WorldFish

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MPEDA-RGCA GIFT Program

Annual Report for the period April 2021 to March 2022

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About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world. Headquartered in Penang, Malaysia and with regional offices across Africa, Asia and the Pacific, WorldFish is a member of CGIAR**,** the world's largest global partnership on agriculture research and innovation for a food secure future.

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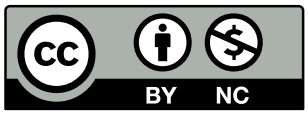

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List of acronyms

BDW	Business Development Wing
CGIAR	Consultative Group on International Agricultural Research
EBV	Estimated Breeding Value
MPEDA	Marine Products Export Development Authority
RGCA	Rajiv Gandhi Center for Aquaculture
GIFT	Genetically improved farmed tilapia
MCs	Multiplication Centers
MoU	Memorandum of Understanding
SOP	Standard Operating Procedures
PMMSY	Pradhan Mantri Masthya Sampada Yojana
RKVY	Rashtriya Krishi Vikas Yojana

1. Executive summary

Rajiv Gandhi Center for Aquaculture (RGCA), India, and WorldFish have been collaborating since August 2009 that led to the establishment of GIFT satellite breeding nucleus and breeding program in India. Phase I of the collaboration running from 2011 to 2016, saw the establishment of a fully pedigreed genetic improvement program for GIFT tilapia in India after the transfer of 100 families (in two batches) from Jitra, Malaysia. Phase II collaboration agreement was signed between RGCA and WorldFish in Jan 2019. The objectives of Phase II of the collaboration (2019-2023) is to continue to improve the genetic performance of the GIFT strain in India and aims to further develop viable dissemination models that can facilitate the long-term delivery of high-quality tilapia seeds to the Indian aquaculture sector.

GIFT germ plasm was supplied to RGCA in 2011 and 2016. Considering 2011 as G0, RGCA had 62 unique families of G7 in 2019. Using the mating list and mating design provided by WorldFish, RGCA Genetics and breeding team produced 41 and 27 families of G8 and G9 in 2020 and 2021, respectively. 27 families of G9 were reared as per RGCA SOP and collected all the relevant data to enable selection of G9 fish for producing G10. The first annual report for the period April 2019 to March 2020 was submitted in April 2020 and the second annual report for the period April 2020-March 2021 was submitted in April 2021. Both were approved by RGCA/MPEDA. This third annual report covers the period April 2021 to March 2022.

2. Introduction

Rajiv Gandhi Center for Aquaculture (RGCA), India, and WorldFish have been collaborating since August 2009 that led to the establishment of GIFT satellite breeding nucleus and breeding program in India.

Phase I of the collaboration running from 2011 to 2016, saw the establishment of a fully pedigreed genetic improvement program for GIFT tilapia in India after the transfer of 100 families (in two batches) from Jitra, Malaysia. The program successfully achieved five generations of selection at RGCA's research station in Vijayawada, AP, resulting in an average genetic improvement for body weight at harvest of over 8% per generation. Simultaneously the program has also successfully maintained increases in the rate of inbreeding accumulation and effective population size to acceptable levels.

Phase II of the collaboration (2019-2023) is to continue to improve the genetic performance of the GIFT strain in India and aims to further develop viable dissemination models that can facilitate the long-term delivery of high-quality tilapia seeds to the Indian aquaculture sector. The project will also explore the development of viable economic models that will allow the breeding program to continue beyond the duration of the project, design and implement a data collection and recording platform to allow monitoring of GIFT dissemination and understand how variations in on-farm performance of GIFT in different farming climates or systems will impact the variability of farmer production, allowing better extension advice and recommendations to be shared with producers. GIFT germ plasm was supplied to RGCA in 2011 and 2016. Considering 2011 as G0, RGCA had 24 unique families of G9 in 2022.

