

DEVELOPMENT AND USE OF THE AXIAL FLOW
LOWLIFT PUMP IN THAILAND

BY

Winit Chinsuwan
Department of Agricultural Engineering
Faculty of Engineering
Khon Kaen University
Khon Kaen 40002, Thailand

and

Billy J. Cochran, Director
Thai-IRRI Small Farm Mechanization Project
P.O. Box 9-159
Bangkok 10900, Thailand

DEVELOPMENT AND USE OF THE AXIAL FLOW
LOWLIFT PUMP IN THAILAND

Winit Chinsuwan* and Billy J. Cochran**

ABSTRACT

The axial flow pump was locally designed in Thailand to suit local conditions. It is now the most widely used small farm machine in Thailand and has become essential equipment for Thai agriculture. This paper describes the origin, modification, adaptation, production, and use of the axial flow pump in Thailand.

* Associate Professor, Department of Agricultural Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen, Thailand.

** Director, Thai-IRRI Small Farm Mechanization Project, P.O.Box 9-159, Bangkok 10900, Thailand.

INTRODUCTION

The axial flow pump is the most widely used small farm machine in Thailand. It was designed to suit local requirements of low lift with high capacity. The initial design in 1941 was made from wood. The original design was not commercially available until 1957 when steel pipe and shaft materials were used and modification of the impeller was made. Since 1957 the pump rapidly replaced the traditional wooden trough water lift system. Using the original basic concept that met the requirements of small farmers, modifications and adaptation to use the 2-wheel tractor as a power source were mainly done by the private sector. It is estimated that over 600,000 units of the axial flow pump were used in Thailand during 1983.

The axial flow pump has contributed a lot to Thai agriculture as well as the small farm machinery industry. The pump makes single cropping possible in some areas and double cropping possible in other areas. Continuous cropping of paddy in the central plain is also a result of the pump. An economic contribution of the pump to the industry is approximately 3 million dollars a year.

ORIGIN OF THE AXIAL FLOW DESIGN

The wooden trough water lift had been the primary water-lifting device in Thailand for a long time. The first axial flow pump was designed in 1941 by the late M.R. Debriddhi Tavakul, the founder of the Agricultural Engineering Division (Tavakul, 1941). His objective was to design a simple, low-price, and efficient low lift pump so the small manufacturers and farmers could fabricate by themselves. For the initial design (Figure 1), most of the components were made from wood. The square pipe was made of 2.5 cm x 35 cm and 2.5 cm x 31 cm lumber. Triangular wedges were placed along the four inside corners of the pipe. The impellers, shaft, and drive pulley were also made from wood. Nine impellers, spaced 23 cm apart, were used for the 2.13 m long pipe. The pump was first demonstrated to the public in 1941. Its capacity was greater than that of the wooden trough water lift. However, there is no detail report on the performance of the pump. With the success of the pump, it was named "Debriddhi Pump" by the Department of Agriculture and Fisheries (at that time), Ministry of Agriculture and Cooperatives. However, the initial design was not commercially available.

Modification of the initial design was done in 1955 by M.R. Debriddhi Tavakul (Tavakul, 1967). For this modification, Figure 2, the main pipe and the discharge pipe were made of sheet steel. The discharge pipe was attached to the main pipe at right angle.

The drive shaft was totally in the main pipe. Only one impeller, attached to the suction end, was used. This impeller was similar to the impeller of the deep-well turbine pump. A screener was also attached to the inlet end. Small gasoline engines (3-5 hp) were used as a power source for the 25 and 33 cm pumps. The design was available to manufacturers in 1957. The use of a small 4-wheel tractor as a power source was also introduced (Figure 3).

The capacity for 0.80 meter head with a 30 degree inclination of the 25 cm and 33 cm pumps were found to be 620 gpm (2346.7 liters per minute) at 1400 rpm impeller speed and 1500 gpm (5677.5 liters per minute) at 850 rpm impeller speed respectively. It was also found that pumping in a vertical position was possible when an electric motor was used as a power source (Noparat, 1960). The capacity of the 33 cm pump was much higher than the one of wooden trough water lift (1700 liters per minute) when operated at the same head (Sidnarane and Limptrakul, 1973).

MODIFICATION AND ADAPTATION

Since the first dissemination of the second version prototype to manufacturers in 1957, an estimate total of 80,000 units of the axial flow pump were fabricated by at least six manufacturers in Bangkok area by 1967 (Debridhi, 1967). During this ten years period, modifications and adaptations

were still being done by the original designer. The modifications were as follows:-

- The impeller was changed to be a three-blade impeller (Figure 4).
- The discharge pipe was attached to the main pipe at a 30 degree angle (Figure 5).
- The size of the pumps for commercial use was reduced to 10,13,15,18,and 20 cm.

- The pump was also modified in such a way that it could be used for propelling a boat as well as pumping water (Figure 6). For this version, two different impellers, one for pumping and the other for propelling, were provided. The discharge pipe of this version was longer than the standard version. This was to pump the water while the pump was still on the boat. However, this version was not popular.

Most of the pumps during this period were powered by small gasoline engines attached to the axial shaft. Using the 10 cm pump, a capacity of 1090 liters per minute could be obtained (Chinsuwan, et al., 1973).

The use of the axial flow pump spread very fast in the central plain during the late 1960's. The pump industry was spread out over the central plain. From then on, modifications and adaptations to use the 2-wheel tractor as a power source were done by the private sector. At the present time, the two major

areas producing the axial flow pump are Chachoengsao and Suphanburi provinces. However, modifications of the pump in these two areas are quite different.

