Eco-Standardization in the Frozen Vegetable and Fruit Industries in Chiang Mai Province

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Summary

Because of Thailand's tropical climate, a wide variety of fresh fruits and vegetables are available all year round. The abundance of fresh produce provides a tremendous opportunity for the country to export its fruits and vegetables to other countries: for example, to cold-climate countries during the winter, where this would constitute an important part of the diet. For these reasons, Thailand has become a significant source of fresh and frozen fruits and vegetables around the world. The popularity of Thai frozen vegetables and fruits is also due to the upward trend in health-conscious consumers. Also, Thailand's non-GMO products are increasingly penetrating European and Japanese markets. Asian countries such as China and Vietnam are especially important markets for frozen fruits and vegetables, and demand there is expanding. However, the production and consumption culture is changing. The increasing global problems of pollution, waste, high energy consumption, and so on, are now of major public interest. Therefore, proper energy and environmental management are needed in order to promote and demonstrate good practices in the frozen fruit and vegetable industries. This study focuses on the eco-standardization of these industries in Chiang Mai province, in the northern part of Thailand. The objectives of the study are to increase awareness of the environmental impact of the industries, and to improve efficiency in their energy and material consumption. Standard requirements were applied to six factories which voluntarily participated in the study. Four significant issues were addressed: energy and environmental policies; good agricultural

practices; energy and material consumption; and waste management and corporate social responsibility. The findings resulted in improvements that could be implemented in each factory that participated in the study. This process of eco-standardization could lead to more environmentally friendly policies, and hence to a more sustainable society.

Introduction

In recent years, it seems that the industrial production and consumption culture has been forced to change, sometimes voluntarily and sometimes due to societal demands. The pressure for change has largely been due to the serious environmental problems that humanity is facing: for example, global warming, photochemical smog, waste disposal problems, overconsumption of energy resources, and so on. Another dominant cause is the rapid growth of the world population, resulting in high production and consumption demands. Thus, sensible energy and environmental management practices are urgently needed.

In order to promote and demonstrate good practices for industries in Thailand, this study introduces the concept of eco-standardization to the frozen vegetable and fruit industries. Energy and environmental criteria are established in order to evaluate how environmentally friendly the industries' practices are. Eco-standardization also aims to stimulate Thailand's industries to shift toward the next level of "green" marketing. The techniques applied in this study are Life Cycle Assessment (LCA) and Clean Technology (CT). LCA and CT can be used to identify opportunities to improve energy usage and other environmental aspects of production at various stages. They also offer a means of input into decision-making for strategic planning or green product/process design.

This study of eco-standardization in the frozen vegetable and fruit industries is a good example of the Thai government's attempt to stimulate and support all industries in the field of socio-economic production. The objectives are to improve environmental awareness, and to improve efficiency in energy and resource conservation. Standards of eco-production have been established and were applied to the participating factories. A manual of eco-production has also been published in order to spread the knowledge of eco-production into these kinds of industries as much as possible. During this eco-standardization study, four significant issues were discussed: policies, good agricultural practices, energy conservation, and environmental protection and corporate social responsibility.

Processing of Frozen Vegetables and Fruits

In the frozen vegetable and fruit industries, the production processes are quite similar. The production stages are illustrated in Figure 1.

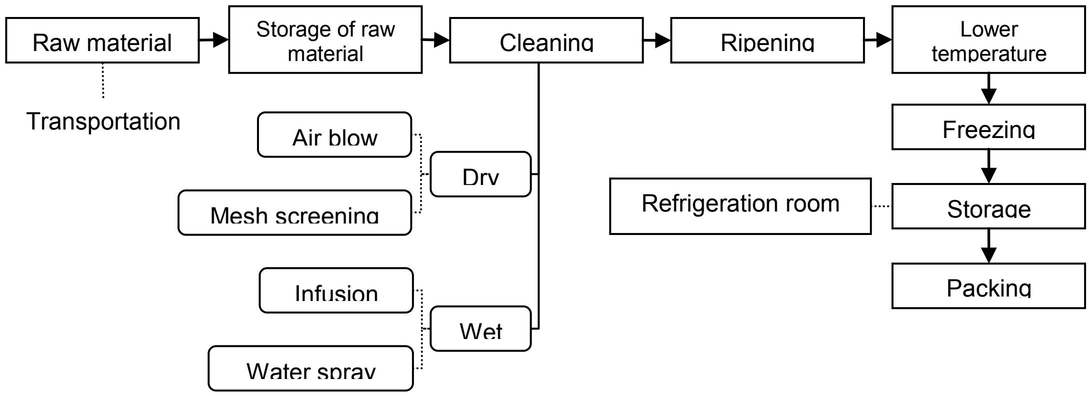

Figure 1 Flow chart of production in the frozen vegetable and fruit industries.

