CHALLENGES OF PRECISION AGRICULTURE TECHNOLOGY ADOPTION: A
CASE STUDY OF TUMKUR DISTRICT, INDIA.

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CHALLENGES OF PRECISION AGRICULTURE TECHNOLOGY ADOPTION: A CASE STUDY OF TUMKUR DISTRICT, INDIA.

ABSTRACT
The term of agriculture technology is becoming an attractive idea for managing natural farm resources and realizing modern sustainable growth for Indian society and individual. This research is intended to study the agriculture technology adoption intention among selected sample population in Tumkur district of Karnataka state, India. Sample size chosen for this study is 203 respondents with the different size of land holdings, educational background, and experience in farming have been considered. Before collecting the responses, farmers were educated through videos and information on precision agriculture technology used in agriculture and response was collected through structured questionnaire. Simple statistical tools were used to analyse the data. It is found that major obstacle for Precision agriculture technology adoption in India is small and medium size land holdings followed by lack of education and lack of support system. Author suggests simple precision techniques can be initiated to start with it. mass precision technology adoption in India will take longer time duration compared to developed countries due to several constraints and limitation in india.

Keywords:- Precision technology in Agriculture, Farming technology, Agriculture technology adoption, challenges for agriculture technology adoption.

INTRODUCTION
Agriculture plays a vital role in economic growth, enhancing food security, poverty reduction and rural development (Mwangi and Kariuki, 2015). It is the main source of income for around 205 billion people in developing country (FAO 2003). Larger segment of which is small and marginal farmers. Therefore, Small agriculture is identified as vital development tool for achieving millennium Development Goal, one of which to solve extreme hunger and poverty (World Bank 2008). These situations are basically due to excessive rely on age old traditional agriculture practices and process adopted resulting in to lower productivity (Muzari et al 2012).This agriculture process has to be replaced by alternative farming to enhance the productivity for their sustainability and economic growth at large.
Today agriculture research and development should predominantly focus towards productivity, economic viability, and environment friendly and socially sustainable. The idea of precision agriculture is becoming an attractive idea for managing natural farm resources and realizing modern sustainable growth (Far, 2017) (Liaghat and Balasundram 2010), (Fountas, Pedersen and Blackmore, 2004), (Anue et al, 2017) (Singh). Precision agriculture may provide solution for global food challenges (Hakkim, 2016). Though precision technology provide solution for many agriculture problems its acceptance and adoption in developing countries is remain low (Mwangi and Kariuki, 2015). However, these technologies are more relevant for small farmers in developing country due many natural and infrastructural limitation they face (Mwangi and Kariuki, 2015) (Muzari et al., 2015).

**NEED FOR PRECISION FARMING IN INDIAN -**

Precision farming deals with accurate farming decisions. Average 40 odd farming decisions have to be taken in one crop production cycle. Simple decisions can be scientifically optimized using precision agriculture technology (Tech Mahindra).

Precision farming approach involved adoption of technologies for better managing the variability at the sub field level to better utilize resources and minimize environmental impact (Aziz et al 2008). Study conducted by Costa and guilhoto (2011) stresses on direct relationship between benefits of Precision agriculture adoption and socio-economic benefits.

- Optimizing production efficiency-global food system is facing challenges today which are anticipated to increase remarkably over next 40 years (Hakkim 2016). Instead of managing the farm on hypothetical average conditions, which may not exist anywhere in the field, site specific precision technology approach within the field and adjusts management action accordingly can help to increase the agriculture productivity (Hakkim 2016).another organizing principle of precision agriculture is to determine best agriculture input combination (seed, fertilizer, and chemicals) and application of these to minimize cost and optimize productivity.
Optimization of production quality- excessive use of pesticides and insecticide damages the quality of agriculture produce (which has to be noticed in pomegranate and mango resulting rejection of Indian produce into international market). Grid technology, remote sensor and GIS technology of precision farming optimizes the quality of produce by effective and required usage of pesticides and insecticides and also ensure effective field management for chemical application, cultivation and harvest.

- To strike ecological balance- Indian Green revolution associated with negative ecological consequences, this gives an early warning to take appropriate measures to overcome present and future adversities (Shanwad 2004).

