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Investigation on Mechanized Harvesting Requirements of Pokkali Paddy for Optimizing Harvester Design

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ABSTRACT

Saline tolerant and the tall cultivars of paddy in the pokkali system is native to central parts of Kerala have importance on several factors such as traditional value and nutrition, taste etc. The cropping area is declining due to the several constraints in cultivation, mainly due to lack of suitable harvesting machine. In initiate a harvester design, the requirements in traditional cultivation practices are to be identified and it's essential to ensure the design is fulfilling the existing requirements. In this context, the requirements of mechanized harvesting of paddy in the pokkali system were investigated through survey on farmers, field observations and sample experimentation. The identified data are crop parameters, sub operations of harvesting to be optimized, customer (farmer) preferences and technical aspects of the machine to be designed, and they form the base for a new design. The chapter discusses the requirements identification and results out of the research.

Key words: *Pokkali farming, Paddy mechanization, Saline Ecosystem, Farmer requirements.*

Introduction

Pokkali Paddy cultivation extends in about 6274 ha in Kerala (Alapuzhai, Thrissur, Ernakulam districts) (Joseph, 2016). The cultivation proceeds in a periodically varying stagnated saline water level in the field due to the backwaters in low lying areas. Adithya (2020) discusses the cultivation practice, farming calendar and other facts about pokkali system. The pokkali paddy received organic certification and Geographical indication in 2007 (Radhika *et al.* 2021). The cultivation is annual during the monsoon periods when less salinity in the field. Rest of the season the field is utilized for shrimp cultivation. Three thousand years old cultivation is diminishing because of various reasons. One of the limitations on pokkali cultivation is mechanization in harvesting. Since the harvesting labours has to work on standing water while operation, experiences various ergonomical issues which leads to labour shortage. The crop is 5 to 6 feet height, and duration is 120 days. Kerala Agricultural University has developed and patented a KAU Pokkali Paddy Harvester, but has limitations on successful running of the machine in the field. Another try, amphibian (machine can run both in land and water) weed harvesting machine, Truxor DM 5045 was tried with weed cutter header assembly, still not suits the needs in unique

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pokkali field. Reddy 2018 studied the design analysis on KAU Pokkali Paddy Harvester and also designed a scaled down prototype of lower field capacity. Such models and designs have the problem with large size, instability in water body, poor cutting performance, lack of storage facility etc.

Hence a research to be conducted to design a suitable harvesting machine with improved feasibility than existing models. Identifying the harvesting requirements for mechanized harvest through a suitable machine finds an importance on initial stage of designing harvesting machinery. This is extreme in case of pokkali paddy because of unique practice and traditional cultivation methods under water stagnated condition. In this chapter, the harvesting requirements of pokkali paddy were investigated as a base data for developing a harvesting machine.

Materials and Methods

The investigation was carried out by survey among the farmers using suitable questionnaire prepared exclusively for the purpose. The questionnaire was prepared in English and duly converted to Malayalam (the local language of the state). The questionnaire including the socioeconomic details, pokkali farming history, crop details and field criteria, labour requirements and cost economics, mechanization status and needs, customer requirements and technical aspects on harvesting machine to be designed. The survey was carried out at Kadamakkudy and Ezhikkara villages in the Keralite district of Ernakulam, by direct interview with farmers at their fields. The type and nature of machinery interested by the farmers, rent bearable, crop factors such as crop height, height of crop on manual cutting, threshing practice, drying requirements etc were the important inferences. Reaping, collection, bundling, manual walking in the field and transportation to bunds were the important sub operations on harvesting. Also the traditional practice of pokkali paddy cultivation was observed from field.

Plant density is calculated based on experimentation from the seed samples (Chootu pokkali and Chettivirippu (indigenous varieties), *Vytilla 1* and *Vytilla 10* (RRS Vytilla varieties) collected from farmers and RRS Vytilla. The seed samples were collected and experimented for bulk density, 1000 seed weight, further the plant density with an assumption of 100% germination. The assumption is because of the fact that, in the natural cultivation scenario the plants have spatial variations on growth. This leads to the condition for a harvesting machine to operate on both denser and loose plant growth per unit area, for the maximum load on harvester, 100 percentage of germination is assumed. Collectively the data was suggested in optimizing the new design of pokkali paddy harvester.

Results and Discussion

The various data collected and analysed on several sectors were discussed as follows.

Socioeconomic details: Most of the farmers and labourers in pokkali system have an age category of 50 to 60. Non involvement of youth in pokkali farming is notable factor. Hence, the technology search and adoption of innovations are difficult. On the other hand, all the farmers are basically literates and post graduate also exists, shows a positive future for mechanization. Harvesting operation is carried out by female workers and other land preparation and transportation operations were done by male workers as shown in the Fig. 1. Hence the harvesting operation is highly demanded for mechanization.