In the Chachoengsao area, modifications are as follows:-

- 1) Straight pipe without a discharge pipe is used

(Figure 7)

- 2) The drive shaft is outside of the pipe, except at the impeller end portion.

- 3) A two-blade impeller made of cast aluminium is used.

Two types of impellers, low speed and high speed

(Figure 8), are available. The high speed impeller

is used when a gasoline engine is used as a power

source, while the low speed impeller is used when a

diesel engine is used as a power source.

These modifications make the pump easier to fabricate, easy to maintain, and requires less power to operate due to less restriction to the flow. This design is popular in the lower part of the central plain.

In the Suphanburi area, major modifications have been made on the design of a low speed impeller using a diesel engine for the power source. Figure 9 shows the present design of the low speed impeller in the Suphanburi area. This impeller has 6 blades made of mild steel. The inlet portion of the pump is also enlarged (figure 10). This design is popular in the upper part of the central plain.

The efficiency of the 18 cm pump having a 6 blade impeller was greater than the one of 13 cm and 15 cm pumps with a 2 blade impeller. For the 18 cm pump, a capacity of 4260 liters per minute could be obtained (Toonim, et al., 1985).

The latest modification was done in 1979 by Mr. Chatchawan Thammathorn, Aree-Arthorn Manufacturer with some technical assistance from the Thai-IRRI Small Farm Mechanization Project. A double-suction impeller (Figure 11) was attached to the inlet end of the pump. The drive shaft is totally outside the main pipe (Figure 12). Two standard sizes, 15 cm and 20 cm in diameter and 5 meters long with extension pipes 2.5 meters and 5 meters are available. A capacity of 4000 liters per minute and 6000 liters per minute can be obtained for the 15 cm and 20 cm pumps respectively. This pump can also be used for pumping water from a river or canals.

PRODUCTION

The production of the axial flow pump by commercial companies was started by a few manufacturers in the Bangkok area in 1957. Since then many more manufacturers in the central plain have started fabricating the pump without any technical assistance from the government sector. Unfortunately, there is no statistics on the number of pump manufacturers available. However, most of the manufacturers are in the central plain.

The total number of axial flow pumps was gradually increased from 80,000 units in 1967 to approximately 175,000 units in 1975 (Table 1 and Figure 13). With an increase of irrigated land area and the wide use of the 2-wheel tractor in the central plain, the total number of pumps was rapidly increased to approximately 600,000 units in 1983. Most of the pumps are powered by 2-wheel tractors with 8-12 hp diesel engines. In other parts of the country, where 2-wheel tractors are less used, a large number of the pumps are powered by small gasoline engines.

At the present time, the most common sizes of the pump commercially available are 13,15,18, and 20 cm pipe diameter. Typical prices not including engines are as follows:-

Length (m)	Price (US\$)*			
	13 cm dia.	15 cm dia.	18 cm dia.	20 cm dia.
3	33.33	37.04	38.89	40.74
4	38.89	48.15	50.00	51.85
5	46.30	53.70	57.41	59.26
6	55.56	59.26	62.96	66.67

* Based on the exchange rate of 1 US\$ equals 27 Baht

Note: The above prices are 1985 quotations from J. Chaidee Panich, Chachoengsao.

The price of the pump has increased by only 50 percent during the last 14 years. The price of a 13 cm diameter and 3 meters long pump was \$22.22 in 1971 and sells for \$33.33 in 1985. This is due to the simple design of the pump, high volume of sales, and competition among manufacturers.

DISCUSSION AND CONCLUSION

The axial flow pump is a good example of a local design for the local needs. In general the required pumping head for paddy in Thailand is not greater than 3 meters. The low lift but high capacity characteristics of the axial flow pump together with its low price makes it more suitable and preferable to the farmers than a more efficient centrifugal pump. This indicates that efficiency alone is not always a major indicator for the success of small farm equipment.

Since the first introduction of the axial flow design in 1957, the pump has become popular rapidly with minimum assistance from the government sector. Modifications of the design and adaptation for using the 2-wheel tractor as a power source were totally done by the private sector. The rapid replacement of the traditional wooden trough water lift by the axial flow pump was due to the followings major advantages of the pump over the water trough.

- higher capacity
- portability and ease of setting up. The axial flow pump can be carried by one or two men and can be set

up for operation within 10 minutes, while at least 2 hours is required for setting up the water trough.

- lower price. The price of a water trough in 1985 is at least 2 1/2 times an axial flow pump. But the service life for the axial flow pump is approximately 4 years while a service life for the water trough is approximately 10 years. Even though the axial flow pump is widely used, some water trough are still in use. The main use of the water trough now is for pumping saline water.

The low price of the axial flow pump is mainly due to its simple design. Most of the axial flow pumps in Thailand use wooden bushings for submerged parts instead of bearings. The bushing costs only 7-11 cents (2-3 bahts) each, and can be replaced by the farmers. However, frequent inspection for wearing of bushings, especially the bushing at the impeller end, have to be done. Wearing of the impeller's bushing will make a swirling rotation of the impeller, which can cut the pipe.

One farmer in Pathumthani province indicated the total annual cost of the axial flow pump was approximately 100 dollars (2700 bahts) for double cropped 3.2 ha (20 rais) of paddy land. With his average yield of 6.25 tons per ha, the total annual cost of the axial flow pump is 2.5 dollars per ton. This cost can be interpreted in many ways. However, without the pump there is no guarantee for producing second crop and for the same high yield.

