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Shrimp genetic improvement in Ecuador

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Initial results of localized mass selection

Cooperative work among farms and a large maturation operation is leading to improved growth rates in shrimp.

A novel genetic improvement program in Ecuador involving an association between the largest maturation facility in the country, Texcumar, and a group of five large shrimp producers that account for over 7,000 ha of commercial shrimp ponds is under way to improve the growth rates of shrimp at the farms of the associates.

To minimize the thorny genotype x environment (G x E) interaction issues that seriously constrain genetic accomplishments in the context of the customary low-density, extensive shrimp production systems of the Americas, a localized mass-selection format was implemented in March 2011. The idea was to start with somewhat modest goals and venture into a more sophisticated program a few years down the road.

The mass-selection format was adopted due to its simplicity, low cost, good fit for the localized strategy adopted and especially because the main breeding objective was only the improvement of growth rates.

New program: separate lines

To tackle the issue of G x E interactions, separate maturation rooms with eight to 10 tanks each in the commercial maturation center were used to produce nauplii selected to serve the specific needs of the program's associated farms and producers. High-performing shrimp at relevant target harvest weights were selected from commercial ponds under commercial conditions.

Selected animals were brought to the maturation center, where they were subsequently managed to complete their growth and reach reproductive competence. Females were later screened by polymerase chain reaction (PCR) for infectious hypodermal and hematopoietic necrosis virus after ablation, and only IHHNV-negative females were finally stocked in the appropriate maturation rooms.

Larviculture was conducted separately from each maturation room, with a traceability framework that ensured each farm would receive only postlarvae derived from its own broodstock.

Initial results

Historic data from each associate farm had been collected for the three years preceding the selection program. All stockings with the new farm-specific postlarvae were followed throughout grow-out, and their harvest data were collected to establish valid comparisons that could help objectively evaluate the outcomes of the program.

With nearly 15 months of the program now completed, many second-generation animals are under commercial grow-out at their respective farms. Results from the first generation of localized mass selections are becoming available for two of the associate farms.

Associate A

Results obtained for Associate A at the three major farms of the group are presented in Table 1 for the most important traits under the scope of the program objectives. These were simple farm averages for the years of 2009 to 2012. Harvests from 2011 were subdivided in two groups: those until August, still not derived from the mass-selected lines under the program (2011-BP), and those after August from grow-outs stocked with the new selected local lines. The latter harvests were aggregated with the completed 2012 harvests and labeled as “AP-11-12.”

It should be mentioned that genetic impacts from the mass-selection strategies implemented in March 2011 could only have been noticed with the harvests occurring in September 2011 and thereafter. Nevertheless, since improved larviculture management protocols and the previously mentioned broodstock IHHNV screenings started to be enforced in late 2012, throughout the commercial harvests of the first months of 2011, the eventual production impacts from these improved practices could have already begun. This may partially explain some of the yearly trends observed in Table 1.

Phenotypic improvements

Results indicated that with the first commercial harvests derived from the new mass-selected lines, phenotypic improvements of 10 to 15 percent for growth and harvested biomass/ha/day were observed for Associate A. The exception was farm 3, which registered a slight decline in the harvested biomass rates. It should be emphasized that for all the farms, improvements in the growth rates were observed with concurrent increases in stocking densities, which magnifies the relevance of the growth improvements verified.

Whether the improvement observed was a consequence of the program is something that cannot be easily ascertained with a simple mass-selection program. The 10 to 15 percent improvement verified could have been due to other factors.

In the context of this genetic improvement scheme, the achievement of positive yearly phenotypic trends comparable to projected potential gains must provide sufficient verification, as the simplicity and low cost of the genetic improvement scheme defined can offer no better alternatives. This was accepted and understood by the partners in the program.

Individual broodstock received eye tags for identification.

Perspectives

Data not shown indicated that patterns of final product variability and size dispersion were not different before and after the first commercial harvests of the new localized lines. The values in Table 1 support a concern that the exclusive focus on improving growth rates may bring some undesirable consequences for survival. Results were particularly concerning for farm 2, since a declining trend for survival was already present at farm 3 since 2009. Associate A is not concerned with this situation for now, but the issue will be scrutinized as the program advances.

