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# Construction of Scale for Measuring Agricultural Performance of Small and Marginal Farmers

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## ABSTRACT

*Agricultural performance is measured in terms of production value of different crops at constant and current prices it helps to look at each crop in detail to understand the cost benefit ratio in terms of investment in rising the crop and profit obtained from the final yields. Due to the non-availability of standard scale to measure agricultural performance of farmers, it was thought that, there is a need to construct a scale to measure the agricultural performance. An attempt was made to develop a scale by using five points' Likert type summated rating scale. For all four dimensions (Land/ Soil fertility index, Market index, Technology achievement index and Labour productivity index) of agricultural performance index. Initially 72 statements were framed and after discussion with the experts in the field of Resource Management and Consumer Sciences, these statements were reduced to 55 statements. Those 55 statements were given to 30 experts from different disciplines for content validity. All 30 experts' data was entered in SPSS software. Both validity and reliability was done for all the statements. The reliability values of all four dimensions were greater than the standard value of alpha 0.7 as recommended by Cronbach, 1951. Regarding validity as per Kasier-Meyer-Olkin (KMO) measure, a measure of 0.6 was recommended. For all four dimensions, KMO values were greater than the standard value i.e. 0.6. Bartlett test of sphericity was done to know the overall significance of the correlation within a correlation matrix. Data of all four dimensions of the present study was found significant. Hence the present data was acceptable for factor analysis. Factor analysis or Principle Component Analysis was carried out by using SPSS; total three components were extracted for each dimension. PCA cut off point was 0.6 for all the four dimensions. By considering the PCA cut off point, finally 49 statements were retained and 6 statements were deleted.*

***Keywords:*** *Agricultural performance, Principle component analysis, Land/soil fertility, Market index, Technology achievement index and Labour productivity index*

## INTRODUCTION

In India, farmers play an important role in agricultural production. More than 65 per cent of the population was economically dependent on agriculture in India. Majority of the farmers in India were small (1 to 2 hectares) and marginal (Up to 1 hectare) farmers. By keeping this point in view, the agricultural performance scale has been developed mainly for small and marginal farmers, however, it can be applied for all types of farmers. Agricultural performance is defined as achievements in the field of agriculture including four aspects like land fertility, marketing, technology and labour productivity. While framing the statements for each dimension, mainly focused on farmers' practices regarding improvement of land fertility of their farm, strategies used for selling the produce to gain more profits, utilization of available technologies for better performance and effective usage of labourers. Thus an attempt was made to measure the agricultural performance of farmers by standardizing the scale.

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## METHODOLOGY

To construct a scale to measure the agricultural performance of small and marginal farmers, five points Likert type summated rating scale was used. Different steps were followed to develop the scale, which were presented under the following headings:

***Step 1- Listing of items***
***Step 2- Rating the items***
***Step 3- Validity and Reliability of agricultural performance scale***
***Step 4- Principle component analysis and selection of items***

### Step 1- Listing of items

The statements of the scale were called as items. Framing of items during scale development requires considerable

preliminary work to refine words and content. To perform the content validity, items were generated for all the four dimensions (Land fertility index, Market index, Technology achievement index and Labour productivity index) from different sources including review of literature, discussion with experts from corresponding discipline i.e. department of Resource management and Consumer Sciences. In addition to this a key strategy followed at this stage was frequent re-examination of items and to ensure that items reflect what was intended and relevant.

Keeping all these things in mind, an initial list was prepared with total of 72 items, in which 19 items were related to land fertility index, 11 market index, 32 technology achievement index and 10 labour productivity index were enlisted through detailed literature. The items were converted into the form of statements. These statements were framed in English language. After discussion with experts in the field of Resource Management and Consumer Sciences these were reduced into 55 statements, on which 13 statements were related to land fertility index, 16 market index, 11 technology achievement index and 15 labour productivity index.