The planted area of rice per one unit of axial flow pump was reduced from approximately 45 ha per pump in 1975 to 16 ha per pump in 1983 (Figure 14). This does not mean the axial flow pump production is reaching a saturation stage. Even though most of the pumps are now used in the central plain, its use in the other parts of the country is increasing. Furthermore, production for replacement is required.

REFERENCES

- Chinsuwan, W., C. Rukarcheep, and P. Chanurai, 1973. Testing the Performance of a Debridhhi Pump. Unpublished under graduate thesis. Khon Kaen University, Khon Kaen, Thailand.
- Noparat, S. 1960. A study on the Use of Debridhhi Pumps of Ten and Thirteen Inch-Diameters (in Thai). Unpublished under graduate thesis, Kasetsart University, Bangkok, Thailand.
- Sidnarane, S., and K. Limtrakul, 1973. The Water Lift Efficiency. Unpublished under graduate thesis. Khon Kaen University, Khon kaen, Thailand.
- Tavakul, D. 1967. Research and Development of Irrigation Equipment (in Thai). Technology and Agriculture. pp 20-24.
- Tavakul, D. 1941. Debridhhi Pump (in Thai). Kasikorn Journal. 14(2), pp 281-283.
- Toonim, N., V. Kamoltiprong, and S. Loahakanvanich, 1985. Testing and Evaluation of Locally Made Axial Flow Pump (in Thai). Unpublished under graduate thesis, Kasetsart University, Kamphangsean Campus, Thailand.

แบบ "เดบริดดิ" "

