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THE POTENTIAL FOR STRIPPER HARVESTING ON SMALL FARMS IN ASIA*

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Introduction

Shelbourne Reynolds in England first marketed a stripper harvesting head which uses a rotor to comb the grain from the straw for attachment to combines in 1985. Since then the demand for strippers has escalated. This British development harvests cereal grains more efficiently and can even double combine capacity because only a small proportion of the straw need be taken in, Figure 1.

IRRI's Agricultural Engineering team have been working on improved harvesting systems for small-scale farmers that can cut costs, improve timeliness and overcome seasonal labor bottlenecks.

Silsoe Research Institute (formerly National Institute for Agricultural Engineering), who had done the development work with Shelbourne Reynolds, were contacted to ascertain the potential for the British stripper harvester principle on the paddy fields of low income rice producers. It was recognized that such a harvester in a pedestrian configuration would have to operate at low speeds. All the results in England and elsewhere at that time indicated that the performance of the stripper head improved as the forward speed increased. Despite the risk a project was initiated. A collaboration between SRI and IRRI, which was subsequently supported by Britain's Overseas Development Agency, was formalized with SRI. Several prototype designs were built and evaluated. The problem of low speed losses did not prove to be as serious as anticipated. By the middle of 1992 IRRI had released its first small-scale stripper harvester system, the SG800 series. The initial results have attracted three manufacturers in the Philippines, and units are on test in ricefields in Thailand, and New Guinea as well as the Philippines. IRRI is also developing other stripper systems, including a small combine model.

Design objectives:

IRRI seeks to improve the well-being of low income farmers.

This was the target clientele for which the principal design parameters sought for the stripper harvester series were specified:

(a) The design must be simple and capable of being fabricated in small rural-based workshops where the supplier can provide a low cost product that he can also service for his customers.

(b) The unit should be portable, while self-propelling, it must be capable of being carried over bunds or channels into small ricefield parcels.

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IRRI is not ignoring other markets -- we also have a prototype small combine (1 m front) underway, but we have ranked the portable walk-behind harvester as our first priority.

(c) Operate with acceptably low losses

(d) Keep down total harvest cost, yet not necessarily be highly labor-displacing. If possible the system should be introduced as a form of "labor-intensive mechanization."

Although low cost was a target, we have learned from our experience in the developing world with axial-flow threshers that a piece of equipment may not necessarily be purchased by individual farmers. Harvesting contractors such as thresher-owners, who live and work in a district are likely purchasers, and they will want greater reliability and ruggedness.

Axial-flow threshers are widely used in the developing world. Philippine government agency staff estimate that around 80% of the countries' rice crops are threshed using axial-flow threshers. The remainder is threshed by portable treadle threshers, or by bundle threshing by hand, or even by foot-treading, although this is only practiced to a limited extent. There is practically no paddy that is combine-harvested in the Philippines. Most of the crop is cut with sickles. Similar methods prevail in a number of other nations in Asia.

There are some few hundred mechanical reapers in the Philippines. These are used in areas where there are shortages of labor at harvest time -- usually in the vicinity of the big cities or near industrial estates.

Places where mechanical reapers are sold are suitable sites for evaluating the impact of the stripper-harvester technology. The first IRRI-SRI stripper harvester to be monitored in the Philippines was introduced near Bataan, on the edge of Luzon's principal rice bowl. The results showed that this new system was potentially cheaper than all prevailing methods, including reapers.

Striving for the design objective of portability has meant that there are consequent weight, power and width constraints. It was decided that the lowest possible weight for a walk-behind stripper would be obtained if the machine was no more than a stripper-gatherer, the rethreshing and cleaning functions being left to a separate operation, using a stationary thresher at the side of the field.

The SG800 stripper harvester system that was subsequently developed represented a compromise: all up weight of the mobile component: the stripper-gatherer, is 190 kg. An engine power of 8 kW is needed, although on firm ground and in upstanding crop an engine as small as 6 kW is satisfactory. Needless to say any engine used has to be lightweight and thus aircooled.

Several types of stripper harvester systems -- all self-propelling -- are under evaluation at IRRI for small-scale agriculture.

Performance of the Stripper-Gatherer System:

The Stripper-Gatherer (SG) system has three components -- the harvester (SG800) with its modular containers, a portable thresher/cleaner (TC800), and a trailer.

