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A study on agricultural engineering equipment in South Tamilnadu using linear regression

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ABSTRACT

Economic growth in India purely depends on the Indian agricultural sector. In developing countries, the mechanization of agriculture plays a vital role in productivity. The research focuses on identifying which farmers in South Tamilnadu mostly use agricultural machinery. In this paper, we have taken farmer names and mobile numbers, choice of implement requirement into consideration by collecting the real data through DBT portal (https://agrimachinery.nic.in). This research work deals with five southern districts in Tamilnadu, namely Dindigul, Madurai, Theni, Ramnad, and Virudhunagar, in which we have predicted which machinery is suitable for that area. The linear regression model was used in this research by testing and training the dataset in all five data frames to get efficient results. Prediction of each data frame reveals the efficient working of the particular machinery for that specific area due to the different geographical features.

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1. INTRODUCTION

Indian economy directly depends on agriculture development by plant cultivation and livestock, and it plays a vital role. In particular, Tamil Nadu agriculture is the most overriding sector in the state's economy with 17% of gross domestic product (GDP) contribution and employment towards 60% of the population. Above 50% of the people in South Tamil Nadu are involved in agricultural activities [1]. There are many types of equipment used in agriculture, from hand tools to tractors and many kinds of farm machinery that they used to tow or operate. Modern agricultural machines can be listed as rotavators, balers, seed drilling, and harvesters for cultivation, planting, and harvesting. It is typically used for escalating the yield of land and effort [2]. The agricultural engineering division has implemented various methodologies for conserving soil & water and managing groundwater in a substantial way to improve agricultural production during the second green revolution. Deprioritization in the agricultural sector was incorporated during the 1990s economic reform. Some of them were welcomed mainly by the farmers in mass [3]. The operation of the modern agricultural engineering implements and maintenance and the training were given to the farmers in

the rural area, especially the young farmers, to utilize and maximize the agricultural machinery to improve farm power. Farmers widely use agricultural machinery to make farming faster. This paper contains different types of agricultural machinery, which shall be explained in the upcoming topics.

We have the details of farmer name, phone number, and their respective machinery used in their farming in the various districts like Dindigul, Madurai, Ramnad, Theni, and Virudhunagar. Each district has different types of crop farming based on their soil. Likewise, the agricultural machinery which has been used also differs. The algorithm built in this research was used to predict it and find which machinery is useful and efficient in that district. While comparing the decades in south India, agricultural mechanization has impacted enormous growth [4]. A wide choice of competitive models, ranging from 12 to 75 Hp, is now available to the Indian farmer. Although the farmers' most profitable tractor power segment in the present scenario is 31–40 hp, contributing almost 50% of the entire tractor industry [5].

2. METHOD

2.1. Background

It is found in the literature that there is a strong potential in the agricultural engineering mechanization for future growth [6], [7]. Electronic systems are used to become a component of modern agricultural engineering equipments. It offten integrates several controls and electrical circuits. For example, in a tractor, the electronics and instrumentation in the tractor can be used to: i) continuously monitor the tractor and ii) advanced mechanized farming. Various equipment or tools are being used for advanced farming. These include communication between tractors and farm implements, sensors, and more. Figure 1 illustrates a tractor using the agricultural communication standard (CANBUS). CANBUS is equipped with a power supply with battery power and ground pin to keep the CANBUS level at the desired voltage.

