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RESEARCH ARTICLE :

Computer aided modelling on farm mechanisation for rice cultivation in Chhattisgarh

■ **NABOMITA MITRA, AJAY VERMA, MANISHA SAHU AND MRITUNJAY MARKAM**

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SUMMARY : Selection of proper size of farm power and machinery is the most important component of any farm enterprise. Among the various inputs to the crop production system, power and machinery jointly represent the largest single item of expenditure constituting about 60% of the total investment on a farm. A decision making program for tractor matching implements during cultivation of rice is framed. Most cost effective rice based cropping system was identified. The cost economics of different cultivation practices was worked out. Computer based least cost models are developed in C++ programming language for the selection of optimum size power and machinery system for paddy cropping system with the input like area under the crop, soil type, number of operations for each crop, crop rotation and time available for each operation etc. The model selected the optimum tractor size from amongst the available sizes and its matching implements keeping in view the capacity of machinery to complete the operation in scheduled time for the given farm. The model also computes the working hours for different field operations along with various cost components. Thus, the model predictions are good for paddy and can be used successfully for selection of optimal power and machinery.

KEY WORDS:
Computer, Modelling, Mechanisation, Cultivation

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Author for correspondence :
NABOMITA MITRA
Department of Agricultural Engineering, SVAET&RS, FAE, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email : sahumanisha79@gmail.com
See end of the article for authors' affiliations

BACKGROUND AND OBJECTIVES

Chhattisgarh state is predominantly mono-cropped with rice as major crop during the rainy season. Chhattisgarh is an assured rainfall zone and here the major issues include increasing the double cropped area in rainfed farming by introducing short duration, moisture stress and high temperature tolerant high yielding varieties of *Rabi* crops such as gram, lentil, linseed, lathyrus, peas, mustard, sunflower, horse gram, niger and sesame after *Kharif* rice. Thus, the major challenge for state agriculture is to increase productivity, production, and profitability while minimizing environmental impact for sustainability and provide economic opportunities. This includes conserving and protecting the quality of the resources that determine the performance of agriculture like land, water, air and biodiversity, ensuring the dissemination of latest knowledge and information, and developing the next generation of farmers and scientists.

Selection of proper size of farm power and machinery is the most important component of any farm enterprise. Among the various inputs to the crop production system, power and machinery jointly represent the largest single item of expenditure constituting about 60% of the total investment on a farm. The decision on optimum size of machinery is quite critical not only because of the high proportion of total cost attributed to machinery but also due to the infrequency and irrevocability of such decisions.

Computer based least cost models are developed in C++ programming language for the selection of optimum size power and machinery system for paddy cropping system with the input like area under the crop, soil type, number of operations for each crop, crop rotation and time available for each operation etc. The model selected the optimum tractor size from amongst the available sizes and its matching implements keeping in view the capacity of machinery to complete the operation in scheduled time for the given farm. The model also computes the working hours and energy requirement for different field operations along with various cost components. Thus, the model predictions are good for paddy and can be used successfully for selection of optimal power and machinery.

Tractor and machinery selection is an important part of machinery management in any farm enterprise as power and machinery jointly represent the largest single item of expenditure constituting about 60 per cent of the total farm investment on a farm. The size or capacity and number of equipment should match the power required by the various sequences of cropping operations that must be performed within specified time periods. The main aim of tractor and machinery selection studies is to complete the field operations during the specified time at minimum cost. Since, the capacity or size of the power-machinery system is directly proportional to their costs, the appropriate selection of these components is important for determining the profitability of the given farming system. Over sizing the power source or the machinery help to reduce the labour cost as well as timeliness costs. However, this benefit may be off set by higher fixed cost. Selection and use of under sized implements on the other hand, may result in higher labour and timeliness cost, thereby, ultimately reducing the net returns. Selection of optimum size farm machinery is quite critical not only because of the high proportion of total cost attributed to machinery but also due to the infrequency and irrevocability of such decisions (Hetz and Esmay, (1986). Modern farming systems require large capital investment, complex economic decisions and higher levels of technical management to minimize cost of production and maximize profit. This kind of enterprise is, however, accompanied by serious economic risks due to uncertainty of weather, timeliness, soil type and conditions, type of crops and crop rotation, management practices, labor availability and high cost of inputs relative to product value. Hence, selecting proper size farm power and equipment to permit economic production in a farm is of paramount important.