Objectives:
Phase II of the collaboration has the following objectives:

- Further improve genetic performance of the GIFT strain through continuation of the formal breeding program (fully pedigreed population) initiated in Phase I (2011-2016)
- Develop a logical breeding structure and dissemination strategy for scaling-up of tilapia aquaculture in India
- Establish a system for recording and monitoring the dissemination of the improved strain to farmers and producers throughout the country
- Understand performance of GIFT (eg profitability and productivity) on aquaculture farms caused by differing environmental conditions and other factors experienced throughout India

3. Activities carried out and tasks accomplished:

Phase II collaboration agreement was signed between RGCA and WorldFish in Jan 2019 and the activities commenced from April 2019. The first annual report for the period April 2019 to March 2020 was submitted in April 2020 and the second annual report for the period April 2020-March 2021 was submitted in April 2021. Both were approved by RGCA/MPEDA. The third annual report covers the period April 2021 to March 2022. In view of covid travel restrictions many of the envisaged activities could not be carried out, instead most of the activities had to be done through virtual meetings.

A1. Production of G9 families of GIFT

Using the mating list and mating design provided by WorldFish, RGCA Genetics and breeding team produced G9 families, reared them as per RGCA SOP and collected all the relevant data to enable selection of G9 fish for future breeding. RGCA successfully produced 27 families of G9.

A2: G9 Data analysis and provision of mating list to RGCA to produce G10.

1.1. Data

Data of nine generation from G_0 to G_9 of Nile tilapia (*Oreochromis niloticus*) of the Rajiv Gandhi Centre for Aquaculture (RGCA) Genetically Improved Farmed Tilapia (GIFT) strain were pooled, checked and managed in Microsoft Excel® 2016 prior to analysis, in order to increase accuracy of genotypic and phenotypic estimations. The data consisted of 43,531 fish (G_0 to G_9 RGAC GIFT), of which 1,610 fish survived at harvest that belong to 27 families of the G_9 RGCA GIFT. These 1,610 G_8 RGCA GIFT fish were with performance data recorded at harvest (body weight, standard length, body depth and body width), representing a survival rate of 78.1% which is good for Nile tilapia that grown in earthen pond.

Descriptive statistic for harvest body weight (in g) and standard length (in mm) of G_9 RGCA GIFT are presented in Table 1. Fifty point one percent of the fish were identified as females

and 49.9% as males. The males were on average 13.4% heavier and 3.6% longer than the females.

Table 1. Number of fish at harvest, harvest body weight (g) and standard length (mm) of G_9 RGCA GIFT. Values are mean ± standard deviation. Coefficient of variation (CV) is in percentage.

Sex	Number of fish (%)	Harvest body weight		Harvest standard length	
		Value (g)	CV	Value (mm)	CV
Female	807 (50.1%)	502.8 ± 97.6	19.4	226.9 ± 15.4	6.8
Male	803 (49.9%)	570.4 ± 110.7	19.4	235.0 ± 15.9	6.8
Both sexes	1,610 (100.0%)	536.5 ± 109.6	20.4	230.9 ± 16.2	7.0

1.2. Pedigree

The pedigree used for analysis included 19 generations, that is, nine generations at RGCA and 10 generation prior to that back to the first generation at WorldFish in Malaysia. It includes 43,531 fish, both dead fish during grow-out and survival fish at harvest.

1.3. Estimation of variance components and breeding values (EBVs)

Variance components and individual breeding values were estimated using the standard-industry ASReml version 4.2 (Gilmour *et al.*, 2015). Significant levels of fixed effects were tested using the qualifier '!DDF' in ASReml. Generation, post-tagging hapa, pond, sex, total age (from spawning until harvest), were found significant (P<0.05) and therefore were fitted in the models for genetic analysis. The mixed effects included fixed effects (generation, post-tagging hapa and pond), co-variate (total age) and random effects (fish and dam) as follows