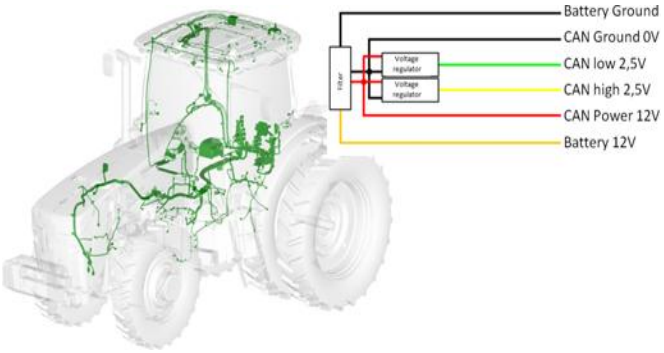


Figure 1. CANBUS in a tractor and the wiring diagram

Due to the poor consultation and understanding of the farmers' needs and the strategies in farming, the extension system available for public agriculture was failed [8]. Let's take each dataset, where we clean the data by splitting the farmer's name and mobile number into individual columns. After that, we fill all the blank spaces in mobile number and machinery columns into valid numerical columns. To get numerical and graphical results, we assigned our suitable number in the machinery column, which contains a name where we have replaced every machinery name data into a unique, and distinct number in the dataset. This section deals with the machinery used in the data set since the data set are more extensive and the real machinery is mentioned in numerical value. Some of the primary sources used by the farmers in agriculture are agricultural workers, draught animals, high-powered tractors, power weeders and tillers, diesel engines for water management [9], [10]. Initially, the given dataset contained two categorical column values (farmer's name and implementation name-machinery name) and one column value (phone number). We changed one categorical column value (implementation name-machinery name) into numeric column values (10-380) to predict the outcome by manually assigning our convenient numbers. The dataset consists of two independent variables (farmer name and phone number) and one dependent variable (implementation name-machinery name). India is one of the prime nations in agriculture growth for high-powered tractors, power weeders, tillers, and other engineering implements in the Asia-Pacific region [1]. The following Table 1 shows the machinery and its types which is taken from the website https://agrimachinery.nic.in/Index for analytics purposes [11]. The datasets consist of 4 columns: farmer name, mobile no, city and implement name (machine name) as shown in Figure 2.

Table 1. The machinery and its types

Machinery name	Allotted No		Types
Tractor	10	–	Tractor with HP range from 20-40 PTO
	60	–	Tractor with HP range from 40-70 PTO
	80	–	2 Wheel drive tractor with HP range from 40-70 PTO
	110	–	4 Wheel drive tractor with HP range from 20-40 PTO
	140	–	Two-wheel drive (2WD) tractor with HP range from 08-20 PTO
	160	–	2WD tractor with HP range from 20-40 PTO
	170	–	Tractor with HP range from 15-20 PTO
	240	–	4WD tractor with HP range from 08-20 PTO
	310	–	Tractor with HP range from 15-20 PTO
	320	–	Tractor with HP range from 8-15 PTO
	280	–	4WD tractor with HP range from 40-70 PTO
Rotavator	20	–	36 blades (5 feet) rotavator for preparation of dry and wetland (tractor (above 30 BHP) driven equipment)
	70	–	42 blades (6 feet) rotavator for preparation of dry and wetland (tractor (above 35 BHP) driven equipment)
	90	–	Rotavator for preparation of dry and wetland (tractor (20-35 BHP) driven equipment)
	120	–	Rotavator for preparation of dry and wetland (tractor (above 35 BHP) driven equipment)
Brushcutter	30	–	Thresser and harvester operated with electric motor and tractor engine below 35 BHP
	100	–	Thresser and harvester operated with electric motor and tractor engine below 20 BHP
Power Weeder	40	–	Power weeder tractor attachment below 2 bhp
	130	–	Power weeder tractor attachment above 2 bhp
	270	–	Engine operated power tiller (below 20 BHP) driven
Power Tiller	50	–	8 BHP & above
Powered Knapsack Sprayer	150	–	Battery sprayer 12-16 ltr with 0.75 to 1.00 hp for protection of plant
	200	–	Battery sprayer 8-12 ltr with 0.75 to 1.00 hp for protection of plant
	230	–	Battery sprayer above 16 ltr with more than 1.00 hp for protection of plant
	290	–	Battery sprayer above 8-12 ltr with below 0.75 hp for protection of plant
Chaff cuttter	180	–	Chaff cutter below 3 HP and by power tiller and tractor of below 20 BHP)
	190	–	Chaff cutter below 5 HP and power tiller and tractor of below 35 BHP)
Balers	210	–	Round balers 16-25 kg per bale with tractor operated above 35 BHP
	340	–	Round balers 14-16 kg per bale with tractor operated above 35 BHP
Arm Cultivator	220	–	9 tyne cultivator for land preparation attachment to tractor above 35 HP
	300	–	Tyne cultivator for land preparation attachment to tractor 20-35 BHP
Disc Plough	250	–	Hydraulic disc plough for land preparation attachment to tractor above 35 HP
Reversible MB Plough Hydraulic	260	–	Hydraulic reversible plough 2 bottom for land preparation attachment to tractor above 35 HP
Post Hole Digger/Earth Augur	330	–	Auger self propelled machinery
Reversible plough (2 bottoms) Mechanical mode	350	–	Mechanical reversible plough 2 bottom for land preparation attachment to tractor above 35 HP
Threshers for multi-crop	360	–	Multicrop threshers operated by a tractor with above 35 HP and electric motor
Groundnut digger	370	–	Tractor operated groundnut digger above 35 HP for sowing, reaping, and digging
MB Plough	380	–	MB Plough for land preparation attachment to tractor above 35 HP