Several models have been developed to simulate field machinery selection (Rotz *et al.*, 1983;Ozkan *et al.*, 1986; Siemens *et al.*, 1990). Selection criteria in those models are based on a combination of economic analysis and life, operational requirements (Krutz *et al.*, 1980), timeliness of operation and machine reliability (Edward and Boehlje, 1980), and least cost technique (Singh and Gupta, 1980; Hetz and Esmay, 1986; Isik and Sabanci, 1993; Butaniand Singh, 1994; Behera *et al*., 1998; Vatsa and Saraswat, 2008). Most of these models are suitable for use of the research workers for a particular crop or crop rotation. These models are either limited to a crop specific enterprise or too comprehensive with a broad application resulting in lower sensitivity.

Keeping these points in view, the main objective of this present study was to develop a user-friendly computer model based on the least cost technique for selection of optimum size of power and machinery for paddy-wheat cropping system. The IGAU research farm Raipur is well equipped having total area of about 114 ha in which 68 ha is cultivated area. Among the *Kharif* crop rice, soybean and maize whereas in the *Rabi* crop wheat, linseed, chickpea etc are grown covering maximum area of IGAU farm. In IGAU farm, considerable progress has been observed on adoption of improved technology and mechanization of agricultural operations for production of agriculture. The uses of this system allow the identification of the farm actions, farm machinery selection, cultivation planning and machinery co-operative.

RESOURCES AND METHODS

Experimental site and climatic condition :

The study was carried out during *Kharif* and *Rabi* seasons of 2016-2017 at the agricultural farm of IGAU,

Raipur (C.G). The IGAU farm is situated on national highway no. 6 in Eastern part of Raipur city and located between $20^0 4'$ North latitude and $81^0 39'$ East longitude with an altitude of 293 m above mean sea level. The general climate of this region is dry moist, sub humid and region receives 1200-1400 mm rainfall annually, out of which about 88 per cent is received during rainy season (June to September) and 8 per cent during winter season (October to February). May is the hottest and December is coolest month of the year. The rainfall pattern has great variations during rainy season from the year to year. The temperature during the summer months reaches as high as 48^0C and drop to 6^0 during December to January.

Selection of crop and optimization technique :

In order to find out the most cost efficient farming operation, the crop thus, selected is Rice. The data of the various operations of the selected crop has been collected. The data thus, obtained was used for cost analysis during various farming operations as well as to find out various tractor matching equipments for cultivation of rice to get higher yield at proportional cost. Optimization techniques, like, linear programming (LP), integer programming, mixed integer linear programming, non-linear programming, dynamic programming, conditional optimization approach, least cost technique etc., have been used by different research workers for selecting optimal system of farm machinery. The complete calculation and investigation of this research work has been framed by C++ programming software. The program allows the user to enter the power source of his own choice whether he is an owner of a tractor or want to buy a tractor. Step by step details of above mentioned program is explained as under.

Computer program :

The program has been written in C++ language. The main program begins with tillage operation data namely number of labor in operation, time of operation, rate of Fuel consumption, weight of machinery and life of machinery. After completion it proceed to next enter the sowing or transplanting (rice) parameter namely number of labor in operation, time of operation, rate of Fuel consumption, weight of machinery and life of machinery. After completion enter the irrigation parameter namely number of labor, total time in irrigation, weight of machinery and life of Machinery. After completion enters the seed fertilizer application parameter namely quantity of seed number of labor, total time in operation, quantity of NPK used. After completion enter manual weeding parameter namely number of labor, total time in operation. After completion enter spraying parameter namely quantity of chemical used, number of labor, total time of spraying, weight of machinery and life of machinery. After completion it proceed to next enter the harvesting and threshing parameter namely number of labor in operation, time of operation, rate of fuel consumption, weight of machinery and life of machinery. After completion it proceeds to next enter the transportation parameter namely number of labor in operation, time of operation, rate of fuel consumption, weight of machinery and life of machinery.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