$$\boldsymbol{harvest\ weight_{ijklm}} = \boldsymbol{\mu} + \boldsymbol{\beta_1} \times \boldsymbol{total\ age_{ijklm}} + \boldsymbol{generation_i} + \boldsymbol{post\ tagging\ hapa_j} + \boldsymbol{pond_k} + \boldsymbol{sex_l} + \boldsymbol{fish_m} + \boldsymbol{dam_n} + \boldsymbol{e_{ijklmn}}$$

where $\boldsymbol{harvest\ weight_{ijklm}}$ is harvest weight of the $\boldsymbol{m}$ fish, $\boldsymbol{\mu}$ is the population mean, $\boldsymbol{\beta_1} \times \boldsymbol{total\ age_{ijklm}}$ is the fixed regression on total age at harvest, $\boldsymbol{generation_i}$ is the fixed effect of generations (10 generations from G_0 to G_9 RGCA GIFT), $\boldsymbol{post\ tagging\ hapa_j}$ is the fixed effect of holding hapas after tagging, $\boldsymbol{pond_k}$ is the fixed effect of the grow-out ponds, $\boldsymbol{sex_l}$ is the fixed effect of two sexes (male and female), $\boldsymbol{fish_m}$ is the random effect of fish $\boldsymbol{k}$, $\boldsymbol{dam_n}$ is random effect of the dam (the mother fish) $\boldsymbol{n}$, and $\boldsymbol{e_{ijklmn}}$ is the random residual term.

1.4. Mating list

Mating list was calculated based on individual breeding values of all fish presented in the pedigree, from all 19 generations (G_9 RGCA back to generation 1 in Malaysia), the full

pedigree, and with a constrained inbreeding at 0.66% in the next generation (i.e., G_{10} RGCA GIFT). This was done using an in-house codes executed in the R software (R Core Team, 2021).

The output mating list consisted of 27 mating pairs, each consisted three full-sibs males (brothers that share the same father and same mother) and three full-sibs females (sisters that share the same father and same mother). This mating list should result in 27 full-sibs families should the all the mating will be successful.

There are two options proposed, as follows:
Option 1: mating design of one male with one female in a single mating hapa.
Option 2: mating design with one male and three females in a single hapa, to speed up the mating and spawning process, example:

Mating hapa	Sire ID	Sire EBV	Dam ID	Dam EBV	Expected inbreeding
1	0G875CA8DF	138.0	0G87720191	164.3	0.0276
	0G87A7B1EB	130.0	0G87A71BDC	154.6	0.0276
	0G8794A3AB	123.8	0G86F07082	149.7	0.0276

EBV = Estimated breeding value.

- First, put the first male 0G875CA8DF with ALL three females 0G87720191, 0G87A71BDC, and 0G86F07082 at once into a mating hapa #1. Note that the three females are full-sibs sisters (sisters that have the same father and same mother). Also, the three males are full-sibs brothers.
- If one or more females spawn, keep all families at the moment.
- When it is sure that having family(ies) with enough fry for nursing, keep one family with the female with highest estimated breeding value (EBV). Among the three females, 0G87720191 has highest EBV, 0G87A71BDC has second-highest EBV, and 0G86F07082 has the lowest EBV.
- If none of the females spawn after two checks for eggs, change the male with the second one 0G87A7B1EB.
- If the second male fail to mate, move the third male 0G8794A3AB.

The Mating List details are below:

Mating_hapa	Sire	Sire_EBV	Cage_Sire	Dam	Dam_EBV	Cage_Dam	Expected_inbreeding
1	0G97AF4258	154.3	A	0G9794B36D	175.8	D	0.035
	0G97A75391	149.9	A	0G975CAB99	172.1	G	0.035
	0G96F29C84	146	G	0G96F03893	170.6	J	0.035
2	0G97AF5540	150.2	O	0G975CA849	145.8	E	0.033
	0G9793B492	145.7	D	0G975CB6F1	143.9	I	0.033
	0G97A7904F	141.1	O	0G976F9F21	139.2	B	0.033
3	0G9771D24D	149.9	C	0G97A720D0	141.4	O	0.063
	0G975CB106	147.3	F	0G97AF5E7D	139.6	Q	0.063
	0G97A76F82	147	B	0G97AF5497	134.4	B	0.063
4	0G97A74048	143.2	Q	0G975CA8F9	141.6	A	0.030