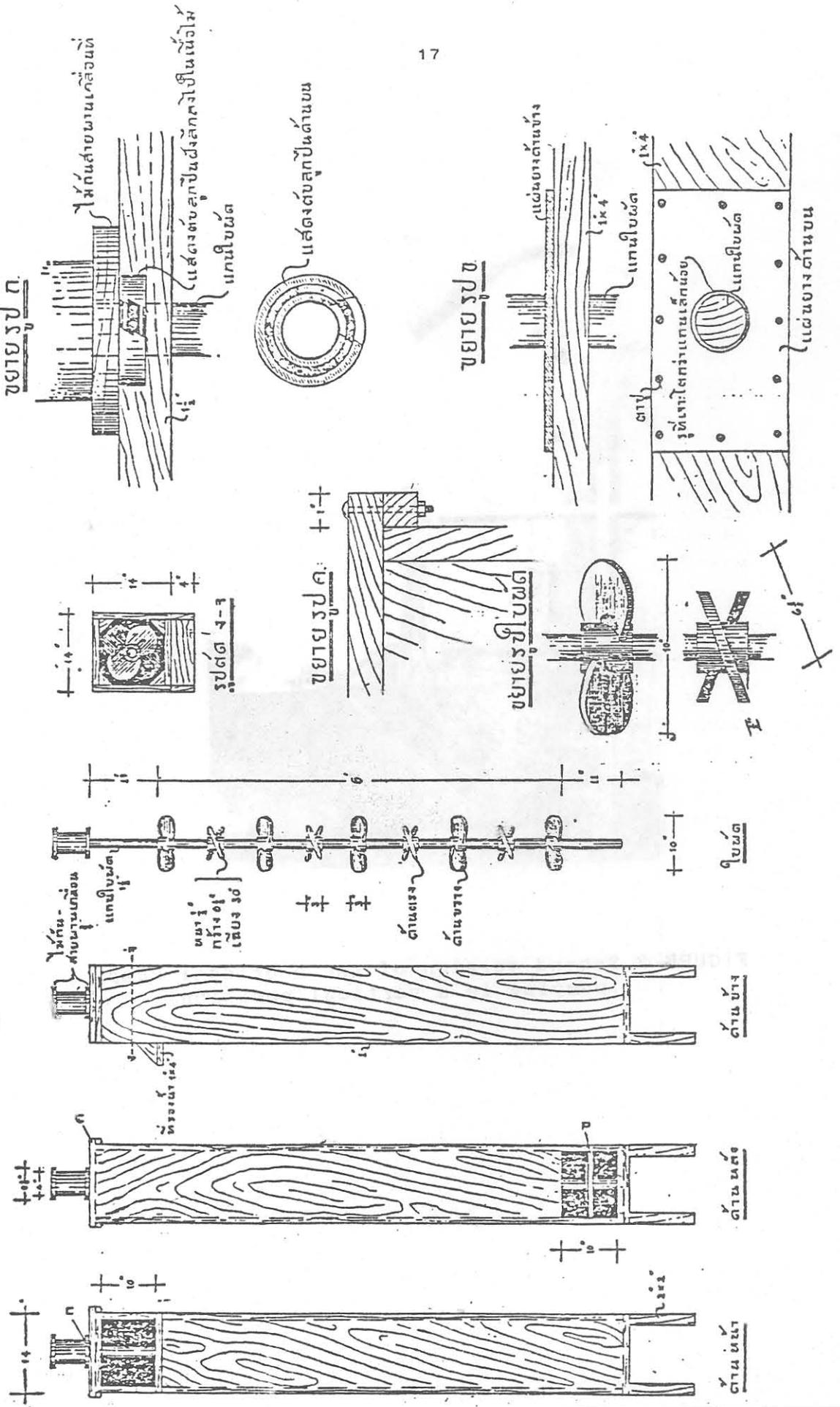


FIGURE 1 Initial design of the "Debriddhi Pump" (Axial Flow Pump) in 1941

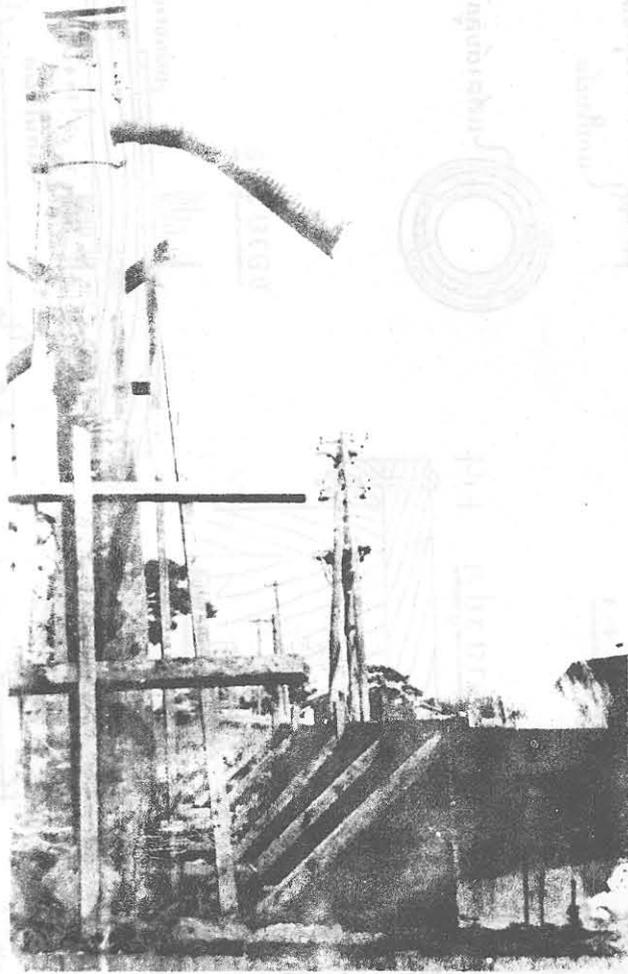


FIGURE 2 Second version of the Debriddhi Pump
(pumping in a vertical position)