OBJECTIVE OF THE STUDY
- To study the precision agriculture technology adoption challenges among farmers with special reference to Tumkur district.
- To study the diversified demographic response on Precision Agriculture Technology Adoption

RESEARCH METHODOLOGY-
Extensive literature review has provided insight into research area of precision adoption in India/developing and developed countries across the globe. Research studies conducted by Hakkim (2016), Say (2017); Mwangi (2015), Mondal and Maity (2013), Shanwad (2004), Ramamoorthy (2016), Maheswari et al (2008) and few others have provided precision technology adoption research in India/developing countries. Determinants of precision farming considered by Mwangi and Kariuki namely, Technological factors, economic factors, institutional factors, and household specific factors are considered as variables for this research study also. Broadly, these determinants are classified into three groups- technological, economical and behavioural; further these group are divided in to sub groups Sample size selected is 203 respondents from Tumkur district of Karnataka (India) with different size of land holding, educational background, and generation engaged in farming have been selected. Farmers were educated through videos and information on precision technology used in agriculture and response was collected through structured questionnaire (refer questionnaire in...
Annexure). Simple statistical tools are used to analyse the data. Factor Analysis has given the result of 0.828 for KMO (Kaiser-Meyer-Olkin) – sample adequacy. Communalities of questionnaire items was above 0.5 hence no item was dropped from the questionnaire.

Table : 1 – Table indicates KMO and Bartletts test

<table>
<thead>
<tr>
<th>KMO and Bartlett's Test</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy.</td>
<td>.828</td>
<td></td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
<td>Approx. Chi-Square</td>
<td>1629.443</td>
</tr>
<tr>
<td>df</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

DEMOGRAPHY OF RESPONDENTS – CROSSTABS

Table : 2- Cross Table for Land size versus educational background

<table>
<thead>
<tr>
<th>land size * educational background</th>
<th>educational back ground</th>
<th>uneduc</th>
<th>primary</th>
<th>high school</th>
<th>higher secondary</th>
<th>Graduate</th>
<th>post graduate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 1 acr</td>
<td>uneducated</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2-5acres</td>
<td>primary</td>
<td>20</td>
<td>19</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>6-9acres</td>
<td>high school</td>
<td>24</td>
<td>40</td>
<td>19</td>
<td>11</td>
<td>3</td>
<td>0</td>
<td>97</td>
</tr>
<tr>
<td>10-12</td>
<td>higher secondary</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>13acres and above</td>
<td>graduate</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>57</td>
<td>76</td>
<td>36</td>
<td>22</td>
<td>10</td>
<td>2</td>
<td>203</td>
</tr>
</tbody>
</table>

Table : 3 - Cross Table for crops per year versus farmer experience

<table>
<thead>
<tr>
<th>number of crops/yr * farm experience in years Cross tabulation</th>
<th>farm experience in years</th>
<th>less than11</th>
<th>11-15</th>
<th>16-20</th>
<th>21 and above</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of crops/yr</td>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td>20</td>
<td>11</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td>24</td>
<td>83</td>
<td>28</td>
<td>138</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>5 and above</td>
<td></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6</td>
<td>47</td>
<td>103</td>
<td>47</td>
<td>203</td>
</tr>
</tbody>
</table>
Table : 4 - Cross Table for crops per year versus farmer education

<table>
<thead>
<tr>
<th>number of crops/yr * educational background Cross-tabulation</th>
<th>educational background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>uneducated</td>
</tr>
<tr>
<td>number of crops/yr</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5 and above</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
</tr>
</tbody>
</table>

FINDINGS

Challenges of Precision technology adoption in India-

Traditionally economic analysis of technology adoption has sought to explain adoption behaviour in relation to personal characteristics and endowment. Imperfect information, risk, uncertainty, institutional constraints, input availability and infrastructure are the major determinants (Uaiene, 2009) there are many determinants of precision technology adoption. Broadly these can be clustered into economic, social, technological and behavioural (Lavison 2013, KK 2019).