	0G96F30A47	141.3	C	0G9771D3B3	139.1	A	0.030
	0G97A730EB	141	P	0G97AF61A0	128	G	0.030
5	0G9754B3B5	145.7	E	0G975C51D9	137.1	A	0.045
	0G97A735C7	141.2	G	0G975CA56C	133.3	M	0.045
	0G97A7330A	134	D	0G975C031B	130.2	O	0.045
6	0G97A792E1	145.4	L	0G9771DA67	130.3	I	0.043
	0G975C9B8C	142.8	K	0G97AF6865	123	J	0.043
	0G975CA21F	134.5	C	0G97A6FB09	122.3	F	0.043
7	0G977232B3	132	K	0G97A7BED6	134.4	C	0.062
	0G97AF59BE	130.2	B	0G97AF5215	131.8	L	0.062
	0G97AF5738	130.1	K	0G97AF54A9	129	A	0.062
8	0G97AF5E73	132.8	H	0G97A75EB4	130.2	J	0.043
	0G97D0AF45	131	J	0G97AF5E15	125.9	O	0.043
	0G971A2038	128.6	A	0G971A438C	114.5	D	0.043
9	0G97A73553	134.2	N	0G975C1C16	119.5	P	0.027
	0G97A761E8	113.8	I	0G97AF5E8F	118	A	0.027
	0G9794638F	112	D	0G97AF60CF	117.9	L	0.027
10	0G97AF4830	134.7	M	0G97AF5D94	118	M	0.038
	0G975BE35D	123.8	E	0G97547648	110.7	D	0.038
	0G979495D5	120	L	0G97724B20	97.65	N	0.038
11	0G979491AD	111.7	F	0G9754A959	116.8	F	0.061
	0G971A20F8	110.6	M	0G97AF471D	109.3	L	0.061
	0G97D0B7F3	107.3	C	0G97724777	99.99	A	0.061
12	0G97AF5E13	105.7	O	0G97D0B9ED	112.2	A	0.046
	0G97AF5A5D	102	E	0G96E8C539	106.9	M	0.046
	0G96F04107	98.18	H	0G97A7214A	106.4	O	0.046
13	0G97AF64D8	125.5	Q	0G97A71A2D	102.4	A	0.040
	0G97AF420F	118	H	0G97A72ECB	96.87	C	0.040
	0G97A7002D	79.38	O	0G975C0364	91.19	I	0.040
14	0G97A73AAD	100.8	D	0G97AF60BD	95.81	I	0.036
	0G975CAE02	100.5	C	0G97AF4402	93.62	J	0.036
	0G96F30134	99.73	D	0G97A74069	89.31	B	0.036
15	0G97AF5789	110.8	L	0G96B91697	89.89	J	0.033
	0G97A78ED8	94.42	B	0G977237AD	86.91	K	0.033
	0G9753791A	94.1	O	0G97A75EC7	85.05	M	0.033
16	0G9794702B	105.8	K	0G97A6FC4F	100.2	Q	0.043
	0G979469E7	97.08	P	0G9771FB89	81.97	F	0.043
	0G9794A084	92.08	J	0G97AF67E8	80.74	H	0.043
17	0G97549A06	99.46	A	0G97AF5678	90.11	B	0.062
	0G97A777BA	95.78	D	0G97A7916E	81.91	G	0.062
	0G97AF456A	95.68	G	0G97CFC333	78.78	Q	0.062
18	0G975BF034	99.84	N	0G97AF536D	90.68	E	0.048
	0G975BE321	94.76	B	0G975BFC87	86.69	O	0.048
	0G9754C0FE	85.95	P	0G9771A0D2	83.23	N	0.048
19	0G96EB48C2	85.74	E	0G9794AA10	97.57	L	0.050
	0G97AF4260	75.42	C	0G96B8FA7C	64.33	K	0.050
	0G97AF523C	69.77	K	0G96EAEEE6	62.48	H	0.050
20	0G96F04E02	81.31	C	0G97A6F362	77.92	M	0.051
	0G97A7759F	72.5	O	0G97AF6650	72.48	E	0.051
	0G97A7002C	71.72	F	0G975CA3D8	70.32	O	0.051

