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Exploration of the parameters for Leagile practices in food supply chain in India

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Abstract

In the global economy, India has increased agricultural imports and exports to other countries. India, being an agricultural power house has most of agricultural practices to be traditional. Compared to previous years, in the present scenario, the growth is not prominent when compared to that of other countries. Across the country, there are different practices followed by farmers which may not add any value to the process but the costs incurred by farmers for cultivation is too high and margin they get is too low. This may be mainly due to productivity of agricultural practices which produces waste before it reaches consumer. The paper primarily focuses in identifying and eliminating non-value added activities and standardize processes to increase effective farm yield

1. Introduction

The increase in competition has evolved various sectors of businesses and business practices to sustain in the competition and satisfy customer demands. Organizations have inculcated many Quality Management Process (QMP) to ensure the mapping of customer specifications to Organization's Vision and mission. It does not alone mean QMP but also lean initiatives that cut down cost by eliminating Waste/processes that does not add any value.

India known to be the second largest manufacturing automobile hub after China. There is a huge difference in manufacturing and agricultural practices. But in countries like India concerned to agricultural sector, process efficiency makes huge difference. There is huge variation in process in India and world. The least used prominent modern practices in agriculture make it less agile. However, the situation has improved a lot when compared to the past. There are evident changes in the cropping and cultivation process indicating the increase in the cultivation of non-food grain crops and decline in the cultivation of the food grain crops. This shift is due to the fact that the non-food grain crops are classified as commercial crops and to gain access to a considerably larger markets the farmers are leaning towards commercial corps rather than the food grains which are classified as non-commercial crops.

Industry Over view:

Farming assumes an indispensable part in India's economy. More than 58 for each penny of the country family units rely upon farming as their main methods for employment. The offer of essential sectors(counting farming, animals, ranger service and fishery) is evaluated to be 20.4 for every penny of the Gross Value Added (GVA) amid 2016-17 at current costs. GVA from the part is evaluated to have developed at 3 for each penny in FY18.

The Indian sustenance industry is balanced for gigantic development, expanding its commitment to world nourishment exchange each year because of its huge potential for esteem expansion, especially inside the sustenance handling industry. The Indian sustenance and basic need showcase is the world's 6th biggest, with retail contributing 70 for every penny of the deals. The Indian nourishment handling industry represents 32 for every penny of the nation's aggregate sustenance advertise, one of the biggest enterprises in India and is positioned fifth as far as creation, utilization, trade and expected development. It contributes around 8.80 and 8.39 for every penny of Gross Value Added (GVA) in Manufacturing and Agriculture individually, 13 for every penny of India's fares and six for each penny of aggregate modern venture.

Market Size

Amid 2017-18 trim year, nourishment grain creation is required to achieve a record 277.49 million ton. Amid 2016-17, it was 275.68 million tons. India has been the world's biggest maker of drain throughout the previous two decades and contributes 19 for every penny of the world's aggregate drain generation. India is developing as the fare center of moment espresso which has prompted fares of espresso increment 17 for every penny in date-book year 2017 to achieve US$ 958.80 million..

Add up to region in India, sown with rabi crops achieved 64.29 million hectares in February 2018. India is the second biggest organic product maker on the planet. India's cultivation yield achieved 300.64 million tons in 2016-17 and is required to achieve 305.43 million tons in 2017-18. Farming fares from India achieved US$ 28.09 billion amid April 2017January 2018 with fares of basmati, bison meat achieving US$ 6.19 billion and US$ 6.59 billion, separately. Dairy area in India is required to develop at 15 for every penny CAGR to achieve Rs 9.4 trillion (US$ 145.7) billion by 2020.

Objectives of the study

- To identify the wastage levels during the transportation of the commodities and the factors associated with it and to develop practices that can significantly control the wastage.
- To eliminate the gap between organized sectors of agriculture and unorganized sectors of agriculture by implementing the concepts of lean and agile manufacturing.
- To develop a procedure to identify non-value added processes, costs ,materials that brings down efficiency of the cultivation

2. Literature Review

Management and manufacturing have evolved to a whole new level in the 21st century. Major companies have adapted and excelled in various practices and very few have made a huge impact on the functioning of the processes, one such practice is lean manufacturing, Toyota pioneered the lean practice and solely concentrated on reducing its operational cost and improving the quality of the process and the product. Agile manufacturing is a practice that companies have started adapting to concentrate more on the customer demands requirements, The companies that manufacture customized and personalized products in their process can benefit by adapting agile manufacturing. (Sindhwani & Malhotra, 2017)