The SG harvester, shown in Figures 2 and 3, consists simply of a walk-behind harvester with stripper rotor which feeds into a removable collection container. The container is changed when full and emptied onto a sheet of canvas or other material at the edge of the field. The path around the field of the machine is chosen so that the container is full when the SG harvester returns to the collection point. As harvesting progresses the collection point is periodically moved, to maximize field efficiency of the system.

The thresher team with the portable thresher/cleaner follows behind the SG harvester and threshes, cleans and bags the grain at the collection point, usually at the edge of the field, Figure 4. The TC800 lightweight axial-flow thresher/cleaner unit has been designed, with several modifications to the standard IRRI axial-flow thresher. This takes advantage of the reduced straw quantity and length, and the high degree of threshing in stripper harvested crop compared to reaped crop, and ensures efficient cleaning. Field capacity of the SG800 system, which requires a crew of 5-7 people, is typically 1 ha/d.

The SG harvester is fitted with a hitch point and a high forward speed gear which allows the system to transport itself to the field at a top speed of about 20 km/h, Figure 5. This feature should allow contractors to save costs otherwise needed for a second vehicle to transport the system from job to job, as is usually the case for contractors who own threshers or reapers.

The SG system allows harvesting and threshing to take place concurrently. With manual or mechanical reaping, on the other hand, there is usually a delay in threshing to allow sufficient crop to be harvested and stacked to justify hiring a thresher. A delay in threshing can lead to crop loss in the wet season because if it rains during harvesting cut unthreshed crop can become wet and spoil. During the dry season, however, reaper windrowed crop is often lift lying in the fields to allow sun-drying of the grain before stacking and threshing. Pavement sun-drying costs are saved.

Stripper harvesting leaves 25-50% more straw in the field than hand or mechanical reaping. Research at IRRI has shown, however, that the incorporation of long straw still anchored to the soil can be accomplished without serious difficulties, and adds less than 10% to land preparation costs compared with reaping or hand harvesting and threshing. However, the initial products of decomposition of rice straw are toxic to rice plants and the incorporation of additional straw can, in poorly drained fields, make it necessary for a longer delay between incorporation and crop establishment. Rice straw has a value as a fertilizer and soil conditioner. A review of the literature concluded that the incorporation of the whole straw yield in warm, well-drained fields (with organic matter content of less than 3%) increases yield by about 0.4 tonnes/ha with moderate levels of application of inorganic Nitrogen.

The cost of harvesting one tonne of rice with the SG system with manual harvesting and mechanical threshing and mechanical reaping and threshing based on prices applicable in Bataan Province in the Philippines were compared,

assuming losses for each system would be the same. It shows that the SG system, harvesting 1 hectare per day, can harvest each tonne of rice 5% cheaper than a mechanical reaper and thresher, and 30% cheaper than manual harvesting and mechanical threshing.

Again, assuming a work rate of 1 hectare per day for the SG system, it has also been calculated that investment in the system can be recouped in one year. This is the payback period [PBP], assuming the system harvests one hectare per day and is used for 50 days a year. The breakeven point [BEP] is 22 hectares per year. This compares favorably with the imported Japanese reaper and TH8 thresher system that is commonly used in Bataan Province, which has a PBP of 1.1 years and a BEP of 55 hectares per year, for the same annual usage rate of 50 days. This system can harvest and thresh about 2 hectares per day.

Tests of the SG System in Other Countries:

The SG800 has also been evaluated in Thailand, and New Guinea. Results have been promising. In Thailand, 3 m wide locally-built combines have become popular in the past four years, as harvest labor scarcities have intensified. The makers of these combines have addressed the severe traficability problems on the central flood plains by exploiting wide wooden grousers on the tracks. These combines are slow and cumbersome and their operators are accordingly disinterested in harvesting small or distant field parcels. These are precisely the conditions for which the SG800 has been developed. The use of the unitary steel starwheel drive overcomes the difficulties in boggy fields. For road transport, rubber tyres can be quickly fitted to the drive axle. Even though the SG800 is a walk-behind machine, it can be driven much faster than the Thai combines. Unless some cost-reducing method of harvesting is forthcoming in Thailand, the smaller farmers may be forced out of rice production. Harvest labor is increasingly scarce and costly. The reaction of farmers, representatives of Agencies and manufacturers was extremely favorable.

