Proceedings of the International Conference for Agricultural Machinery & Process Engineering
October 19-22, 1993, Seoul, Korea

INTERNATIONAL CONFERENCE FOR AGRICULTURAL MACHINERY AND PROCESS ENGINEERING

(October 19 - 22, 1993)

at

Korea Exhibition Center (KOEX)
Seoul, Korea

THE DEVELOPMENT OF WALKING TRACTORS FOR ASIAN AGRICULTURE

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ABSTRACT

This paper describes the research and development of Walking Tractors and Tillage Implements for Phase I (1991 - 1992). The project consists of: (1) the study and need for the development of the walking tractors for Thailand and other Southeast Asian countries; (2) the comparison in the use of the walking tractors and their transmission systems that are made in Thailand and abroad; and (3) the design of future walking tractors for Asian farmers in developing countries. The design of the walking tractors is concentrated to provide the ease to farmers, especially the elderly and female which will play an important role in the future agriculture of Thailand due to the lack of manpower. In addition, the design of the walking tractors is also aiming for small-scale farmers, the majority that have limited land and capital.

The walking tractors consist of several components but the most important one is the "Transmission System". Thus, the research is concentrated in the development and design of a new transmission system. The new machine, currently developed, is named after the Chulalongkorn University as "Chula Walking Tractor", model SPJS - 60. The tractor uses a 6 - 7 horsepower diesel engine with three forward gears and one reverse gear. The tractor also uses the latest

gearing technology so called planetary gearing system with steering clutches system that never been used in any earlier model. The advantages of the planetary gearing system are: (1) the final drive gear can be small, and can be designed to provide higher strength with less wearing resistance, (2) the system eliminates a shaft which is used in other systems, thus reduces the weight and the manufacturing cost. Furthermore, the Chula Walking Tractor has an additional power take-off shaft that can be used or linked with other standard agricultural implements.

Key Word : Transmission System, Planetary Gearing System, Steering Clutches

INTRODUCTION

Thailand has a long history in the development of walking-type tractors for paddy cultivation. The first walking tractor was developed in 1961 by Mr. Dheparit Devakul at the Division of Agricultural Engineering in Bangkaen. The tractor has major features of large and tall structure with long handles and one forward gear with no reverse gear. The iron cage wheels are quite large with diameter of more than 800 mm. The transmission system inside the gear box consists of sprocket and chain and is powered by a 12-14 horsepower diesel engine. Two types of widely used implements that are attached to the tractor are the moldboard plow and the rake. In that time, the walking tractors were mostly built by local repair shops that normally repair motorcycles and rebuild parts for both the domestic and imported walking tractors.

Land and agricultural locations also affect the design of walking tractors. The land level in the central part of Thailand is low with soft soil. This means the hard pan level is deep and larger diameter cage wheels are thus required. In the other parts of the country, smaller diameter cage wheels may be used because the hard pan level is shallow.

In later years, the shortage of agricultural labors and the cost of the traditional farming procedure that uses animals has increased and causes wide-spread using of walking tractors. The local repair shops have increased their productivity. At the same time, the use of other agricultural machines such as water pumps, threshers, farm trucks, etc., has become popular. Currently, there are approximately 20 manufacturers that produce three different types of the walking tractors depending on the classes of tramsmission

system with a total production of at least 80,000 units annually. The latest model of walking tractor has a transmission system that consists of two forward gears and one reverse gear, and steering clutches that help guiding the tractor. Those local manufacturers are attempting to develop and improve their products according to the need of farmers. Up to date, the improvement of these walking tractors had been unsuccessful because the lack of research and development. Most of the tractors sold in Thailand were manufactured by duplicating from those originated in the foreign countries. To cut down the manufacturing cost, some manufacturers have ordered transmission parts from abroad and assembled them for selling in Thailand. Currently, the country can not manufacture the tractor parts that have high quality. This is due to the lack of the "know-how" technology. The need for research and development of the walking tractor in this country is thus important and essential.

NEEDS FOR IMPROVEMENT OF LOCAL WALKING TRACTORS

The walking tractor is considered as the most important agricultural machine because it can replace animal and reduce manpower at the initial stage of industrial promotion. The need of walking tractors increases every year. It is reported that the number of walking tractor on farm-used was 323,846 units in 1982 and this figure became higher than 800,000 units in 1991 as shown in Table 1.

