A Prototype of Small Tractor with Multi-purposes for Livestock Farms

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Abstract

This research aims 1) to invent a small tractor with multi-purposes used in the livestock farm, 2) to test and evaluate the capacity of a small tractor with multi-purposes in the area of 8 meter-width by 3 meter-length, and 3) to analyze the benefits of the small tractor with multi-purposes usage by using breakeven analysis and payback period analysis. This research started with the study of livestock farms in the central region of Thailand; the central beef market in Kamphaeng Sean, Nakhon Pathom. It was found that they were in a high degree of labor-intensive status. Hence, looking for suitable technological tools for them is a must. The small tractor with multi-purposes is created and used in the livestock farm. The results of the test revealed that it is useful for livestock farmers. The small tractor works faster and more efficiently than two workers, so it helps save their costs. Therefore, the small tractor with multi-purposes can be a prototype for use in other farms and develop the production with lower costs.

Keywords**:** *Small Tractor, Livestock Farm, Prototype*

1. Introduction

Agriculture in Thailand is both food crops and non-food crops, including livestock. Thailand's food has been exported on average trading volume of one trillion baht annually and is a leading food exporter, such as rice, chicken, sugar, processed tuna, tapioca flour, and shrimp. Thailand's food exports accounted for 2.5% of the world food trade in 2019. Furthermore, there are many kinds of livestock in Thailand that have been raised for food, fiber, and labor (Department of Livestock, 2019). Raising livestock has been growing up, simultaneously. According to the Ministry of Agriculture and Cooperatives, Thailand is the major producer and exporter of beef products in Japan. Beef has been produced from three major provinces in the central region, are Kanchanaburi, Ratchaburi, and Phetchaburi, respectively (Office of Agriculture Economics, 2019).

Ratchaburi was one of the beginning points of the Royal project for dairy farms in Thailand since 1969 (B.E.2512). Since then, the dairy farms and livestock farms in Ratchaburi have been successively expanded and are close to the central beef market in Kamphaeng Sean, Nakhon Pathom. In Ratchaburi, the number of cattle was 128,482 cows in 2019. However, the management costs overall could not be controlled because of the labor-intensive basis (Boonprong, 2015). Most cattle farms have still managed by using a large number of workers in every single process. The labor costs in Thailand go up year by year. Additionally, the efficiency and productivity of the labor are lower than machines. Therefore, the cattle farmers get into trouble when the price of beef declines.

Advances in technology and worker productivity have moved some industries away from labor-intensive status. Capital intensive by using some technologies is an alternative for livestock farmers to reduce the costs and increase their productivity (Thunwasorn, 2015). This study aims to look for the solution and change their processes with capital-intensive usage. Small tractor with multi-purposes using in the livestock farms is a solution for livestock farmers. Normally, the small tractor can be used for major farm operations; such as plowing, harrowing, sowing, harvesting, digging, and transporting works. Furthermore, it can be used for other purposes by changing and adding some components, therefore it can be used more efficiently, and more economically. Hence, a prototype of the small tractor with multi-purposes would be invented and tested by using in the stable and to replace the labor. Since it is concerned with cost management, the breakeven

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point and payback period have to be calculated and compared between labor-intensive costs and capital-intensive costs whether it is worth for livestock farmers' investment.

2. Objectives

The objectives of the study were

1) To invent a small tractor with multi-purposes used in the livestock farm

2) To test and evaluate the capacity of the small tractor with multi-purposes in the area of 8 meter-width by 3 meter-length

3) To analyze the benefits of the small tractor with multi-purposes usage by using breakeven analysis and payback period analysis

3. Materials and Methods

This research used materials and methods as follows:

3.1 Theories

3.1.1 Livestock Farms

Livestock or beef cattle are cattle raised for meat production; beef, that there more than 100 breeds of cattle worldwide. Thai farmers have been known to raise beef cattle for a long time ago. But beef cattle industry in Thailand has started less than 50 years (Felius, 2007). Most of the beef cattle breeds were native Thai indigenous cattle. The beef consumption in Thailand has been growing, but not as much as in other countries such as the US, Russia, Japan, and China (Department of Livestock, 2015). The beef consumption in Thailand is shown in Figure 1 below.