	Farmer_Name	Mobile_No	City	Implement_Name
0	MUTHUKRISHNAN	9047644308	DINDIGUL	10
1	MUTHUKRISHNAN	9047644308	DINDIGUL	20
2	ALAGESAN	9942608951	DINDIGUL	30
3	ALAGESAN	9942608951	DINDIGUL	30
4	saraswathimayadever	9360397898	DINDIGUL	20
...	...	...	...	...
3347	JEYAKODI	9965561465	VIRUDHUNAGAR	80
3348	Karuppaiah S	9965561465	VIRUDHUNAGAR	70
3349	Karuppaiah S	9965561465	VIRUDHUNAGAR	250
3350	KRISHNAMMAL K	8667253661	VIRUDHUNAGAR	80
3351	KRISHNAMMAL K	8667253661	VIRUDHUNAGAR	160

Figure 2. Agricultural implement requirements in each city

2.1.1. Dindigul district

This city contains 22 different types of implement names in numeric form. The dataset includes a maximum number of 180 types of machinery with fewer values in type 130 machines. We assume that 180 kinds of machines are popular among Dindigul district.

2.1.2. Madurai district

This city has 11 different types of implement names in numeric form. The dataset includes a maximum number of type 50 machinery, whereas it has fewer values in 40 machines. We assume that 50 types of machines are popular among Madurai district.

2.1.3. Ramnad district

This city has 15 different types of implement names in numeric form. The dataset includes a maximum number of type 80 machinery, whereas it has fewer values in 280 machines. We assume that type 80 machines are popular among Ramnad district.

2.1.4. Theni district

This city has 16 different types of implement names in numeric form. The dataset includes a maximum number of type 70 machinery, whereas it has fewer than 240 machines. We assume that type 70 machines are popular among the Theni district.

2.1.5. Virudhunagar district

This city has 18 different types of implement names in numeric form. The dataset includes a maximum number of type 80 machinery, whereas it has fewer than 330 machines. This dataset assumes that type 80 machines are popular among Virudhunagar district.

Figure 3 represents the machinery used by the Ramnad district farmers. This graph shows us the most used machinery and least used machinery for agricultural purposes easily. Type 80 machinery is the most used machinery with nearly 50% of the population. More number of the farmers in Ramnad use the tractor as the central machinery in their agricultural area. Similar process is applied for other district farmers.

