

# **How to Reduce Manufacturing and Management Costs of Tractors and Agricultural Equipment**

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## **I. Introduction**

The free trade and marketing across borders of food and agricultural products have reduced their prices, and have consequently been pushing down the prices of agricultural machinery. Utilizing the worldwide industrial infrastructure, the manufacturing industry, including agricultural machinery manufacturers, has expanded the worldwide sourcing of materials and components and complied with such cost reduction.

In highly industrialized societies, essential requirements for agricultural machinery are becoming more diversified. The requirements in the past were mainly to release humans from heavy physical labor, but are nowadays to make the machinery work quickly, efficiently, precisely and easily. In addition, the requirements involve increasingly taking responsibilities for keeping operators comfortable and safe, for making more environmentally friendly products featuring lower emission noise and gases, and importantly for keeping food safe and reliable.

Agricultural machinery manufacturers need to cope with two different market demands for the specifications and features; one is characterized by need for high-grade products that have cost-effective performance, the other is characterized by the need for simple specification products featuring mainly low price.

In such present conditions, in order to meet the demands of high-grade products featuring high performance, high durability and low price, manufacturers need to strive, not only to reduce manufacturing costs but also to reduce developing and marketing costs.

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Through the Club of Bologna we were invited to provide our comments about "How to reduce manufacturing and management costs of tractors and agricultural equipment". Following the invitation, we intend to explain firstly the agriculture and agricultural machinery being prevailed in Japan, and secondly our recent approach which may be along with the subject of this session.

## **II. How agricultural mechanization contributed to Japanese agriculture**

### **1. Scale of Japanese agriculture**

Historically, Japanese main agricultural products have been paddy rice as a staple food, but supplemented by vegetable and stock farming. Stock farming has been developed by introducing management and mechanization techniques from Europe and North America. The mechanization of vegetable farming excluding cultivation and pest control is far behind the international level, although some governmental support has been provided in these fields.

In recent years, rice consumption has decreased as a result of the diversification in dietary habits, which has led to a continual decrease in the price of rice. Consequently, the importance of machinery related to paddy rice has reduced, resulting in a change in the structure of agricultural as shown below.

(Figure 1-1. Transition of gross agricultural output and rice, vegetables, and stock farming production)

(Figure 1-2. Transition of delivery of agricultural machinery)

### **2. Rice farming mechanization**

The working hours per hectare in rice farming have decreased to 1/5, from 1739 hours in 1960 to 330 hours in 2000. It is the modernization of the agricultural machinery from human work to machine work, from a walk-behind to a riding type, from a small horsepower to a large horsepower machine. The typical machines are tractors, head feeding type combine harvesters and rice transplanters.

(Figure 2. Transition of the number of agricultural machinery and working hours per hectare)

It is proven that agricultural mechanization has contributed to reduction of working hours at each stage of rice farming. At the same time, fertilizer and pesticides technologies have developed manufacturing in the agricultural machinery. Those technologies have also contributed to reduction of working hours greatly. Thus, the mechanization consistency system of the Japanese rice farming has been established.

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(Table 1. Comparison of working hours in rice farming)

### **3. Costs of agricultural machinery and its implements**

Until around 1990 the proportion of the costs of agricultural machinery and implements in the total expense required for rice production had increased. After 1990 this upward trend disappeared.

(Figure 3. Transition of agricultural machinery and implements cost in the total rice production expense. Large decrease from 1995 is caused by the change of calculation method.)

Since 1990 farmers' motivation to invest in agricultural machinery and implements have declined. The possible reasons include;

(1) Saturated diffusion of agricultural machinery. Demand for mainly replacement equipment may be expected,

(2) Decline of rice price. The Japanese Government politically controls the rice price to prevent its erratic fluctuation,

(Figure 4. Transition of the price of rice purchased by Japanese Government)

(3) The promoted reduction of planted acreages for rice production by governmental guidance. The Japanese Government politically controls planted acreages to prevent excessive production of rice,

(Figure 5. Transition of paddy field of planted and reduced acreages)

(4) Decrease in the number of farm households,

(Figure 6. Transition of the number of farm households)

(5) Increase in commissioned acreages of agricultural work.

(Figure 7. Transition of the rate of commissioned acreage for rice planting work)

Furthermore, the service life of a tractor has increased to 19 years from 14 years in the last decade.

(Figure 8 Transition of the mean service life of agricultural machinery)

## **III. Reduction of manufacturing and management costs of tractors and agricultural equipment**

### **1. Reduction of manufacturing cost of tractors**

Shown below are some of our cost reduction activities, which involve three phases:

- Reduction of purchased materials cost,

(Optimal location of production base by considering distribution cost)

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- Reduction of cost by modular design and commonality of units,
- Cost reduction related to the entire corporate activity by utilizing CAE and IT.

### **1-1. Reduction of purchased materials cost**

(1) Reduction of cost by diversification of material procurement:

- Diversification and globalization of suppliers,
- Diversification of procurement systems;
  - Consolidated purchase by group headquarters,
  - Conversion from individual parts purchase to clustered purchase.
 (Figure 9. Promotion of clustered purchase)
- Distribution cost reduction by concentrated collection and delivery,
- Cost reduction of packing (container simultaneous purchase).

(2) Reduction of purchasing cost by concurrent engineering with cooperative manufacturers:

- Pursuit of the best structure and the lowest cost,
- Procurement of tractor implements in the market.

(3) Optimal location of production base by considering distribution cost

- To produce key components such as engines in the main base, and to assemble them into final product in the appropriate market or region.

