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Progress Through Science

Fish Farming
in North India

A Success Story

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Fish Farming in North India

A Success Story

Shri Sultan Singh
(PADMA SHRI AWARDEE)

Managing Director, Sultan Fish Seed Farm
Karnal, Haryana

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Trust for Advancement of Agricultural Sciences (TAAS)
Avenue II, Indian Agricultural Research Institute
Pusa Campus, New Delhi 110 012

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For copies and further information, please write to :

The Secretary
Trust for Advancement of Agricultural Sciences (TAAS)
Avenue II, Indian Agricultural Research Institute, Pusa Campus, New Delhi-110012
Telephone : +91-8130111237;
Telefax No. : +91-11-25843243
E-mail: taasiari@gmail.com
Website : www.taas.in

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Foreword

World fish production is expected to increase significantly from 179 million tons in 2018 to 204 million tons in 2030. The aquaculture production is projected to reach 109 million tons in 2030, an increase of 32 per cent (26 mt) over 2018. Asia's contribution will be more than 89 per cent of the increase in production by 2030. Indian fisheries and aquaculture is economically important and a fast-growing production sector contributing significantly to the national economy in terms of food, nutrition, socioeconomic development and providing livelihood support and gainful employment to more than 14 million people. This sector contributes to the foreign exchange earnings through export besides meeting domestic demand and also provides business opportunities for a number of subsidiary industries. The country is rich in fish genetic resources whose potential needs to be harnessed for enhancing fish production using improved breeds, advanced technologies and appropriate farming practices in order to meet the needs for domestic consumption and export.

The country has vast and varied inland fishery resources such as rivers, estuaries, reservoirs, lakes, floodplain wetlands, ponds, etc. Over the years, there has been significant contribution from inland fisheries and aquaculture to the national economy and in providing food and nutritional security, livelihood and employment generation especially in rural areas. By 2025, the Indian demand of fish domestic market would be around 16 million tons against the present production of 12.60 million tons coming from inland (65%) and marine (35%) sectors. In India about 2.41 million hectares of water bodies are available for freshwater aquaculture which

has tremendous potential in boosting fish production. This can be achieved through mobilization of farmers to adopt innovative technologies in fish and fish seed production and also providing financial support to them. The availability of quality seed in some parts of the country is a limiting factor and transportation of fish seed over long distances adds to cost of inputs. Therefore, to meet the seed demand of fish farmers in these seed deficit areas has become a challenge for entrepreneurs/ farmers since they do not have basic facilities like hatcheries to produce quality fish seed. India is one of the leading seafood exporting nations in the world and hence fishery sector contributes significantly to the foreign exchange. This is largely due to value addition and development of -ready-to-eat, ready-to-cook, ready-to-fry, thaw and eat, heat and serve and retail raw branded products.

I appreciate the commendable efforts made by Shri Sultan Singh (Padama Shri Awardee), a farmer and entrepreneur, in collaborating with TAAS to bring out this important publication entitled "A Success Story of Fish Farming in North India". I also thank Dr. Bhag Mal, Secretary, TAAS and Dr. S.S. Singh, Consultant, TAAS for their help in editing the manuscript. I am sure this publication will be of immense use to policymakers, researchers, farmers and young entrepreneurs.

Raj Paroda
Former Secretary, DARE & DG, ICAR and
Chairman, TAAS

Acronyms and Abbreviations

AFS	American Fisheries Society
BID	Business Initiative Directions
CIBA	Central Institute of Brackishwater Aquaculture
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute of Fisheries Education
CIFRI	Central Inland Fisheries Research Institute
CIFT	Central Institute of Fisheries Technology
CMC	Chinese Major Carps
CSD	Canteen Stores Department
DG	Director General
DDG	Deputy Director General
EU	European Union
HIFA	Haryana Institute of Fine Arts
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research

IIWBR	Indian Institute of Wheat and Barley Research
IMC	India Major Carps
IPRS	In-Pond Raceway System
KFC	Kentucky Fried Chicken
KVK	Krishi Vigyan Kendra
EEI	Extension Education Institute
MANAGE	National Institute of Agricultural Extension Management
MoFPI	Ministry of Food Processing Industries
MoU	Memorandum of Understanding
NACA	Network of Aquaculture Centers in the Asia-Pacific
NAIP	National Agriculture Innovation Project
NFDB	National Fisheries Development Board
RAS	Recirculatory Aquaculture System
TAN	Total Ammonia Nitrogen
WAS	World Aquaculture Society

CHAPTER 1

Background

The aquaculture plays significant role in providing nutritional security and it is one of the important sectors of food industry. Three Indian major carps, namely, Catla, Rohu Labeo and Mrigal contribute over 90 per cent of the total Indian aquaculture production. In Haryana state, there was not even a single hatchery to produce fish seeds. Shri Sultan Singh of village Butana, district Karnal, Haryana is the first person of the State who started recirculation of aquaculture system which is used in home aquaria and fish production where water exchange is limited and the use of bio-filtration is required to reduce the ammonia toxicity by establishing Sultan Fish Seed Farm at Karnal in 1984. Being born in farmer's family, he got good experience of agricultural activities by observing his family members who were engaged in agriculture work for their livelihood. He had very little interest in farm operations like sowing, irrigation, weeding or harvesting of major crops such as rice and wheat being grown at his family farm of about 125 acres of cultivable land. Therefore, his parents used to give him the responsibility to take animals for grazing even when he was studying in the college. Since childhood he always wanted to do something innovative and different from what his family members were doing.

One day his dream came true when he got an innovative idea from one of the boys from his village who was earning a good amount of money from fishing from village pond, and decided to leave farming which he never liked and start fish cultivation. He was worried about the social taboos linked with fishery work as it was considered to be the work of lower castes of the society. However, he stepped forward and initially he took one community pond on lease for one year at Rs. 500 per year for stocking the fish seed. He invested his saved pocket

money of Rs. 28,000 way back in 1983 on community pond for stocking the fish seeds brought from Kolkata. He earned Rs. 1,62,000 from fish sale in 18 months time. This gave him enough confidence to start the fish business at a larger scale.

The major challenge in the fish business faced by Shri Sultan Singh at the initial stage was the lack of availability of fish seed as there was not even a single fish seed hatchery in northern India. The fish seed was largely transported from Kolkata and sometimes through train or flight causing delay in transit resulting in 60-70 per cent seed damage. To solve this problem, he contacted Dr. Jagdish Chander Markandey, Head of the Krishi Vigyan Kendra (KVK), Karnal in 1983 who suggested him to undergo one week training under him for fish breeding and farming in inland fisheries. He then requested his family members to spare a few acres of land required for fish breeding purpose but they refused to share the productive land for fish breeding. He tried hard to persuade them but failed in his efforts. Since he was determined to go ahead for fish breeding business, he requested his family for sharing of barren land for this purpose as that piece of land was unproductive and was lying vacant. Ultimately, his father agreed to share 5 acres of barren land which became the base for starting his fish breeding business.

Shri Sultan Singh was successful in constructing the first Breeding Hatchery in 5 acres of land in Karnal, Haryana in 1986 with the help of Dr. Markandey by using his own tractors. Seeing the dedication and hard work of Shri Sultan Singh, Dr. Markandey helped him in starting the happa fish breeding of common carp fish and initially the success was nearly 80 per cent (Fig.1). However, later on as a result of breeding work he was able to stock his entire fish pond with good healthy live fish seeds of which he also sold to other farmers of Kolkata.

Since Sultan Singh's family was joint family, he was helping his family in agricultural activities like sowing and harvesting of crops and milking of cows in addition to his own work of fish breeding and nurturing. He used to work 14-16 hours a day to manage all works including maintenance of

Fig.1. Happa breeding of common carp

village ponds (Fig.2) which he had taken on lease. So it was the toughest time of his life; however, he earned a lot with these efforts and hard work.

