PN-AAR-527
ISN = 37353

BUFFALO DRAWN IMPLEMENTS

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Paper presented at the FFTC/ASPAC
Meeting on Buffalo Production
at Kasetsart University
Bangkok, during 11-17 August 1981

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Buffalo Drawn Implements

1. Introduction

Better farm practices and timing of operations are major factors contributing to good crop yield. In Thailand, however, farming operations such as soil preparation, planting and weeding, are not always properly done. This results in poor establishment of crops which results in a low level of yields in harvesting time.

The subject of agricultural mechanization is much wider in scope than is often realized. In the Division of Agricultural Engineering, mechanization embraces the design, test, development, manufacture, distribution and maintenance of all the tools, implements, equipment and machines used in agriculture. It is concerned with agricultural land development, tillage, crop establishment, weeding, harvesting, threshing, transporting, drying and storage. It embraces all aspects of production, handling, and processing at the rural level.

Farm mechanization includes three main power sources: human, animal and mechanical. Thus, agricultural mechanization will have an impact on, and a key role to play in, the development of the entire rural sector. This applies whether the technology is hand tool, animal draught, or mechanical power.

2. Animal-draught Technology

Buffalo are the primary draught animal in Thailand and in 1979 there were 6,400,000 buffalo in Thailand. With a total of 10,027,000 ha of rice planted in the 1978/79 crop year, there was one buffalo per 1.6 ha. Assuming 75% of the buffalo are useable for field work, there was

one draught animal per 2.1 ha. Additionally many cattle are used for draught; however, their capacity is less than that of a buffalo. If the buffalo distribution corresponded with rice production, the entire crop could conceivably be grown without using any mechanical power. However that is not the case.

Buffalo and Rice Production (000)

Region	Draught Buffalo	Planted Area, ha, 1978-79			Ha Per D. Buffalo
		1st	2nd	Total	
Northeast	3,000	4,451	25	4,476	1.5
North	525	2,022	92	2,114	4.0
Central	1,125	2,239	554	2,793	2.5
South	150	633	10	643	4.3
Total	4,800	9,346	681	10,027	2.1

There is not much information available on the percentage of land prepared by buffalo in Thailand. It varies by region, and by locality within a region from 20% to over 90%. A recent estimate indicated the following:

	Area, %		Hire Rate, $US/ha(a)	Hours/ha
	Rice	Total		
4 Wheel Tractor	6	24	45	6
Power Tiller	31	25	36	14
Buffalo	63	50	20	40
Manual	T	1	30	100

(a) Two passes, except one pass for manual. Very few power tillers and buffalo are custom hired.

Based on the above estimates, the use of mechanical power is expanding because it completes the task of soil preparation in 15% to 40% of the time required by buffalo. With large 4 wheel tractors, still more time is saved. The advantage of timeliness is selected, even though the cost of mechanical power is approximately double that for animal power for soil preparation. It can be assumed that the increased cost is recovered from higher yields resulting from earlier crop establishment.

Thai rice farmers are more mechanized than other Southeast Asian farmers. However many of them cannot afford mechanical power, and they do not have the resources to invest adequately in other inputs to increase their net income. How can these farmers be helped to improve their position? In the past very little has been done to improve the animal powered tools. The single beam plow with one small moldboard and a combination wood and steel harrow-leveling board are the only animal implements commonly seen throughout Thailand. The agricultural engineers that are concerned with equipment development believe that a feasable solution to the problem of the poorer farmers is to provide improved implements for animal power.

3. Utilization of Buffalo in Thailand

Buffalo are widely used in many areas of the country for farm power.

a. Primary tillage.

A farmer can plow at the rate of approximately .2 ha per day of wet paddy with his buffalo plow, using two plowings at right angles to each other. One buffalo can work effectively for a few hours at a time so rotating two buffalo on the plow through the day

provides a continuous operation. Plowing depth is to 5" which requires 80-120 kg of draught depending on the soil type. For upland plowing or paddy plowing in dry land condition with heavy clay, the pull required is more than double. Under these conditions the use of two buffalo should be considered for the single moldboard plow, unless the plowing depth is shallow.

b. Secondary tillage or harrowing.