### Step 2- Rating the items

In this step all the statements from previous stage i.e. 55 statements were finalized by considering professionals opinion from Department of Resource Management and Consumer Sciences. Scores were assigned for all the statements to express the experts' opinion on relevancy and clarity of the content on four point continuum scale as follows.

| Scale for judgment of the statements for relevancy | | |
|---|---|---|
| **S. No.** | **Response** | **Score** |
| **1.** | Very Relevant | 4 |
| **2.** | Item needs some revision | 3 |
| **3.** | Relevant but needs some revision | 2 |
| **4.** | Not Relevant | 1 |

| Scale for judgment of the statements for clarity | | |
|---|---|---|
| **S. No.** | **Response** | **Score** |
| **1.** | Very Clear | 4 |
| **2.** | Item needs some revision | 3 |
| **3.** | Clear but needs some revision | 2 |
| **4.** | Not Clear | 1 |

### Step 3- Validity and Reliability of agricultural performance scale

Validity was concerned with whether the test items were relevant to the measurement of the intended content area. Content validity was determined by expert's judgment. The scale was validated to ensure their dependability in analyzing agricultural performance of small and marginal farmers. A number of measures were adapted to establish the content validity for the statements which were observed through related literature review and discussion with experts from different disciplines to assess and analyze the agricultural performance of small and marginal farmers.

All the 55 statements were given to thirty experts such as Professors (09), Scientists (02), Associate professors (02), Assistant professors (11), Subject Matter Specialist (SMS) (01), Agricultural Extension Officers (02), Junior scientist (01) and Teaching associates (02) from the fields of Resource Management and Consumer Sciences, Extension Education and Communication Management, Agronomy, Agricultural Extension, Statistics and Mathematics, Soil Science, Horticulture and Economics. Similarly it has given to some institutes like Krishi Vigyan Kendras (KVKs), Extension Education Institute (EEI) and also from Agricultural Department (AEOs) to provide their opinion on each statement on 4 point scale indicate the relevancy and clarity of the statements. Moreover judging the relevancy and clarity, the experts response on each statement was required for the options given like very relevant, item needs some revision, relevant but needs some revision and not relevant.

Based on the expert's response on relevancy or irrelevancy of the statements and also whether given statements were clear or not clear with respect to the language or sentence formation, the responses in the form of score on all the statements by all the experts were tabulated for the next step of principal component analysis.

Further the criterion related reliability and validity was established by calculating principle component analysis.

### Reliability:

The reliability values of all four dimensions of the present data were 0.880, 0.919, 0.902 and 0.929 for land fertility, market index, technology achievement and labour productivity respectively as per table 1. If we compare this reliability value with standard value of alpha 0.7 as recommended by Cronbach[1]. It was found that the scale was sufficiently reliable for data analysis.

Table: 1 Reliability Statistics

| S.No. | Dimension | Cronbach's Alpha | Cronbach's Alpha Based on standardized Items | No. of items |
|---|---|---|---|---|
| 1. | Land fertility | .880 | .893 | 13 |
| 2. | Market index | .919 | .918 | 16 |
| 3. | Technology achievement | .902 | .906 | 11 |
| 4. | Labour productivity | .929 | .935 | 15 |

### Validity:

***Kasier-Meyer-Olkin (KMO):*** Regarding validity, KMO measure of sampling adequacy is a measure of whether or not the distribution of value is adequate for conducting Factor analysis. This measure varies between o and 1, value closer to 1 is better. As per KMO measure, a measure of >0.9 is marvelous, >0.8 is meritorious, >0.7 is middling, >0.6 is mediocre, >0.5 is miserable and <0.5 is unacceptable [2].

For the present study KMO values of >0.6 scores were considered. The data of present study found sampling adequacy values of all four dimensions they were 0.758, 0.632, 0.725 and 0.615 of land fertility, market index, technology achievement and labour productivity correspondingly. These values indicate moderate and middling as per table 2. It indicates that the data set was suitable for factor analysis.

| Table: 2 KMO and Bartlett's Test | | | |
|---|---|---|---|
| **Dimension** | **Test name** | | **Value** |
| **Land fertility** | Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .758 |
| | Bartlett's Test of Sphericity | Approx. Chi-Square | 241.783 |
| | | df | 78 |
| | | Sig. | .000 |
| **Market index** | Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .632 |
| | Bartlett's Test of Sphericity | Approx. Chi-Square | 382.960 |
| | | df | 120 |
| | | Sig. | .000 |
| **Technology achievement index** | Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.725 |
| | Bartlett's Test of Sphericity | Approx. Chi-Square | 206.119 |
| | | df | 55 |
| | | Sig. | .000 |
| **Labour productivity index** | Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .615 |
| | Bartlett's Test of Sphericity | Approx. Chi-Square | 375.875 |
| | | df | 91 |
| | | Sig. | .000 |