Graph 1 :- Percentage of respondents express challenges in precision agriculture adoption

Challenges of precision adoption

3 Behavioral factors
- Lack of awareness of government/ institutional...
- Reference group influence
- Rigidity to adopt new technology/believe in old...
- Lack of technology awareness/knowledge

2 Economic factors
- Lack of institutional and government assistance
- Higher operational cost
- Higher initial cost

1 Technology factors
- Availability and accessibility in sale
- Lack of installation/ training assistance
- Limitation of technology use
- Complexity of technology usage
Table: 5 - Respondents opinion on precision agriculture adoption

<table>
<thead>
<tr>
<th>Challenges of precision adoption</th>
<th>Total number of respondents</th>
<th>No. of respondent’s face challenges</th>
<th>Percentage of respondent’s face challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Technology factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity of technology usage</td>
<td>203</td>
<td>158</td>
<td>77.83</td>
</tr>
<tr>
<td>Limitation of technology use</td>
<td>203</td>
<td>167</td>
<td>82.75</td>
</tr>
<tr>
<td>Lack of installation/ training assistance</td>
<td>203</td>
<td>176</td>
<td>86.69</td>
</tr>
<tr>
<td>Availability and accessibility in sale</td>
<td>203</td>
<td>163</td>
<td>80.29</td>
</tr>
<tr>
<td>2 Economic factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher initial cost</td>
<td>203</td>
<td>189</td>
<td>93.10</td>
</tr>
<tr>
<td>Higher operational cost</td>
<td>203</td>
<td>136</td>
<td>66.99</td>
</tr>
<tr>
<td>Lack of institutional and government assistance</td>
<td>203</td>
<td>154</td>
<td>75.86</td>
</tr>
<tr>
<td>3 Behavioural factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of technology awareness/knowledge</td>
<td>203</td>
<td>161</td>
<td>79.31</td>
</tr>
<tr>
<td>Rigidity to adopt new technology/believe in old traditional factors</td>
<td>203</td>
<td>187</td>
<td>92.11</td>
</tr>
<tr>
<td>Reference group influence</td>
<td>203</td>
<td>122</td>
<td>60.09</td>
</tr>
<tr>
<td>Lack of awareness of government/ institutional support.</td>
<td>203</td>
<td>130</td>
<td>64.03</td>
</tr>
</tbody>
</table>

- **TECHNOLOGICAL CHALLENGES**-
  Characteristics of technology are preconditioned of adoption. Degree to which potential adopter can try technology act as a major determinant before adopting technology completely (Doss 2003); (Mignoouna et al 2011).

1. Complexity of technology- precision technology combines several technology and management tools which vary from hardware-software and management tools. These technology functions can be performed by skilled/educated person on these technologies.
Indian farming is characterized with low education and lack of technical skilled farmers. The study conducted reveals that, 77.83 percent of the respondents are of the opinion that precision technology is complex and feel it will be difficult to use.

Major challenge of precision technology is yield mapping and obtaining information on yield map. The bigger agronomic hurdles is retrieving the information in the yield map and using it for agriculture process. This might pose greater bottlenecks for adopting precision technology due to lack of Decision Support system (Shanwad, 2004).

2. Limitation of technology- Multiple technologies are used for various farming jobs. There is limited function of every single technology which resisted the adoption process because any expensive technology is expected to perform multiple jobs, and functions to get return on investment on capital intensive technology investment. 82.75 percent of the respondents have expressed technology limitation cannot reward in terms of job performance of any particular technology.

3. Lack of installation/training assistance-local technical assistance and expertise is an obstacle for precision technology adoption (Shanwad, 2004). Similar results are revealing by the study. 86.69 percent of the respondents feel lack of local technical support and training is a obstacle for adoption. Study conducted by Reichard and Jurgens (2009); (Brorghi et al 2016) reveals large issues related to PA adoption were lack of technical support to PA tool and lack of knowledge to manage the data to apply them correctly in the crop production system. Incompatibility between different equipment and hardware device further add technical complexity.

4. Availability and accessibility in sale-awareness of technology is another determinant of technology adoption. Indian agriculture research institutions most of the time work in isolation and has limited reach to the local farmers except few institutions which are slowly but doing noticeable change in farming field. The agriculture melas, fairs, exhibitions are conducted but attendance of small farmers to these again a question due to distance to be covered to reach and lack of information about them. 80.29 percent of the
respondents reveal that lack of availability and accessibility in sale is the technology adoption challenge. These technologies need more local demonstration through connecting extension services, local SHG (Self Help Group) leaders, influencers in the villages, and progressive farmers.