After the plowing operation, the farmer will use his comb harrow to break up clods, produce a finely textured seedbed, and remove some trash from the soil. This tool is usually made of wood by the farmer.

c. Weeding or cultivating.

For upland row crops, the buffalo plow is a popular tool for use in inter-row weeding. In a corn field the row spacing may be 80 cm which requires several passes between adjacent rows; however it is much faster than hand weeding.

d. Threshing.

One of the traditional methods of threshing is by animal treading. It is estimated overall that 3% of Thailand's rice crop is threshed by buffalo. In local areas the usage is higher. The paddy is

placed on the threshing floor and the buffalo walk in a circle over it. Subsequently the threshed straw is raked off. The threshed grain is taken up and the chaff is removed by winnowing.

e. Transportation.

A sled or the more popular two wheel cart pulled by a buffalo is used as family transportation and for carrying farm products from the field to the shelter or market. This method of transportation is very popular outside of the mechanized central region.

4. New Developments in Animal Power Equipment.

a. Bed forming equipment.

There is a need for implements to shape beds for areas that plant usually two rows per bed such as peanut. A furrowing implement for the buffalo may be a feasable solution to this problem.

b. Seeding with traditional tools.

A few farmers have applied their experience for expanding the use of conventional tools. A seed tube has been attached to the plow for dropping seed in the furrow during the plowing operation. The comb harrow can be used with new attachments for a multiple seed furrow opener. After sowing seeds along the rows; the seed is covered by foot, or by brushing soil into the furrow.

Row seeding makes weeding easier than if the seed is broadcast. This concept is under test and has high potential for expanding the use of the buffalo.

c. Fertilizer application with a buffalo plow.

An attachment is under test for applying fertilizer in conjunction with plowing. The fertilizer is metered, dropped in the bottom of the furrow and covered by the next furrow slice. The plow capacity is decreased by about 10% for filling the hopper, which is a savings over two separate operations. Results of comparative tests with four other methods of application conclude that the plow-down deep fertilizer placement makes more efficient use of the chemical than other methods.

d. Buffalo weeder.

An attachment for replacing the plow moldboard can be mounted on the plow frame with a series of weeding shovels or blades. This will reduce the number of passes between the rows of upland crops compared to weeding with the narrower buffalo plow.

e. Alternative methods of primary tillage.

Chisel plows or other tined implements for primary tillage should be pursued as alternative to the animal plow, especially for rainfed and upland crops. Objectives in exploring other methods should be to reduce the draught required and increase the productivity of the buffalo for primary tillage.

f. Buffalo tread threshing.

Increasing the efficiency of this traditional method has not yet been tried. It is very slow because the buffalo hoof is relatively small and he must walk a long time to complete the threshing operation. Why could not an attachment for his feet be designed to provide a larger foot print and increase his efficiency as a threshing machine? If this is possible the use of the buffalo would be expanded. It could replace some of the manual beating which is hard manual labor and is used for an estimated 63% of the rice crop in Thailand.

g. Stationary power.

With present practice, most of the buffalo are not utilized full time after the tillage work is completed. In some countries, equipment has been used for stepping up the velocity of a buffalo for powering a water pump, corn sheller, winnower, etc. The buffalo walks in a circle and the stationary device is driven through a series of gears to increase the speed to an appropriate number of revolutions per minute. It is realized that the buffalo may need a rest after soil preparation, but they can be utilized for many stationary power requirements to reduce the drudgery of performing the operations manually.

h. Improved buffalo plow.

The buffalo plow continues to be used for paddy tillage by many Thai farmers; particularly in the Northeast, because they cannot afford mechanical power. The Thai-IRRI Cooperative Farm

Machinery Project undertook the objective of reducing the draught of the buffalo plow, two years ago.