Table 1. Private profitability of the SG System, Mechanical Reaper (Raja brand) and the Thai (3 m) Combine

	SG System	Reaper[1]	Combine
Initial cost (B)	58000	38000	650000
Payback period (year	1.3	1.48	2.20
Net present value (B)	103600	54100	406900
Benefit cost ratio	1.42	1.48	1.39
IRR(%)	71	60	34
Cost per tonne (B)	1306	NA	1388

[1] *The mechanical reaper only cuts and windrows the crop, while SG System and the Combine harvests, threshes and cleans.*

[2] *US$1 = 25 Baht*

In New Guinea, performance was good and the outcome encouraging. In the Philippines performance has been consistently high in indica varieties, losses being below 1%. The exception, however, is in traveling down a severely lodged crop, but crop pickup by the rotor when traveling against a lodged crop is excellent -- losses are one third or better than for cutterbar-equipped combines. Wheat has also been satisfactorily harvested with the SG800.

Conclusions

There is a real need for labor saving harvest technology in Asia, even in regions which are heavily populated. Labor shortages at harvest time are exacerbating farmer's difficulties through increased labor costs and/or crop losses due to delayed harvest, especially in the wet season. In areas of lower population density, especially in the zones of rapid economic growth, harvest labor is in chronically short supply.

The only alternatives to hand labor so far and in some regions are reapers and combines.

The mechanical reaper, used with a stationary (axial-flow thresher) while having the advantages of saving the straw and allowing an intermediate curing stage prior to threshing has several drawbacks, namely

- high labor requirement to pick up the reaped windrow and stack in small piles (6-7 people per hectare per day) and then transfer the small piles to the thresher pile (5 people per hectare per day)
- high grain loss while handling the cut crop prior to threshing
- poor performance in lodged and weedy crop
- not capable of harvesting in deep standing water
- the reaper is a dedicated machine that cannot be used for other field operations

Smaller combines have been developed in China (tractor wrap-around type) and in Thailand (on extra-wide-tracked chassis) that are successfully meeting needs on larger ricefields. Small scale farmers and those with crops inaccessible to road access are at a distinct disadvantage.

The stripper-gatherer (SG) system developed around the SRI stripper rotor has demonstrated the capability to uniquely match those needs.

Unless small-area farmers have access to such a system that will allow them to reduce their harvest and threshing costs, they will stop growing rice, at present market prices.

An initial financial appraisal indicates that the SG system can harvest at a lower cost per tonne than the 3 m Thai combine.

Farmers in several countries who have seen the SG system operate are impressed with all aspects of the performance. They were particularly attracted by the ability the system gave them to harvest and thresh at the same time, and the removal of the need to collect, gather and stack manually-reaped crop.

Farmers perceived that there would be no problem in incorporating the straw left in the field after stripping, and a recognition that the extra straw would benefit the soil.

The SG harvester was able to harvest lodged crop with acceptably low losses. However, field capacity was reduced. Modifications are required to the SG800 to allow it to efficiently harvest standing crop higher than 1 m.

The potential of the stripper principle to reduce losses and greatly improve harvest work rate in rice compared to a cutterbar gathering system on small combines provides an incentive to continue the development of stripper threshers and small stripper combines for Asian farming conditions.

In summary, the SG system, now in operation, can harvest more cheaply than any existing system used on small farms in Asia and is a simpler design capable of local, rural-based fabrication. It is eminently suited to the region's rice farmers and may be of considerable importance to help small area farmers survive under difficult economic conditions.