Inventory data, such as input-output of energy and raw materials consumption, are collected and calculated by measurement, plant reports, and literature review. Inventory analysis also includes material and energy balance. In this study, the system boundary is the focus from gate to gate on the factory production process. The schematic diagram of the system boundary is shown in Figure 2.

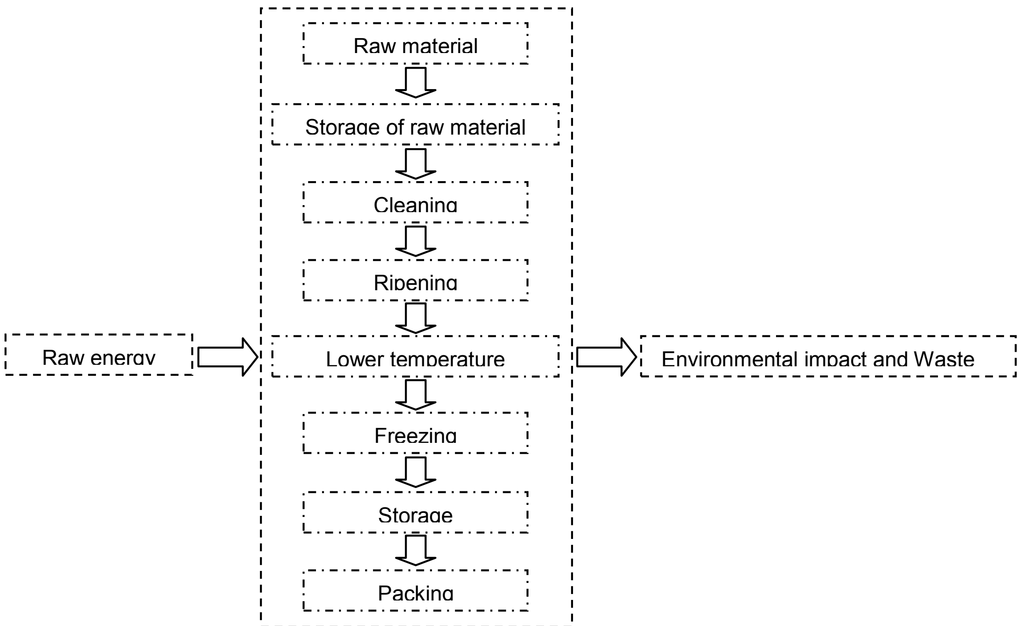

Figure 2 System boundary of gate-to-gate frozen vegetable and fruit production.

Key data – such as raw materials; energy use; and chemical substances, waste water and emissions released – involved during the gate-to-gate life cycle are collected, as shown in Table 1. The investigation concerns the input and output of all steps, from the first step of raw material procurement to the end step of packaging.

Table 1 Examples of input-output in the production stage

Input	Process	Output
- Raw materials	- Raw materials	- Products
- Water	- Storage	- Emissions from direct combustion
- Electricity	- Cleaning	- CO_2
- Refrigeration	- Ripening	- CO
- Fuel oil	- Low temperature	- NO_x
- Plastic baskets	- Freezing	- CH_4
- Shelves	- Storage	- SO_x
- Plastic bags	- Packing	- Particulates
- Cardboard boxes		- Waste water
- Etc.		- Solid waste

Eco-Standardization Directives

In addition to the research team from the Department of Mechanical Engineering, Faculty of Engineering, Chiang Mai University, three other parties were members of the committee: representatives from Thailand's Department of Environmental Quality Promotion; representatives from the Chiang Mai provincial government; and representatives from the vegetable and fruit industries.

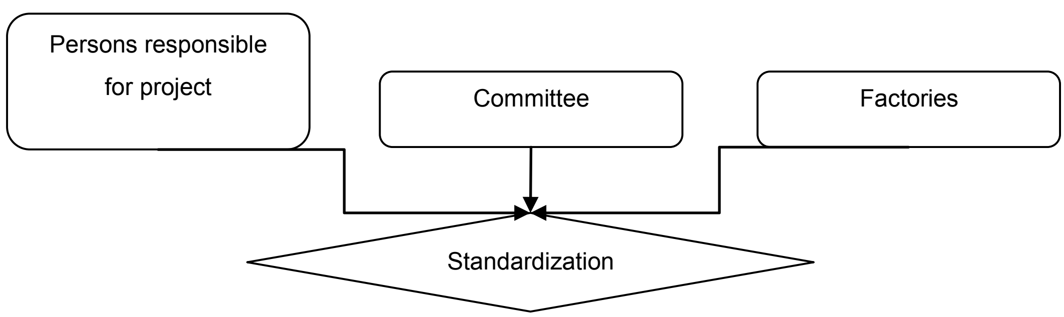

Figure 3 Relevant parties who create standard criteria.