ECONOMIC CHALLENGES
Indian agriculture witness Interdependency of size of land holding and economic status of the farmer. One of the highlighted determinants of precision technology is size of cultivable land holdings (Carletta et al 2007) larger the land holdings facilitate experimentation with new technology and also determine the pace of technology adoption. Indian agriculture is featured as small and marginal farm size, lower agriculture productivity greater economic dependency on farming activity and market irregularities has pushed Indian farmers into economic poverty (Sahoo), (Shanwad et al 2004).

1. High initial Cost of technology- precision technology use expensive technology. The cost related to soil sampling grid and analyses is high (Brorghi et al 2016). In developed countries percentage agriculture revenue is invested in technology (brorghi et al 2016) however Indian farmers cannot assure their livelihood with agriculture revenue, and most of the time are trapped in debt due to lower agriculture productivity. With this economic status PA technology investment by farmers in individual capacity is not possible. 93.10 percent of respondents find it challenging to invest in precision technology due to high investment cost.

2. Higher operational cost- operational cost involved in this technology is high due to complexity of technology. 66.99 percent of the respondents find it difficulties in adoption of precision technology due to operational cost. Remote sensing, grid management and software technology need frequent changes with changing nature of crop and weather conditions (Indian agriculture predominantly depends on monsoon).

3. Lack of awareness of financial assistance to farmers can stimulate new technology adoption (Vaiene et al 2009). Several government and institutional initiatives have slowly
triggered adoption process in some areas. However largely it has not been aggressively implemented and informed to the masses. Many small and marginal farmers are not aware of these financial benefits extended by government and institutions. 75.86 percent of respondents are not aware of financial benefit available to them. Another bottle neck problem is disbursement process; several ghotala/scams are evident of miss management of these farmers fund for personal benefit of few involved in the process of reaching funds to the farmers.

**BEHAVIOURAL CHALLENGES**
- Success of precision agriculture productivity predominantly depends not on data available on spatial variability but on use/management of these data for solving operational issues of the farming (Shanwad, 2004). But the Indian farming community is dominated with low education and lack of skilled farmers. The greater challenge is transferring this technology knowledge to farmers (Shanwad, 2004).

Behavioural challenges are studies into following four segments.

1. **Lack of technology awareness/ knowledge** - during the survey it was identified that farmers are unaware of most of the technologies used in farming process. Vague idea they have about modern farming technology. 79.31 percent of the respondents are not aware of precision technology.

2. **Rigidity to adopt new technology/ believes in old traditional process** - innovation adoptability in farming needs harder push from all sectors- government, institutional, social and personality traits. Farming in India has been the age-old process carried out by generation and passed on to next without any change. 92.11 percent of the respondents believe in old farming process and feels that these assure them minimum guaranteed returns. They also expressed the fear of uncertainty of technology adoption.
Social/Reference group influence- rural social structure reflects into small group of farmers who have strong influence on each other. Belonging to social group enhances social capital. Farmers belonging to social group tend to learn adopt new technology and innovation (Mwangi 2015).

4. Lack of awareness of institutional and government support- many initiatives designed by government and institutions are failed to reach the required segment. This study has identified the communication gap in this regard. Several schemes and subsidies are neither farmer aware of nor are there is effort made by communication channels to reach targeted farming communities. 64.03 percent of the respondents are unaware of institutional and government support.

