Analysis of eco-innovation with triple helix approach: case-study of biofloc catfish farming in Yogyakarta

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Abstract. Concerning environmental into focus of innovation process will expand the number of actor involved. Eco-innovation and triple helix are often frameworks applied to analyse how environmental concern are integrated in innovation process and how different stakeholder groups are having inter relation. Case study from biofloc catfish farming in Yogyakarta is presented to demonstrate a possible approach for researching the success of triple helix frameworks. This case is considered on basic of the result of a survey among farmers, academician and government. The paper concludes the creating of full triple helix encounters problem in practice. It also includes suggestion for further research on fisheries development.

1. Introduction
Sustainable development (eco-innovations) as innovation processes have received increasing attention during the past years [1]. Eco-innovation is increasingly connected to green growth in terms of global climate change as it is to be multi-win approach [2]. In aquaculture industry using bioflocs technology as eco-innovation aquaculture is a promising alternative to overcome the problems. Moreover, application of this technology is more profitable by decreasing inorganic nitrogen waste as well as providing additional feed for cultured fish, thus increasing fish growth and feed efficiency. Biofloc technology can be applied using addition of organic carbon into the culture media to increase C/N ratio and to stimulate the growth of heterotrophic bacteria [3]. Moreover, [4] concluded that by using bioflocs technology will had high sludge accumulation after harvest, because the deposition of dead organic matter and algae in the absence of water exchange. So, it is important to implement management to control ammonia and sludge formation. Bioflocs technology could certainly be an ideal method for farmers. The biofloc-dominated no water exchange conditions need more resources to maintain adequate water quality, growth, yield and profitability [5].

The triple helix metaphor generalized innovation dynamics to non-linear interactive process among multi-stakeholders. It provides a framework for disclosing how innovations are generated by analyzing university-industry-government linkages [6]. Integration and differentiation of triple helix are important for proper institutions and infrastructure, knowledge-intensive services tend not to contribute to local synergies in the economy because of their flexibility of moving across the administrative borders of regions [7]. It is important how Region Government should active to manage this synergy to maximize regional economic development. It is in line to [8] who concluded that market–led intermediary organizations should be used as a policy tool to promote triple helix networks. Government-funded intermediaries may help in creating triple helix networks.
The problems are how eco-innovation can be developed and giving impact to economic development. Innovation needs changes in many things. It is important to synergize all of the actors or stakeholders such as firms, politicians, unions, associations and private household. In general, they can be categorized into three actors: academician, business and government or ABG.

Eco-innovations dynamics is the process that innovative firms with clear intentions toward economic and environmental benefit developed by utilizing stakeholder interactions. Eco-innovation can be categorized as: product innovation, production (process) innovation, organizational innovation, market innovation and business model innovation. The problem is how such kind of innovation can be introduced and developed, then how to apply in business and finally how can give positive impact to the business and regional economy. This paper focuses on triple helix frameworks to disclose eco-innovation activities are developed by stakeholder interactions.

The purposes of this research are: (1) to describes the eco-innovation of biofloc technology for catfish farming and (2) to analysis of the triple helix framework in order to assure that eco-innovation can gives impact to the business and regional economic development.

2. Materials and Methods

2.1. Materials
Primary and Secondary data was used for identification of the catfish farming system. Data was gathered through observation and in-depth interview to the object of this research. The objects of this research are (1) Tunas Muda Catfish Farming Yogyakarta, (2) Faculty of Agricultural Technology Universitas Gadjah Mada (UGM) and (3) Yogyakarta Special Region Government.

The need data of this research are: (1) the role of stakeholders in triple helix frame, (2) the catfish farming system before and after introducing bioflocs technology such as the catfish total production, cost production, number of manpower, kind of technology, feed utilization, density, survival rate and production management. The secondary data is research reports, policy reports and annual reports of The Ministry of Marine and Fisheries as well as Yogyakarta special region government.

2.2. Methods
This research was done through (1) stakeholders identification of biofloc catfish farming, (2) description of biofloc catfish farming and (3) triple helix frame of biofloc catfish farming. Finding and discussion was done through descriptive-qualitative analysis.

3. Results and Discussions

3.1. Eco-innovation dynamics at Tunas Muda bioflocs farming
*Tunas muda* is a fishery group that has a catfish culture business with 25 members. *Tunas muda* sees environmental problem in relation to water limitations under climate change and the high cost of commercial fish feed as an opportunity. Intensive innovation by using bioflock technology have proved successful, as its business catfish aquaculture has extended another product such as catfish fingerlink and tilapia.

Based on a document of fisheries minister report, we outline the changing intensions at *tunas muda* catfish farming integrating environmental problem into innovation strategy and business development. Table 1 below presents eco-innovation dynamics at *tunas muda*. Table 1 shows that at *tunas muda*, eco-innovation relates not only to their product development, but also production process and organization.