Table 1. Number of walking tractors on farm-used in Thailand
(Source : Agricultural Economic Research Division)

Year	Units
1982	323,846
1983	364,948
1984	408,827
1985	402,082
1986	450,033
1987	515,075
1988	582,753
1989	660,685
1990	750,542
1991	854,279

More than 90 percent of machines were produced by local manufacturers. This is because the price of local walking tractor is cheaper than exported one. Moreover, its structure is more simple and thus easy for the maintenance. However, farmers are still facing with many problems in using these locally - made walking tractors.

Some of these problems are listed as follows;

1. The structure of the machine is too big due to long handles which is inconvenience during operation.
2. Heavy force is required to turn the machine at the headland.
3. The machine has only two forward gears and one reverse gear. Therefore, the speed of walking tractor is not suitable for some implements and operations.
4. The distance between wheels can not be adjusted to suit the implement width and the row distance. This will cause difficulty in operation and reduce quality of work.
5. Farmers need to have walking tractors with power take - off shafts in order to install rotary, mower and other implements.

The above requirements force the manufacturers to develop and improve local walking tractors that have higher quality and can be operated easily.

DEVELOPMENT OF CHULA WALKING TRACTORS

The Chula Walking Tractor represents the first accomplishment of the international cooperation between Thailand and Japan for development walking tractors suitable for using in the Southeast Asia region. The Thai representative is the Chulalongkorn University. The Japan representative is Kyushu University which is led by Professor Jun Sakai and the ISEKI & CO., LTD.

This research and development project has considered the following factors:

1. The project is to help the Thai farmers from the shortage of the farming labor. Currently, the labor force has been moved from the agricultural sector to the rapid growing industrial sector.
2. The project is to help the Thai industry for creating human resources and manufacturing

higher quality of agricultural machines.

3. The project is to help promoting the use of agricultural machinery within the country so that the manufacturing productivity would be increased, thus improving the country industry.
4. Smaller machines are currently suitable for Thai farmers because most of the farmers own limited land areas and capitals.
5. Small and suitable walking tractors for local multi-purpose farm works should be developed and promoted. This is because most of farmers are not able to understand farm mechanization through only the utilization of advanced and big machines.
6. The knowledge and technology from the project must be transferable to other Southeast Asia countries. This will help increasing cooperation among these countries in the future.

The new machine, currently developed, is named "Chula Walking Tractor model SPJS-60" as shown in Fig.1. The main objective of development is to overcome the problems mentioned and to improve local manufacturing technology through R & D process. The unique characteristics of the machine is the use of planetary gearing system with steering clutches system and safety devices that have never been used in any earlier model. The safety devices are installed and worked together with steering clutches as shown in Fig. 2. The safety devices can prevent accident from sudden turning of the tractor when clutches are automatically disengaged or compressed springs are immediately broken.