*Extraction method: Principal Component Analysis.*

**Bartlett test of sphericity:** It is a statistical test for overall significance of the correlation within a correlation matrix. It uses Chi Square distribution. It is a measure of the multivariate normality of the set of distributions. It also tests whether the correlation matrix conducted within the factor analysis is an identity matrix. Factor analysis is meaningless with an identity matrix. According to George and Mallery [3] a significant value of <0.05 indicates that the data do not produce an identity matrix, thus there is a significant correlation among variables also suitable for multivariate normal and acceptable for factor analysis.
The data of the all four dimensions of the present study found a significant value of 0.000, indicating that there is a significant correlation among variables hence the present data was acceptable for factor analysis as per table 2.

### Step 4- Principal component analysis and selection of items

The results indicates that a factor analysis can be applied to the set of given data as the value of reliability test was greater than Alpha 0.7 as depicted in table 1. KMO statistics value was greater than 0.6 and the Bartlett's test of sphericity was significant it depicted in Table 2.
For all four dimensions rotated component matrix was used with 0.6 cut off point for factor loading and naming the factors.

### First dimension: Land/soil fertility

There are three factors resulting from the analysis explaining a total of 73.277 per cent of variations in the entire data set. The percentage of variation explained by the first, second and third factors are 30.099, 24.843 and 18.335 per cent respectively, after maximum rotation was performed, showed in table 3. In this way became three factors.

| Table: 3 Total Variance Explained | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Component** | **Initial Eigenvalues** | | | **Extraction Sums of Squared Loadings** | | | **Rotation Sums of Squared Loadings** | | |
| | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** |
| **1.** | 5.851 | 45.008 | 45.008 | 5.851 | 45.008 | 45.008 | 3.913 | 30.099 | 30.099 |
| **2.** | 2.412 | 18.551 | 63.559 | 2.412 | 18.551 | 63.559 | 3.230 | 24.843 | 54.942 |
| **3.** | 1.263 | 9.718 | 73.277 | 1.263 | 9.718 | 73.277 | 2.384 | 18.335 | 73.277 |
| **4.** | .837 | 6.438 | 79.715 | | | | | | |
| **5.** | .646 | 4.967 | 84.682 | | | | | | |
| **6.** | .502 | 3.859 | 88.541 | | | | | | |
| **7.** | .390 | 3.001 | 91.543 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **8.** | .290 | 2.234 | 93.777 | | | | | | |
| **9.** | .263 | 2.020 | 95.798 | | | | | | |
| **10.** | .200 | 1.535 | 97.333 | | | | | | |
| **11.** | .159 | 1.225 | 98.558 | | | | | | |
| **12.** | .108 | .829 | 99.387 | | | | | | |
| **13.** | .080 | .613 | 100.000 | | | | | | |