Manufacturing practices such as lean an agile are all bi products of global competition amongst the organizations as a result of globalization. As the companies evolved, their manufacturing processes also evolved to keep to the global competition and meet the customer demands. The company has to forecast the customer demand with a marginal tolerance level and manufacture the models. In the case, where the copany the has over produced, then it has to experience the losses for all the unsold products and rework cost to consume them into other new products. (Ustyugová & Noskievičová, 2013)

The term agility means the capability of a company to respond to adapt to the changing business environment. The most significant factors that induce the change in the business environment are cardinal principles, customer satisfaction, change over of equipment and rapid adaptation. Lean manufacturing is beneficial for the companies which have low mix and high volume of production, whereas agile manufacturing is beneficial for the companied which have a high mix and low volume of production.(Dr.Bhekithemba & Lemohang S.N., 2015) Companies like the General Electric have implemented agile manufacturing into their manufacturing process of the General Electric Company Marconi Aerospace (GECMAe). Audit will be performed on Enriching Customers ,Co-Operating Competitiveness Mastering Uncertainty and Change ,Leveraging People and Information

This enabled GECMAe to identify ,investigate and correct the problems to provide good results that enables the officials to identify the agility index (a percentage) to an extent where at particular points

in the process. GECMAe has adapted agile manufacturing only at the points with a high agility index, this enables the company to improve the points and become more agile and thus manage the customer requirements more efficiently. (A. Gunasekaran a E. Tirtiroglu a, V. Wolstencroft b, 2002) Adapting agile manufacturing enables the companies to succeed in a competitive unanticipated business environment and respond quickly and adapt all rapid changes valuing the products and services of the organization. The process of agile adaptation is unique for every company and hence careful and stringent analysis has to be made to identify certain points that may be responsible for the downfalls .The company process becomes more flexible and hence can adapt to the rapid market and customer requirement changes. (Thilak, Devadasan, & Sivaram, 2015)

Research Hypothesis:

H0 :The hidden time consumption has no overall effect in the overall production time.
H0 : Transportation has no significant relationship with the wastage of commodities.

Sources of data

Primary data: The primary data was collected based on a questionnaire and the response of the same from agriculturists, farmers and agriculture students. A population size of 335 was considered for the analysis to locate the most prominent phase that consumed more time and the changes that can be made to reduce the wastes due to handling of the crops.

Secondary Data: The secondary data was collected from various government databases and the datasets of the quantity and prices of the crops, for each state and the wages for the farmers for each crop type and each state are considered to analyze the pattern of the product yield quantity and the pattern in the changes of wages over the years to support the primary data.

Process Flow & AS-IS Model

Process Flow System

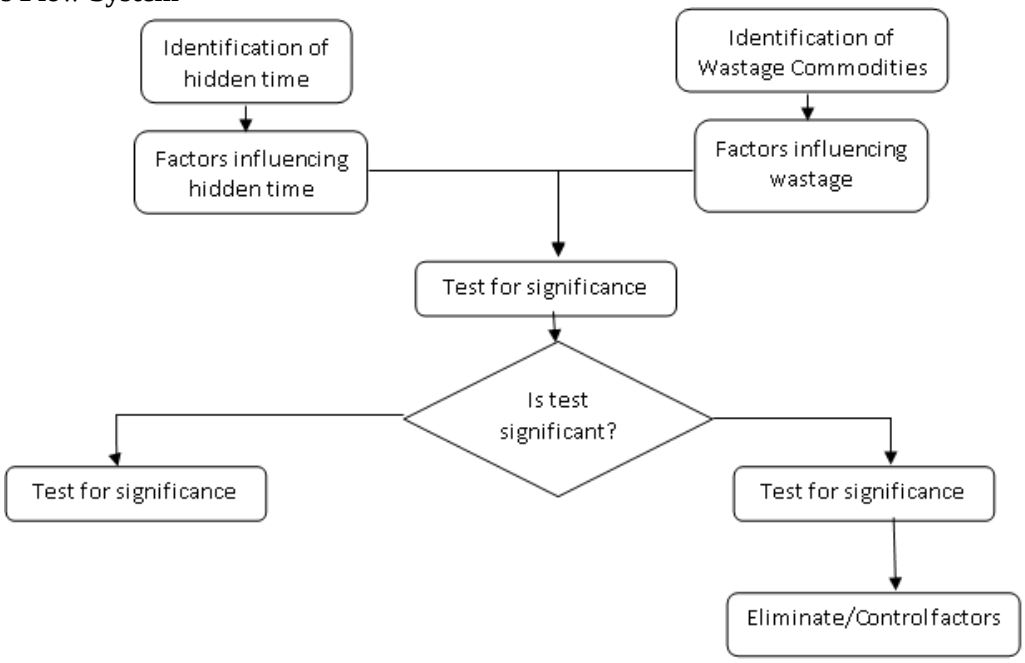


Figure 1: Process flow system for identification and elimination of factors influencing the unwanted time consumption and wastage of commodities during transportation

