for paste production of important locally available microalgae in aquaculture This study aimed to establish optimal conditions for the production of algal paste through electrolytic flocculation using important, locally available microalgal strains/species in aquaculture by manipulating the following factors in the design/operation of the flocculator: (a) current/power source; (b) salinity; and (c) the flocculator's metal component. The pastes produced were assessed in terms of viability, length of storage and metal residues (*e.g.* lead or Pb) that may be found in the paste. Preliminary culture and scale up of algae was done for diatom *Chaetoceros calcitrans*. Results show the potential of *C. calcitrans* for mass production and subsequently for algal paste production as it can easily be mass produced in 4 days. Trials on Artemia being fed rice bran plus *C. calcitrans* paste were compared with Artemia fed live *C. calcitrans* showed that the algal paste feeding resulted to better growth in brine shrimp. Lead content in the paste is reduced by 97% via manipulation of settings (number of anode or cathode and voltage) using a variable voltage flocculator. Meanwhile, lead residue levels were examined in the brine shrimp that were fed the algal paste with reduced lead content. Levels of lead in the brine shrimp were reduced by 77. Finally, the best storage conditions for the algal paste are provided best by the use of a freezer followed by the use of either a chiller or an airconditioned room.	**2018-2019**	
Development of a modified continuous culture system for natural food production **Larval food** Development of a modified continuous culture system for the mass production of *Nanochlorum* sp. and *Brachionus rotundiformis* This study aimed to (a) determine pH and substrate and nutrient concentration for *Nanochlorum* species in batch culture, (b) determine turnover rate to achieve stable and sustainable algal culture, (c) determine biochemical composition at different turnover rates, and (d) reduce cost of producing live food in fish and crab hatcheries. Preliminary experiments comparing *Nanochlorum* sp. cell growth under different pH levels showed significantly high cell growth at pH 8.0 while the lowest is at pH 6.0. Cell size on the other hand, was highest at pH9.0 and the lowest was again at pH 6.0.		
Milkfish (*Chanos chanos*) Developing transport techniques for milkfish *Chanos chanos* juveniles In the milkfish, a study that aims to develop a protocol in transporting milkfish juveniles (with an average total length of 5-6 inches) from the nursery to sea cage facilities was completed this year. This experiment hoped to define optimal temperature and salinity requirements for the transport of milkfish juveniles. The study likewise included trials on the suitable conditioning period of confinement in cages in ponds		

before the juveniles are transported to milkfish sea cage farming sites. Results showed that milkfish juveniles (5-7 inches) can be transported for up to 12 hours in a closed system under various salinities, temperatures and their combinations, with minimal mortalities. The conditioning period of confinement prior to juvenile transport showed the best result for the 4-week period and the least favorable result was those conditioned for 1 day. As for the effect of 2 phenoxy-ethanol (PE) as sedative during actual juvenile transport, it was noted that juvenile survival did not differ among treatments as survival was comparable in treatments that have 2 fish/L, 4 fish/L, 4 fish/L plus 50 ppm PE and that of 6 fish/L plus 50 ppm PE.		
Increase awareness on available genetically selected/improved stocks and optimize their use for improved on-farm aquaculture production		
Mangrove crab and abalone The genetic improvement research initiatives that have been completed are on two species, the abalone and the mangrove crab. The mangrove crab project aimed to produce fast growing and disease resistant lines while the abalone project focused on improved breeding performance through strain comparison/evaluation and other beneficial traits such as growth.		
Promotion of technically and economically-viable breeding and seed production schemes		
Abalone Seed production of donkey's ear abalone *Haliotis asinina* juveniles Under this program, large-scale production of abalone is being conducted since 2008. The aims of this study were to (a) increase juvenile yield to 5% by the application of interventions such as feeding, appropriate diatom strain, supplementation with microparticulate diet, application of anesthetics for early harvesting of juveniles, (b) determine effect of seaweed quality on broodstock and larval performance and, (c) demonstrate large scale production of abalone using refined AQD methods. Results showed that the improvement in target yield to 5% was achieved through increased diatom feeding.	**2008-2019**	Abalone juvenile production shall continue, technology dissemination through training will also continue
Mangrove crab Seed production of mangrove crab A total of 3.3 million newly hatched larvae and 383,160 pcs of crablets were sold. The monetary value of all the crabs sold was Php 1,913,740 (USD 37,026).	**2018-2019**	

4. PROPOSED FUTURE ACTIVITIES FOR THE YEAR 2020

4.1 Planning of the Project Activities

Project/Activity Title	Duration	Remarks
All aforementioned study will continue in 2020. New studies on *Anabas testudinaeus* (*e.g.* breeding and seed production), mudcrab nutrigenomics, and milkfish genomics will be proposed.	**2020**	

4.2 Expected Outcomes/Outputs

With the continuation of several studies from 2019, all activities especially those involving emerging species *e.g.* giant grouper, Anguillid eels, *Anabas testudinaeus*, among others will be studied. New

information shall be generated and hopefully, science-based technologies shall be developed and disseminated. Advance scientific research such as those dealing with genetics/genomics shall provide novel approaches in producing quality seedstock, and in developing feeds for nursery rearing that are formulated either for improved growth and/or resistance to diseases.