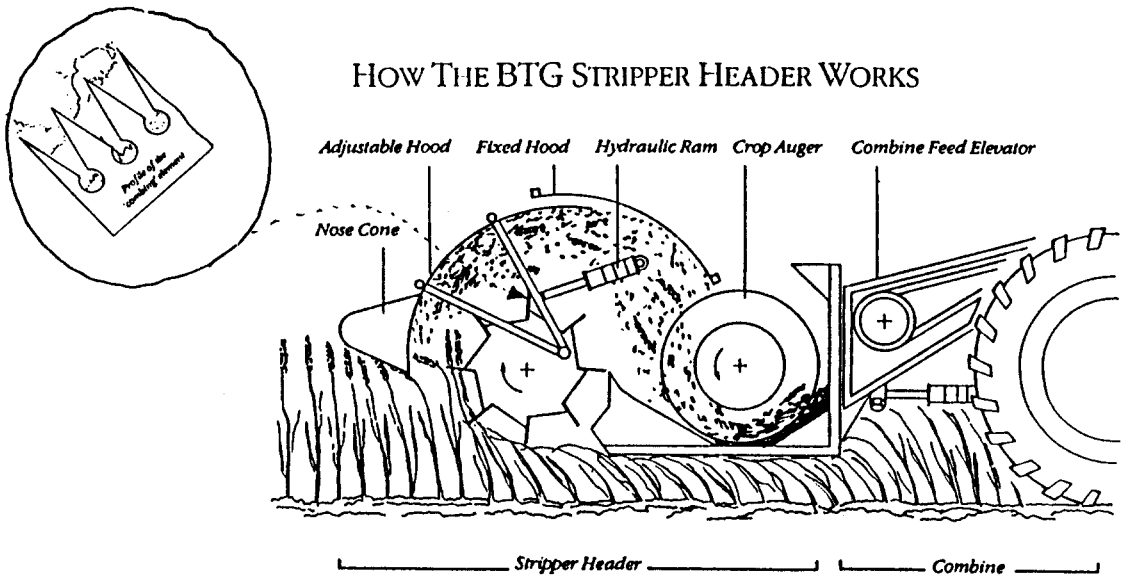

Figure 1. Schematic showing the operating principle of the Silsoe upwardly-combing stripper rotor and stripping teeth (inset). In the UK the teeth are made of plastic. This stripper rotor principle is patented by the British Technology Group and is marketed for bigger combine harvesters by Shelbourne Reynolds Engineering Ltd., Suffolk, England.

Figure 4. The TC800 thresher that is used to rethresh and clean the grain from the collection module of the SG800. Both the SG800 and the TC800 can be carried into small ricefields by a team using bamboo poles. This portability requirement is a key feature of the SG800 system.

Figure 5. SG800 system in transport mode . The trailer containing the TC800 thresher/cleaner and collection containers is coupled up and towed to the field by the SG800 stripper gatherer. The harvester has a special road gear for transport up to 20 km/h if rubber tyres are fitted in place of the unitary drive starwheel shown.

Figure 2. An SG800 Stripper Harvester at work in a muddy rice field.

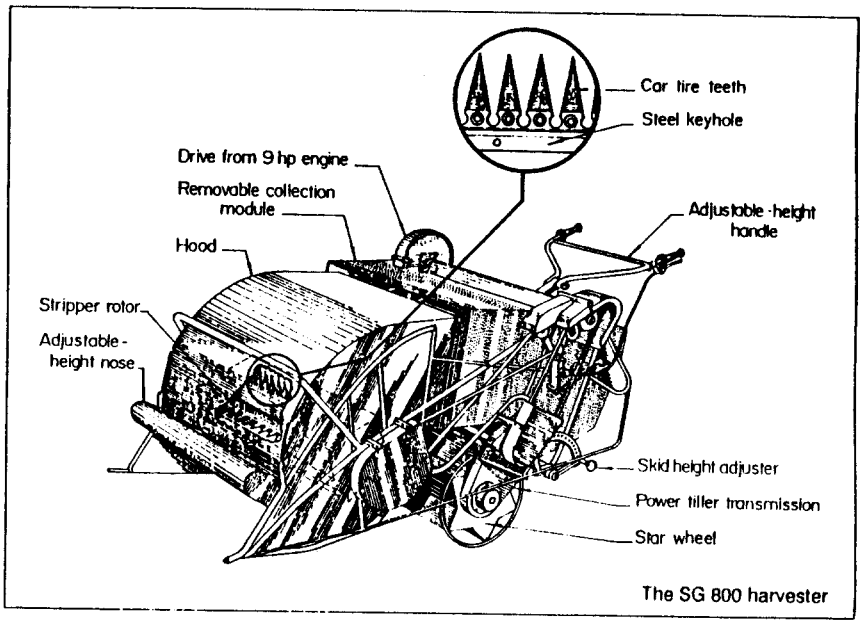

Figure 3. The SG800 Stripper-Gatherer which was developed at IRRI Los Baños, under a collaborative activity with Silsoe Research Institute, UK, funded by the British Overseas Development Administration (ODA).