WILLINGNESS TO ADOPT PRECISION TECHNOLOGY
Precision Technology adoption in Indian context is largely determined by educational background, and size of cultivable farm land
Table: 6 Crosstab for Land size versus age of sample respondents

<table>
<thead>
<tr>
<th>i think i would adopt PA</th>
<th>land size * age of respondents * I think I would adopt PA Cross tabulation</th>
<th>age of respondents</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>neutral</td>
<td></td>
<td>26-35</td>
<td>36-50</td>
</tr>
<tr>
<td>neutral</td>
<td>6-9acres</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>agree</td>
<td></td>
<td>2-5acres</td>
<td>0</td>
</tr>
<tr>
<td>agree</td>
<td>6-9acres</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>agree</td>
<td>10-12 acres</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agree</td>
<td>13acres and above</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>strongly agree</td>
<td></td>
<td>2-5acres</td>
<td>2</td>
</tr>
<tr>
<td>strongly agree</td>
<td>6-9acres</td>
<td>8</td>
<td>29</td>
</tr>
<tr>
<td>strongly agree</td>
<td>10-12 acres</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>strongly agree</td>
<td>13acres and above</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>less than 1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2-5acres</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6-9acres</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>10-12 acres</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>13acres and above</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>14</td>
<td>76</td>
</tr>
</tbody>
</table>

Farmers with land holding 6-9 acres have expressed their readiness to adopt precision technology, followed by farmers with land holding 2-5 acres (Table 5). Table 6 reveals significant correlation between size of land holdings and readiness of farmers for technology adoption. It evident from table 5 that greater adoptability to technology is registered by age group above 50 years and 36-50 years.
RESEARCH ANALYSIS

DATA ANALYSIS: Collected data was analysed with the help of SPSS (Statistical Package for Social Science) software. Data was analysed separately for employees and for managers. Statistical tools like t-test, Anova. The results of the tests as follows.

Table: 7 – Table indicates summary of various statistical tests

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Variable group</th>
<th>Sig (P) value</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-test</td>
<td>Type of Farming Ownership (Own or Rented) Vs Model variables</td>
<td>Insignificant</td>
<td>Since the p value greater than 0.05 hence test is statistically insignificant for all variables and can be claimed there is no difference in opinion between different type of farming ownership group.</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Age Vs model variables</td>
<td>Insignificant</td>
<td>Since the p value greater than 0.05 hence test is statistically insignificant for all variables and can be claimed there is no difference in opinion between different Age group.</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Education Vs model variables</td>
<td>Insignificant</td>
<td>Since the p value greater than 0.05 hence test is statistically insignificant for all variables and can be claimed there is no difference in opinion between different education group.</td>
</tr>
</tbody>
</table>

CHI SQUARE ANALYSIS

In this analysis, chi square test is undertaken to study the association between categorical and continuous variable. Theoretical model variables such as PEOU, PU and SN are considered as continuous variable and education of population sample is considered as categorical variable.
Table 8: Precision Agri Technology adoption variables and education level of sample population

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>PEOU</th>
<th>PU</th>
<th>SN</th>
<th>education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>353.256&lt;sup&gt;a&lt;/sup&gt;</td>
<td>294.222&lt;sup&gt;a&lt;/sup&gt;</td>
<td>251.034&lt;sup&gt;b&lt;/sup&gt;</td>
<td>119.433&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>df</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Asymp. Sig. (p value)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

The above table reveals that P value (significant value) is less than 0.01, hence it was concluded that, there is an association between education level of sample population and the theoretical model variables. This indicates that if the education level increases then the chances of adopting the Precision Agriculture technology for farming is high.

Table 9: Precision Agri Technology adoption variables and Land size of sample population

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>PEOU&lt;sup&gt;1&lt;/sup&gt;</th>
<th>PU&lt;sup&gt;2&lt;/sup&gt;</th>
<th>SN&lt;sup&gt;3&lt;/sup&gt;</th>
<th>land size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>353.256&lt;sup&gt;a&lt;/sup&gt;</td>
<td>294.222&lt;sup&gt;a&lt;/sup&gt;</td>
<td>251.034&lt;sup&gt;b&lt;/sup&gt;</td>
<td>141.360&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>df</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Asymp. Sig. (p value)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

The above table reveals that, since P value is less than 0.01, hence it was concluded that, there is an association between education background of sample population and the theoretical model variables. This indicates that if farm land size is more then the chances of adopting the Precision Agriculture technology is increases.