AS-IS Model

Area and Production of Horticulture Crops - All India: 2016-17 to 2017-18

Sl No	Crops	2016-17		2017-18			
				(1st Estimate)		(2nd Estimate)	
	Vegetables	**Area**	**Production**	**Area**	**Production**	**Area**	**Production**
1	Bitter gourd	95	1030	93	1063	106	1069
2	Bottle gourd	153	2529	158	2677	160	2683
3	Brinjal	733	12510	729	12616	732	12668
4	Cabbage	395	8807	400	8972	403	9011
5	Capsicum	24	306	24	321	24	297
6	Carrot	86	1350	88	1446	90	1487
7	Cauliflower	454	8557	459	8805	460	8792
8	Cucumber	74	1142	76	1217	130	1550
9	Chillies (Green)	316	3634	311	3761	277	3013
10	Elephant Foot Yam	29	748	29	555	30	797
11	Mushroom	182	441	182	432	0	469
12	Okra/Ladyfinger	507	6003	501	5972	506	6073
13	Onion	1306	22427	1196	21402	1315	21838
14	Parwal/Pointed gourd	18	268	20	325	19	303
15	Peas	530	5345	540	5427	543	5425
16	Potato	2179	48605	2176	49344	2153	50327
17	Radish	203	2898	209	3174	208	3197
18	Pumpkin/Sitaphal/Kadu	74	1664	76	1709	59	1337
19	Sweet Potato	128	1460	131	1465	133	1494
20	Tapioca	199	4171	190	3627	210	4073
21	Tomato	797	20708	801	22337	784	22073
22	Others	1558	21557	1584	22059	1614	22149
Total Vegetables		**10238**	**178172**	**10172**	**180684**	**10147**	**182034**

The area and production of fruits and vegetables for all the states and union territories in India for the year 2016-2017 is represented in the above table.

3. Limitations

- The limitations are that not all farms can implement the agile concepts as certain farm lands are suitable for very particular type of crops.
- The wastage cannot be predicted as the crops are perishable in nature and yield prediction may not be true as the number of variables to be considered are highly random.
- The intricate timing details for the cultivation process cannot be taken as the survey may be wide spread and the procedure of cultivation for the same crop may be different for different locations.
- The transportation for certain crops cannot be avoided as the crop may have demand in various places.

Analysis

Commodity/Crop wastage split including the losses during transportation, losses during farm operations, losses during storage are mentioned in the above table. It can also be seen that the fruits and vegetables have no split values but has a wider range of wastage up to 15.88% which totals to 40811 crores (in Rs.)

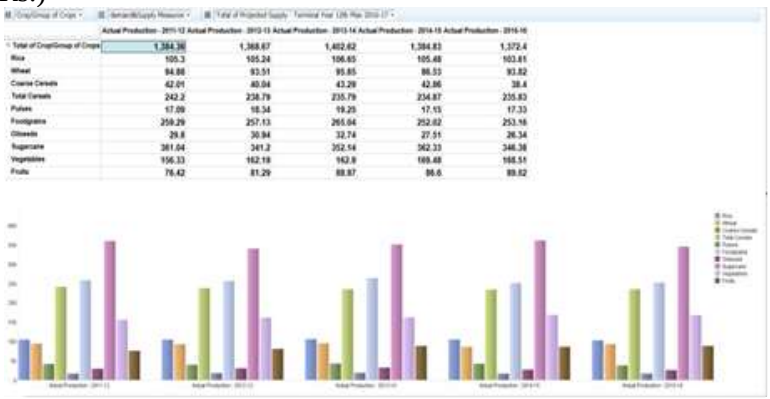


Fig. Comparison of production of crops in India year wise

Further the comparison of production individual crop is for the years 2011-2012 to 2015-2016 are made using the tool IBM Cognos Insight. It can also be noticed that the cultivation in general for majority of the commodities are experiencing a decline in the year 2014-2015 and 2015-2016

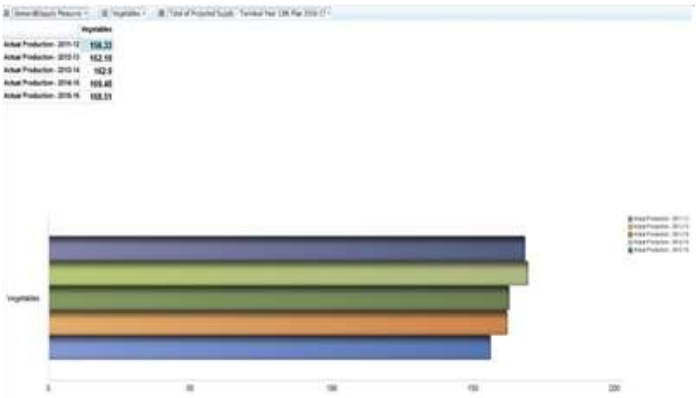


Fig. Comparison of the production of vegetables

The graphical representation of the production of vegetables for the year 2011 to 2016 is given in the figure 10. It can be seen that the production is consistently increasing till the year 2014-2015 and has seen a marginal decrease in the year 2015-2016.