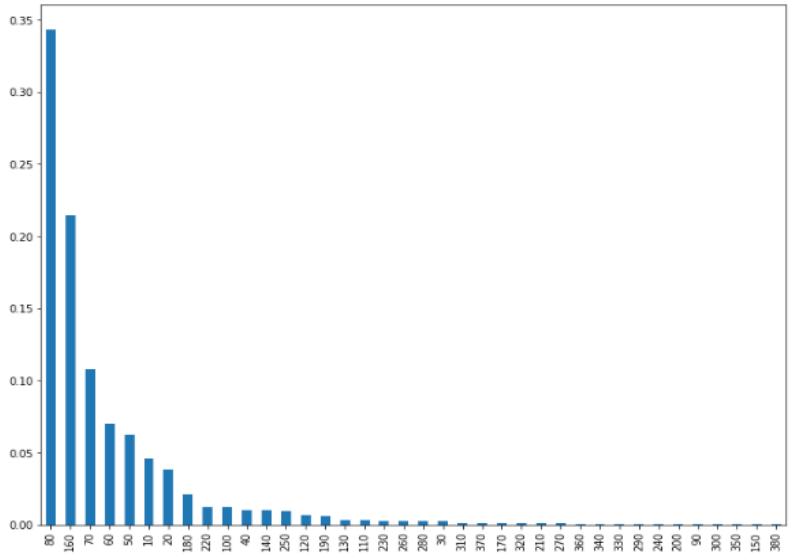


Figure 3. Ramnad district machinery usages

2.2. Research method

In machine learning, regression offers mathematical methods that allow people to predict a continuous outcome based on the value of one or more predictor variables. Regression may be a statistical procedure employed to seek out the strength and estimate the connection between the variable and the experimental variable [12]. In regression terminology, the variable which is being predicted is called the dependent variable. Regression analysis needs some features on which analysis is to be made. It has *n* features and *m* rows of training data. In linear regression [12], the relationship between X and Y is linear and

non-deterministic, where Y is distributed normally at each value of X. The observations are independent. The dependent variables Y are also called outputs or responses. The independent variables X are also called inputs or predictors.

In this research, we have analyzed and studied the data using linear regression by two approaches: statistical formula-based regression. Another one is the inbuilt linear regression function in python. For the statistical formula method, we initially get the mean of the column values, mobile number, and implement name stored in variables *ma* and *mb*, respectively. After that, we initiate numerator and denominator zero. By using a 'for' loop, we find the numerator and denominator, respectively. Values of *m* and *c* are found and printed; then, we use the *y=mx+c* formula, representing them in a scatter plot is shown in Figure 4. From the sklearn library, the class linear regression is imported and initialized to an object called a model. Data fitting is an essential process in which we fit the data to get accurate results. Then, we predict the value of x_test data using the predict function and store it in prediction, which is then compared with the y_test values. Finally, the result is visualized as a scatter plot is shown in Figure 5.

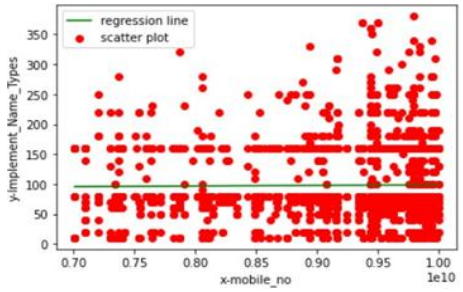


Figure 4. Scatter plot using linear regression with statistical formula

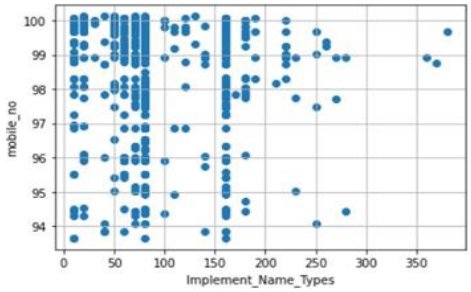
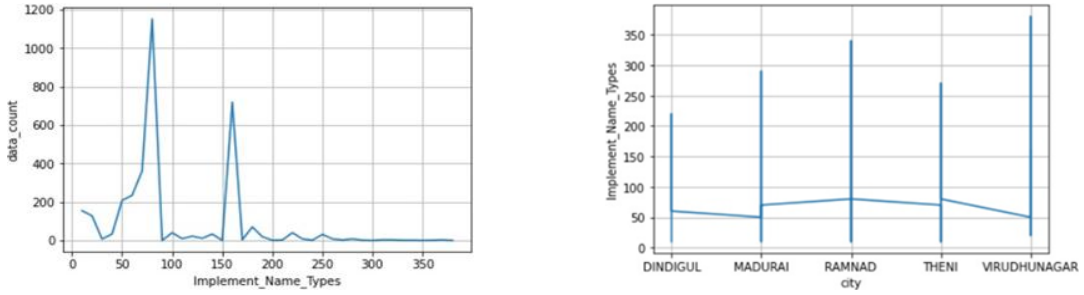