Pokkali farming history: Most of the farmers were average 40 years experienced and continuing the pokkali system from their ancestors, as already discussed, pokkali system is a 30 centuries old farming system. Out of 80 percent of the farmers interviewed, major economic interest is on prawn farming, which requires pokkali paddy cultivation essential as an environmental and ecological demand. Some of the pokkali fields were transferred into prawn/fish farms due to economical reasons. This is because of the lack of harvesting machine. Even though a fact found that the indigenous pokkali rice varieties were at extinction because of the frequent floods occurred in the past few years (2018 and 2019). The RRS Vytilla released varieties and other indigenous varieties from neighbouring parts of the state were used to be cultivated in majority in present situation.

Crop details and field criteria: The crop height varies from 150 cm to 180 cm depending on the crop variety. Indigenous varieties may grow upto 180 cm, RRS Vytilla upto 130 – 150 cm only. Costlier indigenous pokkali paddy varieties (usual yield – 1500 kg ha^{-1}) show almost lodging at maturity whereas cheaper RRS Vytilla varieties (high yielding - 3000

Fig. 1. Harvesting of crop and transportation of cut stalks to bunds

kg ha^{-1}) are not facing lodging problems. The crop cutting height was top 30 to 50 cm (ear heads of plant alone) was interested. Since the pokkali farming is under an ecosystem which is unique, the paddy stalks left over in the field after harvest feeds the shrimps cultivated after paddy cultivation; also it serves as organic manure for the field. So cutting away higher stalk height is not possible. The water level in the field will be varying from 30 to 150 cm varies spatially and temporally. The field size is varying spatially with respect to flow of backwaters. Outer bunds of the fields were not strong enough to sustain the heavy machine movement. If the machines are passing, it might break the bunds, which are highly prone to drastic water level changes and economically impacts the farmer. As reported Sudhan *et al.* (2016), by water salinity changes from 0-31 ppt, the salinity to corrode the components of machine.

Fig. 2. Matured crop (Vytilla variety on the right and indigenous variety on the left)

Based on the 1000 seed weight, plant density was found to be 218 for *Chettivirippu*, 261 for *Chootu pokkali*, 268 for *Vytilla 1* variety and 281 for '*Vytilla 10*' variety, seedlings per square meter based on the assumption of 100% germination. Few farmers are following the mound making and transplanting system whereas others follow broadcasting nowadays in order to minimize the labour charges.

Cost economics: Loan and subsidies along with financial support of NGO's were available. About fourty percentage of the investment cost were subsidised in for some farmers some cases. 30 to 40% of the investment lies on harvesting charges.

Customer requirements on harvesting machine: The farmers with small land holding (<1 ha) were

Table 1. Cost Economics of Pokkali Paddy Cultivation

S. No	Charge	Quantity	Unit
1	Harvesting labour	300 – 450	Rs. day^{-1}
2	Harvesting expenditure	15000 - 20000	Rs. ha^{-1}
3	Thresher rent	500	Rs. day^{-1}
3	Total investment	50000 – 65000	Rs. ha^{-1}
4	Gross income	50000 - 150000	Rs. ha^{-1}
5	Subsidy	20000	Rs. ha^{-1}

demanding walk behind (manual reaper type) type harvester with collecting provision with less field capacity. The sub operation such as manual walking is not a major problem, but the cutting and collection are to be mechanized. Whereas the large land holders (>1 ha) demands the self propelled machine including all the sub operations of harvesting to be mechanized. Smaller operational width of about 1 – 1.2 m is suitable for small scale farmers and larger width of 2.1 m for large farmers can be suggested. Cutter header loss upto 25% is acceptable by the farmers in comparison with manual harvest, which is higher than a normal combine harvester. Rent of above Rs.12500 per ha for a harvesting machine is bearable by the farmers, with all sub operations mechanized.

Technical requirements of harvesting machine: The design should facilitate amphibian nature (to work in both land and water) like existing designs with improved stability. The crop was almost in a lodged and floating condition which restricts the normal paddy harvester cutter header assembly works. But the KAU Pokkali Paddy Harvester with cutter header assembly similar to paddy combine harvesters can be redesigned suitably. Threshing is to be done after sun drying (on average 2 days); hence the integrated unit of thresher is not required in the machine to be designed as in earlier designs. The collection system is necessary to hold the cut crop stalks for one acre of coverage without interruption. Cut crop stalks are expected to be delivered in tied bundles.

Fig. 3. Cut crop stalks

Conclusion

From the discussed parameters, a new design can be initiated by fulfilling the constraints identified such as amphibian harvesting machine to deliver the cut stalks in tied bundles at bunds of the fields once an acre covered. Rent can be bearable upto Rs.12500 with a cutter header loss of 25%. For a small farmer, walk behind type machine of about 1.2 m width cutter header assembly similar to commercial walk behind reapers can be tested and for a large farmer, 2.1 m width or even reduced size cutter header assembly can be tested along with bundling and storage facilities. By the introduction of suitable harvesting machinery, the declined area of pokkali system can be restored, through the additional supports from government and NGO's. Thus maintaining the pokkali system can preserve the tradition and also ecological and environmental balance on the locality. Thus it prevents the problems such as soil salinity changes, sea water intrusion, extinction of species etc.

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