Transforming waste to wealth: An onsite demonstration of transforming fish waste into fish fertiliser to tribal communities of Jharkhand

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Waste management is one of the serious issues modern civilisation is grappling with, further fuelled by population explosion in emerging economies like India asserting tremendous pressure on the production side to meet ballooning demand. On 15 November 2022, the United Nations celebrated "8 Billion Day". In 2023 India toppled China as the world's most populous country with 1.42 billion people (Sundaram, 2023). The United Nations projects that by the end of this century world population will cross the 10 billion mark. Hence, with such a projected scenario, the demand for food and other goods and services will inevitably rise. The producers have always been in the race to meet demand and with help of new technologies have been able to increase production over a period of time. However, in this process waste production has also increased which is now a major issue humanity faces today, especially in urban areas.

In recent times to tackle waste management novel concepts like "reduce-reuse-recycle" and the "circular economy" have been floated and brought into application to some extent. In agriculture and allied sciences, fisheries in particular, waste management has been least attended. Tropical climate, high perishability and a deficient cold chain and storage infrastructure are key factors contributing to fish spoilage, apart from waste generated during harvesting and processing stages.

In marine capture fisheries with the prevalent use of non-selective gears, a large portion of bycatch is discarded in the open sea which could be otherwise used as fishmeal for feed production. Likewise in the inland sector waste generated from fish is discarded in open areas causing pollution and risk health hazards.

Demonstrating fish fertiliser preparation.

To address these issues and bring the discarded portions of fish into use some innovative techniques have been developed such as using fish scales for cosmetics, air bladder for fish maws, use of fish collagen to make suture materials for medicine, aquaculture feeds, silage, fertilisers, fish-mince, and fishmeal. Processing the waste into fertiliser is one of the best options because it requires limited equipment, and machinery and utilises the bulk of the fish waste, is cost-effective and requires less space. This inexpensive technique of converting fish waste into fish fertiliser in the inland sector is least reported and in the state of Jharkhand not yet reported. Therefore, the College of Fisheries Sciences, Gumla, undertook an initiative to introduce fish fertiliser to resource-scarce tribal communities through demonstrations for preparing fertilisers from fish waste, which can be used for kitchen gardens or in backyard ponds, targeting the tribal communities of Jharkhand. Converting fish wastes into fertilisers services the twin objective of adding value to fish waste and reducing the environmental pollution caused by discarding waste into open areas.

Importance of fish waste management

Consumption of fish is increasing continuously worldwide, and seafood is gaining in popularity for both delicacy and health benefits. However, large amounts of fish waste are also being generated in the process of bringing fish from the deck to the plate. Waste disposal and by-product management in the food processing industry pose problems in the areas of environmental protection and sustainability (Russ and Pittroff, 2004). Organic wastes have been found to contain compounds capable of promoting plant growth (Day and Katterman, 1992) and seafood processing wastewater does not contain known toxic or carcinogenic materials, unlike other types of municipal and industrial effluents (Afonso and Bórquez, 2002).

During the processing of fish, usually only the fish fillets are retained while the bulk of other material is discarded. These large quantities of fish waste, if not utilised or disposed of properly, can have large harmful effects on local environments. For that reason, there is a need to find an ecologically acceptable means for reutilising fish waste. Traditionally both whole fish and

remains from processing were used to make fertiliser. According to Faid et al., (1997), conventional methods for the utilisation of fish waste include ensilation and the production of high-protein meals used in animal feeds. Liao et al., (1997), suggested composting as a viable solution to the problem of fish waste disposal. Yeasts and/or lactic acid bacteria were used to ferment fish wastes and remove odours (Faid et al., 1994). Acid hydrolysis of fish wastes has been studied to produce low-cost nutrients for the production of lactic acid (Gao et al., 2006), and low-cost protein sources have been produced by ensiling hydrolysed fish viscera to obtain a suitable medium for lactic acid bacteria (Vazquez et al., 2008). A new low-cost fermentation technique using *Aspergillus awamori* that could also apply to fish wastes was reported by Yamamoto et al. (2004) and Yano et al. (2008) described a fermentation technique that improves the quality of fish meal from fish wastes rich in lipids. Some studies have recently examined the re-utilisation of biodegraded fisheries-waste products as a liquid fertiliser (Kim and Lee, 2009; Kim et al., 2010; Dao and Kim, 2011). Therefore, fermented fish wastes could be used as a valuable resource for supplementing nutrients in agriculture.

Fish fertiliser packaged in discarded bottles.

Types of fish fertilisers

Fish fertilisers can be prepared by several different methods based on the use and type of technology utilised for their production. A number of common fish fertilisers include fish meal, fish emulsion, dried fish, soluble and enzymatically digested fish liquids. Fish meal is heated and de-oiled to make the dry meal generally much lower than other types of cold-temperature processed fish fertilisers. Microorganisms and plants do not rapidly utilise this type of fish, although it still provides a beneficial effect but takes longer to do so. Fish emulsion is mainly used for its rapid high organic nitrogen and available soluble phosphorus and potassium benefits as a foliar feed. Fish emulsion is also used as a drench for root feeding. Most fish emulsions have an N-P-K value of 4-1-1 with some having an N value of 5 or 6. Fish meal is mainly a great soil conditioner and great bacterial food to help feed the soil microorganisms. Most commercially made fish emulsions come from trash products of the menhaden fish. This group of fish includes herrings, sardines, and anchovy fishes. The commercially produced fish emulsion also contains 5% sulfuric acid as a preservative, but also it supplies sulphur to the plant and soil. Most commercially produced fish products do not contain fish oil which supplies beneficial soil fungi, or fish bone which provides needed calcium. Fish emulsion contains 9-10% nitrogen available to the soil. Other types of fish fertilisers utilise low-temperature enzyme digesting technology which does not denature the fish, thus making the end product a much more microbial-friendly fertiliser with nearly instant fertility for the crops where it is applied.