*Tunas muda* is as catfish farmer group success to apply the bioflocs technology. Table 1 above describes that the introduction of bioflocs technology results product innovation, process innovation and organizational innovation. Total production and revenue are increase. Feed utilization changes from extensive production with commercial fish feed to become active nitrogen bacteria and bubble blower. It is also increase in stocked density and survival rate. *Tunas muda* business activities become more
efficient due to the establishment of organization farming, grading procedure check point, water quality periodic procedure analysis.

**Table 1.** Eco-innovation dynamics at *tunas muda*.

| Eco-innovation dynamics           | Before                           | After                               |
|----------------------------------|----------------------------------|-------------------------------------|
| Product Innovation               | Catfish consumption size         | fingerlink catfish, tilapia         |
| Total Production                 | 2.5 ton                          | Round ponds fiber 5 ton             |
| Cost production                  | Rp. 32,500,000,-                 | Rp 60,000,000,-                    |
| Manpower                         | 2                                | 1                                   |
| Total Revenue                    | Rp. 37,500,000,-                 | Rp. 80,000,000,-                   |

- **Production Process Innovation**
  - Traditional
  - Eco-innovation;
- **Technology**
  - Extensive production
  - Active nitrogen bacteria, bubble blower 7 : 3
- **Feed utilization**
  - Commercial fish feed
  - Practically 100 tail.m⁻³
  - Increase to 200 tail.m⁻³
- **Stocked density**
  - 80–90 %
  - 90–95 %
- **Survival Rate**
  - $3 \times 5 \times 70$ m³
  - 250 m³
- **Ponds**
  - Private household
  - Organization farming, grading procedure check point, water quality periodic procedure analysis
- **Production management**
  - three persons
  - Catfish aquaculture
  - 10 persons
  - Breeding catfish division established

Business development at *tunas muda* is the result of the interaction of several stakeholders. Figure 1 present the stakeholder’s relations and linkages. As the result of increasing in interaction between *tunas muda* and the government, then it can improve catfish production system. The government provides support with the strengthening of funds and quality assurance. Increased fish production provides indirect income for local government in the form of taxes. Universities in this case UGM has an interest to improve transfers benefits of research that has been done. Relationship between *tunas muda* with other fishery industry such as finger link supplier, fish feed factory and another community group is mutual support to improve prosperity together.
3.2. Triple helix framework

According to agro industry system, there are three actors or stakeholders that involved in this framework system. They are academician or university entity, business entity and government entity. UGM is as academician entity, Biofloc catfish farmers is as business entity and Ministry of Fisheries and Yogyakarta Special Region Government are government entity. They are having relationship through triple helix concept or ABG (Academician, Business and Government) model.

Bioflocs technology was developed by UGM (aquaculture research) and government (Ministry of Fisheries) representative. Each stakeholder has role in this framework. UGM itself as a university organization, there are assets such as researchers or lecturers, laboratories and networks. Their assets can make the university’s role as incremental cost reduction in aquaculture system, creative invention and technology transfer. The role of bioflocs farmers as the owner of catfish cultivation business is to produce catfish fingerlink and catfish consumption size. The Yogyakarta Special Region Government through Fisheries and Marine Office has a role to support by applying government regulations to implement regional economic development.

The development of aquaculture business can be improved by maximizing the role of each actor. Changes or evolutionary in the types of interactions on triple helix models occurred in recent years. The interaction of actors in the triple helix of static in which government control university and industry to laissez-faire stage in which has a balanced relationship between the three institutions; And last is the hybrid stage in which each institution has its own different roles and cuts in the same time [5]. The changes process underlying the Triple Helix system is graphically described in figure 2 below.
The interaction change in the triple helix system is due to the paradigm shift in the role of each institution. The government itself tends to release its role, from powerful and dominant role to networking role. Dynamic interactions occur in the interaction of aquaculture catfish bioflocs. Each institution has a different role in accordance with the goals of their respective vision and mission. However, these institutions simultaneously have a role to support the availability of catfish supply to meet consumer needs. Catfish farmer group, as an institution, was supported by government, changes to be more independent. Each stakeholder simultaneously have a role to support the application of bioflocs technology, in order to maintain the availability of catfish supply to meet consumer needs.

4. Conclusion
University, government and fish farmers have a significant effort to promote eco-innovation as Triple Helix system in order to improve catfish production. The triple helix mechanism is a synergistic role for catfish farmers to get more profit. Business development is the result of the interaction of triple helix mechanism, by which each stakeholder simultaneously have a role to support the application of bioflocs technology, in order to maintain the availability of catfish supply to meet consumer needs.

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