Fig.2. Community pond in Butana village, Karnal, Haryana

It is well known that Haryana was a vegetarian state wherein village ponds were used for washing clothes, for bathing their herds and also people used to throw garbage causing high pollution in these ponds. But when Shri Sultan Singh started taking those ponds on lease, the villagers started passing sarcastic remarks on him. But, he never reacted and lost heart, rather gathered strength to make success in his endeavor and was confident of setting example of his extraordinary work in this field of fish breeding and nurturing. With his great efforts, Gram Panchayats were benefitted a lot as the lease amount of one pond increased from Rs. 500 to Rs. 15,00,000 annually. Now the same old people who once discouraged and rebuked him are eating fish for maintaining good health. They are also appreciating and blessing Shri Sultan Singh for his good work and significant contribution in the fish business and also bringing Haryana state a good name and fame in this venture.

CHAPTER 2

Initial Establishment

The initial support he got for this enterprise was from his family as they finally trusted him and shared land for starting a new business on fish cultivation which nobody else was doing in Haryana state at that time. Moreover, with regard to gaining knowledge and resources, it was a very big leap at that time to adopt fish production as a profession. He proved the success of his work to the family and developed some confidence in them resulting in all kinds of support extended by them in his venture.

The moral support he got from his father Shri Jeet Singh, a renowned farmer in the area, resulted in leasing out ponds for fisheries, being used during that period of time for washing clothes and bathing animals, from other *Gram Panchayat Sarpanchs.* The second most important moral supporter was his wife Shrimati Santoshi Devi who always admired his excellent efforts which made him stronger to face any new challenges in this venture.

Shri Sultan Singh had no knowledge of fishery technologies. Dr. Markandey supported him at all levels as teacher and guardian and trained him in fish breeding and provided consultations required from time to time even after his transfer from KVK, Karnal.

The other important aspects of his success in this field are: i) suitability of environment for the fishery sector, ii) the state is not prone to flood, and drought, and iii) most importantly, the people who were once convinced with the efforts made by him provided full support at all levels. This encouraged him and developed greater confidence in him to do

something better and more beneficial for all farmers of the country.

Major difficulty he faced in initial stages was the lack of manpower for harvesting of fish as women and old persons used to think that this venture is against the religion. They used to pass sarcastic comments when Shri Sultan Singh and his fisherman fellows used to catch the fish from ponds and sometimes they were not even allowing them to harvest fish. Most of his relatives and friends were annoyed and created problems for him and tried to discourage him from doing such business.

In Haryana and Punjab, not many farmers were engaged in fish cultivation and there was not even a single hatchery to produce fish seeds. Therefore, to get fish seeds from Kolkata which was herculean task because most of the times bags containing seeds received through trains or by air got damaged and adversely affected the production. However, he never felt frustrated and lost confidence and hence Dr. Markandey used to appreciate him for his devotion and dedication towards work and solving his problems by himself.

There was not a single fishery expert amongst staff even in the Fishery Department having knowledge and technical knowhow to guide the farming community. If there was any problem related to fish or ponds, the farmers used to tackle it at their level itself.

The biggest problem faced was vegetarian nature of Haryana people which was a big hindrance in local sale of fish. Therefore, Shri Sultan Singh was compelled to visit Delhi fish markets for sale of his produce. It was not an easy job but there was no other alternative. Sometimes he did not get good price of his produce even after taking so much of pain to carry fish to Delhi for sale. Realizing the problem due to such difficulties, he adopted the concept of selling live fish which proved to be highly remunerative as compared to selling dead fish. The

quality of fish was also better and highly hygienic for the consumers.

Most of the time the fishes died as problems could not be identified and resolved in time causing huge losses since no laboratories were available for studying the water and soil parameters and also health or disease related problems. In addition, another serious problem was of non-availability of fish seed (resulting in smaller size of fishes) and equipments related to aquaculture like aerators, oxygen generators, root blowers and many other equipments required for aquaculture sector. Also, the fish feeding was dependent only on mustard oil cakes and a few grains on which fish growth was not optimal.

CHAPTER 3

Infrastructure and Further Strengthening

In the beginning, there was not much infrastructure available for fish farming and the work was only limited to village ponds taken on lease. But after gaining wide knowledge on aquaculture, the confidence level increased to move ahead and develop large infrastructure for fish farming. In 1986, the first breeding hatchery was established in North India with one breeding pool and four hatching pools (Fig.3). In addition to these, additional infrastructure consisting of breeding pools (Fig.4), conditioning pools, overhead water tank and tube wells, feed storage rooms and resting facilities for labourers were also created by him.

Fig.3. Fish hatchery set-up

Fig.4. Fish breeding pool

By 1989, more village ponds were taken on lease adding up to 35 and also established inland farm in 15 acres of land wherein breeding and farming work was started with three fish species of Indian major carps (IMC), namely, Catla, Rohu, Mirgal and three Chinese major carps (CMC), namely, Grass, Silver and Common Carp. Chinese breeding methodology was practiced at the farm (Fig.5). In this technology, hormones are induced to both male and female fish which hatch eggs and rear them till spawn, fry, early fry and fingerlings stage. Then

netting is done to identify which fish variety is ready for breeding purpose. The other methodology is strip breeding methodology.

Fig.5. *Chinese breeding methodology*

In order to move further towards increasing fish production, he gained knowledge through training in government organizations including Central Institute of Fisheries Education (CIFE) Mumbai; Central Institute of Fisheries Technology (CIFT) Kochi, Kerala; Central Inland Fisheries Research Institute (CIFRI) Vadodra, Gujarat; Krishi Vigyan Kendra (KVK), Karnal; Central Institute of Freshwater Aquaculture (CIFA) Bhubaneswar, Odisha; Central Institute of Brackishwater Aquaculture (CIBA) Chennai and also undergone three months training on integrated fish farming system at Network of Aquaculture Centers in the Asia-Pacific (NACA) in Wuxi, China. Using the knowledge gained in these trainings, he adopted hi-tech farming system in ponds with aerators to enhance the fish production and water quality parameters to

earn more profits. After gaining confidence in fishery, he entered in other sectors such as dairy farming to use wastes in ponds as fish manure, established small poultry with 1,000 birds and a stud with seven horses and keeping dogs for farms protection.

Fresh water prawn (Macro brachium rosenbergii) was introduced in Haryana state with the help of fishery department and incurred heavy losses in the year 2002. However, cultivation was not stopped and today cultivation of prawn is highly successful. In 2005, Shinghada (Mystus aor) an endangered species was introduced which is generally found in rivers but due to river pollution its population was decreasing. Its parent fish were collected from river and their nature was studied for three years which was followed by breeding in stagnant water at the farm successfully. Then its seeds were allowed to grow in river so that public in general is benefitted as this indigenous species is very good in taste and also has high nutritional value.

A new breed known as Pangaas, a bone less fish, was introduced for the first time in north India from Kolkata in 2008 and grown in high density in ponds because it has higher number of erythrocytes (red blood cells) than any other fish. This fish also has an additional respiratory organ and can breathe through bubbles and skin which helps it tolerate the environment short of dissolved oxygen. Therefore, it can be stocked in ponds at higher density, can grow well in seven months time and can survive in bad quality of water as well. Encouraged by these results, other farmers also introduced this new breed to their ponds. In 2008, a record production of 7 tons per acre of land was achieved which was a very high production level at that time.

In order to manufacture value added fish products, ready-to-cook and ready-to-eat, like kalimirch tikka, masala fish tikka, grilled fish, fish nuggets, fish burger and other 35 value added fish items without adding any preservatives, the first fish

processing plant of India was established at Karnal in 2011 (Fig.6). The processing machines and other equipments for this processing plant were purchased from China, Germany and USA. The value added products have no bone, no additives, no bad smell and a self- life up to twelve months. This processing plant has been built on European Union (EU) standards. Since farm and processing plants are very close to each other, transporting fish/ prawn from farm to processing plant takes very less time resulting in unmatched freshness and control over quality. The pre-processing and processing halls are fully climatically controlled. Other facilities include blast freezer (German make), two cold storage units of 100 tons capacity and flake ice machines with capacity of 5 tons per day. The fish feed plant was also started in 2013 for own fish farms and also for selling purpose. All processing plant wastes were utilized as feed additive as source of fish meal and oil. These processing plants are being frequently visited by several visitors including fish farmers.