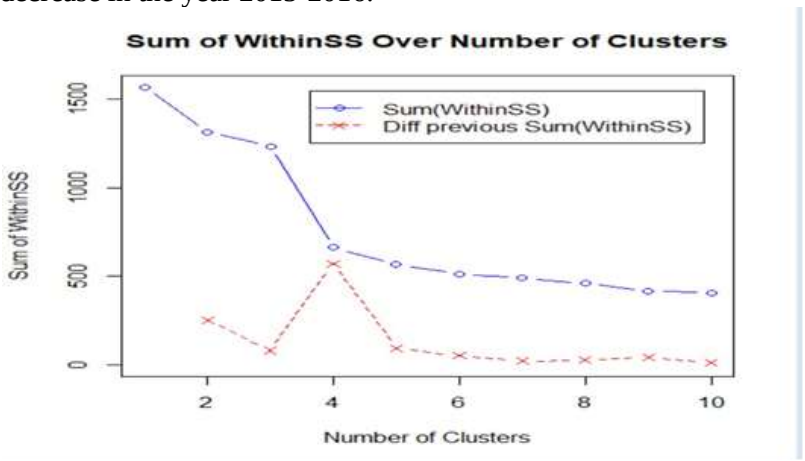


Fig. Cluster characteristics plot

From the above curve, it above curve it can be observed that the distance between the nodes change abruptly after at the point 4, where the number of clusters are 4.
The discriminant plot shows the cluster plot and the dispersion data among the 4 clusters.

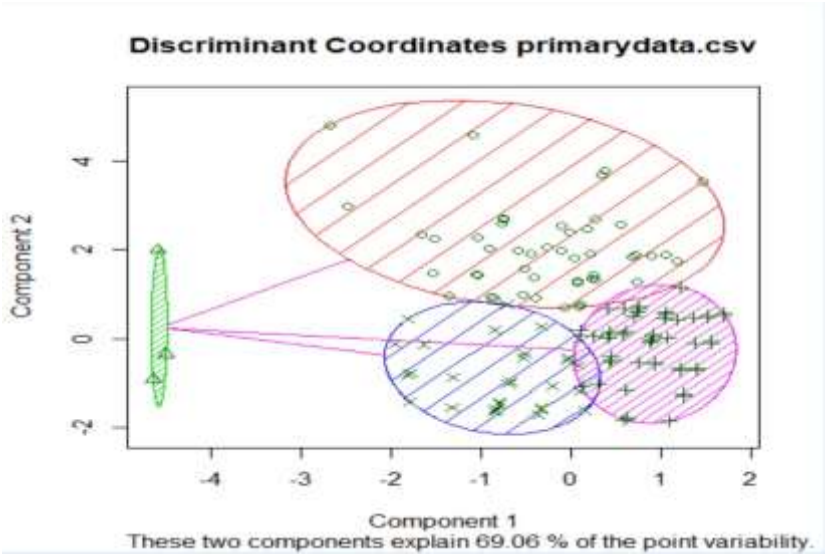


Fig. Discriminant plot of clusters

```
$clus.avg.silwidths
        1         2         3         4
0.04911558 0.90402831 0.50086581 0.09975487

$avg.silwidth
[1] 0.3863569
```

Fig. Silwidths

```
Data means:

    equipment      workers        tools transportation      wastage
     2.245536     2.312500     2.232143       2.272321     3.361607
     rotation        local
     2.906250     2.982143
```

Fig. Data means of the variables

The average silout width is a measure of goodness of fit or the overall model fitness for the cluster analysis. The individual cluster silout widths are within the limit (0 – 1) and the overall average siloutwidth 0.3863 being inside the permissible limits of 0 to 1. Thus, it can be said that the overall clustering model and the individual clusters have significance and are fit for clustering analysis.The mean value of every parameter is given in the data means, givens that average scoring of the responses.

```
Summary of the Multinomial Regression model (built using multinom):
Call:
multinom(formula = wastage ~ ., data = crs$dataset[, c(crs$input,
    crs$target)], trace = FALSE, maxit = 1000)

n=321

Coefficients:
  (Intercept) equipment    workers    tools transportation rotation     local
1    7.143076  1.114846 -0.5484217 1.041100     -0.7477477 1.615141 -3.307186
2    7.681809  1.515401 -0.6865641 1.023384     -0.8833570 1.064626 -2.860148
3    6.445076  1.721615 -0.9010285 1.585215     -0.9737671 1.509350 -2.828167
4    4.968358  1.098960 -0.9650151 1.542822     -0.3322218 2.130488 -2.550860
```