We, Yanmar, manufacture Japanese style head feeding type combine harvesters in China and walk behind tractors in Indonesia, together with engine facilities. A joint venture company for tractors, equipped with a horizontal water-cooled engine, was started up in China.

(See Figure 10. Optimization of production, procurement and distribution)

### **1-2. Reduction of cost by modular design and common unit**

Compared with our competitor's tractors, our products are characterized as follows:

- Similarity in the number of basic models available,
- Too many factory options,
- A few derivative export models from domestic models,
- High manufacturing cost that may result from production of too many varieties in small number.

However, by modular design, we can satisfy a lot of demand from the market, and at the same time we can reduce the cost by using common components and clustered parts.

Our goal is "Reduction of the total investment and the manufacturing cost by using common

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parts for both domestic and export models." The number of major components such as mechanical front wheel drive units, transmissions, and cabs will be reduced to 2/3, and the number of factory installed options will be kept by the combination of units. Consequentially we can reduce the total manufacturing cost.

### **1-3. Cost reduction related to whole corporate activity utilizing CAE and IT**

Examination using virtual prototypes is useful for conceptual design, actual drawing, testing and manufacturing. It enables;

- (1) Shortened development period and minimized unnecessary retries,
- (2) Examination on figure of stamping die and machining fixture,
- (3) Examination of assembly process,
- (4) Arrangement of sales documents (catalog, operator's manual, part table, and workshop manual, etc.) from 3D data which will improve the operational accuracy, reduce manpower and consequently reduce cost.

## **2. Cost reduction of development and manufacturing of combine harvester by national project**

The above mentioned is the activity that each company may execute respectively.

In Japan, "Urgent Development of Agricultural Machinery project" has been initiated by the government, the feature was reported here several years ago by Mr. Yotsumoto of Kubota. We would like to introduce a unique machine which was developed and manufactured with less manpower and less cost.

### **2-1. Organizations of the project**

(Figure 11. Urgent development of Agricultural Machinery project)

- (1) Bio-oriented Technology Research Advancement Institute (BRAIN)

Purpose of the project:

- Development of machinery for limited markets where private companies could not develop by themselves,
- Development of machinery which contributes to the establishment of consistent mechanized systems for uses such as vegetables and orchards farming,
- Development of machinery which contributes to environmental burden reduction such as PF.

- (2) New Agricultural Mechanization Enhancement Co., Ltd. (NAME):

- Temporary load investment for molds to support small amount production,
- Promotion of common usage of the parts and components and promotion of OEM supplies of machinery,

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(3) Accomplishment of research and development of the project shown above are 34 efficient agricultural machines by 2002.

## **2-2. Development and commercialization of large-scaled combine harvester**

(Figure 12. Structure of YANMAR combine harvester)

There are various restrictions in Japan, such as road conditions, field conditions, cultivation kinds, etc., which means that combine harvesters made in Europe or USA are not suitable for the harvesting of the rice plant, the staple food of Japan. On the other hand, head feeding type combine harvesters developed in Japan have superior accuracy in harvesting the rice plant and wheat. However, their structures are complicated, and it is difficult to widen cutting width and improve durability.

Yanmar's desire was to develop a combine harvester with excellent operational accuracy for Japanese rice, which is also applicable for other plants such as wheat, soybean, rapeseed and so on, to reduce the cost of farm management. Yanmar succeeded in commercializing a medium sized multipurpose combine harvester in 1986 under the technical guidance of BRAIN.

After the diffusion of the combine harvester, there was demand for development of larger-scaled types. We, at Yanmar, could not afford to invest in the development and the manufacture of such additional types. The development became possible to be nominated for this project. Moreover, temporary burden of the investment borne by NAME reduced the burden on the manufacturer in the commercialization process.

(Figure 13. Supply of machines and components)

Consequentially, Yanmar bore the redemption of the development cost and the production preparation expense, supplying the whole products or major components to other companies. On the other hand, other companies could consequently save development manpower and facilities.

The benefits farmers received from the development of the "Multi purpose combine harvester" are as follows. As mentioned above, the reduced planted acreages for rice production is almost 40% on average. In the northern part of Japan, where this type of combine harvester is very popular, it is 50%. They have to grow other crops such as wheat, soybean, buckwheat and etc., together with rice. Previously they harvested rice by using the head feeding combine harvester and other crops by using the reaping machines and threshers with heavy physical labor, or alternatively by harvesting all crops by using imported combine harvesters accepting considerable grain loss of rice.

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However, they now have a way to harvest all crops by using just one combine harvester. Their initial cost to buy it is almost the same as that in the other two cases above, without any assistance from the government. If they could receive governmental assistance, the cost would be half.

In addition, they frequently harvest others' crops as a contractor, thanks to the combine harvester's durability and the applicability to the crops. Consequently they can amortize the machine cost quickly. The working hours are assumed to be more than twice as much as that of the head feeding combine harvester, with almost the same maintenance cost.

#### **IV. Summary**

Japanese manufacturers have made great efforts in the subject area, as well as manufacturers in other countries, as follows:

- (1) Reduction of development cost, production preparation expense and manufacturing cost has been achieved by means of modular design.
- (2) Reduction of material cost is achieved by diversification of procurement method.
- (3) 3D-CAD systems have been utilized for shortening the development period and the reducing cost through concurrent activity in the related sections of development, production, sales, and service.
- (4) In Japan, manufacturers can share products and components, which one or a few manufacturers are involved in development and production, under the Urgent Development of Agricultural Machinery project. NAME's investment contributes to the reduction of the total cost of the products.

Moreover, Japanese manufacturers are developing unique products by themselves. A large number of products are shared on an OEM basis.