Fig.6. *Fish processing plant*

For marketing frozen fish items a fish retail chain with brand name 'Fish Bite' was started in 2015 followed by launching of two 'Fish Bite' exclusive stores in Lokhandwala, Mumbai for selling of ready-to-eat fish items (Fig.7).

Fig.7. Fish Bite Store launched at Lokhandwala, Mumbai

A quality control laboratory for testing of fish products and other food items for own use as well as public use was set-up in 2016 (Fig.8). This project was initiated with the help of Ministry of Food Processing Industries (MoFPI) and Indian Council of Agricultural Research (ICAR) and the technical support was provided by the CIFT which is a fish based microbiology laboratory for testing of samples for the export purpose.

Fig.8. A quality control laboratory for testing fish products and other food items

Fig.9. India's 1st RAS for producing fish in fresh water at Sultan Fish Seed Farm

In the same year, the very first re-circulatory aquaculture system (RAS) was installed in the country for conserving land and water with a vision that recycling of 90 per cent water up to 15 years and increase the production up to 20 times per cubic meter (Fig.9).

The RAS (Fig.10) consists of following infrastructure and equipments:

1. The tanks to hold water and fishes
2. Pipes/ valves

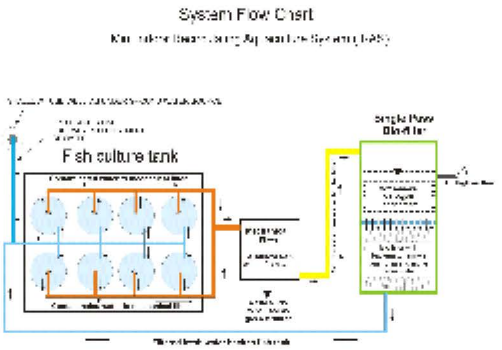

Fig.10. RAS infrastructure and equipments

3. Mechanical filter to remove the solid waste
4. Biological filtration system to remove the total ammonia nitrogen (TAN)
5. Pumps/ generator and electrical panel control

Under this technology, it is possible to produce 50 tons of fish from just 200x40 feet pond area whereas in open pond farming system for the same production level, there is need for at least 20 acres of land and also 90 per cent more water. In this technique, water is recycled for 15 years with the help of mechanical and biological filtration process. The indoor RAS system is comprised of six circular tanks, each of 20 feet diameter and 4 feet depth paddlewheel aerators, mechanical and biological filters, etc. In RAS, Desi Magur (Clarias batrachus), Sea Bass (Lates calcarifer), Rohu (Labeo rohita) and other carps were successfully cultured with production ranging from 36 to 130 kg per cubic meter/ 6-9 months (depending on the species cultured), whereas the maximum yield attained in earthen ponds was 3.0 kg per cubic meter over the same period. In RAS, 9,000 fingerlings of fresh water fish (Pangasius sutchi) were stocked per tank; formulated feed was fed as much as consumed; production obtained was 5.2 tons/ tank/ 6 months with 600 g average weight of fish. He is able to raise two crops per year in six tanks resulting in total production of 60 tons per year. The fish weighing an average of 600 g each were sold live at a farm-gate price of Rs.85 per kg, while the total production cost was Rs.40 per kg.

Aquaponics and hydroponics were also started with the use of fish tanks/ pond water so that plants utilize nutrients from fish waste available in water and grow well without any use of soil. The use of these technologies is very important since the produce is always pure and organic and has high market value. These technologies are being applied only after fish breeding season.

Shri Sultan Singh got an idea to study how fish can grow very fast in rivers. So he studied the nature of fish on river culture. He found that the river water is always full of oxygen

and rich in minerals, nutrients and vitamins which are necessary for fish growth. In 2018, based on this principle, he adopted in-pond raceway system (IPRS) a latest advance technology developed to increase production efficiency and yield. The IPRS concept is to concentrate fish feed in cells or 'raceways' within a pond and provide them with constant water circulation to maintain optimal water quality and to improve feed management. He made an earthen fish pond of one acre size and in this pond constructed 10 raceways of 10 feet wide and 100 feet long with 8 feet depth and flown water from the same raceways channel with the help of machines and equipment. The water was rich in oxygenated nutrients so the fish growth was similar to that in rivers and resulted in total production of 75 tons annually from one acre of fish pond. In this technology, fish gets proper environment to move around the same way as in rivers which makes the growth well and the waste of fishes can be utilized outside ponds (Fig.11). The following species were grown successfully using this system:

Fig.11. *In-pond raceway system (IPRS) of fish production*

- All carps, Sole fish, Roopchand, Pangassius, Shingi and Pabda species grown in fresh water system
- Trout, Mahasheer, Snow Trout, Salmon and Arctic Charr species grown in cold water area in this system
- Prawns (Vannamei), Sea bass, Milk fish and Cobia species grown in brackish water in this system

In the integrated farming system, fruits and other trees are grown on the ridges of ponds to earn an additional profit and to maintain pollution at low level with the help of trees.

CHAPTER 4

Current Production Scenario and Significant Achievements

The current fish production in open pond farming system at the maximum is 2-3 kg per cubic meter water area. The scientific recommendation is to stock the maximum seed between 4,000-5,000 per acre which results in production of 3 tons per acre in one year with average weight of 800 g per fish which is very less. In the same area at Sultan Singh Fish Farm, the stocking is 10,000 fishes with a production of 8-9 tons per acre in nine months time. The production is 9 kg per cubic meter with semi-high tech. farming method which is three times higher as compared to other farmers which produce 3 kg per cubic meter.

An inland or intensive fish farming system is the well-managed form of fish farming in which all attempts are made to achieve the maximum production of fish from the minimum quantity of water. This system involves small ponds/ tanks/ raceways with very high stocking density (10-50 fishes/ m^3 of water). In this system, fishes are fed with wholly formulated feed. Extensive fish farming usually refers to fish farming conducted in medium to large-sized ponds or water bodies. The fish production relies merely on the natural productivity of the water which is only slightly or moderately enhanced. Sultan

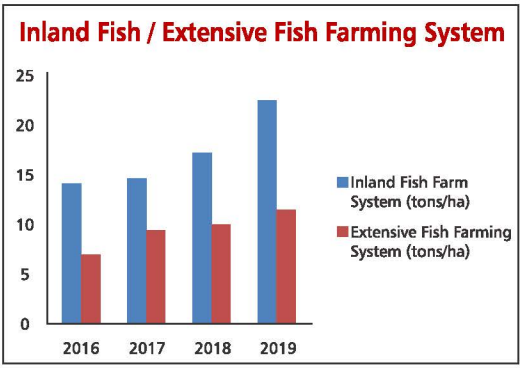

Fig.12. Fish production from inland and extensive fish farming systems

Singh Fish Farm is concentrating more on inland fish farming system in which fish productivity in four years (2016-2019) increased from 14.0 tons/ha to 22.4 tons/ ha. In extensive fish farming system, fish productivity increased from 7.0 tons/ ha (2016) to 11.4 tons/ ha (2019) (Fig.12).

Re-circulating aquaculture system (RAS) for better development of aquaculture was adopted by Shri Sultan Singh at his farm. Through this technology, it is possible to produce 30-50 times more fish as compared to open pond farming system. Under this technology one can grow high marketable fishes like Sea Bass round the year which is not possible in open pond farming system. Advantage of this technology is saving land and conserving water as the same water can be recycled up to 10-15 years in addition to increase in yield up to 30-50 times. Another advantage of RAS is that it has round the year growth period independent of winter and summer stress on growth and high individual fish weight gain leading to high production. Using RAS, Pangasius (Pangasius hypophthalmus), Shingi Fish (Heteropneustes fossilis), Desi Magur (Clarias batrachus) and Common Carp (Cyprinus carpio) are being successfully cultured at Sultan Fish Seed Farm with different production range.