*Extraction Method: Principal Component Analysis.*

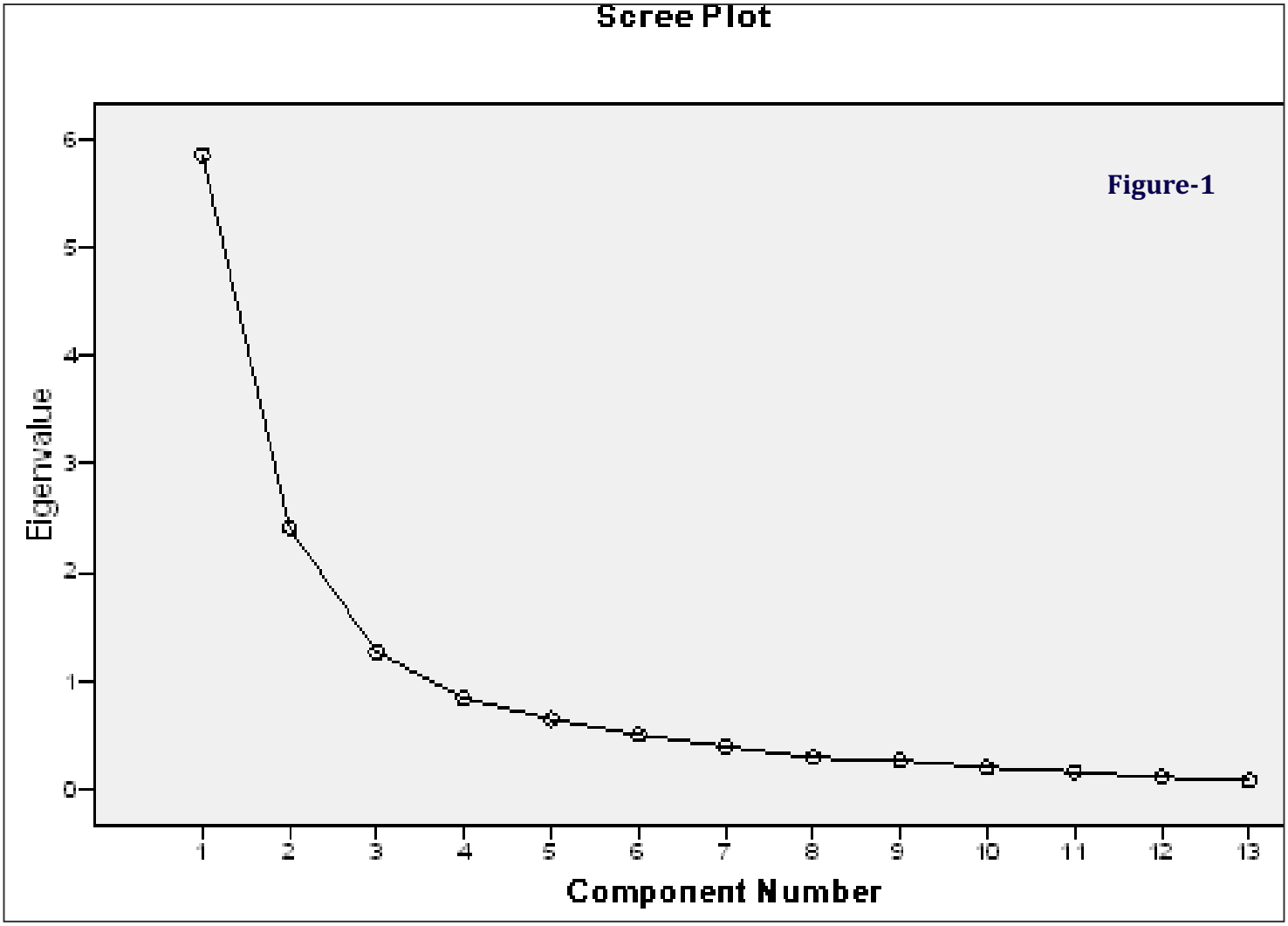


**Figure-1**

**Table: 4 Component Matrix (a)**

| Statements | | Component | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| **(X1)** | Crop rotation with legumes | .753 | -.318 | .445 |
| **(X2)** | Inter - cropping with legumes | .589 | -.230 | .546 |
| **(X3)** | Organic farming | .510 | .490 | .337 |
| **(X4)** | Farm yard manure | .753 | -.463 | -.003 |
| **(X5)** | Chemical fertilizers | .710 | .248 | .070 |
| **(X6)** | Green manure | .707 | -.357 | -.237 |
| **(X7)** | Growing fodder crops | .580 | .515 | .396 |

| | | | | |
|---|---|---|---|---|
| **(X8)** | Penning | .769 | -.438 | -.013 |
| **(X9)** | Deep plough and expose the soil to sun | .547 | .593 | -.143 |
| **(X10)** | Stubble- mulching and incorporation | .835 | .084 | -.306 |
| **(X11)** | Pre plough | .714 | .159 | -.469 |
| **( X12)** | Soil test based fertilizer recommendation | .739 | -.289 | -.288 |
| **(X13)** | Stubble burning | .353 | .831 | -.132 |