A popular plow manufactured in Khon Kaen was selected as a basis for comparison. Initial tests indicated that a moldboard with a larger radius of curvature required less specific draught. Further reduction was obtained when the plow point and moldboard assembly was rotated 20° to 25° clockwise about a horizontal axis, providing a more gradual approach to the soil. The suction angle of the test plow points were reduced to 18%, from the manufacturer's 22°.

A test plow frame with provision for indexing the attitude of the plow in 5° increments from 0° to 35° was constructed. A strain gage dynamometer and continuous recording equipment were obtained for data collection. Depth was controlled at 127 mm (5") with gage wheels in upland, and with skids in paddy. Mechanical power was used for data collection because velocity was more uniform than with a buffalo. Ground speed and other parameters were controlled. The largest radius of curvature moldboard, 380 mm produced the best results of the radii tested.

Subsequently a larger power tiller moldboard with 457 mm radius of curvature was mounted on the test plow, which improved the performance further. The reduction in specific draught that was achieved was quite similar for upland and paddy conditions. Usually it was about 33% less than that for the manufacturer's plow. This generated two recommendations:

1. A new wider point and moldboard with 50% more projected area and top width than the control plow at 127 mm plow depth. The radius of curvature is 457 mm, attitude angle is 20° and the suction angle is 18°. This requires approximately the same total draught in limited testing as the control plow but it will reduce the plowing time by about one third, producing a timeliness benefit.

2. A plow with projected area and top width at 127 mm plow depth comparable to the manufacturer's plow. This reduces the total draught to two thirds. It may be used with small animals, for deeper plowing, or for upland conditions.

The department of Extension at Pitsanuloke became interested in this development. A production plow frame with the two interchangeable recommended plow bottoms, was provided for use in comparative tests with a local plow. A vertical hitch adjustment was provided so they could control the depth comparable to that of their local plow, without depth gaging means. On three successive days they ran one of the plows for five hours, using the same buffalo. The plow depth was 120-130 mm in each test. The area plowed was measured each day.

	m^2	% increase
Local plow	1,980	
Recommended narrow	2,480	25
Recommended wide	3,290	66

The Pitsanuloke tests indicate an increase in productivity for the recommended narrow plow over the comparable width local plow. The lower draft requirement apparently resulted in a higher buffalo ground speed; the recommended narrow plow also had a timeliness advantage. There is a similarity between the area plowed for each moldboard in the Pitsanuloke tests and the specific draught data obtained in our tests.

The reduction in specific draught that has been obtained for the buffalo plow will benefit Thai farmers who cannot afford mechanical power. It may also have application in other countries who rely heavily on animal power.

i. Upland seeder.

There is a need for an animal powered mechanical upland seeder in Thailand, to replace the traditional method of hand seeding by dropping seeds in a row or in hills made with a hoe. When a rainfed farmer wants to grow another crop, either before or after the main rice crop, a faster method is needed to reduce the seeding time, so both crops will have more moisture to produce a higher yield. If

paddy can be seeded before the soil is flooded, a seeder can be used. However, it would have competition from hand broadcasting, which is becoming more popular.

An upland seeder has been tested and improved in Thailand over the past few years. It can be used for five rows spaced 20 cm, three rows spaced 40 cm or for two rows spaced 70-90 cm. Interchangeable seed plates are available for rice, corn, sorghum, soybeans, mung beans, peanuts or wheat. The seed drop in the row can be spaced 20,25 or 33 cm. The hopper is split so fertilizer can be applied when seeding. This machine weighs about 105 kg with empty hoppers. It can be pulled by a buffalo with the operator sitting on the hopper. However the draught requirement is about 130 kg which requires a fairly strong buffalo. The capacity is 1.2 hectares per day with one person required.

A three row 20 cm spacing version of the upland seeder was built primarily as a low cost machine for use with a buffalo for rainfed upland farmers. It will also seed two rows spaced 40 cm. It has been under test for the past two seasons by the Land Development group in the Roi Et area. Blueprints for the 5 and 3 row seeders will be available to manufacturers in the near future.