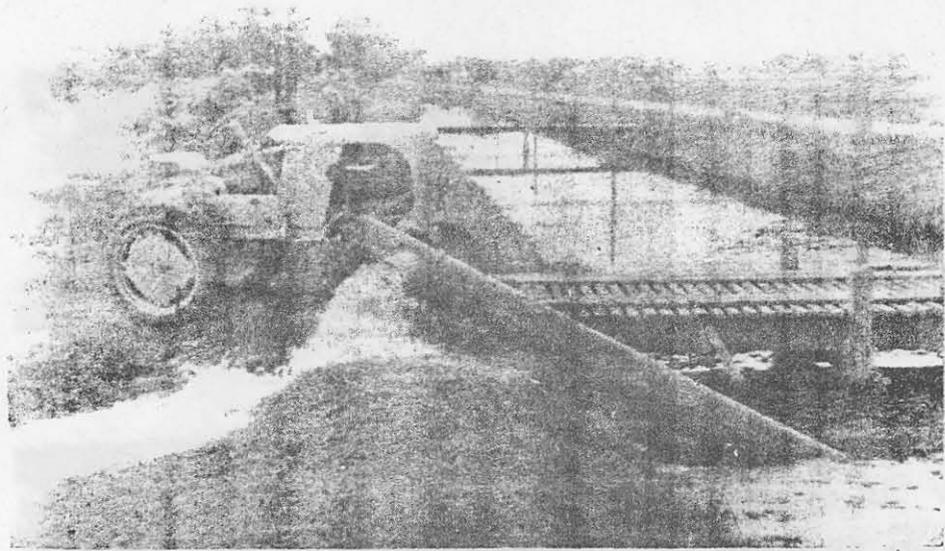


FIGURE 3 The Debriddhi Pump powered by a small 4-wheel tractor

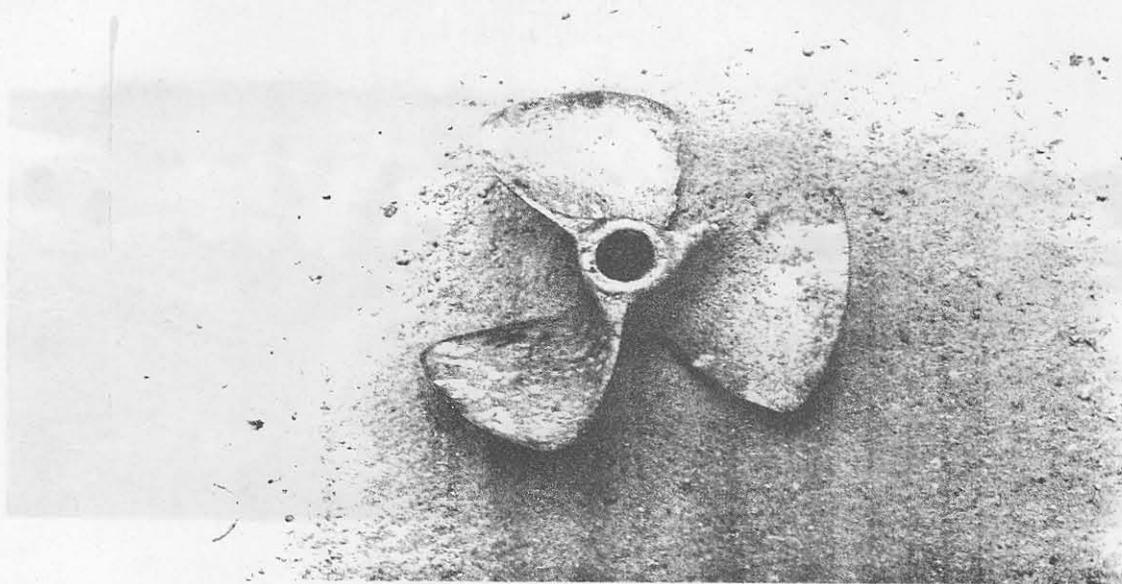


FIGURE 4 Three-blade impeller

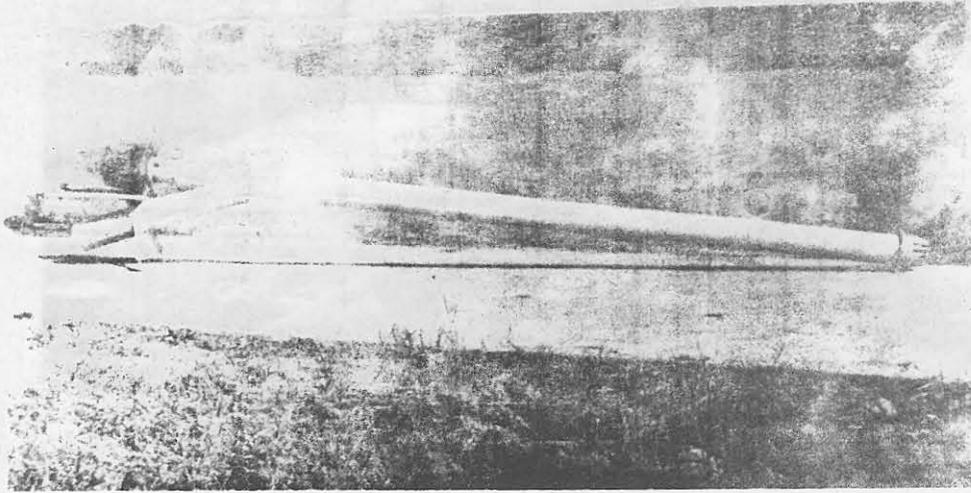


FIGURE 5 Modification of the discharge pipe during 1957-1967



FIGURE 6 The Debriddhi Pump propelling a boat (left) and pumping water while stationing on the boat (right)

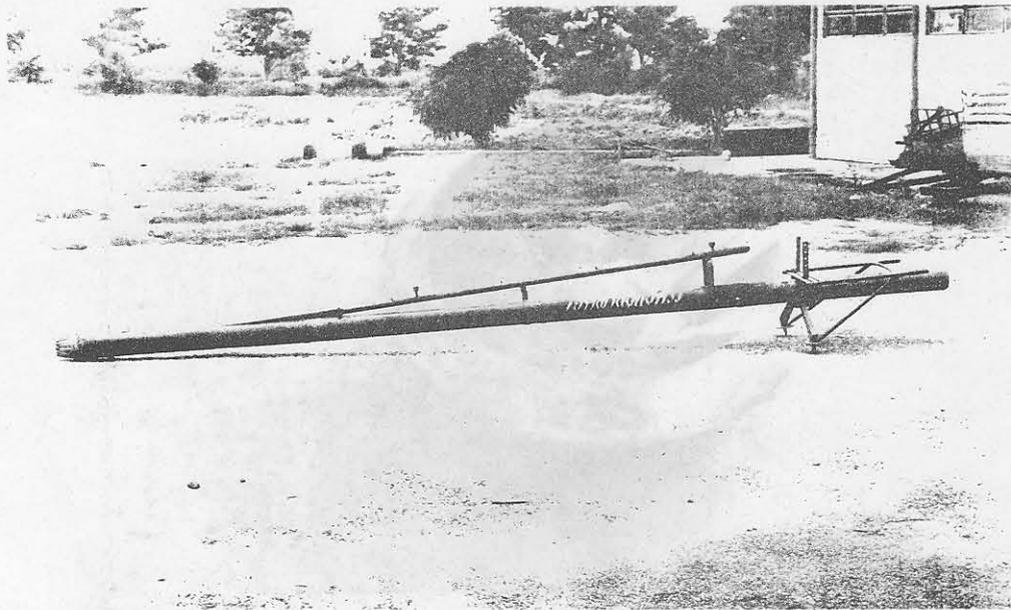


FIGURE 7 Present design of the axial flow pump in Chachoengsao area

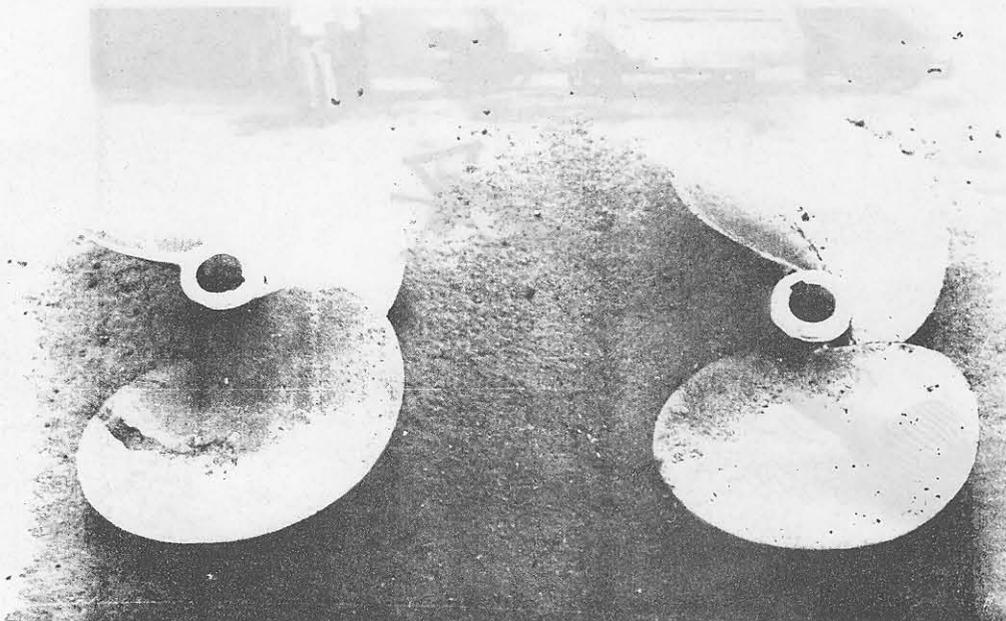


FIGURE 8 Low speed (left) and high speed (right) impellers for axial flow pump in Chachoengsao area