The factories participating in the study can be divided into two main groups: processing, and cold storage. After eco-standards were applied to the six factories, each factory was audited, and suggestions and comments made for improvement procedures.

The committee agreed to focus on four significant issues: policies; good agricultural practices; energy conservation and environmental protection; and corporate social responsibility. The results of many discussions led to a classification of standard criteria development.

Criteria 1: Good policy notification – Identification of good practices in environmental policies or manufacturing standards, such as ISO, GMP and HACCP.

Criteria 2: Good agricultural practices – Identification of good practices in contract farming, and in understanding the safe handling of raw materials.

Criteria 3: Environmental declaration – Identification of good practices in energy and environmental management, including resource management, production management and waste treatment.

Criteria 4: Social responsibility – Identification of good practices in community involvement, such as corporate social responsibility activities in nearby villages.

After the six factories volunteered to become involved in the certifying process, the procedure of evaluation by eco-standardization was followed, as shown in Figure 4.

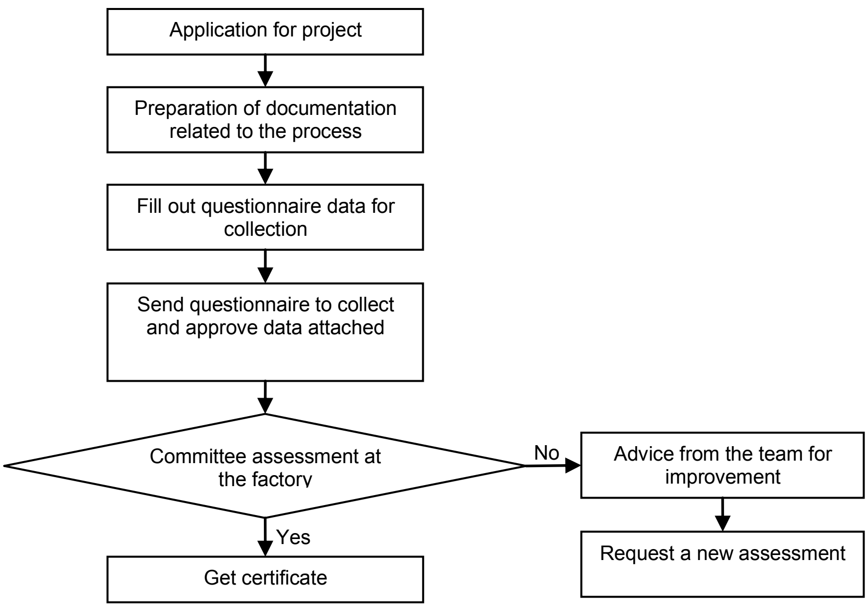

Figure 4 The certification process of eco-standardization in the frozen vegetable and fruit industry.

Evaluation Criteria and Score

Participating factories were divided into two types:

(1) Frozen vegetable and fruit factories (with production stage)

(2) Frozen vegetable and fruit storage facilities (without production stage)

The auditors examined all of the evidence according to the four criteria, and also performed evaluations using the inventory data from each plant. The total score was set at 100%, and the score for each criterion was an average of the auditors' decisions. Weighted scores are shown in Table 2.

Table 2 Weighted scores by criteria

Decision criteria	**Factory Type 1 (Points)**	**Factory Type 2 (Points)**
1. Good policy notification	20	30
2. Good agricultural practices	20	N/A
3. Environmental declaration	50	60
4. Social responsibility	10	10
Total	100	100

Evaluation Levels

The finalized total scores evaluated the success of production management from an environmental point of view, and were divided into four percentage levels:

Less than	60%	Needs improvement
	60 – 69%	Fair
	70 – 79%	Good
More than	80%	Excellent

Results and discussion

A Case Study of the Production Process in a Frozen Green Bean Factory

An environmental impact assessment of the life cycle from cradle-to-gate was performed with LCA software SimaPro7.1 using the "environmental design of industrial products" (EDIP) method. The environmental impacts are divided into 11 categories, as shown in Figure 5.

The primary environmental impacts of the production process result from water consumption and waste water, refrigeration fluid, fuel oil usage, electric power consumption, and material usage such as packaging materials. The magnitude of impact depends on the type of packaging material, storage duration, boiler efficiency, number of machines, and waste treatment technology.