Fig. Multinomial Regression equation

A multinomial regression analysis is carried out and the 4 corresponding regression equations are obtained

Wastage = 7.143076 + 1.114846Equipment – 0.584217 + 1.041100 Tools – 0.7477477 Transportations + 1.615141 Rotation -3.307186 Local

One unit change in the wastage of the crops will have 1.11 units change in the waiting time for the equipments , -0.58 units change in the availability of workers, 1.04 units change in the type of tools used, -0.74 units change in the transportation time, 1.61 units change in the rotation of crops and -3.30 units change in the local market adjusting to the changes of the other variables.

Wastage = 7.681809 + 1.515401Equipment – 0.6865641 + 1.023384 Tools – 0.8833570 Transportations + 1.064626 Rotation -2.860148 Local

One unit change in the wastage of the crops will have 1.51 units change in the waiting time for the equipments, -0.68 units change in the availability of workers, 1.02 units change in the type of tools used, -0.88 units change in the transportation time, 1.06 units change in the rotation of crops and -2.86 units change in the local market adjusting to the changes of the other variables.

Wastage = 6.445076 + 1.721615 Equipment – 0.9010285 + 1.542822 Tools – 0.9737671 Transportations + 1.509350 Rotation -2.828167 Local

One unit change in the wastage of the crops will have 1.72 units change in the waiting time for the equipments, -0.90 units change in the availability of workers, 1.58 units change in the type of tools used, -0.97 units change in the transportation time, 1.50 units change in the rotation of crops and -2.82 units change in the local market adjusting to the changes of the other variables.

Wastage = 4.968358 + 1.098960 Equipment – 0.9650151 + 1.585215 Tools – 0.93322218 Transportations + 2.130488 Rotation -2.550860 Local

One unit change in the wastage of the crops will have 1.09 units change in the waiting time for the equipments, -0.96 units change in the availability of workers, 1.58 units change in the type of tools used, -0.93 units change in the transportation time, 2.13 units change in the rotation of crops and -2.55 units change in the local market adjusting to the changes of the other variables.

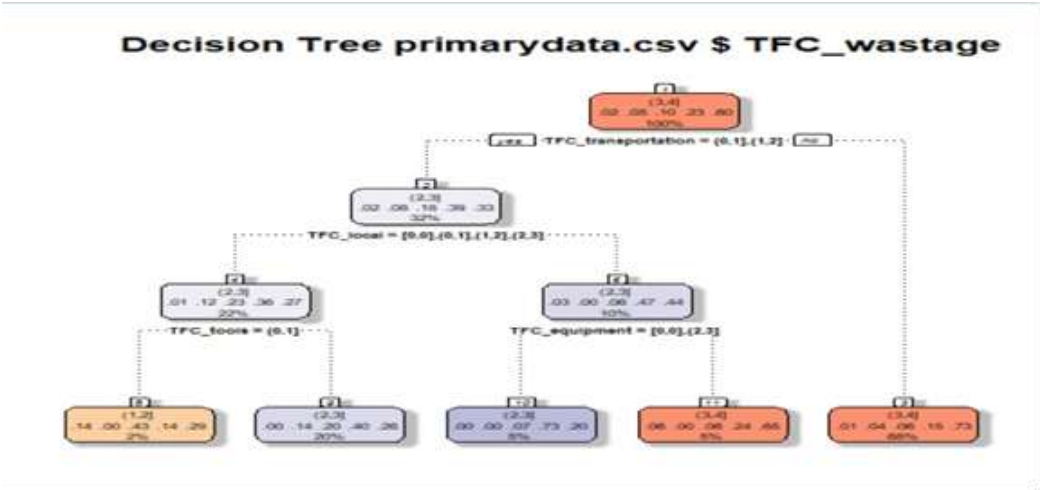
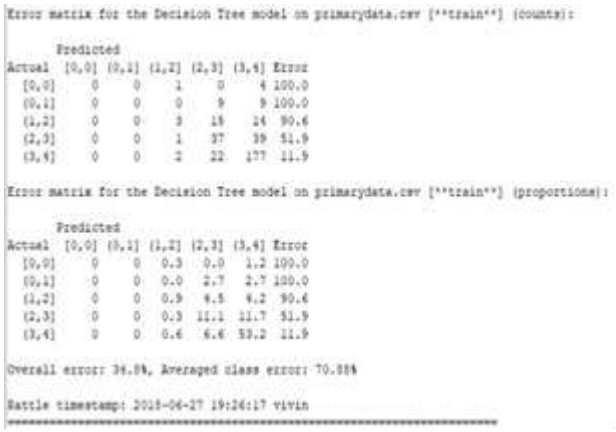