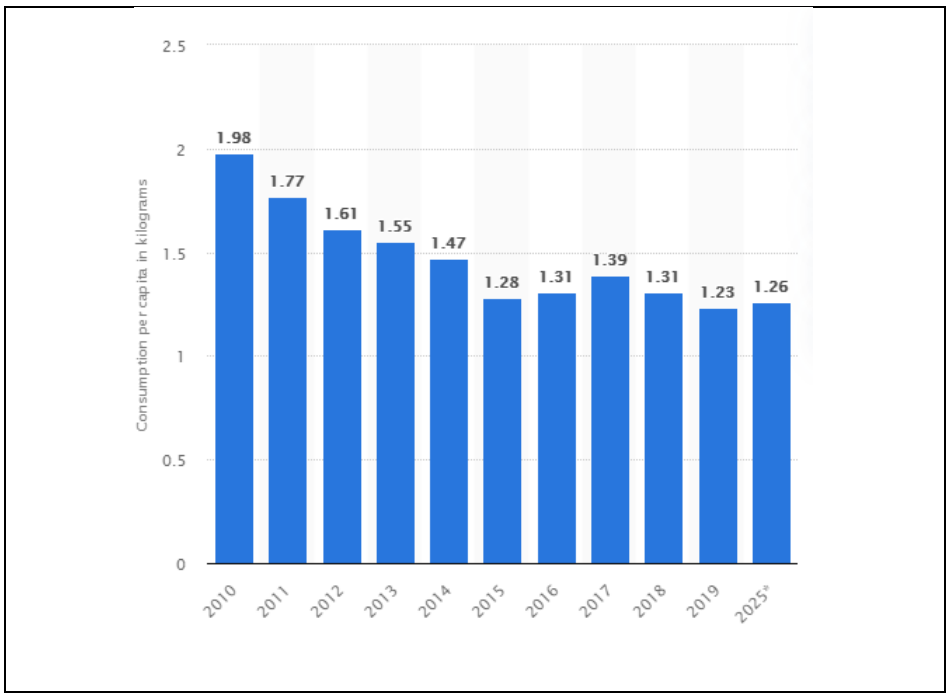

Figure 1 The statistics of per capita beef consumption in Thailand
Source: Statista Research Department

However, Beef is one of the most popular kinds of meat, and the market value is expected to rise year by year. Therefore, the Ministry of Agriculture has promoted the campaign for raising beef cattle, especially in the central and northeastern regions of Thailand.

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3.1.2 A Four-Stroke Engine

One of the objectives of this research is to invent a small tractor with multi-purposes. The authors studied the system of a four-stroke engine for our small tractor. It is suitable for use in livestock farms because of its advantages such as fuel economy, high torque, clean emissions, and durability. A 4-stroke engine is a very common variation of an internal combustion engine (Tim Esterdahl, 2019). Most modern internal combustion-powered vehicles are 4strokes, powered by either gasoline or diesel fuel. There are four strokes; intake stroke, compression stroke, power stroke, and exhaust stroke as shown in Figure 2 (Universal Technical Institute, 2020).

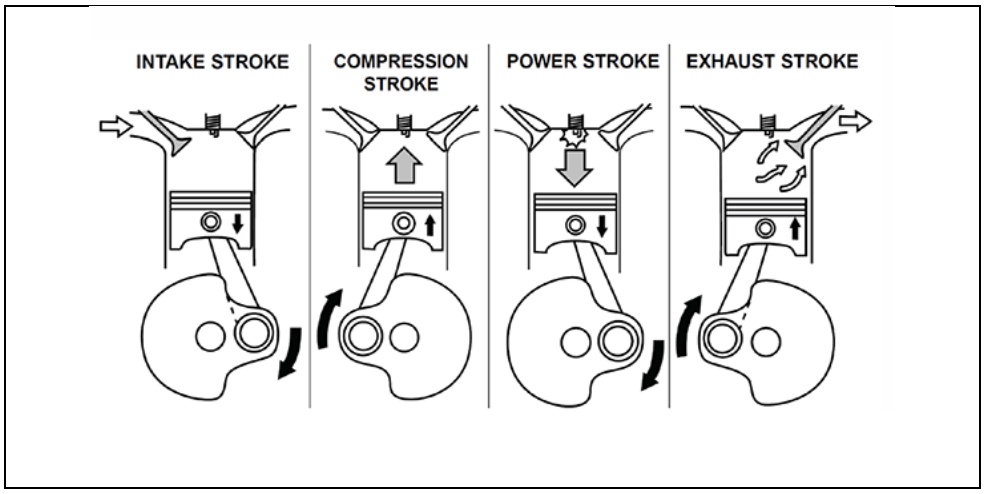

Figure 2 A visual of four-stroke engine work
Source: Universal Technical Institute (UTI)

So, a prototype of a small tractor with multi-purposes using in Thai livestock farms is set up with a four-stroke engine.