*Extraction Method: Principal Component Analysis.*

3 components extracted.
Factor 1 has comprised variables X4 (Farm yard manure), X6 (Green manure), X8 (Penning), X10 (Stubble- mulching and incorporation), X11 (Pre plough) and X12 (Soil test based fertilizer recommendation). Factor 2 comprises X3 (Organic farming), X7 (Growing fodder crops), X9 (Deep plough and expose the soil to sun) and X13 (Stubble burning). Factor 3 comprises X1 (Crop rotation with legumes) and X2 (Inter - cropping with legumes) depicted in table 5.

**Table: 5 Rotated Component Matrix (a)**

| Statements | | Component 1 | 2 | 3 |
|---|---|---|---|---|
| **(X1)** | Crop rotation with legumes | .423 | .119 | .821 |
| **(X2)** | Inter - cropping with legumes | .212 | .122 | .799 |
| **(X3)** | Organic farming | .003 | .697 | .359 |
| **(X4)** | Farm yard manure | .729 | -.035 | .498 |
| **(X5)** | Chemical fertilizers | .391 | .568 | .310 |
| **(X6)** | Green manure | .788 | .021 | .250 |
| **(X7)** | Growing fodder crops | .012 | .757 | .432 |
| **(X8)** | Penning | .737 | -.006 | .489 |
| **(X9)** | Deep plough and expose the soil to sun | .262 | .774 | -.053 |
| **(X10)** | Stubble- mulching and incorporation | .756 | .462 | .111 |
| **(X11)** | Pre plough | .731 | .458 | -.104 |
| **(X12)** | Soil test based fertilizer recommendation | .815 | .092 | .201 |
| **(X13)** | Stubble burning | .024 | .887 | -.210 |

*Extraction Method: Principal Component Analysis.*
*Rotation Method: Varimax with Kaiser Normalization.*
*a Rotation converged in 8 iterations.*

**Second dimension: Market index**

There are three factors resulting from the analysis elucidating a total of 73.389 per cent of variations in the whole data set. The percentage of variation elucidated by the first, second and third factors are 38.861, 22.077 and 12.451 per cent respectively after maximum rotation was performed, represented in table 6. In this way acquired three factors.

**Table: 6 Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| **1.** | 7.511 | 46.947 | 46.947 | 7.511 | 46.947 | 46.947 | 6.218 | 38.861 | 38.861 |
| **2.** | 2.646 | 16.537 | 63.483 | 2.646 | 16.537 | 63.483 | 3.532 | 22.077 | 60.938 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **3.** | 1.585 | 9.906 | 73.389 | 1.585 | 9.906 | 73.389 | 1.992 | 12.451 | 73.389 |
| **4.** | .885 | 5.530 | 78.919 | | | | | | |
| **5.** | .661 | 4.131 | 83.049 | | | | | | |
| **6.** | .573 | 3.584 | 86.633 | | | | | | |
| **7.** | .475 | 2.968 | 89.601 | | | | | | |
| **8.** | .365 | 2.283 | 91.883 | | | | | | |
| **9.** | .362 | 2.260 | 94.143 | | | | | | |
| **10.** | .294 | 1.839 | 95.983 | | | | | | |
| **11.** | .196 | 1.226 | 97.209 | | | | | | |
| **12.** | .148 | .924 | 98.132 | | | | | | |
| **13.** | .138 | .865 | 98.997 | | | | | | |
| **14.** | .102 | .636 | 99.634 | | | | | | |
| **15.** | .044 | .273 | 99.906 | | | | | | |
| **16.** | .015 | .094 | 100.000 | | | | | | |