**Chi Square Analysis Between Land Size and Intention to adopt PA**

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<sup>1</sup> PEOU : Perceived ease of use  
<sup>2</sup> PU : Perceived usefulness  
<sup>3</sup> SN : Subjective norm
Here, Chi square was used to test the Precision Agriculture technology adoption with the respondents Land size and educational background to

Table: 10 Precision Agri Technology adoption and size of land correlation

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>land size</th>
<th>I think I would adopt PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>141.360a</td>
<td>163.813b</td>
</tr>
<tr>
<td>df</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

Results in tables 8 and 9 of the chi square output indicates a significant positive association between Land size and Intention to adopt the precision agriculture technology. Therefore, our assumption that land size has a positive association on the Behavioral intention to use Precision agriculture technology was accepted.

Table: 11 Precision Agri technology adoption and education background of the farmers

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>I think I would adopt PA</th>
<th>educational background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>163.813a</td>
<td>119.433b</td>
</tr>
<tr>
<td>df</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

Similarly from table 9 the chi square output indicates a significant association between Educational background of respondent and Intention to adopt the precision agriculture technology, therefore our assumption that educational background has a association on the Behavioral intention to use Precision agriculture technology was accepted.

**SUGGESTIONS**

This study provided few suggestions to enhance the precision agriculture adoption in India. A phase-wise technology penetration enhances acceptance and adoption (Tech Mahindra). Initiatives taken by public and private organization has not generated a desired result in terms of awareness and adoptability.
The sequential adoption of mechanization, first for power intensive and then for control intensive operations, is not a historical artefact, it is a farmer response induced by the changing relative prices of factor inputs (Pingali 2007). Though the average size of land holding is small and major precision agriculture technology is ruled out by the individual small farmers it at his farm level there can be collective effort which can bring in the major technology transforms in Indian agriculture sector if collative efforts are made in this direction.

- Creating awareness among the farmers can be entrusted to local Extension/ICT centers established by government. The worsening agriculture condition may act as catalyst to enforce adoption process.

- Dealership assistance—Lack of or low level of adoption of mechanization is often attributed to supply side constraints, such as the lack of equipment and spare parts suppliers and skilled mechanics that can provide maintenance services (Pingali 2007). Precision agriculture adoption supported with technical assistance (soil sampling, field mapping, result interpretation and recommendation) by companies has increased greater adaptability among farmers (Borghi et al 2016). Similar model adopted can be emulated in Indian Farming to increased adoption of precision farming.

PA branch of companies focus should be on providing the technology on rental and consistent services. Which can facilitate small/mid-size progressive farmers to adopt a technology (the model of the rental of tractor/JCB rental adopted in Indian agriculture)? Training to extension workers, and service providers can reduce the knowledge gap and helps in creating awareness among farmers to increase the possibilities of PA Adoption.

- Institution integration with Government bodies/Co-operative Societies—several initiatives by government bodies and private research institutions have paved way towards precision technology adoption in India. Efforts should be made towards driving the extensive contribution of towards agriculture sustainability and productivity. Integration of these two different bodies can bring in better results multidimensional focus and coverage in
respect of technology adoption and required economic support. Few Indian initiatives such as ITC chopal, TATA Kisa Kendra, Indian Space Research Organization, Ahmadabad initiatives and M S Swaminathan Research Foundation are able to bring in change, but an extensive communication of success stories and effectiveness is needed for the hour for greater adoptability.

CONCLUSION
Our research reaffirmed that major obstacle for Precision agriculture adoption in India is small and medium size land holdings. However, the greater dependency of farmer on agriculture necessitates the adoption of technology for optimum utilization of resources and to achieve the greater productivity is at most urgent in the present scenerio. Simple precision techniques can be initiated by the government. Mass precision technology adoption in India will take longer time duration compared to developing countries due to several constraints and limitation. The development of more simple technologies is most important for wider adoption of Precision Agriculture. Simple precision irrigation technique can easily introduce to enhance and improve the technology acceptance attitude among the farmers. Due to adverse ecological and climatic conditions farmers are pushed to think innovatively to utilize the basic water recourse in optimal manner. innovative technology ensures early maturity of crop, water saving by 40%-70%, controls weed growth, saving fertilizers, controls disease, soil erosion is eliminated and several other advantages.

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Appendix - I

i FAO : Food and Agriculture organization

ii GIS : Global information system

iii ICT : Information Communication Technology

iv JCB : synonym for earth movers and Heavy equipments

v PA : Precision Agriculture