density microalgal particle do not settle well and are unsuccessfully separated by settling.

- Filtration and screening: Grima et al. (2003) reviewed harvesting process options to recover biomass and the related economic costs. Screening involves introducing the suspension through a screen with a particular pore size. Microstrainer and vibrating screen filters are two of the primary screening devices in microalgae harvesting
- Flotation: Flotation is a gravity separation process in which air or gas bubbles attached to solid particles and then carry them to the liquid surface. Chen et al. (1998) noted that flotation is more beneficial and effective than sedimentation with regard to removing microalgae. Flotation can capture particles with a diameter of less than 500 micro meter by collision between a bubble and a particle and the subsequent adhesion of the bubble and the particle

Micro algal cultivation in India:

- In India Murugappa Chettier Research Center (MCRC) set up the 1st semi commercial plant for Spirulina in 1986
- Ballarpur had set up the largest commercial plant with the technical knowledge of Central food technological research institute, Mysore
- Panbari tea company has setup a plant of 30 tons capacity per annum
- Several small scale industry and NGO has also taken up the micro algae culture.

Challenges of Algal Production:

- Not grow in highly selective environment
- The climate often not optimal for growth
- Requires expertise
- Cost production strongly affected by economics of scale

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RECIRCULATORY AQUACULTURE SYSTEM: A SUSTAINABLE APPROACH

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1. Introduction

Millions of people are getting their nutrition and livelihoods from inland fish farming. Most fish are cultured in constructed ponds or floating cages in natural or man-made water bodies. Freshwater fish farming is often integrated with the farming of crops, where wastes and by-products from one system are used as inputs for another. Developing new technologies offer new opportunities to conserve the water resource thereby increasing the productivity of freshwater aquaculture field (Goddard and Delghandi, 2019). Aquaculture has been on the frontline of public concerns regarding sustainability (Martins et al., 2010). As conventional aquaculture methods, such as outdoor pond systems and net pen systems, are not likely to be sustainable in the long term, due to significant environmental issues and their inability to guarantee the safety of their products to the consumer. Recirculating aquaculture systems (RAS) have been developed with great potential to reduce the water requirements and environmental impacts of fish farms. On the other hand, indoor fish production employing RAS is sustainable, infinitely expandable and environmentally compatible as it guarantees both the safety and the quality of the fish produced throughout the year as indoor RAS offers the advantage of raising fish in a controlled environment, permitting controlled product growth rates and predictable harvesting schedules. Instead of the traditional method of growing fish outdoors, Recirculating aquaculture systems represent a new way to fish farming as this system rears fish at high densities in indoor tanks with a 'controlled' environment there by conserving heat and water through water reuse after reconditioning by biological filtration using biofilters (James and Michael, 2012).

Recirculation aquaculture systems are systems in which the water is re-used after undergoing treatment (Rosenthal et al., 1986). Recirculating systems filter and clean the water for the purpose of recycling through fish culture tanks. Water is mostly recirculated when there is a specific need to minimize

water replacement, to maintain water quality conditions which differ from the supply water, or to compensate for insufficient water supply (Halvorson and Smolowitz, 2009). Each treatment step reduces the water exchange in the system to the requirements of the next limiting waste component.

There are numerous designs for recirculating systems and most will work efficiently if they perform the functions of aeration, removal of particulate matter, biological filtration effectively to remove waste ammonia and nitrite, and buffering of pH and these processes can be achieved by biofilters. A biofilter is a place where beneficial bacteria remove (detoxify) fish excretory products, primarily ammonia. Biofilters are living filters composed of a medium (corrugated plastic sheets, beads, or sand grains) upon which bacteria grow. The bacteria provide waste treatment by removing pollutants. The water pollutants which are to be removed are (1) fish waste (toxic ammonia compounds) excreted into the water and (2) uneaten fish feed particles.

2. Recirculating Aquaculture Systems (RAS)

RAS represents a new technique of fish farming. In this system, fish are cultured at high densities, in indoor tanks with a 'controlled' environment. RAS filter and clean the water for recycling through fish culture tanks. Water is usually recirculated when there is a need to minimize water replacement, to maintain water quality conditions which differ from the supply water, or to compensate for insufficient water supply. Growing fish in RAS has numerous advantages in