Rocha, Mean yearly trendsm Table 1

Trait Farm 1	2009 Farm 1	2010 Farm 1	2011-BP* Farm 1	AP-11-12** Farm 1	Change*** Farm 1
Growth (g/week)	1.052	1.084	1.243	1.301	+ 0.175 (15.5%)
Harvested biomass (lb/ha/cycle)	1,683	1,898	1,745	2,017	+ 242 (13.6%)
Harvest weight (g)	17.0	17.8	17.2	17.8	+ 0.5 (2.7%)
Growout days	113	115	97	96	− 12.5 (11.5%)
Stocking density (shrimp/m^2)	11.1	9.9	10.4	11.0	+ 0.5 (5.1%)
Survival (%)	40.6	48.9	44.5	46.8	+ 2.1 (4.8%)
Feed-conversion ratio	1.66	1.61	1.43	1.46	− 0.11 (6.8%)
Aeration (hp/ha)	1.0	1.0	1.0	1.0	0 (0%)

Sample size (ha farmed)	73 (600)	66 (543)	39 (312)	74 (600)	N/A
Farm 2	**Farm 2**	**Farm 2**	**Farm 2**	**Farm 2**	**Farm 2**
Growth (g/week)	1.398	1.291	1.399	1.499	+ 0.136 (10.0%)
Harvested biomass (lb/ha/cycle)	2,734	2,858	3,302	3,310	+ 345 (11.7%)
Harvest weight (g)	20.7	21.2	19.2	21.1	+ 0.7 (3.6%)
Growout days	104	115	96	98	– 6.6 (6.3%)
Stocking density (shrimp/m^2)	12.2	11.1	13.5	15.3	+ 3.0 (24.7%)
Survival (%)	49.2	55.2	57.9	46.6	– 7.5 (13.9%)
Feed-conversion ratio	1.47	1.61	1.48	1.47	– 0.05 (3.3%)
Aeration (hp/ha)	1.25	1.25	3.00	3.00	+ 1.2 (63.6%)
Sample size (ha farmed)	18 (135)	18 (144)	12 (98)	16 (141)	N/A
Farm 3	**Farm 3**	**Farm 3**	**Farm 3**	**Farm 3**	**Farm 3**
Growth (g/week)	1.061	0.902	1.020	1.098	+ 0.104 (10.4%)
Harvested biomass (lb/ha/cycle)	2,953	2,608	2,494	2,590	– 96 (3.6%)
Harvest weight (g)	18.2	18.4	17.6	20.1	+ 2.0 (11.3%)
Growout days	120	143	121	128	+ 0.2 (0.16%)
Stocking density (shrimp/m^2)	11.4	10.9	11.4	12.0	+ 0.8 (6.8%)
Survival (%)	64.7	59.1	56.5	48.8	– 11.3 (18.8%)
Feed-conversion ratio	1.42	1.84	1.43	1.42	– 0.14 (9.2%)
Aeration (hp/ha)	1.25	1.25	3.0	3.0	+ 1.2 (63.6%)
Sample size (ha farmed)	22 (142)	18 (92)	13 (72)	22 (116)	N/A

* Means from growouts harvested between January and August 2011, stocked with lines not yet mass-selected, but from IHHNV-negative female broodstock and subjected to better larviculture protocols.
** Means from growouts harvested from September 2011 to date, stocked with mass-selected lines.
*** Phenotypic change coinciding with the beginning of the genetics program – difference between AP-11-12 and average of 2009, 2010 and 2011-BP. The corresponding percentage change is shown in parentheses.

Table 1. Mean yearly trends for phenotypic changes at Associate A farms.

It should be mentioned that of Associate A's three farms, farm 1 was the only one where the localized program strategy was rigorously followed. All of its stockings were with localized mass-selected lines that originated from Associate A farms. Due to scarcity of the appropriate locally specific postlarvae, many pond stockings at farms 2 and 3 used mass-selected lines from other program associates.

It is significant that of all three farms, farm 1 had the greatest phenotypic improvements for growth and harvested biomass, and it was the only farm for which a phenotypic improvement in survival was observed coincident with the starting of the program. This may reinforce the merit of the localized mass-selection strategy to tackle the aforementioned G x E interaction issues.

Finally, Table 1 shows that coinciding with the improvements observed for growth rates, the trends for feed-conversion ratios were in a favorable direction.

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