Fig. Decision Tree analysis

Decision tree analysis for the dependent variable vs the independent variable explains to what percentage the dependent variable is explained by the independent variables at what level of the decision tree. Here the independent variable transportation (i.e.,) waiting time for transportation explains 68% of the wastages due to transportation of the primary data. The balance 32% is explained by the independent variable local markets, which is further explained by tools used and the equipment waiting time. As per the decision tree analysis, it can be seen that the 100% of the wastages in the cultivation process is explained by the independent variables equipment's waiting time, local markets, transportation time and tools used but, waiting time for the availability of the workers is not considered as it does not directly contribute to the wastage.



Error matrix for the Decision Tree model on primarydata.csv [**train**] (counts):

Actual	Predicted [0,0]	[0,1]	[1,2]	[2,3]	[3,4]	Error
[0,0]	0	0	1	0	4	100.0
[0,1]	0	0	0	9	9	100.0
[1,2]	0	0	3	15	14	90.6
[2,3]	0	0	1	37	39	51.9
[3,4]	0	0	2	22	177	11.9

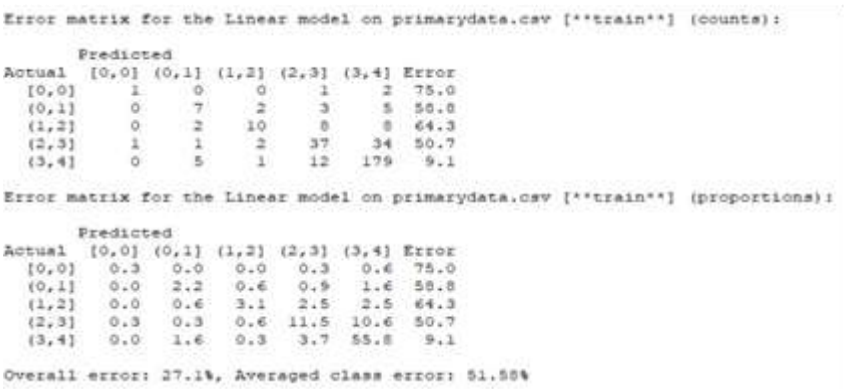
Error matrix for the Decision Tree model on primarydata.csv [**train**] (proportions):

Actual	Predicted [0,0]	[0,1]	[1,2]	[2,3]	[3,4]	Error
[0,0]	0	0	0.3	0.0	1.2	100.0
[0,1]	0	0	0.0	2.7	2.7	100.0
[1,2]	0	0	0.9	4.5	4.2	90.6
[2,3]	0	0	0.3	11.1	11.7	51.9
[3,4]	0	0	0.6	6.6	53.2	11.9

Overall error: 34.8%, Averaged class error: 70.88%

Rattle timestamp: 2018-06-27 19:24:17 vivin

Figure 14: Error matrix Without the variable worker availability



Error matrix for the Linear model on primarydata.csv [**train**] (counts):

Actual	Predicted [0,0]	[0,1]	[1,2]	[2,3]	[3,4]	Error
[0,0]	1	0	0	1	2	75.0
[0,1]	0	7	2	3	5	58.8
[1,2]	0	2	10	8	8	64.3
[2,3]	1	1	2	37	34	50.7
[3,4]	0	5	1	12	179	9.1

Error matrix for the Linear model on primarydata.csv [**train**] (proportions):

Actual	Predicted [0,0]	[0,1]	[1,2]	[2,3]	[3,4]	Error
[0,0]	0.3	0.0	0.0	0.3	0.6	75.0
[0,1]	0.0	2.2	0.6	0.9	1.6	58.8
[1,2]	0.0	0.6	3.1	2.5	2.5	64.3
[2,3]	0.3	0.3	0.6	11.5	10.6	50.7
[3,4]	0.0	1.6	0.3	3.7	55.8	9.1

Overall error: 27.1%, Averaged class error: 51.58%

Figure 15: Error matrix with the variable worker availability

The over-all error rate of the multinomial regression analysis model is 34.8%, which means that the model has misclassifications and that it can be further optimized. The overall error rate of the multinomial regression analysis model is 27.1%, which means that the model has much lesser misclassification and has been further optimized further optimized.