21	0G97546EC6	75.85	E	0G97A7078C	76.68	G	0.044
	0G97A6F59C	70	Q	0G9754C497	74.27	O	0.044
	0G979466BA	66.62	C	0G97AF4520	65.73	A	0.044
22	0G97AF5D51	77.81	K	0G97AF59C4	75.33	L	0.061
	0G97AF63A4	66.83	B	0G97AF521B	70.53	N	0.061
	0G9794437C	63.31	A	0G9793E629	66.84	L	0.061
23	0G97A78C76	63.55	G	0G97947306	62.05	C	0.053
	0G977211B3	60.69	E	0G97AF544B	58.04	O	0.053
	0G975C155D	60.69	A	0G97724ED1	56.51	D	0.053
24	0G975C5275	71.54	L	0G975CA807	22.71	N	0.032
	0G97948875	67.81	K	0G97948EDD	18.07	O	0.032
	0G97A73123	67.18	A	0G97A763A0	17.3	A	0.032
25	0G975C037A	74.06	K	0G9754B406	74.1	A	0.051
	0G9754B83F	53.58	Q	0G975CAC1D	68.7	D	0.051
	0G97D0B1FF	52.85	P	0G9754AEB9	67.47	L	0.051
26	0G975CA39B	52.94	H	0G979467AC	58.86	C	0.060
	0G97A78D33	50.89	O	0G9754C841	45.51	O	0.060
	0G97AF584C	48.6	B	0G97533AB8	45.36	N	0.060
27	0G97A76E6C	23.05	I	0G9754A6E6	47.53	F	0.036
	0G97A71476	14.94	N	0G97AF56C2	47.53	F	0.036
	0G97AF5B93	13.2	D	0G9719FC42	43.84	C	0.036

1.5. Production of G10

Tilapia team of RGCA has performed 5 numbers of egg collection for G9 brooders for the production of G10 (dated: 01/01/2022). The breeding programme started this time with 27 nos of unique families maintaining in 81 nos of 1mX1mX1m hapas with First, Second and Third choices as per the recommendations from WorldFish genetics team. Till date, 53 families representing 24 unique families were produced. The tagging of the fishes is planned to be conducted during the month of April 2022.

A3. GIFT Dissemination in India

RGCA during Y3 produced and disseminated 6.93 million mono-sex GIFT to 37 licensed farmers in different states of India. In addition, RGCA also disseminated 31,300 mixed sex GIFT germplasm to 6 number of private and 7 public sector hatcheries during Y3. As a part of this work, a simple GIFT dissemination recording platform has been established in RGCA.

A4. Influence Policy and Developing a GIFT dissemination and scaling strategy for India

As a part of influencing policy, WorldFish was invited to join a meeting with senior representatives of Confederation of Indian Industries (CII) to explore possibilities for scaling of GIFT in India. Ministry of Commerce has selected 12 Champion sectors which could take the lead to make India a manufacturing hub for the world that can help grow our export. Fisheries and Aquaculture is one of the key sectors identified due to the huge potential of export and the inherent strength India possesses. CII's Food and Agriculture centre of excellence (FACE) has been working on this initiative with Ministry of Commerce & Industry and have presented a broad roadmap before the Hon'ble Commerce Minister in April 2020. Within this initiative tilapia has been identified as one of the key species for

impact at scale. The meeting between CII, MPEDA, RGCA and senior research and management team of WorldFish was held on 15th March 2021 and WorldFish provided all the needed inputs and resources to CII.