Figure 5. Scatter plot using linear regression by model selection

3. RESULTS AND DISCUSSION

The obtained results exploiting machine learning in Figures 6(a) and 6(b) shows that the usage of agricultural engineering equipment has increased in the areas of South Tamilnadu with increased production and profitability in operations and time limitations in farming [13]. The agricultural implements like tillers, cultivators, rotavators, sowing machines, and threshers can be operated with the tractor's attachment. The usage of tractors in South Tamilnadu is mainly for field operations like puddling, ploughing, land preparation, and transporting the materials with trailer attachments with different loads from 2 to 10 tons [14].



(a) (b)

Figure 6. Line chart showing the machinery used mainly by the farmers all over five districts (a) the relationship between the machine name (in number) and (b) the distribution of the machine among five districts

This line chart speaks about the usage of machinery in South Tamilnadu. The most commonly used machinery is type 80, tractor 2WD (above 40-70 PTO HP), followed by type 160 tractor 2WD (above 20-40 PTO HP). The selection of tractors is hypothetically tricky since there are various tractors; the selection process is done regarding the land and many other factors [15], [16]. As discussed above, the steps used in cultivation starts from land preparation with the help of 5 tyne, 9 tyne cultivators, and the soil is further

grinded using rotavators in a wetland and dry land. The histogram in Figure 7 represents the given combined dataset where we can see an increase in the range 50 to 80 and 160 to 190. To be specific, we find maximum no of farmers uses 80 and 160 type of machinery uniformly in various districts is shown in Figure 8. We observe a clear picture of how data is scattered over the various districts. With the above diagrammatic results, common machinery among the different districts has been found and its difference. Based upon correlating the dots, we can get the desired results. Type 70 (rotavator (42 blades -6 feet)) used with 25 HP tractor for development of land, tillage, 80 (tractor with HP ranges from 40-70 PTP), 220 (9 tyne cultivator) attached with tractor above 35 HP are the most commonly used machinery. Thanked machine learning algorithms, this large data can be wisely processed not only on agricultural engineering equipment but also in many aspects of applications [17]-[23].