Pangasius (Pangasius hypophthalmus)

Pangasius is a highly migratory riverine omnivorous fish species that makes long-distance migrations over several hundred kilometers (potamodromous) between upstream refuge and spawning habitats and downstream feeding and nursery habitats. The life cycle of Pangasius is intimately tied to the annual monsoon flood cycle, with spawning taking place in May-June at the start of the monsoon season. In the dry season, this and other species congregate

Fig.13. *Pangasius fish*

and shelter in the deeper refuge areas. Pangasius has more red blood cells than any other fish, an additional respiratory organ and can breathe through bubbles and skin. This means it is able to tolerate environments with little dissolved oxygen. Pangasius became extremely popular due to myriad health benefits and significant nutritional value being less fatty and oily than other single-boned fish. Its high protein content contributes towards building muscle mass and maintaining proper enzymatic function of cells in the body. Fat is also present in ample amounts in this fish. This contains the Omega-3 fatty acids which is very effective in reducing the risk of heart ailments. This fish is good for people with blood pressure fluctuations, being naturally low on sodium.

Shingi (Heteropneustes fossilis)

Fig.14. Shingi fish

Shingi fish is highly preferred in Assam and locally known as Singhi. In Bangladesh, this fish is called Shingi Mach while in Sri Lanka, it is called Hunga by the Sinhala-speaking community. This species is omnivorous and is found mainly in ponds, ditches, swamps, and marshes, but sometimes in muddy rivers. It breeds in confined waters during the monsoon months, but can breed in ponds, derelict ponds, and ditches when sufficient rain water accumulates. It is in great demand due to its high medicinal value

Desi Magur (Clarias batrachus)

Fig.15. Desi magur

The walking catfish is a species of freshwater air breathing catfish native to Southeast Asia. It is named for its ability to 'walk' and wiggle across dry land, to find food or

suitable environments. While truly, it does not walk as most bipeds or quadrupeds do, it has the ability to use its pectoral fins to keep it upright as it makes a wiggling motion with snakelike movements to traverse land. This fish normally lives in slow-moving and often stagnant waters in ponds, swamps, streams, and rivers, as well as in flooded rice fields, or temporary pools that may dry-up. When water dries up, its 'walking' skill allows the fish to move to other aquatic environments. In India, Desi Magur has a big commercial market due to its popularity and its nutritive value especially high protein.

Common Carp (Cyprinus carpio)

Fig.16. *Common carp*

The common carp is a freshwater fish species. It is also called 'European Carp' and actually a freshwater fish of eutrophic waters in lakes and larger rivers in Asia and Europe. Common carp is generally a heavy-bodied fish with barbels on either side of the upper jaw. The common carp can generally tolerate most of the environmental conditions. They generally prefer large bodies of slow or standing water and soft, vegetative sediments. This species is loaded with various nutrients. It is able to lower inflammation, enhances heart function, promotes digestive function and slows down the aging process. It has high content of protein and low amount of saturated fat.

Following the RAS, during four years (2016-2019), fish production of four species, namely, Pangasius, Shinghi, Desi Magur and Common Carp has significantly increased from 65.4 tons in 2016 to 122.2 tons in 2019 leading to total production of 366 tons (Table 1).

Table 1. Production of four fish species in RAS (tons) during 2016-2019

Year	Pangasius	Shingi	Desi Magur	Common Carp	Total (tons)
2016	18.0	14.2	16.2	17.0	65.4
2017	22.2	16.9	19.9	20.2	79.2
2018	27.8	22.8	24.8	23.8	99.2
2019	33.5	28.5	31.5	28.7	122.2
Total	101.5	82.4	92.4	89.7	366.0

Innovative methodology for breeding Chitala fish

Breeding of Chitala fish (*Chitala chitala*) was started for the first time in India by Shri Sultan Singh in 2016 (Fig.17). He brought 30,000 seeds of Chitala fish from Ganga river at Kolkata and reared the seed at his farm for four years. This fish is carnivore and it eats small fishes to survive and grow. Accordingly, these fishes along with Indian major carps (IMC) seedlings were purchased at a cost of around Rs.8,00,000-

Fig.17. *Shri Sultan Singh holding a Chitala fish in his hands*

Fig.18. *Chitala fish*

Fig.19. *Making hideout of tyre in hatchery*

10,00,000 and then these Chitala fishes were grown-up to 5 kg to 13 kg at his farm in four years time (Fig.18). This fish gets matured for breeding in four years and now matured Chitala brooders are available at the farm. During these four years, Shri Sultan Singh with the help of his son Mr Neeraj Chaudhary learnt the breeding methodology for this species of fish. He also made hideouts with the help of big tyres in the hatchery as this fish breeds in hideouts (Fig.19). After laying eggs, the fish can take care of its eggs and therefore Mr. Singh used the induced breeding method and made good hideouts in captivity and put one female and two males in these hideouts. In 18 hours time after ovatide fish breeding hormone injection, the fish releases eggs and then hatching occurs in 7-10 days time. The first stage is called as chital spawn which is of 15-16 mm size and is ready for stocking in ponds for making them up to fry size and fingerling size and then big fishes. This has been made successful for the first time in India because this fish only breeds in river water and not in ponds or hatchery. Hence, Mr. Singh did a commendable work with a big achievement which will prove to be immensely useful to all fish farmers

Other significant achievements in fish and integrated farming

a). Breeding of catfish in captivity: Catfish (Mystus aor), a fresh water fish which comes under vulnerable species has been bred successfully in the pond at Sultan Fish Seed Farm which is otherwise not possible to grow in farm ponds due to the habit and habitat of this species.

b). Rearing of shrimp in adverse climatic conditions: Shrimp (Macrobrachium rosenbergii) has been reared in the temperature ranging between 8-20°C during November 2004 to January 2005 against its optimal temperature range between 21-33°C in open system without using any water heater or gadgets.

c). Early breeding of catla: Catla (Catla catla) has been bred in the second half of March which otherwise breed from July

to September and hence the technology gives fish farmers three months more time to earn profit from fish especially table fish.

d). More than double production in half of the time from rohu: Rohu (Labeo rohita) was mono-cultured and produced 8 tons of fish in seven months time by feeding thrice a day while using traditional method, the production was only 2.5 to 4 tons in a long period of 14 months.

e). Induced breeding in common carp round the year: Induced breeding was introduced to produce the common carp (Cyprinus carpio) which is otherwise not possible in all 12 months of the year.

f). India's first fresh water processing plant: India's first fresh water processing plant was launched at Karnal, Haryana in 2011 to manufacture the value added fish products like fish cutlet, fingers, burger, tikka, crunchy, etc. in order to gain more profit instead of selling raw fish to the market. The fish waste was utilized to make fish silage, fish meal and extracting fish oil form the fish waste. This proved successful in setting a good example for other farmers that fishery has also ample scope like other industries and can be developed at large scale. Also, about 800 farmers were united to buy seed from Sultan Fish Seed Farm and whatever raw fish was produced by farmers was bought to the processing plant to make value added products.

g). The first exclusive fish retail stores 'FISH BITE': On the pattern of McDonald and Kentucky Fried Chicken (KFC), exclusive fish retail stores were launched for the first time under the brand name "Fish Bite". The Fish Bite is selling fish and its value added products ready- to- cook and ready- to- eat throughout the year. Currently, three stores are based in Karnal, Panipat and Rohtak districts of Haryana (Fig.20).

Fig.20. Fish Bite store in Karnal, Haryana

h). Stud farm: Horses at Sultan Fish Seed Farm are also reared, cared and trained for various state level animal shows and exhibitions. The certificates of appreciation for the state level animal shows/exhibitions have also been received for the same.