5. Local Manufacturing.

Farm equipment is produced in Thailand by over 100 firms. Some of them are family operations of 3 to 6 people with a drill press and welder as the principle shop equipment. There are a few factories with 200 employees and a

full range of machine tools. Most of them were purchased used. The larger firms are more sophisticated, as a result of assistance from ISI, with an assembly line and particular emphasis on plant layout, material flow and reduction of time for moving parts from one department to another. The result is increased efficiency and cost reduction. These larger firms may results in difficulty of smaller shops to compete, unless they sell locally with reduced transportation costs or lower labor rates. There are a few instance where a larger firm is purchasing more components rather than fabricating all of the parts. They have discovered that some items can be acquired from a specialty shop that has high volume at a lower unit cost than fabricating in their own shop.

Production of farm equipment has been generally expanding, except in case of the adverse effect of a drought on farmer income. Power tiller production is estimated at over 60,000 units per year. Small 4 wheel tractors to 20 Hp have a volume over 10,000 per year. The axial flow thresher has expanded rapidly from 135 machines in 1976 to nearly 10,000 per year at present. Buffalo plows, disk plows, water pumps, harrows, puddlers, hand sprayers and hand hoes are produced in large volume.

A cutterbar reaper is arousing an unusually high interest among farmers and manufacturers because of a labor shortage in many areas of Thailand during the harvest season. Several hundred machines have been imported and three firms built 221 units during the first six months of 1981. Some transplanters have been built, 12 row engine powered, and a few 5 row manually operated machines. Seeders and other small machines are also expected to go into production.

With country production continuing to increase, there is a significant quantity of farm machines imported. As an example, a Sukothai retailer indicated that he sells 300 power tillers built in Thailand and an equal number of imported units per year. The imported machines have a lower price, due to lower labor costs. However, some manufacturers are beginning to export to other Southeast Asian countries.

6. Popularization of Improved Implements.

In order for improved implements to benefit the country and its farmers, the machines must be in demand, and in use on farms. Farmers need to comprehend that they will benefit economically through ownership of the new model. It must reduce the time required for the operation or it should do the task better than the existing tool. A reduction in time required may result in a timeliness benefit of higher harvested yield. When an apparent demand develops, manufacturers become interested in supplying the market potential. Here again, production must benefit the company by way of a reasonable profit to the owner.

Several methods are employed to popularize improved implements among farmers and manufacturers.

a. Exhibits at machinery shows and other events for farmers and manufacturers. Personnel are provided at the exhibits to explain the merits of the new mcchine and to answer questions. Typically 10 or more such exhibits are held annually.

b. Field demonstrations of new machines. This is most effective in conveying the merits of new machines to interested parties. Often such activities are in conjunction with another division

of the Ministry of Agriculture and Cooperatives, or with the Department of Extension. These groups advertise the event in the particular area to attract a large number of farmers.

c. Training courses. The Agricultural Engineering Division conducts training courses for about 400 young farmers annually. Classroom, laboratory and field operation of machines are included. The farm machinery section of the department of Extension is also planning to conduct courses for farmers at various locations.

d. Department of Extension. The farm machinery development groups in the Agricultural Engineering Division are working very closely with the farm machinery section of the Department of Agricultural Extension. The collaboration is mutually beneficial. It will assist them in carrying on their extension activities throughout Thailand and will help in popularizing and promoting new developments in farm tools. Meetings are held periodically, two extension people have attended IRRI sponsored training course, their farm machinery section has assisted in test activities, and an engineer has been furnished to help the section in conducting a series of four training courses at Chainat for extension personnel.

e. Manufacturer visits. Agricultural Engineering Division personnel visit over 65 farm machinery manufacturers at least twice a year. The principle purpose of these contacts is to

inform them of new developments, and to provide technical assistance if they or their customers have problems with the firms' products.

Summary

Research and development of animal drawn implements has been more advanced in some countries in the region. More work is needed in Thailand. The Agricultural Engineering Division, with help from cooperating agencies such as IRRI and the UNDP and FAO of the United Nations are tackling the problem. Progress has been made and the work will continue to have a high priority. In spite of increasing acceptance of engine powered equipment in Thailand, the intent is to continue the development and improvement of existing and new implements for animal power.