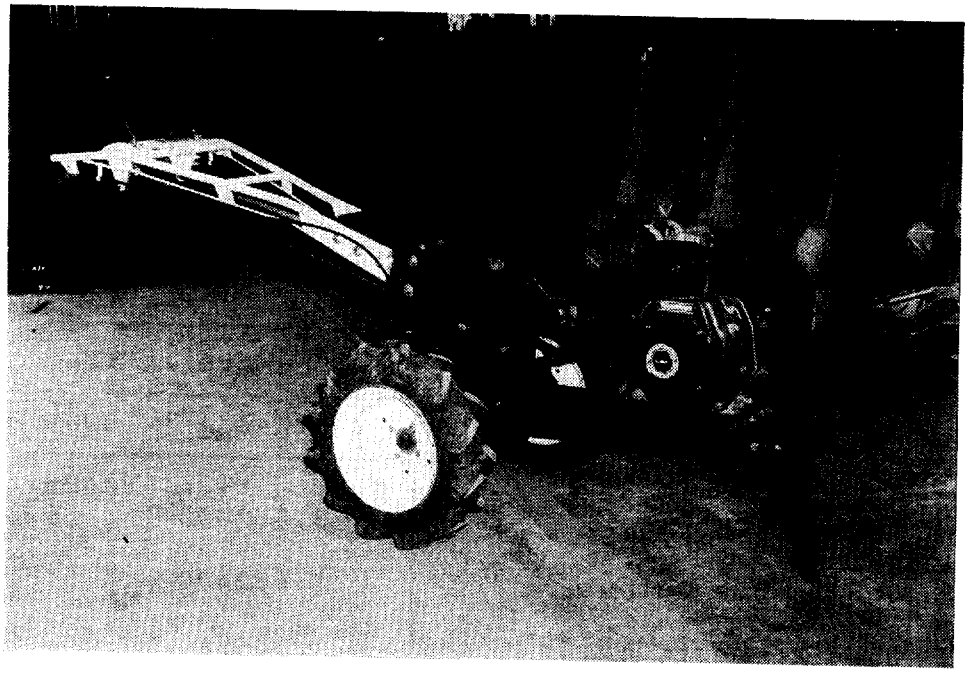

Fig. 1 Chula walking tractor, model SPJS-60

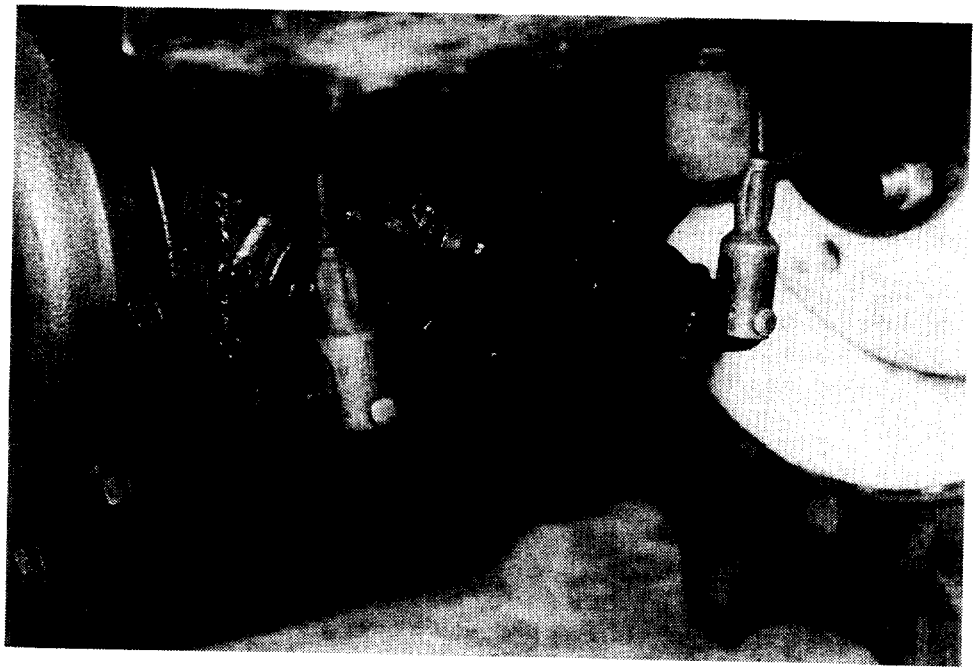

Fig. 2 Safety devices of steering clutches

TECHNICAL SPECIFICATIONS OF THE CHULA WALKING TRACTOR

The technical specifications of the most advanced locally - made walking tractor and the Chula Walking Tractor is compared in Table 2.

Table 2. Comparison of some technical specifications between locally - made and Chula walking tractors.

Items		Walking Tractor	
		V.J.K - 4	SPJS - 60
ENGINE	Model	Kubota ET95	Yanmar L60E
	Maximum Output, PS/RPM.	9.5/2400	6/3600
	Continuous Output, PS/RPM.	8.5/2400	5.5/3600
	Displacement, cc.	547	273
	Dry Weight, kg.	107	30
BODY	Length x Width x Height, cm.	296x121x120	230x95x110
	Diameter of Iron Wheel	800 mm.	700 mm.
	Dry Weight, kg. (Without Engine)	247	152
	Number of Forward Gear	2	3
	Number of Reverse Gear	1	1
	Revolution of PTO.Shaft	-	1440 RPM.

At present, the second prototype of Chula Walking Tractor has been developed and tested for performance and durability. At beginning of the next year, it is expected that the machines will be offered to the market.

CONCLUSIONS

The international cooperation in the research and development project described in this paper has been conducted during the past two years. Eventhough the time period is short, the project has almost been completed. This is due to the charitable and constant assistance from Japanese experts. The outcome of this project is the design and development of walking tractors that have higher efficiency and can be

operated easily compared to the existing ones. Furthermore, the participating Thai researchers and engineers from manufacturers have received the "know-how" technology by performing actual practice through R & D process.

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