I). Integration of dairy and fish farms: A dairy unit has been established with five cows, two buffaloes and other calves. Dairy farm is scientifically designed and the hygienic conditions are being maintained. The wastes of this farm are diverted to fish ponds. With innovative and latest technology, each of these cows produces 52 liters of milk and the buffalos produce 23.3 liters of milk per day.

j). Adoption of integrated nutrient management system through vermi-compositing: Vermi-composting is very important method of preparing organic manure. Madhyam slurry is prepared and mixed well into farm waste. This mixture is heaped and the heap is turned once a week and temperature is measured on regular intervals. The organic manure is ready in 4 to 6 weeks which is being used for flowering plants, vegetable crops, fruits trees, wheat and paddy crops and also in fish ponds.

k). Agri-horticulture using improved varieties of fruits and vegetables: Improved varieties of papaya, guava, pomegranate, mango and aonla have been grown utilizing the extra vacant space on the ridges of fish ponds which is about four acres of land. Through this method, an additional income is generated and also this approach has positive effect on environment and is also helpful in maintaining the temperature of water for fish survival.

l). Ornamental fish production in north India: For the first time in India, ornamental fish seed of five varieties, namely, Anglefish, Black Molly, Koi Carp, Gold Carp and Suban-Kee have been produced at Sultan Fish Seed Farm, Karnal. Earlier, the ornamental fish seed used to be imported from different countries like Taiwan, Malaysia, and Thailand, etc. but now with great zeal and efforts, Sultan Fish Seed Farm has made it possible to breed ornamental fish. This has created a revolution in fishery sector in north India.

m). Aquaponics for vegetable cultivation in ponds: In India high value market rice, vegetables like red and yellow capsicum, salads, cucumbers, cherry, tomatoes and broccoli have been successfully grown by utilizing the thermocol cartons. The floaters were created using cartons for cultivation of vegetables above the water in ponds and also growing fish in the water underneath. With this double use of the same piece of land, the net profit from the same piece of land was doubled due to production of vegetables and fish . Also, in this system, the fish waste is automatically utilized as organic manure in the ponds and the vegetables produced are organic.

The revenue generated during the period 2014-2019 gives a picture of consistent year-wise income from fish farming at Sultan Fish Seed Farm (Table 2).

Table 2. Revenue generated during the period 2014-2019

S.No.	Financial Year	Revenue (Rupees)
1	2014-15	1,86,00,000
2	2015-16	2,21,45,678
3	2016-17	3,65,23,456
4	2017-18	3,89,34,567
5	2018-19	3,97,87,432
6	2019-20	3,77,69,874

CHAPTER 5

Efforts Towards Value Addition and Marketing

Shri Sultan Singh was attracted towards value added fish products after seeing these products in one of the fish processing factory during integrated fish farming training in the year 2000. Then he tried himself by boiling fish and taking out their bones. After that he prepared cutlets by adding some good ingredients. These cutlets were very good in taste. In order to get feedback from friends and relatives, a few more items were prepared in the same manner and served to them and their response was quite positive. Then with support and help from ICAR and Government Department, he visited a few more processing plants in India and abroad. Mr. Neeraj Chaudhary son of Shri Sultan Singh also had undergone seven days training at the Central Institute of Fisheries Technology (CIFT), Cochin on value addition with the help of former Director General (DG), ICAR Dr. S. Ayyapan, (the then DDG (Fisheries). This gave more confidence to establish own fish processing plant and to enter in value added fish product business.

The fish processing plant was established in 2011 and started producing new fish products like kalimrich fish tikka, masala fish tikka, grilled fish and many more items. However, in order to attract people and get their feedback on quality of the products, initially these products were sold free of cost. The positive response from people encouraged in marketing these value added fish products. The marketing was another big challenge as in north India people do not prefer eating fish due to many reasons. Therefore, the company started participating in exhibitions relating to the food shows, food fairs organized by the government institutes like ICAR, IARI, NFDB and by other

private organizations or companies in India and abroad to attract people to this venture.

The fish processing plant is currently manufacturing value added ready- to- cook and ready- to- eat fish products such as kalimirch tikka, masala fish tikka, grilled fish, fish nuggets, fish burger, prawns, honey fish, fish fingers, fish cutlets, fish soups and 35 more value added fish items. The production of these processed fish products progressively increased from 3.6 tons (2016), 4.2 tons (2017), 14.8 tons (2018) to 22.1 tons (2019) as exhibited in Fig. 21.

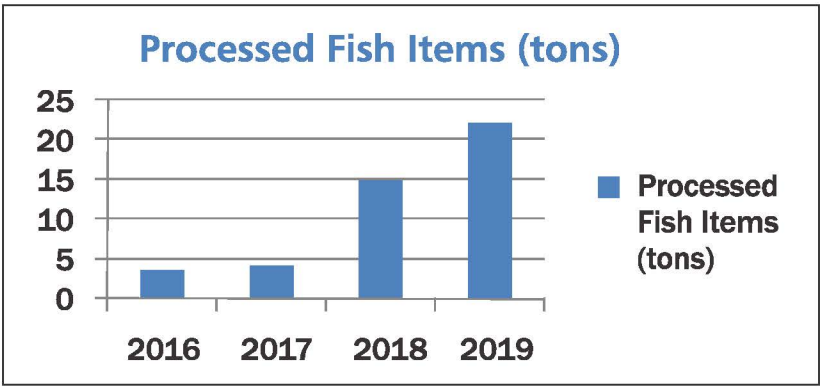

Fig.21. Production of processed fish products during 2016-2019 (tons)

For attracting customers, a lot of work was done on standardization of packaging, designing and marketing as well as appropriate training to the salesman. Thereafter, non-Canteen Stores Department (CSD), and army canteens were contacted and this resulted in significant increase in sales. Also, Shri Singh started supplying value added fish products to super markets and other modern trade chain outlets and finally established 150 retail stores for this purpose.

Supply of fish feed and aquaculture systems was another important activity of fish business at Sultan Fish Seed

Farm. Floating fish feed extruder is being used to make pellets in which the ingredients used are rice husk (rice polish), soybean, pearl millet, fish meat and oil, etc. Different formulations include use of medicines and growth promoters to protect fishes from diseases. Around 2 tons fish feed is produced every day which is sold in local market. The shelf- life of this feed is one year if kept in closed container away from moisture.

Over the years, production of different varieties of live fish (Catla, Rohu, Mrigal, Grass Carp, Common Carp, Silver Carp. Catfish, Pangasius, Shingi, Sole, Chital, Desi Magur and Roopchand) had significantly increased from 200 tons (2016) to 332 tons (2019).Year-wise trend of production increase is given in Fig. 22.

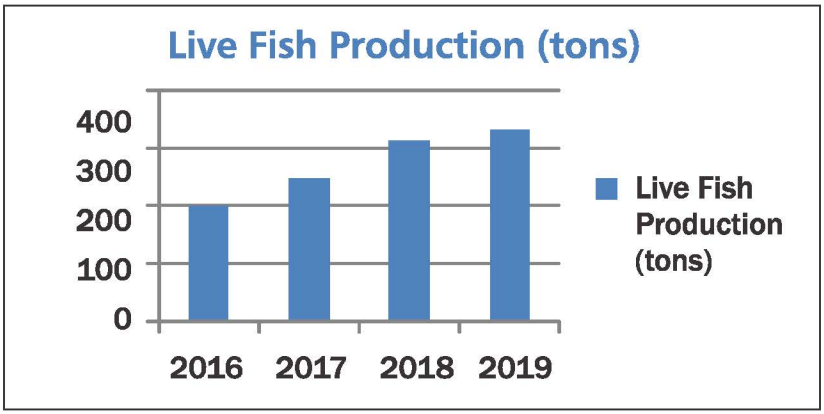

Fig.22. *Live fish production during 2016-2019 (tons)*

CHAPTER 6

Economic Returns Over Investments

In every livestock business, there is always risk but in the field of fisheries there is not much risk involved and the benefit is quite good. From economic point of view, one can double or triple income in one year time with simple fish farming. For that purpose, one has to be vigilant about water quality parameters, feed consumption and dissolved oxygen level in ponds.

The total cost of production in one acre of pond is about Rs.4,00,000 per year which includes the following:

i) Cost of fish seed in one acre of land for 10,000 yearling fishes - Rs.50,000
ii) Cost of manuring/ fertilization, etc., in the pond - Rs.25,000
iii) Cost of feed and other feed related products - Rs.2,50,000
iv) Miscellaneous expenses of labour, water, electricity etc. - Rs.25,000
v) Cost of lease rent of land - Rs.50,000.