As a follow up to the above, in the last 12 months, WorldFish researchers have worked very closely with CII to develop a business case for tilapia in India. This work through several rounds of forecasting analysis, modelling and consultations with key stakeholders including MPEDA/RGCA, NFDB, Ministry of Fisheries, Animal Husbandry and Dairying has resulted in the publication of "WorldFish and the Confederation of Indian Industry. 2021. ***A Business Case for Scaling the Production of Tilapia in India: A Report for the SCALE Committee of the Government of India***". This document will be submitted to the Ministry soon to initiate steps to start the scaling process as outlined in the business case.

A strategy for GIFT dissemination and scaling in India is imperative to ensuring that the positive changes in policy and the increased efforts and investments in the tilapia industry succeed to scale impacts of GIFT adoption. Therefore, India's GIFT strategy aims at ensuring increased productivity, incomes, food and nutrition security, and reduced poverty through effective dissemination and scaling of GIFT within a sustainable business model. The strategy was prepared with insights from the Dalberg report (Dalberg, 2020). It also draws from previous and current MoU with MPEDA-RGCA, the comprehensive tilapia seed systems evaluation research conducted in Bangladesh and Malawi under the SPAITS project, the dissemination strategy for improved carps in Bangladesh (WorldFish, 2020), consultations with colleagues at WorldFish and in-country partners, and experiences from previous and on-going projects in India.

A6. GIFT Performance data collection and analysis

Current knowledge of how GIFT tilapia is performing under local Indian conditions is limited, and may indeed show varying productivity (and therefore profitability) in regions that, for example, have cooler temperatures in northern regions, higher salinity in coastal regions or use small-scale farming systems. This critical gap in understanding must be filled in order to provide an accurate basis for grower management decisions and predicting the economic benefit of large-scale dissemination of GIFT. RGCA is providing specific feed back forms to all farmers while they lift seed from RGCA. Using WorldFish GIFT performance assessment tool, WorldFish and RGCA team implemented joint activities to collect required information from GIFT farmers from different geographical regions of India. The data gathered is presently being analysed to produce scientific reports on performance of GIFT in India

A7. Training programs

The planned training programs in Penang during Y3 could not be undertaken in view of covid travel restrictions. Therefore one virtual training program on data analysis using ASReml was conducted in May/June 2021 and RGCA team were trained on data analysis and finalization of mating lists for producing future generations.

Training Period: 10 hours (five days; two hours each day)
(15/05/2021; 22/05/2021; 29/05/2021; 05/06/2021 and 12/06/2021)

Si No	Name	Designation	Project office
1	Dr. Anup Mandal	Project Manager	RGCA-HQ
2	Shri. B Appala Naidu	Assistant Project Manager	RGCA-Tilapia Project
3	Shri. P Srinivasa Rao	Assistant Project Manager	
4	Shri. Mathews Varkey	Assistant Project Manager	
5	Shri. U. Gunasekaran	Assistant Technical Manager	
6	Shri. M. Gnanavel	Assistant Technical Manager	
7	Shri. G. Senthil	Technician	

Training Schedule

Session	Date	Time	Topic
Day - 1	15-05-2021	01.30 pm to 03.30 pm	Arrangements of data for input files (pedigree and data file)
Day - 2	22-05-2021	01.30 pm to 03.30 pm	Identification of individuals, families and pedigree file
Day - 3	29-05-2021	01.30 pm to 03.30 pm	Preparation of data file and command file for ASReml software
Day - 4	05-06-2021	01.30 pm to 03.30 pm	Interpretation of ASReml output files for various modles and estimation of variance components and heritability
Day - 5	12-06-2021	01.30 pm to 03.30 pm	Estimations for fixed effect, covariates and EBV of all fish in the pedigree file