Operation during rice cultivation :

Tillage :

Under this section, comparisons between various primary as well as secondary tillage implements are done. Firstly, the user needs to select the option for owner of a tractor. Hence, according to its matching size and various field conditions, user obtains a list of implements which is useful in his field (Fig.1). Accordingly he selects and obtains the total cost during operation per hectare of land per hour.

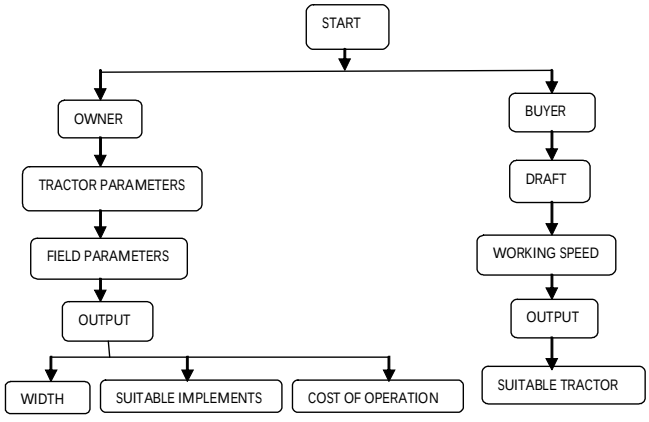

Fig. 1 : Flow diagram for tillage

Sowing :

Under this section, user will be easily able to

compare the difference between *biasi* or broadcasting type and inclined plate planter type of sowing operation. Meanwhile, he will also be able to minimize his cultivation cost by comparing both the above mentioned sowing operation (Fig. 2).

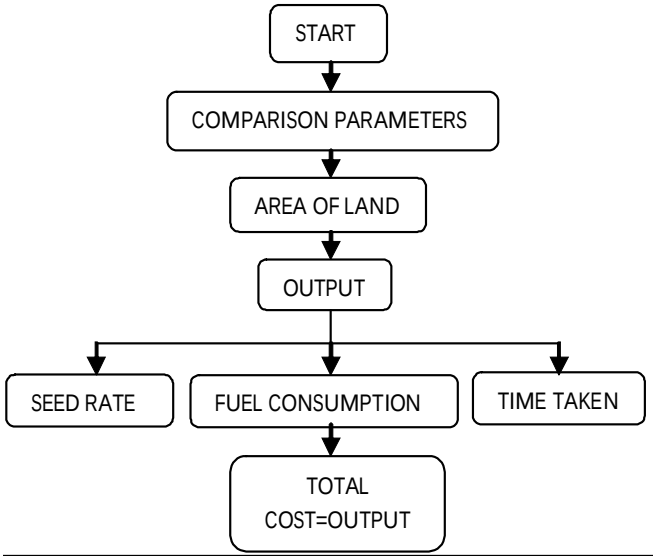

Fig. 2 : Flow diagram for sowing

Weeding :

With the aid of C++ programming user can solve the problem of weeds by comparing three basic weeding operations which are mainly practiced during rice cultivation (Fig. 3). The user while using the program will directly obtain the cost of weeding with the help of ambika paddy weeder, power weeder or manual operations for the area of land he owns.