FIGURE 9 Low speed impeller for axial flow pump in Suphanburi area

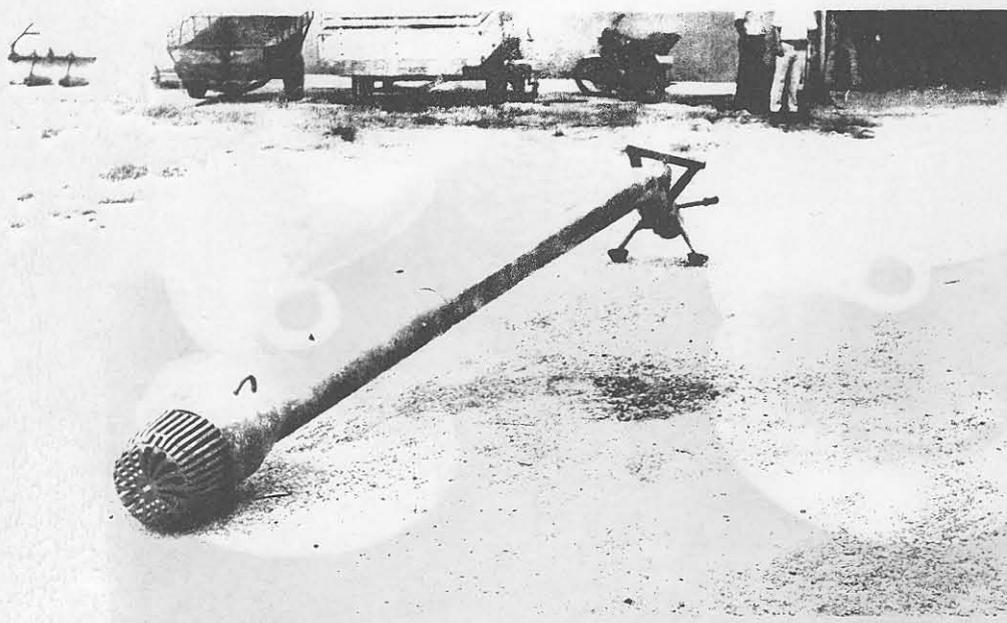


FIGURE 10 Present design of the axial flow pump in Suphanburi area

Number of Axial Flow Pumps and Rice Planted Area in Thailand During 1967-1983

YEAR	No. of Pump	No. of Axial Flow Pumps	Planted Area for Rice (000 ha)
1967	251288	17892	7982.24
1975	277084	19399	8886.32
1976	317328	22137	8575.20
1977	359308	25156	9031.04
1978	473975	331783	10026.72
1979	517975	362583	9435.36
1980	603548	423484	9817.60
1981	780610	546427	9595.20
1982	888671	601070	9821.44

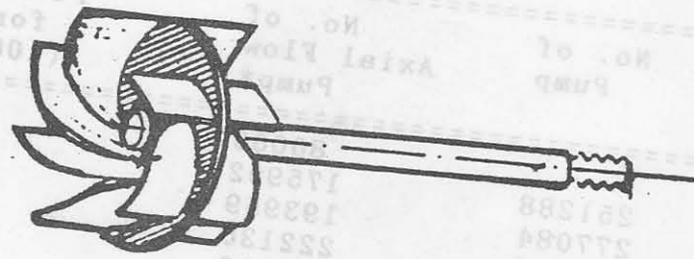


FIGURE 11 Double-suction impeller

Number of axial flow pumps is estimated to be 70% of the total pumps.

Sources:
 1) Tavanul D. 1987. Research and Development of Irrigation Equipment. Technology and Agriculture. pp 20-24.
 2) Center for Agricultural Statistics, Office of Agricultural Economics, Ministry of Agriculture and Co-operative, Bangkok, Thailand. 202, 1983; and 202, 1983; and 188, 1983.