Day – 1 (15-05-2021)

Topic: Arrangements of data for input files (pedigree and data file)

- Year-wise data of RGCA-GIFT projects was arranged in the readable format for ASReml software.
- The data in the Excel sheet was renamed for each column.
- The filter option was used to identify the blank cells in each column.
- The scatter diagram was prepared to check the data if there is any significant variation from the normal range (i.e. outliers).
- The use of pivot table was demonstrated to provide descriptive statistics (average, count, maximum, minimum, standard deviation, etc.) for fixed effects/class variables (i.e., factors or groups)

- The G8 family harvesting data was selected for practicing the techniques and the data was examined for blanks, deviation from normal range (outliers), sorting and calculation of values using pivot table was practiced.
- The descriptive statistics for traits like weight, standard length, width, depth and sex were calculated with the help of pivot table.
- The grow age, tagging age and harvest age (i.e, covariate) of the animals were calculated from tagging data and hatchery breeding unit form.

Day – 2 (22-05-2021)

Topic: Identification of family and pedigree

- The second training session was dedicated to study the techniques to look up the family identification of harvested animals, the sires (fathers), the dams (mothers). The sire and dam information were used to construct the pedigree of all animals in the breeding program based on physical Passive Intergrated Transponder (PIT) tags.
- The family number of the Fish ID of the harvested fish is attached in the G8 Tagging data.
- The excel function VLOOKUP was used to look up the family number associated with fish Tag ID.
- The same option was applied to identify the sire and dam of the fish by utilizing the G7 hatchery and breeding unit data form.
- The sire and dam of the animals were identified and the ID were trimmed for the first 10 digits with the excel option LEFT.
- The duplicate values were deleted using 'Remove duplicate' function of excel.
- The process was repeated for all the generations back to the base population G0.

Day – 3 (29-05-2021)

Topic: Preparation of CSV files (pedigree and data file) and command string for ASReml software

- Two excel files (g8data.csv and g8ped.csv) were created for using in ASReml.
- The data contains all the parameters like fish id, harvest data, harvest weight, tag data, family number, standard length, width, depth, sex, harvest age, growing age, tagging age etc. in column wise.
- The pedigree file contains with fish ID, Sire, Dam and generation numbers starting from G0 to G8.
- Introduction to ASReml software and preparation of various parts of the ASReml program file for RGCA-GIFT data sets. The 'harvest weight' was taken for data analysis using ASReml software.
- ASReml program file was run successfully with the RGCA-GIFT data and pedigree.

Day – 4 (05-06-2021)

Topic: Interpretation of ASReml output file and "model" for phenotypical variance

- The outputs of the programme was interpreted during the session.
- The phenotypic variance with harvest weight was performed in the example file. The model has only one fixed effect *i.e.* population mean (mu) and only one random effect *i.e.* fish ID.
- The output was satisfactory as the last line of the result displayed "LogL converged" meaning that the model was successfully converged and the outputs were meaningful. The LogL had only 7 lines and any result less than 10 lines of LogL indicated that the model fitted the data. The values of Sigma (i.e, variance) for id

and residual were significantly larger than zero considering the ratio of the estimates and their standard errors were larger than 2.

- The p value of F statistics was also < .001 and it indicates that the fixed effect is significant.

Day- 5 (12-06-2021)

Topic: Calculation of EBV of Sire and Dam

- The ASReml programme was practiced again and the model was modified with additional fixed effect (sex), covariate (harvest age) and random effect (id and dam). All the results were good and in range, except for model with 'dam' for which the variance component was at the boundary.
- Heritability of the trait/s was calculated.
- EBV of each fish in the pedigree file was calculated.
- The histogram for EBVs shows a normal distribution.