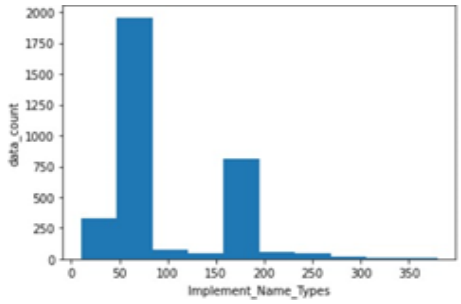


Figure 7. Histogram graph for machinery

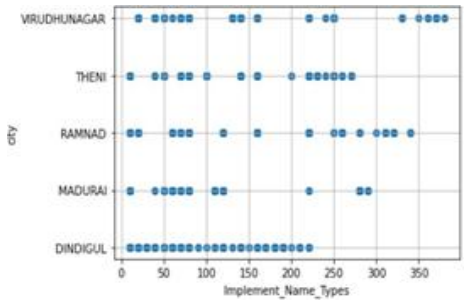


Figure 8. Scatter plot for representation of machinery

The scatter plot speaks about the machinery used by the five districts. Here Dindigul district has not even used the machinery above type 250, but in Virudhunagar district, it has a scatter over all the ranges. Virudhunagar is the only district that has used the machinery above type 350. Madurai district has mainly used machinery ranging from 40 to 90. Figures 9 and 10 show the population of the farmers in each district and the machinery used by farmers. The first graph shows the population of farmers and Ramnad is the district with the highest population among the five districts, followed by the Virudhunagar district. Theni district has the least population among the others. The second graph shows the machinery which is mostly used and least used over all other machinery. Type 80 (i.e.). tractor2WD (above 40-70 PTO HP) is mostly used over every district then, followed by type 160 (i.e.) tractor2WD (above 20-40 PTO HP). Tractors play an important role in land preparation and carrying out multi operations in farming [24]-[31]. The least used machinery is more because the district has rarely used it. Various agricultural engineering implements in South Tamilnadu have tremendous growth with improved tools and equipment. It helps reduce labor and time, especially draught animals, increasing crop production, and machinery plays a vital role [32]-[44].

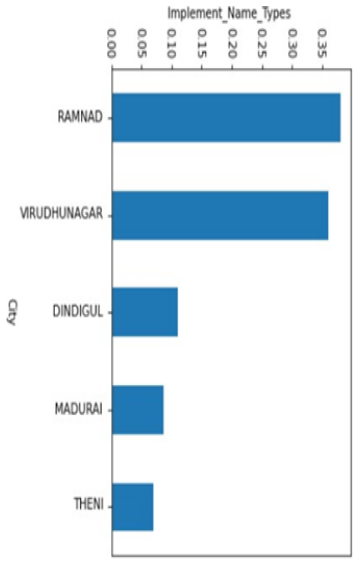


Figure 9. Bar chart for machinery

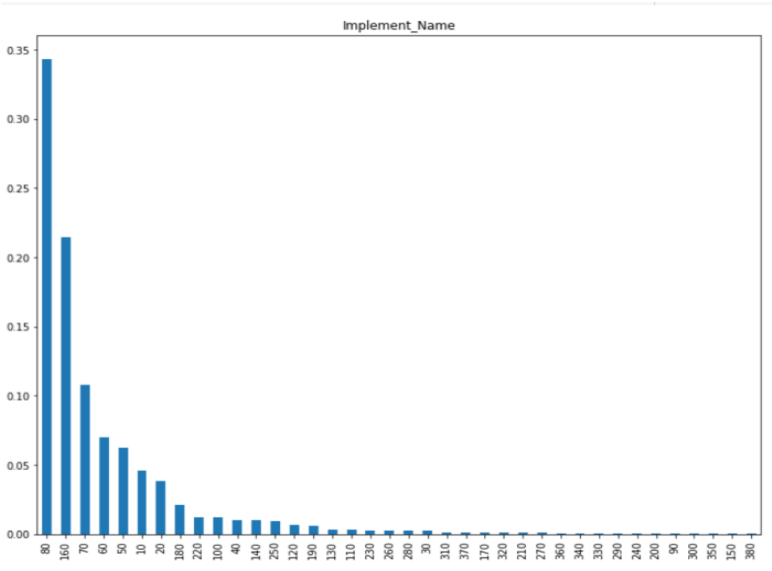


Figure 10. Bar chart for the city as the x-axis & population as the y-axis

4. CONCLUSION

This paper concludes that maximum data collection has been done in districts Ramnad and Virudhunagar. Different types of machinery are used by the farmers in the five given districts, and as per the result, the tractor (type 80) is the most commonly used machine among all the districts. Among the five districts, the Dindigul district has many kinds of machinery used by the farmers, and Madurai is the district where different machinery types are used less. The most used machinery is a tractor of various types like it differs in ranges. The selection of tractors is the most critical process as they should be selected based upon the agricultural land. Implements like cultivators and rotavators are very common for all types of crop cultivation. This research work helps the farmers and consultants to find the appropriate agricultural tools for the selected area.

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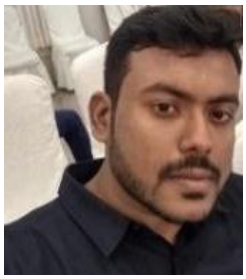

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