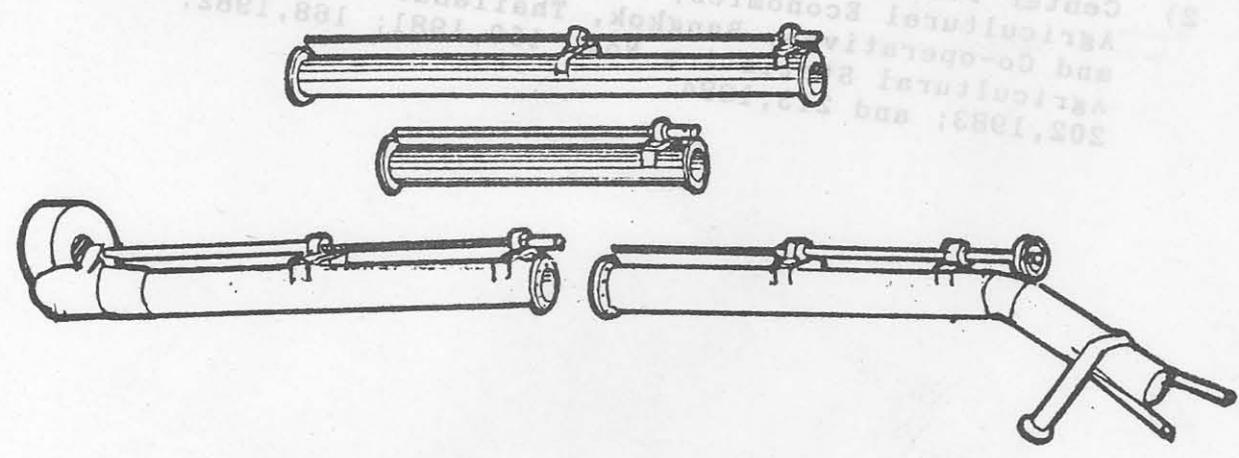


FIGURE 12 Low lift pump by Aree-arthron manufacturer

TABLE 1 Number of Axial Flow Pumps and Rice Planted Area in Thailand During 1967-1983

YEAR	No. of Pump	No. of Axial Flow Pump*	Planted Area for Rice (1000 ha)
1967	-	80000	-
1975	251288	175902	7982.24
1976	277084	193959	8896.32
1977	317328	222130	8575.20
1978	359308	251516	9031.04
1979	473975	331783	10026.72
1980	517975	362583	9435.36
1981	603548	422484	9617.60
1982	780610	546427	9595.20
1983	858671	601070	9621.44

* Number of axial flow pumps is estimated to be 70% of the total pumps.

Sources:

- 1) Tavakul, D. 1967. Research and Development of Irrigation Equipment. Technology and Agriculture. pp 20-24.
- 2) Center for Agricultural Statistics, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok, Thailand. Agricultural Statistics Nos. 150, 1981; 168, 1982; 202, 1983; and 213, 1984.

