Development of a Model to Predict and Intimate Optimum Farm Matching System for Sikkim Using Ms Office 2016 Software

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ABSTRACT

Choice and usage of optimum tractor power and agricultural machinery size is important to decrease cost and complete agricultural operations in available time. Improper size machinery increases the production costs in the farms. Determination of optimum tractor power and machinery size is a tedious and complex procedure that requires many calculations and computational work. In this study, a Microsoft office 2016 software was developed to enable the model and imitate different conditions to determine optimum size of farm machinery and power considering all parameters for selection of farm machinery base on “the least cost method” for Sikkim. The program developed in this study was applied to the representative farm size and crops such as buck wheat, rice, and maize.

Keywords: Mechanization, Field Efficiency, Tractor Power.

Introduction

Sikkim is a small multi-ethnic state with a geographical area of 7096 sq km, mostly with rugged mountainous terrains. About 2500 sq km of the State is human habitable. Agriculture and allied activities continue to be the important occupation and form the main base of the economy. The arable land is 1.09 lakh hectares which is about 11% of the geographical area. The net cultivable area is 79,000 ha with a total cultivator of 1.31 lakhs and 16,939 agricultural labourers. The irrigated area is only 11% hence agriculture is, by and large, rainfed. The state receives adequate rainfall well spread from May to October. Though, the average size of operational holding is 3.9 ha against national average of 0.69 ha the entire holding cannot be used for agriculture due to rugged topography or high slopes. Population growth and consequent fragmentation of farm land has caused reduction in per capita holdings. Further, about 82% of the geographical area is under various types of forest hence, the arable land to agrarian (cultivators and agricultural labourers) ratio is only 0.74 ha/person. Agricultural is still traditional. Cultivation is done in hill slopes with and without terracing. Use of inorganic pesticides and fertilizers are low hence, farming is organic by default. In 2003, Sikkim was declared as organic State. Agriculture in Sikkim is maize based but large cardamom, ginger and mandarin are the main cash crops. Animal husbandry is a subsidiary occupation. The total cattle population is 1.59 lakhs. Baring these crops, the production and productivity of other crops are below the national average. In many places, traditional system of farming still prevails and agricultural operations are carried out mostly by men and women. The topography is rugged with difficult terrain, wide variations in slopes and altitude. Infrastructure including transport is poor. All these factors hamper mechanization of agriculture in Sikkim (Rahman et al., 2008).

The cropping pattern consists of pre-kharif (Feb-July) maize, followed by paddy, finger millet, beans, ginger, tomato, chillies, etc. in kharif (May-Oct) and rajma, mustard, peas, potato, cole crops during winter (Oct-Feb). The principal horticultural crops are large cardamom, ginger, turmeric, mandarin, off-season vegetables, flowers like orchids, gladiolus, lilies and gerbera. The population density is low (76 person/sq.km) as compared to national level (324 person/sq.km). Only 6.43 % of total workers of Sikkim are agricultural labourers (i.e. 3.13% of total

population) and labour scarcity during peak season is a serious bottleneck. Agricultural labourers are increasingly diverted to non-farm jobs. The wages of labour is high and can't be brought down below Rs.100/day and increase in cultivable area in Sikkim is not possible beyond 79,000 ha. Therefore, increase in production and productivity of crops must come from intensive cultivation which among other requirements warrants adoption of farm mechanization or use of improved farm tools and machinery (Rahman et al., 2008). Appropriate Agriculture Mechanization in Sikkim demands a set of machineries, which are small in size, light in weight and has the capability to do maximum possible operations. The machine should be such that it could be easily taken to uphill or down the slope by two or three persons. It must be able to operate in the narrow terraces where other bigger machinery is unable to reach or operate. The required machine should have more field efficiency and reduce drudgery.

The main aim of tractor and machinery selection studies required to complete the field operations during the specified time at minimum cost (Dash and Sirohi, 2008). 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). A careful approach to matching tractor and implement can increase efficiency of operation and farm profitability. When they are correctly matched, the results include reduced power loss, improved operating efficiency, reduced operating costs and optimum use of capital on fixed costs (Taylor et al., 1991). While this approach may enable the farm managers and scientists to carry out the intended operation, the system may not be operating at optimum operating efficiency (Ishola et al., 2010). For proper sizing, one must (Grisso et al., 2007) predict the draft and power requirement of the implement considering factors such as depth and speed of operation, implement width, and soil condition, predict the tractive ability and the drawbar power of the tractor considering factors such as vehicle configuration, weight distribution, ballasting, tractive device type, and terrain conditions.