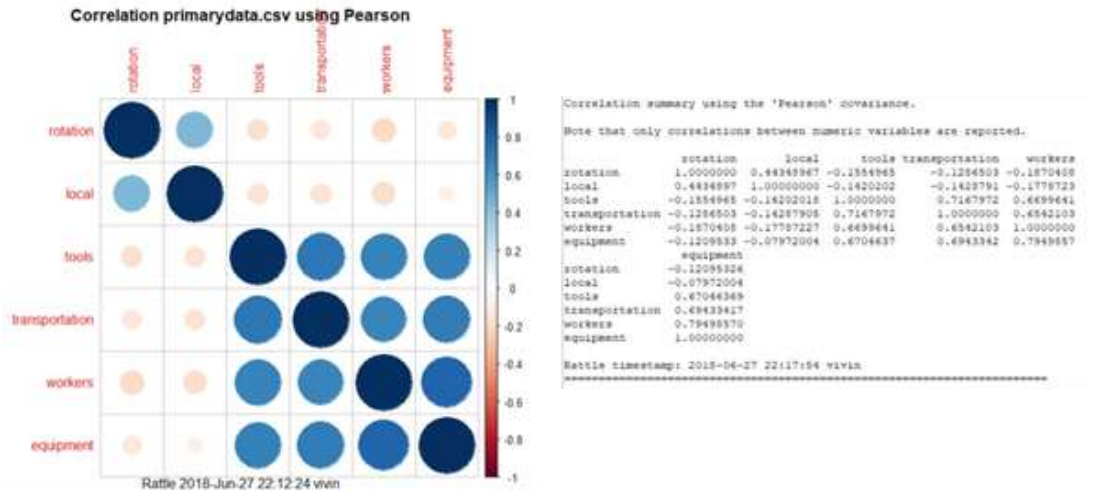


Fig. Correlation plot and correlation matrix of the independent variables

Though 100% of the dependent variable is explained by transportation, tools, local and equipment, it can be observed form the correlation plot that the variable workers have strong correlation between the variables, equipment, transportation and tools. Hence the variable workers are considered for the multinomial regression equation.

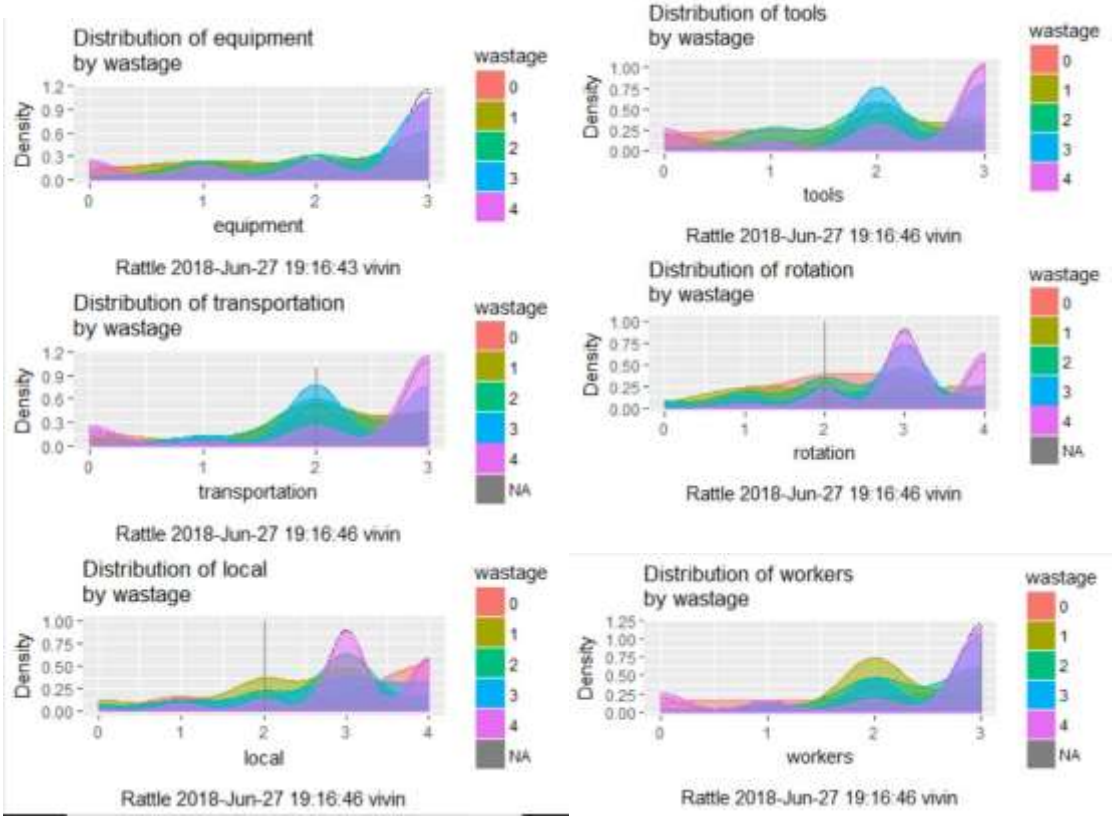


Fig. Distribution of the independent variables over the dependent variable

The distribution of the independent variables explains the extent of the independent variable associates or influences the dependent variable adjusting for the changes of the other independent variables.