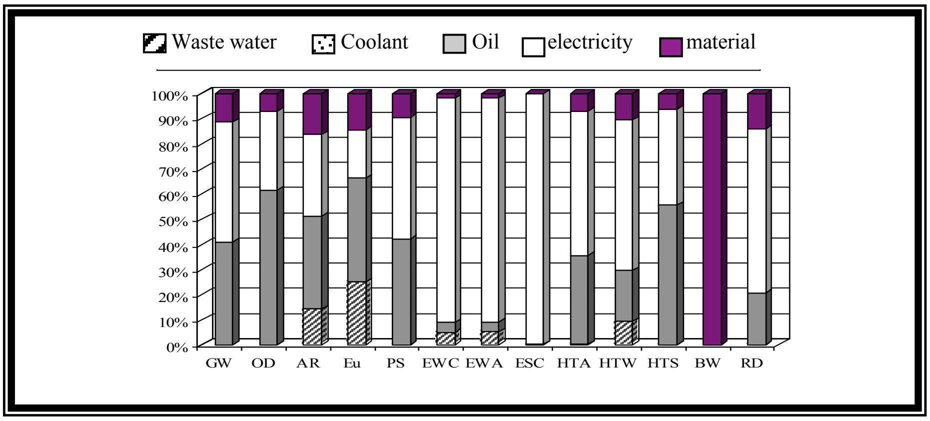

Figure 5 Environmental impact of production processes in the factory.

Once the environmental impacts have been clearly established – which processes lead to the most severe effects – the next step is to understand how to deal with those kinds of environmental problems and achieve conclusive results. LCA results clearly show that the adverse impacts which usually occur in the manufacturing process are due to lack of proper energy and environmental management. Therefore, in order to solve or prevent these problems, Clean Technology (CT) is introduced to control and improve inadequate management.

CT is normally used to change production processes to become more effective, generating greater economic value with minimal waste and little or no pollution. Thus it reduces pollution at its source. CT also includes the re-use or recycling of raw materials. This will help preserve the environment and simultaneously reduce production costs.

Based on the LCA evaluations of each participating plant, the CT and energy management suggestions are shown in Table 3. Each topic had significance values which participants could decide to improve. After that, the factories were assessed, rechecked, and scored for successful measures by the audit team. Factories with scores lower than the standard level were informed by the team that improvement was needed, and that they must request a new assessment. Factories with a score level higher than standard set received a certificate from the committee. The results are shown in Table 4.

Table 3 CT and energy management suggestions

Energy Management	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F
Low-watt-loss ballasts	5	3	1	2	4	5
Compact fluorescent lighting	4	2	1	2	4	5
Cleaning the hot tube of boiler	NC	NC	NC	5	5	5
Adjust air/fuel ratio	NC	NC	NC	5	5	5
Removal of $CaCO_3$ in boiler	NC	NC	NC	5	5	5
Waste heat recovery	NC	NC	NC	5	3	4
Alternative fuel selection	NC	NC	NC	1	1	1
Variable speed drive of motors	3	2	3	1	3	NC
Conveyor support	4	4	5	NC	NC	NC
Cooling pad Installation	5	5	5	5	NC	NC
Reuse of condensate	NC	NC	NC	5	NC	2
Replacement of old plastic curtains	1	1	1	1	1	1
Sunshield protection of the cool room	2	NC	NC	NC	NC	NC
Cleaning the evaporation system	1	1	1	1	1	1
Reducing the temperature of raw material before the cooling process	1	5	5	5	5	5
Improving story and shelf arrangement (without obstructing the fan coil)	1	5	5	5	5	5
Better peak load management (relaying when to start the machines)	2	2	5	5	5	5
Replacing refrigerants with ozone-safe substances	3	3	3	3	NC	NC

Note: 1 – 5 = Significant values (bad to good)

NC = Not considered

Table 4 Auditors' assessments of frozen vegetable and fruit factories using the eco-standardization evaluation method

Participating factories	Score (%)	Level
1. Plant A	46.74	Poor
2. Plant B	71.24	Good
3. Plant C	71.06	Good
4. Plant D	70.25	Good
5. Plant E	90.19	Excellent
6. Plant F	89.50	Excellent

Conclusions

Based on the principles of LCA, a framework of ideas was generated for environmentally friendly production criteria in the frozen vegetable and fruit industries. Positive results – i.e. the development of environmentally conscious production methods – were demonstrated at each factory that agreed to participate in the study. Eco-standardization is one of many strategic "green" policies that Thailand is using to stimulate industries to improve their methods of production to be more environmentally friendly, thus contributing to good corporate social responsibility and leading to sustainable economic development for the future society.

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