While the production of fish in one acre pond is around 8 tons per year with an average weight of 800 g per fish. Sale of 8 tons of fish at farm gate is about Rs.9.60,000 at the rate of Rs.120 per kg of fish. Hence, annual profit from fish farming is Rs.5,60,000 from one acre of land. This profit margin is quite good and achievable, if farmers adopt improved fish farming technologies.

If farmer adopts RAS farming system, then he can make a profit of Rs.50,00,000 from one acre of land in 18 months time. To make huge income like farmers of Andhra and Gujarat, they have to come together and form a society for processing and exporting purpose. Therefore, it is easy for farmers to increase their income minimum 2.5 times in a year. In addition, farmers are also benefited by recharging of the ground water by digging ponds.

On an average, a kilogram of fish gives 35 per cent of fish meat and 65 per cent goes waste. This 65 per cent of waste material is being used in making byproducts like fish feed, fish meal using ingredients like rice bran, soybean, ground nut oil. Waste water out of production plant of catfish is also being used after collecting it in a rearing pond of catfish. In fact, an omnivorous fish consumes everything like gut, blood and flesh (Fig.23).

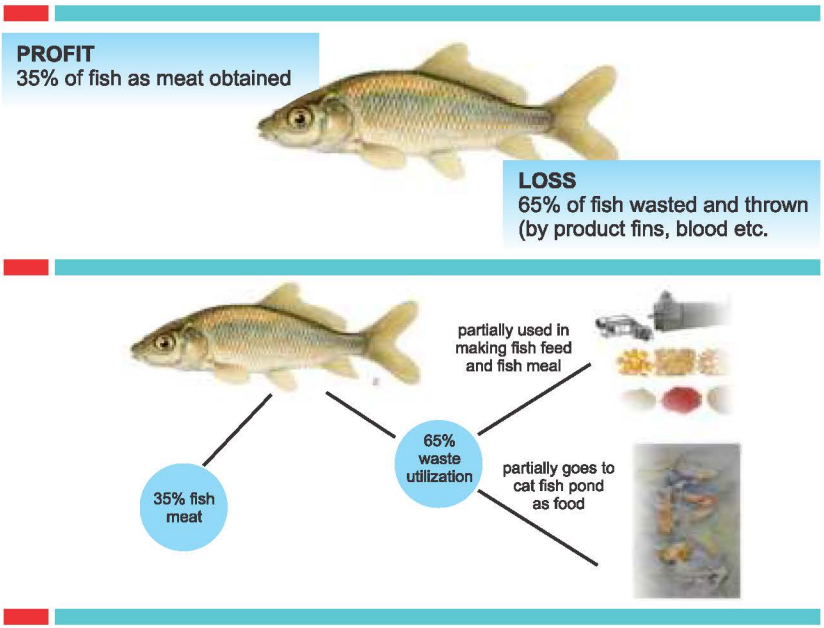

Fig.23. *Use of fish waste in rearing pond of cat fish*

CHAPTER

Problems/ Constraints and Lessons Learnt

Shri Sultan Singh faced several problems in his venture and he struggled hard to find out their solutions which also paved way for his success in fishery sector. In the beginning, public acceptance of fisheries sector was the most crucial hurdle to tackle. All villagers, and his relatives and friends were vegetarian and hence were against this work. Not only that, the whole state of Haryana was largely vegetarian and religious sentiments were involved. However, all this did not stop him from moving forward in fish farming sector. Eighteen years of hard work and initial bold step of providing fish free of cost convinced most of the population to gradually adopt fish eating for maintaining good health.

Seed mortality was another big problem as seed was used to be brought from Kolkata and during transportation this seed was damaged many a times. In addition to seed mortality, receiving seed was another problem because sometimes trains were late and one has to wait whole night at railway station. However, these problems encouraged him to establish his own seed hatchery and produce seed at his own level which made him very popular not only in India but also abroad and hence subsequently generated huge profit.

During those years when he started his venture, fish culture technology was not so developed and using old technology, harvest was very low and sometimes crop was

lost due to dissolved oxygen problem. In order to manage this problem, he had undergone fish culture trainings in West Bengal and Andhra Pradesh and adopted new techniques which helped in enhancing fish production at his farm.

During that time, there were no technical experts to guide about fish farming in the Fishery Department of Haryana government. Therefore, he himself took lead and adopted new species, breeding work, experiments on fish growth with different feed materials and manures available with them at that time. He also started helping other farmers and solving their problems which resulted in significant increase in clientele and consequently in enhanced sale of diverse fish products.

In north India, weather conditions are not congenial for fish farming as low temperature adversely affect fish growth during winter season. Due to this, the fish stop eating and growing at low temperature which results in low production and reduced profit. Concerted efforts were made during the past 20 years to tackle problems related to environment and water, and ultimately RAS technology was adopted which gives round the year production with about 90 per cent recycling of water. This resulted in 20 times increase in production. Many other problems are being faced on daily basis and being addressed effectively which give lessons to learn and ultimately give courage and strength to pave the way for faster progress.

CHAPTER 8

Key Factors of Success

For success in fish farming sector, Shri Sultan Singh had always been trying new innovative approaches and was always prepared to take the risk. The following points are important for success as per his experience:

a). **Hard work and perseverance:** He used to keep on taking-up new challenges everyday and always tried to adopt the latest and advanced technologies like RAS, Raceway Farming, improved post-harvest technologies in order to feed public with deboned fish products. Therefore, he keeps on working 365 days with 14 hours a day devoting full time to fisheries and fish farmers and in dealing with new challenges every day. Such a hard-work ultimately results into good success rate. In order to be a successful farmer/entrepreneur in fisheries, one has to keep sharp eye on fishes on a day to day basis starting from dawn to dusk to avoid losses as different weather conditions prevail during sunny day, cloudy day, rainy day, etc.

b). **Patience for achieving success:** One has to keep high degree of patience in fish farming business because mortality rate is very high due to very high egg laying in fish. Hence, from egg stage to table stage, the fish farmer has to be very patient at every stage and watch carefully the effects weather, insects and food and oxygen related problems.

c). **Advance planning:** Future planning to undertake any work is extremely important. To be successful in fishery sector, advance and meticulous planning for future and also for

day-to-day activities is very much needed. Fish species develop different types of symptoms when there are some problems due to weather conditions. So one has to be very watchful to take steps timely to urgently address those problems otherwise it may result in heavy losses.

d). **Never give-up and face the challenges:** One should always try to face the challenges and never give up, because this sector is full of challenges even on a daily basis.. This advice is especially for farmers who enter in fishery sector for the first time. Generally, if a farmer fails in his first attempt and incurs huge losses, he quits the business which is not a right step. He should rather contact an experienced person who is in this business for years together and take his advice, guidance and gain knowledge and then should start the business again facing and addressing all the challenges coming in his way. He has sufficient time and opportunities to rectify his mistakes because average life of a fish is around 12 years.

e). **Clear vision:** The farmers engaged in fishery sector should have a clear vision of doing something big and then only they can achieve the targets with good profit. The farmers entering fishery business should always think and adopt new models and innovative technologies which ultimately lead to success and provide confidence for further rise in future.

f). **Self-confidence and trust:** It is extremely important to have self-confidence and high degree of trust and not to be discouraged by others. Once you have determined to do something positive in life, never get discouraged by anyone including relatives, friends and community people, etc. and then only you will be able to get success. For example, in case of Shri Sultan Singh, his relatives and community people tried to discourage him in the beginning but he never listened to them and never involved in any arguments with them and kept on doing his work as per his plans. Later

when he became successful in his business, the same people who used to criticize started praising him. Therefore, one should have confidence and trust in himself which is the key to success.

g). **Knowledge sharing:** It is important to help others and share with them the knowledge and experiences gained by you during your successful career. This not only develops more confidence in you but also makes you popular, in your field of work and also gives recognition not only amongst your community but also all over the country.

h). **Hard decision making:** One should always be a hard decision maker and should execute the work and achieve the targets and goals without bothering much about results. If your decision is correct, then you will definitely have success because hard decisions develop confidence and ultimately lead to success.