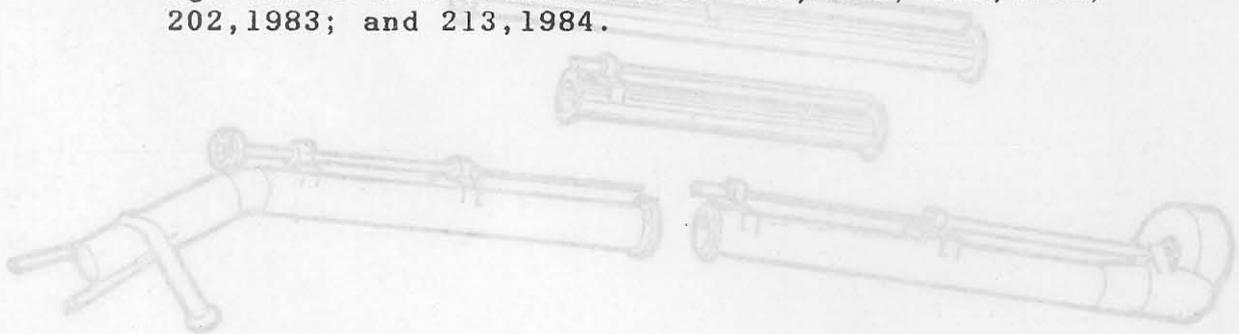


FIGURE 13 Low lift pump by AEE-archon manufacturer

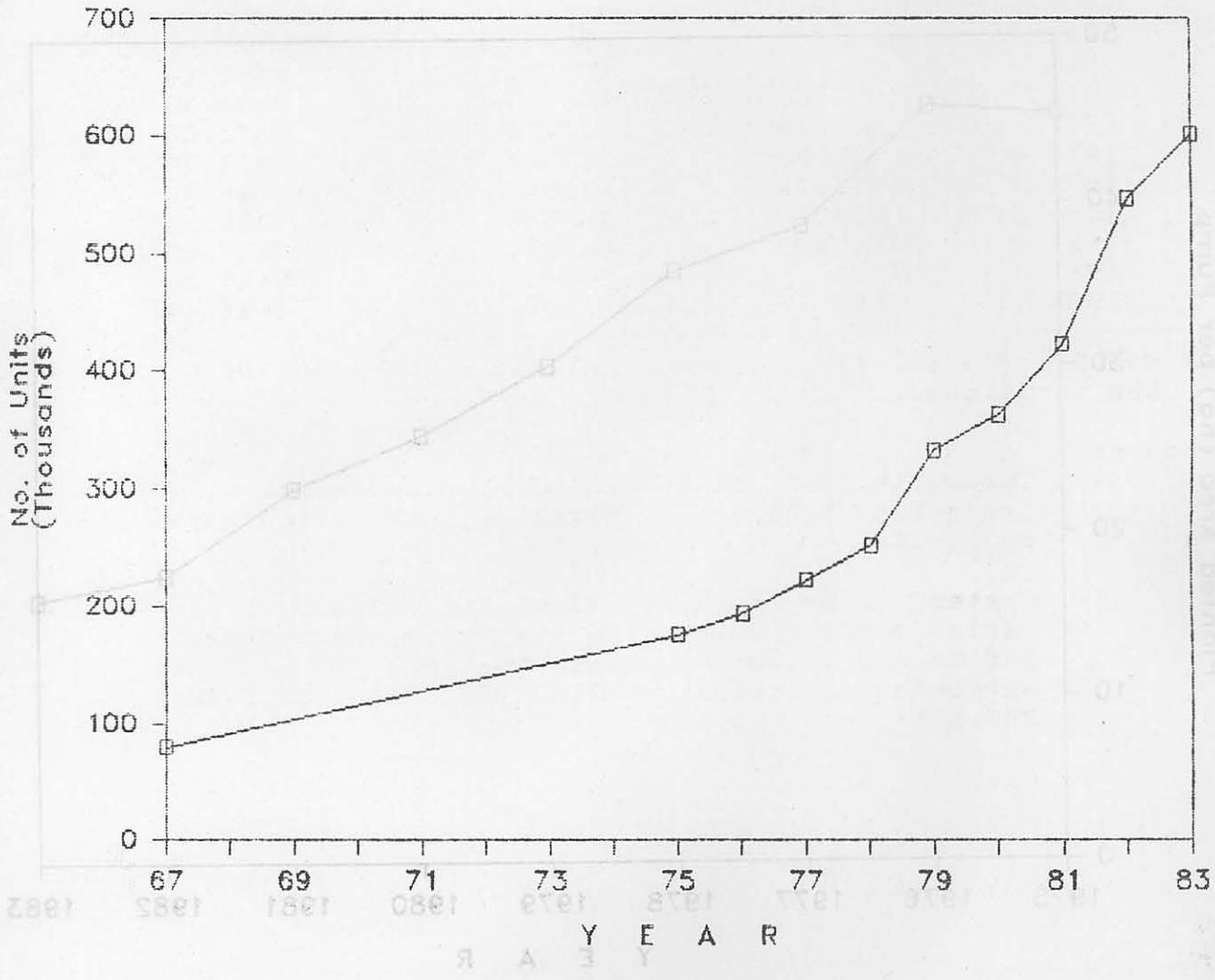


FIGURE 13 Total number of axial flow pumps during 1967-1983

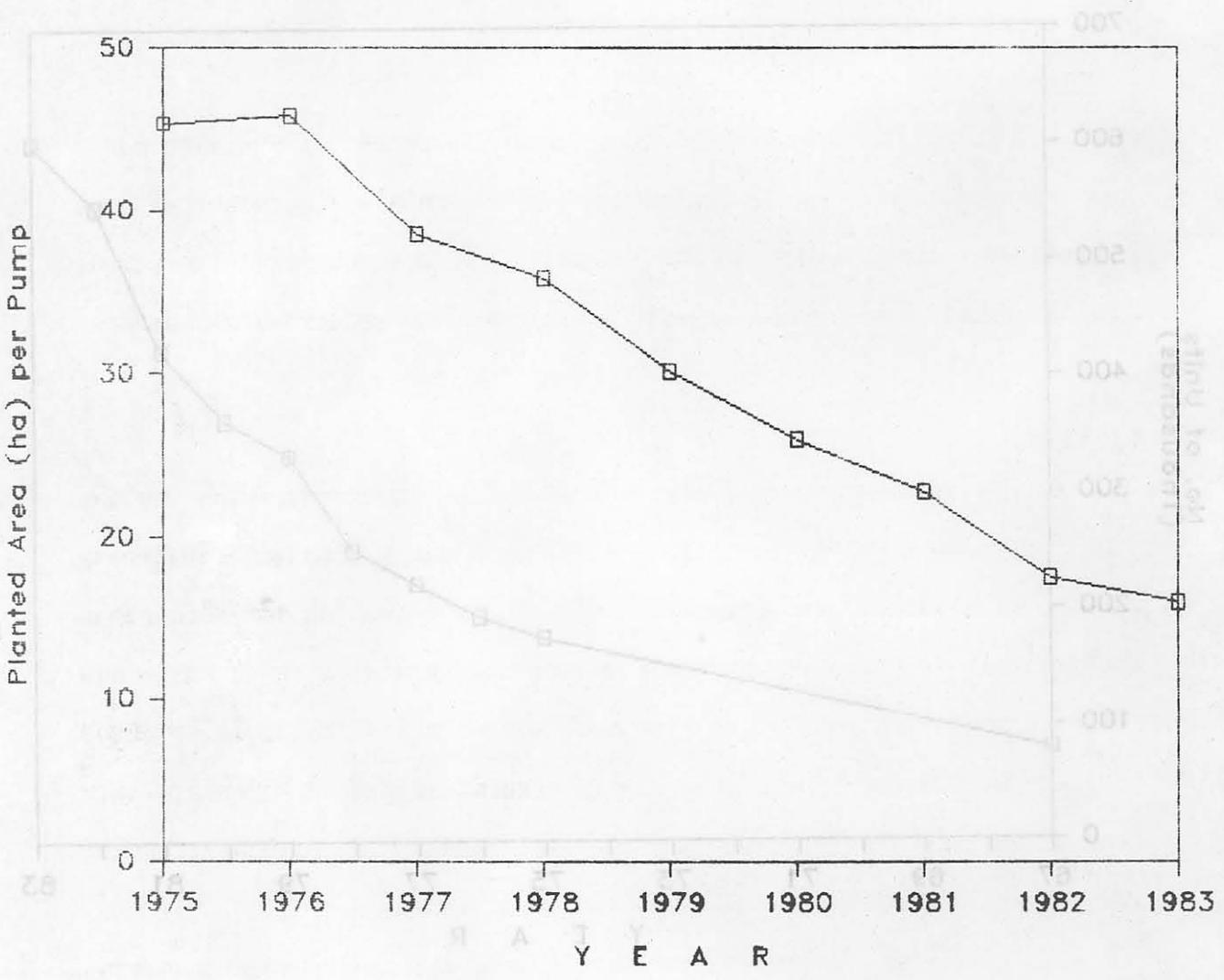


FIGURE 14 Rice planted area per one unit of axial flow pump during 1975-1983