Explaining the advantages of fish fertiliser.

Preparation of fish fertiliser

Whole fish, trash fish, or fish discards like heads, guts, intestines and various other parts can be used as raw material. Whole fish will yield a better product. Add the raw material into a blender to mash it up into little pieces. The finer the fish bits, the more effective the fermentation. Add three parts of water to ferment one part of the material. Always prefer non-chlorinated water as it kills microbes. Blend the mixture again. Add *Lactobacillus* to the blended mixture. Add sugar as one third of the amount of fish added. Any cheap glucose source could be used as it provides energy to the microbes. Blend the mixture again. Pour the mixture into a container with a loose cover on it. There is no need to seal the container as it may explode due to the release of CO_2 by fermentation. The process takes three weeks to over a month to finish. During fermentation, there is a nasty smell, but once completed, there will be almost no odour. Finally, the prepared fish fertiliser can be used. The benefits of homemade fish emulsion are many. For one, it is cheap to make in large quantities. There are nutrients in homemade varieties that are not available in commercially-produced products.

How to apply fish fertiliser on agricultural land?

Liquid fish fertiliser can be applied by different methods to any type of cropping. Liquid fertiliser is usually applied via irrigation water through sprinklers, micro sprinklers, foggers, spitters, drip emitters, drip tape, furrow, flood systems, and overhead sprayers. Among these methods, liquid fish fertiliser results will show the best results when the foliar method is applied via a sprayer application. This method is excellent method for providing rapid sources of fertiliser to crop systems. Liquid fish fertiliser is rapidly absorbed and utilised by plants when applied following these techniques.

Advantages of fish fertilisers

Fish fertilisers are considered excellent sources of nutrients for soils and plants as fish contain most of the nutrients necessary for them. Fish fertilisers contain significant quantities of nitrogen as protein (an important source of balanced nitrogen) as well as a healthy balance of all 18 nutrients known to be significant for crop growth. Fish also contains more than 60 other trace minerals which have positive effects on soil biology and crop health. The nutrients in fish are a quick and direct stimulant to the plant's roots and leaves. Applying fish fertilisers can rapidly improve crop fertility in almost all situations. Additionally, fish provides both immediate fertilisation response as well a longer-lasting fertility effect for later in the growth of the crop. The balanced, moderate levels of nutrients in fish products provide a broad spectrum of fertility without the problems associated with the excess application of any one nutrient. Fish fertilisers provide balanced, moderate amounts of nitrogen and all the other essential nutrients, plus many more trace minerals not found in chemical fertilisers. This balance helps to provide full spectrum fertility without an excess of nitrogen and reduces problems with pests and diseases while supplying a fertility boost, and increasing plant growth and vigour. A significant additional benefit of fish as a fertiliser is the dramatic stimulation to the soil's beneficial microorganisms such as bacteria and fungi which consume, digest and release abundant nutrients in the fish when it is applied to the soil. Fish products can make a significant contribution to the overall fertility of the soil and crop while at the same time stimulating the biological activity in the soil, thus improving the quality of the soil for many years to come.

Faculty of College of Fisheries Science, Gumla group photo with tribal women after completion of onsite demonstration of the preparation of fish fertiliser.

Fish fertiliser preparation demonstration to tribal communities of Jharkhand

Jharkhand has as 32 recognised tribal communities mostly dwelling in rural areas. In general, 76 per cent, (2011 census) of the population of Jharkhand still resides in rural areas. Jharkhand is one of the richest states in terms of natural resources, unfortunately, its population are amongst the poorest communities in the country. The tribal communities are resource poor and hardly able to live decent livelihoods due to various constraints that stymie their progress, including a lack of access to knowledge and information that could improve their circumstances. Different institutions and organisations including public, private and NGOs are involved in facilitating these communities' access to modern knowledge and information intended to bring positive changes in their livelihoods. One such effort was carried out by the College of Fisheries, Gumla, providing onsite demonstration to tribal communities on converting fish waste into fish fertilisers which can be used in their kitchen gardens and plants to enhance crop yield. The onsite demonstrations that were positively received by the tribal communities as the technology was easy to adopt without any cost burden. The whole process, types and advantages of fish fertilisers were communicated in vernacular language which helped them receive the technology without any communication constraints.

Conclusion

The demonstration was well received by the tribal communities and since it doesn't require any investment. After hearing the advantages of fish fertilisers, the tribal communities showed interest in adopting this technique. From this demonstration, it was realised that resource-poor communities are open to adopting new technology which has prospects of bringing positive changes in their livelihoods. Like fish fertilisers, there are many available technologies which are inexpensive and have shown significant impact on the production process that could be introduced to these resource-deficient tribal communities to improve their livelihood and socio-economic conditions.

Acknowledgement

The authors would like to acknowledge and express gratitude to ICAR-CIFT for providing financial assistance under TSP-Plan which has made these onsite demonstrations successful.

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