Shri Sultan Singh strongly believed that there are two keys to success in life, one doing something new and another taking risk. He had taken breeding work in some exotic endangered or near extinct species such as Shinghada which was never bred in India before. He took risk and was the first in the country to breed this species in stagnant water. Usually fish breeding farms stick to 3-4 fish species but he introduced new species such as Shingi, Sea Baas and Desi Mangur and achieved good success.

CHAPTER 9

Impact of the Work

Being a farmer Shri Sultan Singh believes that every farmer of India has got some hidden talent in the field of agriculture. To bring out this talent, he shares his experience and expertise with other farmers to boost their morale and adopt fish farming as a profession. Since 1983 when fish farming was adopted as a profession and convinced with his achievements in this business, more than 20,000 farmers started fish farming throughout the country. They all are highly satisfied with this endeavor and earning their livelihood comfortably.

Every year more than 750 students of B. Sc., M. Sc. and Ph. D. courses from north India visit Sultan Fish Seed Farm for exposure and training (Fig. 24) and this is going on for the past

Fig.24. *Shri Sultan Singh explaining about fish hormone to college students*

20 years. Seven hundred sixty one students were trained during the year 2018-2019. Generally, it is a training- cum- exposure visit program for one day in which they are given practical training on various aspects, viz., fish breeding methodology of fresh water fishes, fish farming practices, fish rearing methods and techniques, maintenance of nursery and farming ponds, fish diseases and their prevention and control, fish processing and field visits, visit to the processing factory and fish feed unit (Table 3). Shri Sultan Singh has his own open land for

Table 3. Training to students at Sultan Fish Seed Farm, Karnal during 2018-2019

S. No.	University/College	Number Students	Type of Training Given
1	Kurukshetra University, Kurukshetra	37	One day training-cum-exposure visit program in which they are given practical training on: · Fish breeding methodology of fresh water fishes · Fish farming practices · Fish rearing methods and techniques · Maintenance of nursery and farming ponds · Fish diseases and their prevention and control · Fish processing · Field visits · Visit to the processing factory and fish feed unit
2	Dayal Singh College, Karnal	27	
3	Govt. College, Karnal	33	
4	DAV Girls College, Karnal	41	
5	KVA College for Women, Karnal	27	
6	Arya College, Panipat	25	
7	Desh Bandhu Gupta College, Panipat	32	
8	DBG Govt. College, Panipat	20	
9	SD College, Panipat	48	
10	DAV College for Girls, Yamunanagar	65	
11	Guru Nanak Girls College, Yamunanagar	31	
12	RKSD College, Kaithal	51	
13	Indira Gandhi PG College for Women, Rohtak	25	
14	Govt. PG College for Women, Rohtak	56	
15	Goswami Ganesh Dutt Sanatan Dharma College, Rohtak	25	
16	GVM Girls College, Sonipat	84	
17	Govt. College, Alewa in Jind	50	
18	Govt. College, Safidon	34	
19	Manohar Memorial P.G. College, Fatehabad	50	
	Total students trained	**761**	

aquaculture and he provides this facility free of cost for research purpose to Indian researchers. In addition, free fish seeds are also made available to Ph. D. students for their research work.

Around 20,000 farmers from all over India have been trained from 2001-2020 free of cost in innovative fisheries technologies (Fig. 25). They all are benefitted by seeing the infrastructure and also gaining knowledge on various aspects of fish farming. The organizations like National Institute of Agricultural Extension Management (MANAGE), Hyderabad, Extension Education Institute (EEI), Nilokheri, Haryana and Fishery Departments of various states get farmers and entrepreneurs trained utilizing all facilities available at Sultan Fish Seed Farm. The staff of Fishery Department of Haryana state and KVK, Karnal also collaborate and support these training programs. Mostly these training programs are of three days' duration which also include question and answer sessions and thorough discussions. Generally, the specific areas of training include fish breeding methodology of fresh water fishes; integrated fish farming practices; fish rearing methods and techniques; maintenance of nursery and farming ponds; fish diseases and their prevention and control both in RAS and ponds; working components; advantages and disadvantages

Fig.25. *Training to farmers, students and young entrepreneurs*

of RAS technology; seed selection, stocking ratio, feeding technique, manuring and related information on RAS; ponds to grow more fish from lesser area; species selection for viability of RAS unit; fish processing and value addition; Government schemes on fisheries for subsidy to farmers and visit to RAS facility, field, processing factory and fish feed unit. In addition, every Saturday and Sunday, Shri Sultan Singh provides training to 7-8 trainees from different places at their own cost.

For the past around 40 to 50 years, there had been a practice of throwing village wastes in the village ponds and tanks and even in those which were constructed under the Indira Vikas Project. These ponds and tanks were cleaned and utilized for fish production giving poor farmers the new means of earning their livelihood with fish culture.

Memorandum of understanding (MOU) has been signed with some of the universities to train students for two months in the field of fish farming and breeding techniques. The students are trained without any charge on fish farming from first stage of fish seed to the last stage of fish. This has helped students to run their own breeding farms. In addition,

Fig.26. *Norwegian Ambassador, other diplomats and Counselor of Norwegian Embassy visited RAS facility at Karnal*

young entrepreneurs have been trained and they are now engaged in fisheries business and earning handsome profits.

The officers of different State Agriculture Departments visit Sultan Fish Seed Farm and gain knowledge on fish breeding and culture free of charge. Several foreign visitors also visit fish seed farm and are very much impressed by the infrastructure, facilities and fish production activities at this farm (Fig.26).

The *Gram Panchayats* are also getting benefitted from fish farming by earning good income through leasing of ponds. This income is being used for village development purpose. Young entrepreneurs encouraged from Shri Sultan Singh's achievements visit his fisheries farms from almost every state and get the needed training to start their own fish farming. Shri Sultan Singh is also running regular training programs on weekend basis wherein 7-8 new farmers are being trained and they are adopting fish farming as a profession for their livelihood.

In late 1980's, Shri Sultan Singh started reservoir farming system in Rajasthan and also trained local farmers with the result that today many farmers have adopted this system and have very good earnings. Previously these reservoirs were used only for irrigation purpose but after their use for fish farming resulted in huge benefit to Fishery Department since these reservoirs are now leased out to generate revenue of crores of rupees. Now-a-days, 70 farmers from reserved category in his village also started this business adopting latest technologies and are earning a lot which can be judged from their beautiful houses and way of living as compared to other villagers.

CHAPTER 10

Specific Suggestions

For becoming a successful entrepreneur in fish business, Shri Sultan Singh being a farmer and having vast experience and knowledge about fishery sector suggested that the youth and entrepreneurs of our country should to adopt fish farming after completing education because this sector has immense scope for growth through the use of new technologies, innovative approaches as well as upscaling and outscaling of production of fish and various fish products. The students from science discipline can develop new techniques of fish farming aimed at enhancing production and income which can benefit the smallholder farmers and the country as a whole. The students from disciplines other than science can adopt fish farming as profession because it is highly remunerative and is vital for sustainable livelihood. He also emphasized that one has to face some new challenges every day and struggle hard to overcome these problems/difficulties and find appropriate solutions. In the process, one develops interest and finally starts loving this sector. He suggested that the youth (men and women) should not be 'job seekers' rather they should be 'job providers'. If students come together and form a group/network to work using technical knowhow, the investment and work stress per person will be drastically reduced and the huge manpower will become available to take-up the fish farming enterprise at a bigger scale for harnessing benefits for all the partners. He also assured them to provide any help needed at any stage and time to make the business successful and highly remunerative.