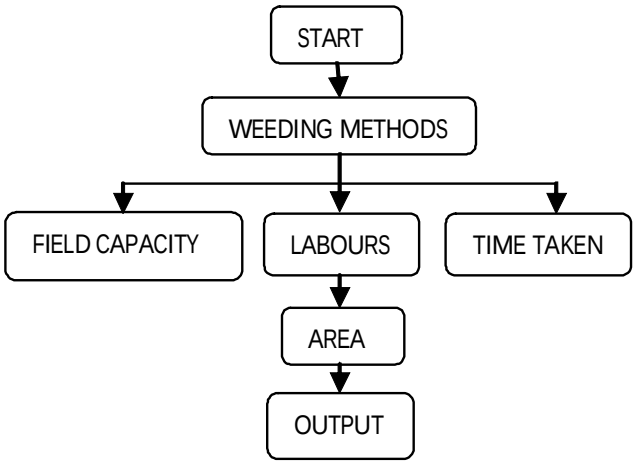

Fig. 3 : Flow diagram for weeding

Plant protection equipment :

In our investigation, we observed that during rice cultivation generally knapsack type and power sprayer are used. Hence, these two types of sprayers have been compared according to its field capacity, application rate and operating pressure (Fig. 4).

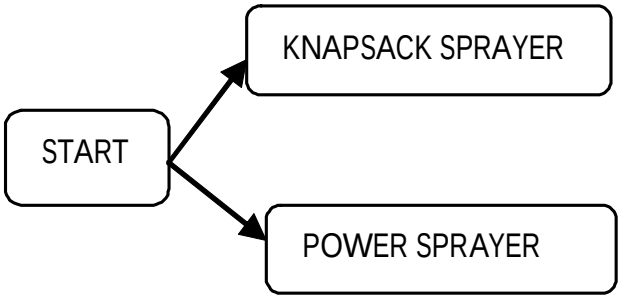

Fig. 4 : Flow diagram for plant protection

Harvesting :

This is the last operation done in this project which provides the user to practice cost efficient harvesting. Under this section, user will be very beautifully aware of various harvesting operation and its cost according to the land he owns (Fig. 5).

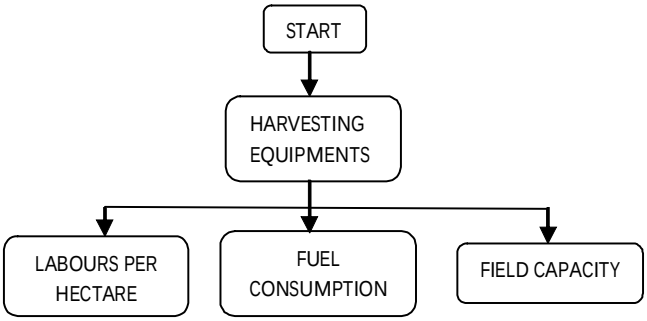

Fig. 5 : Flow diagram for harvesting

Conclusion :

The study on computer aided modeling for Rice Based Cropping System were carried out during 2016-17 at I.G.A.U. Farm, Raipur (C.G.) to investigate the tractor size matching implements and cost effective rice based cropping system on IGAU farm. It was observed that with the help of computer aided modeling, trial and error method for tractor matching implements can be avoided and a complete list of cost of various operations during rice cultivation is calculated. With the advancement of technology it is easier to directly get an approximate capital investment for the cultivation of rice crop. During

sowing operation it is observed that inclined plate planter proved to be economically correct when compared to *biasi* or broadcasting type sowing operation. Hence, it invokes farmer to follow the trend of mechanization in order to avoid high capital investment and lower yield. During weeding operation with manual weeding, farmer analyses time consuming behavior whereas it becomes very easier to use ambika paddy weeder or power weeder instead. Power weeder proves to be cost efficient as well as time saving during the whole operation. But initial investment in power weeder tends to bit costlier than the remaining two. Hence, ambika paddy weeder is generally chosen for the same as it is cheap as well as time saving.

Authors' affiliations :

MRITUNJAY MARKAM, Department of Agricultural Engineering, SVAET&RS, FAE, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA

AJAY VERMA AND MANISHA SAHU, Department of Farm Machinery and Power Engineering, SVAET&RS, FAE, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA

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