The whole training sessions were very smoothly conducted by Dr. Trong Q. Trinh and the participants were able to understand and follow the instructions easily. The next scheduled training programme with more advance application of the ASReml software (e.g., bivariate model to estimate genetic correlations) will be planned soon after consulting both RGCA and WorldFish team.

Photo: RGCA officials participated on-line Data Analysis training programme

A8. RGCA collaboration with FARD, Odisha

WorldFish has been collaborating with FARD since July 2016. During the reporting period (April 2021-Mar 2022), RGCA's Genetics team has initiated steps to collaborate with FARD Odisha and support functioning of the GIFT hatchery at Kausalyaganga and also support establishment of one more GIFT hatchery at Sambalpur. Arrangements and MOAs are being finalized between FARD and RGCA. This will enable wider dissemination of GIFT in the state of Odisha.

A9. Work Plan from April 2022 to March 2023

The expected outputs of Y3 work and their alignment to collaboration objectives, including key activities and timelines are summarized in the below table.

Objective 1:.Further improve genetic performance of the GIFT strain through continuation of the formal breeding program	**Q1**	**Q2**	**Q3**	**Q4**	Outputs
Using mating list and mating design undertake G9 breeding to produce G10 families	**X**				------- G10 families produced
Nursing, tagging and phenotyping of G10 Families		**X**	**X**		On station monitoring report
G10 brood development			**X**	**X**	On station monitoring report
G10 family growth data cleaning, analysis and developing mating list and mating design				**X**	Mating list and mating design for producing G11, Training report of RGCA staff
G10 breeding to produce G11 families				**X**	--------- G11 families produced
G11 Nursing				**X**	On station monitoring report
Travel of RGCA team to Penang for Data Analysis using ASReml			X	X	Pending from last year
Objective 2: Dissemination strategy for scaling-up GIFT in India	**Q1**	**Q2**	**Q3**	**Q4**	
Finalization of the Tilapia business case and scaling strategy in collaboration with CII, Scaling Committee, NFDB, MPEDA/RGCA and Fisheries Ministry	**x**				Submission to the Ministry and release of Business case
Convene one policy workshop to highlight the potential of tilapia for Indian aquaculture and sensitize policy makers and other stakeholders on the dissemination and scaling strategy		**X**			Policy workshop report
Facilitate consultations with selected state governments (e.g. Bihar, Uttar Pradesh, Jharkhand) and interested private sector players to explore setting up of GIFT MCs and farming of GIFT			**X**	**X**	Scoping reports
Objective 3: Establish a system for recording and monitoring the dissemination of the improved strain to farmers and producers throughout the country	**Q1**	**Q2**	**Q3**	**Q4**	
Review the current recording and monitoring tool used by RGCA	**X**	**X**			Status report
Review the current recording and monitoring tool used by 3 public and 5 private GIFT MCs	**X**	**X**			Status report
Share the recording and monitoring tool used by WorldFish in its breeding programs in focal and scaling countries	**X**	**X**			WorldFish tool ready for sharing
Convene a 2 day training program in RGCA to bring together all the GIFT MCs and develop an online tool that can be used by RGCA to keep a GIFT dissemination database in India			**X**		Online recording and monitoring tool and GIFT dissemination database
Develop RGCA-CII-WorldFish guidelines and protocols for GIFT seed certification and accreditation system in India			**X**	**X**	Guidelines for GIFT seed certification system in India
Objective 4: Understand performance of GIFT	**Q1**	**Q2**	**Q3**	**Q4**	
Design a robust performance assessment study for GIFT in India, using 2019, 2020 and 2021 crop information from one or two states (e.g. Odisha and Kerala)		**X**			GIFT Performance study design
Data analysis and GIFT performance study report			**X**	**X**	GIFT Performance report/draft paper

WorldFish

About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world. Headquartered in Penang, Malaysia and with regional offices across Africa, Asia and the Pacific, WorldFish is a member of CGIAR, the world's largest global partnership on agriculture research and innovation for a food secure future.

For more information, please visit www.worldfishcenter.org