About Author

Shri Sultan Singh studied in Kurukshetra University, Kurukshetra, Haryana for his degree of Bachelor of Arts. In 1983, he took one week training on fish breeding and farming in inland fisheries under Dr. Jagdish Chander Markandey, Head of *Krishi Vigyan Kendra* (KVK), Karnal, Haryana. Subsequently, he got several trainings from recognized institutions like ICAR-NDRI, KVK, Karnal for fish breeding and culture in 1984; ICAR-CIFA, Bhubaneswar, Orissa on breeding of catfish and ornamental fishes; ICAR-CIFE, Mumbai, Maharashtra on breeding of ornamental fishes and 90 days training from the Asia-Pacific Regional Research and Training Centre for Integrated Fish Farming, Wuxi, China sponsored by the Government of the People's Republic of China in the year 2001. In addition to basic trainings from various national and international institutes, he has been attending national and international workshops on pisciculture to increase his knowledge in this field. Shri Sultan Singh is member of numerous national and international organizations and clubs, namely, Management Committee of Extension Education Institute, Ministry of Agriculture, Government of India; Working Group of 11th Planning Commission Committee, Government of India; National Agriculture Innovation Project (NAIP), Government of India; NITI Ayog, Haryana; Kisan Ayog, Haryana; American Soybean Association, USA; International Biographical Centre, Cambridge, England; World Aquaculture Society (WAS), USA and American Fisheries Society (AFS)), USA. He is the Managing Director of Sultan Fish Seed Farm, his own proprietary and a Village Chief (*Sarpanch)* for 25 years of his village Butana in Nilokheri, district Karnal, Haryana.

He is the recipient of most prestigious award of India, the Padma Shri by Shri Ram Nath Kovind, Hon'ble President of India in 2019. Several national and international awards were bestowed on him which include Gold Quality Summit Award in New York from Business Initiative Directions (BID)) for the innovation in the field of fishery in 2006; Jagjeevan Ram Kissan Puraskar for the year 2006 for the innovation in field of prawn; Ideal Personality Award presented by the Bharat Vikas Parishad for the year 2006; Karma Bhoomi Samman presented by the Chief Minister of Haryana State, organized by the Haryana Institute of Fine Arts (HIFA) for his work in fish culture and fish breeding for the year 2008 and Progressive Farmer Award in Rabi Kisan Mela presented by ICAR-IIWBR, Karnal, Haryana for wheat production for the year 2008. In addition, he received all awards at state level and district level for the highest fish seed and fish production in the state and district by Haryana State Fishery Department since years 1986 to 2018. His biography was published by Marquis Who's Who in Science and Engineering publication 2008-2009 of USA. This certificate is provided to those individuals who have demonstrated outstanding achievement in their own fields of endeavor and who have, thereby, contributed significantly for the betterment of contemporary society. In 2012, he was awarded the Best Incubatee Award by the Hon'ble Former President of India, Dr. APJ Abdul Kalam.

Shri Sultan Singh is regularly invited by various media groups to give interview and share his knowledge and experiences on fish breeding, fish diseases, utilization of water logged land and lab to land programs by TV channels like NDTV India, Krishi Darshan, STAR News, TOTAL TV, etc. and through Radio channels like Rohtak Station and Kurukshetra Stations in Haryana. He is invited for radio talks for the benefit of farmers frequently on various topics such as renovation of pond for fish culture, how to start fish farming, fish production, fish diseases and their control, etc. which are being broadcasted by radio stations of different states. After hearing on radio, many fish farmers contact him frequently for suggesting solutions to their problems which are attended by him without any delay.

Recent TAAS Publications

- Brainstorming Workshop on Soybean for Household Food and Nutritional Security - Proceedings and Recommendations, March 21-22, 2014.
- The Eighth Foundation Day Lecture on "Sustainable Agricultural Development - IFAD's Experiences" by Dr. Kanayo F. Nwanze, President, IFAD, August 5, 2014.
- Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia - Strategy Paper by Dr. R.S. Paroda, September 25, 2014.
- Global Conference on Women in Agriculture - Proceedings and Recommendations, March 13-15, 2015.
- Brainstorming Workshop on Upscaling Quality Protein Maize for Nutritional Security - Recommendations, May 21-22, 2015.
- The Ninth Foundation Day Lecture on "21st Century Challenges and Research Opportunity for Sustainable Maize and Wheat Production" by Dr. Thomas A. Lumpkin, Former DG, CIMMYT, September 28, 2015.
- National Dialogue on Efficient Management for Improving Soil Health - Soil Health Declaration - September 28-29, 2015.
- Regional Consultation on Agroforestry: The Way Forward - New Delhi Action Plan on Agroforestry, October 8-10, 2015.
- National Dialogue on Innovative Extension Systems for Farmers' Empowerment and Welfare - Road Map for an Innovative Agricultural Extension System, December 17-19, 2015.
- Round Table Discussion on Promoting Biotech Innovations in Agriculture and Related Issues - Proceedings & Recommendations, August 4, 2016.
- Awareness-cum-Brainstorming Meeting on Access and Benefit Sharing – Striking the Right Balance – Proceedings, October 22, 2016.
- Delhi Declaration on Agrobiodiversity Management – Outcome of International Agrobiodiversity Congress 2016, November 6-9, 2016.
- National Conference on Sustainable Development Goals: India's Preparedness and Role of Agriculture, May 11-12, 2017.
- Policy Brief on Efficient Potassium Management in Indian Agriculture, August 28-29, 2017.
- Regional Policy Dialogue on Scaling Conservation Agriculture for Sustainable Intensification, Dhaka, Bangladesh, September 8-9, 2017.
- Policy Brief on Scaling Conservation Agriculture in South Asia, December 2017.
- Retrospect and Prospect of Doubling Maize Production and Farmers' Income – Strategy Paper by Dr. N.N Singh, September 10, 2017.
- Indian Agriculture for Achieving Sustainable Development Goals - Strategy Paper by Dr. R.S. Paroda, October, 2017.
- Strategy for Doubling Farmers' Income - Strategy Paper by Dr. R.S. Paroda, February, 2018.

- Livestock Development in India - Strategy Paper by Dr. A.K. Srivastava, Member, ASRB & Trustee, TAAS, February, 2018.
- Policy Brief on Agricultural Policies and Investment Priorities for Managing Natural Resources, Climate Change and Air Pollution - April, 2018.
- Women Empowerment for Agricultural Development - Strategy Paper by Dr. R.S. Paroda, May, 2018.
- Brainstorming Meeting on Harnessing Intellectual Property to Stimulate Agricultural Growth – Proceedings and Recommendations, July 27, 2018.
- Road Map on Motivating and Attracting Youth in Agriculture (MAYA), November 2018.
- Regional Conference on Motivating and Attracting Youth in Agriculture (MAYA) - Proceedings and Recommendations, August 30-31, 2018.
- Motivating and Attracting Youth in Agriculture - Strategy paper by Dr. R.S. Paroda, November, 2018.
- Tenth Foundation Day lecture on "Can India Achieve SDG 2 – Eliminate Hunger and Malnutrition by 2030" by Dr. Prabhu Pingali, Professor in the Charles H. Dyson School of Applied Economics and Management at Cornell University, January 24, 2019.
- Urgency for Scaling Agricultural Innovations to Meet Sustainable Development Goals (SDGs) – Strategy Paper by Dr. R.S. Paroda, April, 2019.
- Horticulture for Food and Nutritional Security - Strategy Paper by Dr. K.L. Chadha and Dr. V.B. Patel, October, 2019.
- National Dialogue on Land Use for Integrated Livestock Development – Proceedings and Recommendations, 1-2 November, 2019.
- A Road Map on Efficient Land Use and Integrated Livestock Development
- Crop Biotechnology for Ensuring Food and Nutritional Security - Strategy Paper by Dr. J.L. Karihaloo and Dr. R.S. Paroda, December, 2019.
- A Road Map on Policy Framework for Increasing Private Sector Investments in Agriculture and Enhancing the Global Competitiveness of Indian Farmers, 4 December, 2019
- A Road Map on Stakeholders Dialogue on Way Forward for the Indian Seed Sector, 22 February, 2020.
- Biofertilizers and Biopesticides for Enhancing Agricultural Production - A Success Story by Dr. Basavaraj Girennavar, June, 2020.
- A Road Map on Stakeholders Dialogue on Current Challenges and Way Forward for Pesticide Management, 24 July, 2020.
- Dr MS Swaminathan Award for Leadership in Agriculture - A Compendium, October 2020.






















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Trust for Advancement of Agricultural Sciences (TAAS)

Avenue II, ICAR-Indian Agricultural Research Institute Campus
New Delhi 110 012, India
Phone: +91-11-25843243; +91-8130111237
E-mail: taasiari@gmail.com; Website: www.taas.in