Data Interpretation:

Out of total 335 respondents

	High Time	**Medium Time**	**Low Time**
Equipment	**59.4**	**16.7**	**12.5**
Workers	**62.3**	**19.2**	**18.5**
Wrong Tools	**52.6**	**28.2**	**19.2**
Transportation arrangements cultivated crops	**56.7**	**28.15**	**15.15**

- 59.4% of respondents said that they had to wait for days to get equipment's or rent them to work for their fields.
- 62.3% respondents said that it takes days to get the workers on boardpaid on daily basis during the harvest season and in that case a farmer may have to wait for days to get the workers available to work on the field.
- 52.6% of the respondents have said, if the workers used wrong tools over the right tools,

Delay in producing the crops happens in days.

- 56.7% of the respondents have said that with out transportation plan, delay is said to happen for days.
- Out of 336 responses, 59.5% of the responses have said that the wastage of the crops before transporting the to the market is greater than 15% and 22.9% of the responses have said that the wastage could be between 10-15%, since 59.5% is highly significant over 22.9%, it can be said that, wastage of crops before transporting them to the market could be greater than 15% of the production.
- Out of 335 responses, 47.8% have agreed that rotation of the crops to meet the seasonal demand helps increasing the sales and 28.1% have strongly agreed to that rotation crops to meet the seasonal demand helps in increasing the sales.
- Out of 333 responses, 47.7% have agreed the reaching out to local markets is more economical that reaching out to distant markets and 30% have strongly agreed that reaching out local markets is economical than reaching out to distant markets.

4. Conclusion

With the data analysis and interpretation, Lean methodologies are not being implemented at ground level. The traditional practices increase the lead time and decrease the productivity.Unless and until farmers exclusively take initiatives to have lean and agile processes, it is very difficult to utilise the time and make efficient output of it.

References

1. Thilak, V. M. M., Devadasan, S. R., & Sivaram, N. M. (2015). A literature review on the progression of agile manufacturing paradigm and its scope of application in pump industry. *Scientific World Journal*, *2015*. https://doi.org/10.1155/2015/297850
2. Hallgren, M., & Olhager, J. (2009). Lean and agile manufacturing: external and internal drivers and performance outcomes. *International Journal of Operations & Production Management*, *29*(10), 976–999. https://doi.org/10.1108/01443570910993456
3. A. Gunasekaran a E. Tirtiroglu a, V. Wolstencroft b, *. (2002). An investigation into the application of agile manufacturing in an\naerospace company\n. *Technovation*, *22*, 405–415.
4. Ustyugová, T., & Noskievičová, D. (2013). Integration of lean and agile manufacturing based on principles from wikinomics. *Quality Innovation Prosperity*, *17*(1), 48–56. https://doi.org/10.1234/QIP.V17I1.63

5. #1, B. V, #2, L. S. N., & Professor, A. (2015). 9. An Analysis on Agile Manufacturing System. *SSRG International Journal of Industrial Engineering*, *2*(3), 36–40. Retrieved from www.internationaljournalssrg.org
6. Sindhwani, R., & Malhotra, V. (2017). Agile Manufacturing System : An Introduction, *12*(4), 857–861.
7. Colgan, C., Adam, G., & Topolansky, F. (2013). Why try Lean ? A Northumbrian Farm case study, *2*(3). https://doi.org/10.5836/ijam/2013-03-06
8. Dora, M., Lambrecht, E., Gellynck, X., Goubergen, D. Van, & P, V. A. N. G. (2015). Lean Manufacturing to Lean Agriculture : It ' s about time, 2015.
9. Gumbulevich, E. (2015). Lean and Agile Manufacturing in Natural Food Production : The Key to Saving America ' s Health and Environment.
10. Et, M. A. R. K. (n.d.). 'Lean' principles applied to a farm.
11. Navjith Singh, (2014), "Indian Agriculture : Before and After Economic
12. Reforms Indian Agriculture : Before and After Economic Reforms,"
13. https://data.gov.in/
14. http://www.mca.gov.in/mcafoportal/vpdDocumentCategoryDetails.do
15. https://vincentarelbundock.github.io/Rdatasets/datasets.html
16. https://knoema.com/atlas/India/topics/Agriculture/datasets