Need felt to develop programs to assist in the decision-making process for the selection and management of machinery. Considerable research has been conducted in developing computer-based models and simulation programs to determination of optimum tractor power and machinery sizes. According to Dash et al. (2008), 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; Butani and Singh, 1994; Behera et al., 1998; Vatsa and Saraswat, 2008). Mehta et al., (2011) developed computer software to select either an implement to match the tractor or to select a tractor in order to match the implement under different soil and operating conditions.

In this study, a Microsoft office 2016 software was developed to determine optimum size of farm power and machinery. All information's was organized and analyzed by considering the actual condition of Sikkim agricultural system.

Materials and Methods

- ✎ All data for agricultural mechanization were studied and collected. The data included will help production area, labor supply, number of tillage operation, cropping pattern, weather conditions, planting and harvesting dates (Table 1).
- ✎ Field efficiency (η): was calculated by taking ratio of effective field capacity (EFC) to theoretical field capacity (TFC).
- ✎ The total power (hp) used to select required implement was calculated by the following formula $dbhp = (S \cdot D) / 270$ where D = draft (kg), S = speed (km/h)
- ✎ All estimations of required data were taken from the data sheet and standards taken form (IS: 9164 – 1979).
- ✎ Model flow chart for farm machinery and power sizes was developed (Figure 1).
- ✎ Power/energy requirement for farm machinery selections was calculated (Table 3 to 4).
- ✎ Farm machinery and power for Sikkim's condition was optimized (Table 4).

Figure 1. Model flow chart for farm machinery and power sizes

Table 1: Time available for different operations

Operations	Crops	Climate	Soil
Seed bed preparation and from May to July	Buckwheat	Rain Season (July-Oct)	Clay loam
Sowing from June to July and April to May	Rice	Winter Season (Oct-June)	
Planting from October to November and April.	Maize		
Harvesting and Threshing October to December and from April to May.			
Haulage any month depending on the necessity.			

Table 2: General field capacity with selected standards

Time		Area		From Table Recommended Speed and Efficiency (IS 9164 - 1979)				
Days	Hours/Days	Max (ha)	Min (ha)	Operation	Soil Condition	Draft/Width (kg/m)	Typical Speed (km/h)	Field Efficiency, %
30	8	2.5	0.2	Seed bed Preparation	Clay loam	1400	5	80
15	8	2.5	0.2	Seed drilling	Heavy Draft	150	5	70
15	8	2.5	0.2	Planting	Heavy Draft	175	5	70

Table 3: Field capacity in Sikkim

Operation	Actual Working Hours	Theoretical Field Capacity (Ha/h)		Efficiency	Typical Speed (km/h)	Implements Width (m)		Recommended Implements Width (m)	
		Max	Min			Max	Min	Max	Min
Seed bed Preparation	192	0.01	0.001	0.8	5	0.03	0.003	1	0.5

Seed drilling	96	0.03	0.002		5	0.07	0.005	1	0.5
Planting	96	0.03	0.002		5	0.07	0.005	1	0.5

Table 4: Optimized power for Sikkim's condition

From Table Recommended Speed and Efficiency (IS 9164 - 1979)				Width (m)		Draft (kg)		Power Requirement	
Operation	Soil condition	Draft/Width (kg/m)	Typical Speed (km/h)	Max	Min	Max	Min	(kW)	(HP)
Seed bed Preparation	Clay loam	1400	5	1	0.5	1400	700	26	39
Seed drilling	Heavy Draft	150	5	1	0.5	150	75	2.7	4
Planting	Heavy Draft	175	5	1	0.5	175	87.5	3.2	5

Table 4 shows that, power requirement for different farm operations (seed bed preparation, seed drilling and planting), different crops (buckwheat, rice and maize) and under different soil conditions (Clay loam and heavy draft). The power requirement it ranged from 4 hp to 39 hp. Therefore, all farm machinery with different power sources was selected within the optimized range.

Conclusions

The developed model was tested for prediction of farm machinery system for Sikkim. The program is user-friendly and could be run on Windows 10. In current stage, the program can calculate the required numerical values which indicate working widths of farm machinery and power. Expert systems, which can determine real number of tractor and farm machinery from the market for different crop patterns and different regions, should be developed in the future researches.

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