

## **THESIS INFORMATION**

**Doctoral thesis title: Developing the system and solution for optimal environmental management for the cassava production chain in Tay Ninh province.**

Specialization: Natural Resources and Environmental Management.

Specialty code: 62850101.

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Training course: 2019.

Supervisor: Prof. Dr. Le Thanh Hai.

Training institution: Institute for Environment and Resources – Viet Nam National University Ho Chi Minh City.

### **1. SUMMARY**

The cassava starch industry is a key industry in Tay Ninh province, however, the cassava starch production chain also causes many negative impacts on the environment. The circular economy is the current approach to sustainable development. Implementing the circular economy brings many benefits, such as reducing operating costs, meeting requirements of environmental protection standards, enhancing the corporate image, conserving raw materials, minimizing waste, reducing risks, and increasing safety for the environment and society.

The objective of the thesis is to propose a suitable, sustainable, and environmentally friendly production system for the cassava starch production chain suitable for the specific conditions of Tay Ninh province. The study has applied multi-criteria analysis methods, mathematical programming, zero-emission techniques and systems, and circular economy concepts. The results have implemented an integrated system in the direction of circularity and zero carbon emissions for the cassava starch production chain in Tay Ninh, an agro-industrial symbiosis system towards zero emissions, and a set of best available technical solutions to minimize pollution for cassava starch factories.

In the circular economic system, the inputs in the production chain are minimized, aiming to achieve zero electricity usage, zero waste, and zero reliance on fossil fuels.

The valuable products generated in this process include 528,000 tons of bio-oil per year, 207,000 tons of bio-char per year, and 190,000 tons of dry residue per year. Overall, the proposed system and solutions offer systematic and practical approaches for pollution prevention and reduction in the cassava starch production industry, working towards the goal of "Net Zero." Furthermore, to enhance the circular system and increase the value of the cassava starch production chain, future studies should assess the impact of using organic fertilizers made from by-products on crop productivity. Additionally, consideration should be given to the feasibility of a microalgae production plan utilizing the biogas wastewater from the cassava starch factory's wastewater treatment system, tailored to the specific conditions of Tay Ninh province.

## **2. KEYS FINDING**

The novelty of the thesis contributes to the scientific evidences for the cassava starch production industry chain, specifically the following contributions:

- Create a set of criteria to evaluate and select the optimal production chain aimed at achieving zero carbon emissions.
- Establish a set of criteria to assess and select the best integrated agro-industrial production system toward zero emissions.
- Develop a methodology to evaluate and propose the best available technical for the cassava starch production process in Tay Ninh.

The proposed criteria and methods have been applied. The results have implemented a circular production system toward zero carbon emissions for the cassava starch production chain in Tay Ninh, an integrated industrial and agricultural system toward zero emission, and a set of best available techniques to minimize pollution for the cassava starch factory.

## **3. APPLICABILITY OF THE THESIS AND ISSUES NEEDING FURTHER RESEARCH**

### **3.1. Applicability of the thesis**

The results of the thesis highlight the potential for agro-industrial symbiosis applicable in the field, particularly in the cassava starch industry. The findings are as follows:

- An integrated system for the entire production chain is proposed to optimize input materials and achieve zero carbon emissions. Management units in the province, especially those in the cassava starch industry should consider implementing this system to achieve "Net Zero."
- The agro-industrial symbiosis involves the combining of cassava starch factories with surrounding areas, focusing on maximizing the use of local resources and conditions.
- The circular system offers the best effective technical solutions available for the starch production process. These solutions can be widely adopted to optimize the use of raw materials and reduce emissions.

### **3.2 Further research**

Based on the results of the thesis, the PhD student proposed some research directions in the coming time as follows: biogas effluent water

- Research to evaluate the impact on crop productivity when using organic fertilizer from by-products of the cassava starch processing process. In addition, consider the feasibility of the solution to produce microalgae from post-biogas wastewater of the cassava starch processing plant's wastewater treatment system in accordance with the specific conditions of Tay Ninh province.
- Research to develop support tools in inventorying and calculating some environmental indicators for the cassava starch processing industry chain to serve as a basis for assessing emissions as well as the effectiveness of applying solutions to prevent and reduce pollution.
- This study only evaluates the cassava starch production process. Future research needs to be expanded to the processing of cassava starch-related products. At the same time, apply the principles of the agro-industrial system to other industry chains.

**Supervisor**

**PhD Student**

**Prof. Dr. Le Thanh Hai**

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