3.1.3 Labour-Intensive and Capital-Intensive Basis

There are four basic factors of production (economics), namely, land, labor, capital, and entrepreneurship. Producers who want to reduce their costs of production have to understand two terms used in this research, labor-intensive and capital-intensive, and concerned with engineering economics and costs analysis. Since one of the major elements in the capital factor is the usage of technological instruments for production. Labour intensive refers to a process that requires a large amount of labor to produce its goods and services. It requires large quantities of physical effort to compete for necessary tasks, therefore, productivity is not stable and low compared with capital-intensive industries. A prime example of a labor-intensive industry is the agricultural industry, and examples of capital-intensive industries include automobile manufacturing, oil production, and refining, steel production, telecommunications, and transportation sectors. That means advances in technology will move the industry from labor-intensive status (Frankenfield, Jake, 2020). The beef cattle farms work on a labor-intensive basis, hence, the costs of production in the farms are quite high as well. The use of more technology is the less of production costs.

3.2 Methodology

This research invents a prototype of the small tractor with multi-purposes for livestock farms to help the farmers to reduce their production costs from higher labor costs. There are 5 steps of this research as follows:

3.2.1 To study the information of livestock farms; states of problems and types of works

3.2.2 To make the appropriate methods for livestock farms in central regions of Thailand; Ratchaburi, Nakhon Pathom, and Kanchanaburi

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3.2.3 To design a small tractor with multi-purposes for livestock farms as shown in Figure 3

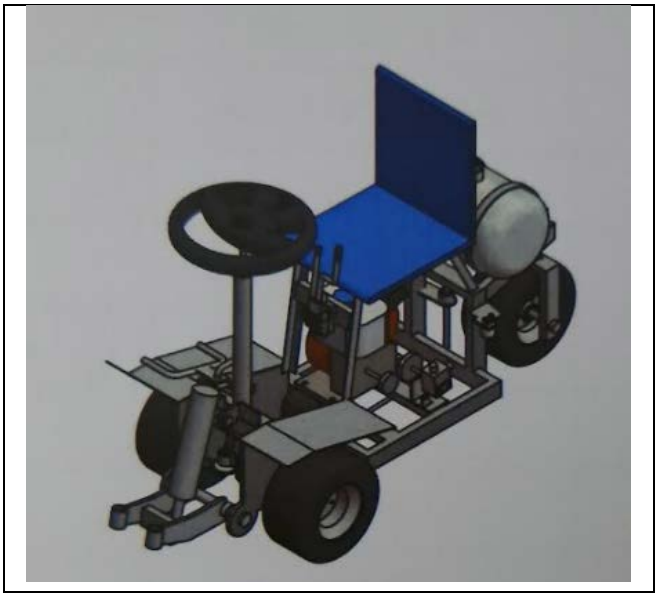

Figure 3 A Small Tractor Design

3.2.4 To plan for the details of the expenditures for creating small-tractor with farm conditions
3.2.5 To create a prototype of a small tractor with multi-purposes

4. Results and Discussion

The results of A Prototype of Small Tractor with Multi-purposes for Livestock Farms revealed as follows;

4.1 A prototype of a small tractor with multi-purposes

A prototype of a small tractor is created in a small size of 60 centimeters wide and 100 centimeters long with a 7-horsepower engine and a fixed inclined blade, as shown in Figure 4. The total cost of a prototype was 44,103 Baht.

Figure 4 A prototype of a small tractor

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4.2 Test of a prototype of a small tractor

After setting the system of the prototype of a small tractor, it was tested at the central beef market in Kamphaeng Sean, Nakhon Pathom. The size of a cement stable is 3x8 meters, and there are 40 stables. The results of the test are shown in Table 1.

Table 1 The result of a prototype of a small tractor test

Stable No	Time Used (min.)
A9	60.03
A2	8.26
A1	25.30
A1	18.38
A18	30.46
B21	35.58
Average time used	30.45

The results show that the duration of work depends on the thickness of cow wastes and the expertise of the worker who controls the small tractor. The average time was 30.45 minutes a stable.

4.3 An analysis of the benefits of the small tractor with multi-purposes usage by using breakeven analysis and payback period analysis

The small tractor can work 30.45 minutes per stable on average, therefore, it can work for 15 stables a day (8 hours). Before there were 2 workers in the central beef market in Kamphaeng Sean who spent 8 hours for one stable, meaning that the tractor works 15 times human work. If this farm uses a small tractor, 40 stables can be cleaned within 3 days, instead of 40 days by the workers. Moreover, only one worker is needed for driving the tractor.

It roughly saves 300 Baht a day of labor cost in case of using a small tractor. Therefore, the payback period of a small tractor cost is about 14 days, calculated by saving labor cost basis.

5. Conclusion

The labor-intensive industry as the livestock farms has wasted the budget for employing a lot of workers with fewer outcomes, while other industries with a high operating based on advanced technology can save their costs of production. Adding some capital-intensive thoughts in the production is the beginning for saving costs, then selecting the appropriate technological tools is the following step. When the higher proportion of technology is used, the more capital-intensive the business can gain. The livestock farmers in Thailand have to integrate more technological instruments in their farms to gain more benefits and work efficiencies.

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