Aquaponics (RAS) Trial 2.0 – Experience from Vigyan ashram , Pabal (Pune, India)

Vigyan Ashram is working on aquaponics farming system from past 3 years. Aim is to standardize this system as per Indian agro-climatic conditions and market potentials. We conducted a fresh trial @ Vigyan ashram, Pabal, Tal-Shirur, Dist- Pune during September 2016 to May2017. This report covers details of trial with some of challenges faced during this period.

Following were the tested aquaponics system components & trial details as -

System components -

A. Bio-Bed -

Plastic paper (HDPE 250 GSM) lined bio-bed was constructed with approximate volume of 10000 lit (0.7 M depth , 2.5 width & 3.5 M length) .Total of 5 grow beds constructed with cumulative volume of 6 M^2. Elevation difference of 0.25 M was maintained in each bed so as to achieve siphon based water circulation. Beds were field with red mud bricks as growing media. Coco-pit filed grow beds were also placed in each bed as vegetable planting beds while *Colocasia esculenta* (Alu) , *Solanum lycopersicum var. cerasiforme* (Cherry tomato) , *Brassica oleracea* (Cauliflower), *Capsicum annuum* (Chilli) and *Cucumis spp.* (Cucumber) during trial period.

B. Fish tank –

Fish tank of with approximate 10000 lit capacity constructed with HDPE plastic paper linings. A drainage line was fixed at bottom of tank for removing fish / food waste. This drainage pipe was connected to sludge tank with floating valve for maintains of water level in tank. Water from fish tank is pumped to bio-bed & taken back to fish tank by with siphon based system.

C. Water circulation-

Water circulated through bio-bed during night time, while during day time water was circulated through solar based heating system to maintain fish tank temperature. Two separate motors were fixed for circulation through grow-bed (1.5 Hp) & water heating system (0.5 Hp). Both motors were connected with separate timers for system automation.

Water circulation system pump was fixed in sludge tank. Water was pumped to grow beds @ 500 lit cycle with frequency of every 10 min (during night time only) . Water holding time for each bed was approximately 5 minutes. Cumulative water holding (circulation through siphon system) of 20 min for each cycle is achieved. Water from bio-beds ultimately returned back to fish tank with effective nitrification.

D. Fish & Fish feed-

Tilapia , mono-sex culture fish with 2 Gm average weight & 3-5 Cm length were grown in aquaponics system. Commercially available floating pellets (protein 28 to 32 %) were used as fish feed with pellet size of 2 to 4 mm depend on fish requirement. Fish feed probiotics and water probiotics were also used on regular basis during initial 3 months phase of trial. Fish were fed on basis of their body weight with feeding rate of 10 to 2 % of body weight based on growing stage. Additional feeding of live worms , azolla , coriander leaves etc also tried for testing acceptability of feed.

Photo slides –

Fish tank with HDPE lined plastic paper

Grow bed (bio-beds) with siphon system

Plastic grow bed with coco-pit

Veggies harvest

Initial fish (tillapia monosex 3-5 Cm , 2-3 Gm)

Final fish (15 to 18 Cm , 300 to 350 Gm)

Result & discussion -

Bio-bed & plant growth –

Siphon based flood & drain system of water circulation in combination of above plants worked very well during trial. Cauliflower, chilies, cabbages and allu leaves were harvested on regular interval. Siphon based flood & drain system helped to add necessary oxygen to root zone & fish tank. Water holding in bio-beds also helped in achieving necessary nitrification effect for maintaining ammonia & nitrates levels in desire range.

Water circulation, fish tank water parameters and fish growth–

Nitrification - During night time water circulation helped in nitrification. Though we haven't tracked ammonia or nitrite level, but by visual observation they were kept below un-desire levels.

Oxygen levels – Dissolved oxygen maintained above 5 ppm through water circulation in bio-bed and water heating system. For bio-bed water flow rate of 500 lpm while for water heating system 200 lpm water circulation was maintained for getting desire DO & water temperature.

Water temperature - Ideal water temperature tilapia is 28 to 32 ˚ C , but during winter season water temperature dropped to lowest of 11 ˚ C during at morning hours. It affected fish growth, so separate pump & solar water heater system tried to raise water temperature during day time.

While starting trial we assumed lowering water temperature in fish tank won't be major limitation of aquaponics system in Indian conditions. This was wrong consideration, as average water temperature during winter months was much lower than desire level. It was observed that, during night time for each bio-bed circulation cycle, water temperature dropping by 2 ˚C , ultimately reducing fish tank water temperature by 10 – 12 ˚C for 5-8 Hr circulation time. This was due to evaporative cooling, in bio-beds.

Average minimum & maximum water temperature during October to February months was 17 ˚ C and 25 ˚ C respectively. This badly affected feeding activity of fish increasing FCR. Due to disturbing in water temperatures and lower feeding rate fish density reduced in fish tank several time ultimately affecting fish growth record.

Fish feeding & growth – Fish fed with 2 to 4 mm floating pallets with 32 % protein. Water & gut probiotics, worms, coriander leaves were also tried to increase feed acceptability. Trial started with average fish weight of 1 gm , fish grown up to 300 gm during final harvest in 9 month duration.

Scope of further development

- Aquaponics system in Indian conditions would need fish tank water temperature system. Particularly when tank volume is limited with lower depth. Increasing tank volume will definitely have better heat retention but water circulation in bio-bed is going to loss heat. Similarly bigger fish tank , would need larger bio-bed for nitrification with additional cost. There is scope for further work in this regard with respect to fish tank design, bio-bed, fish species etc.
- Power (electricity) failure and water circulation automation system are important area in standardization & feasibility of system.
- Cost of feeding Vs FCR , need to be worked out as per local fish demand and unit price.

Conclusion -

During this trial we learnt designing & construction of bio-beds with water circulation system, various species of plants suitable for aquaponics system and importance of tank water temperature with respect to fish growth & FCR. . It been also found that, there is scope for fish farming but fish species need to selected properly based on local market for achieving system feasibility. This trial has helped us to take one step ahead in standardizing aquaponics system. We are hoping to resolve fish tank water temperature issue in upcoming trial by improving fish growth and FCR.