*Extraction Method: Principal Component Analysis.*

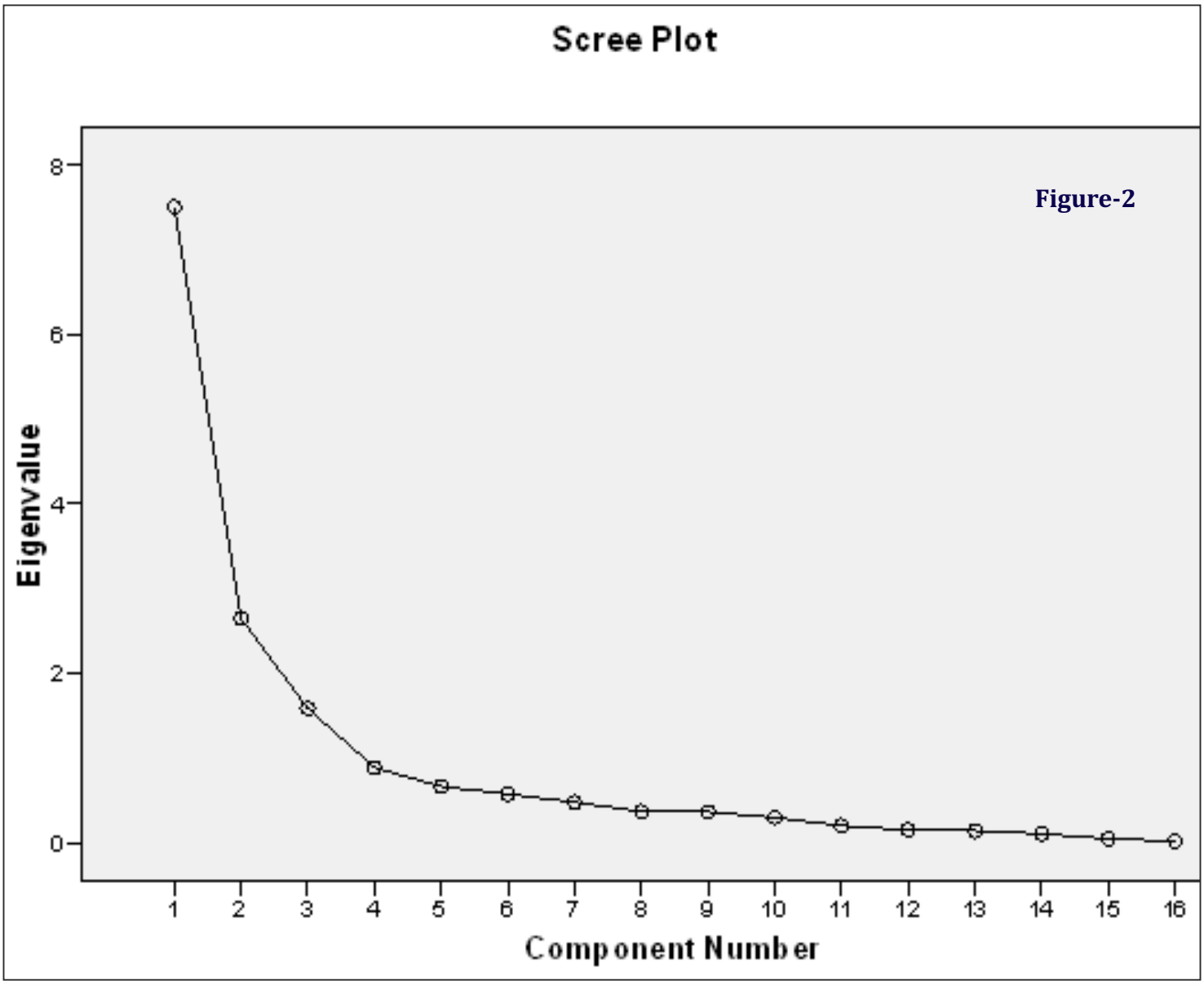


**Figure-2**

| Table: 7 Component Matrix (a) | | | | |
|---|---|---|---|---|
| **Statements** | | **Component** | | |
| | | **1** | **2** | **3** |
| **(X1)** | Selling the produce within the farm | .804 | -.434 | .013 |
| **(X2)** | Selling nearby market | .740 | -.326 | .344 |
| **(X3)** | Selling to government agencies | .694 | .383 | .395 |
| **(X4)** | Selling without drying | .794 | -.446 | .123 |
| **(X5)** | Selling after drying | .310 | .052 | .701 |
| **(X6)** | Selling to middlemen who offer high price | .723 | -.262 | -.027 |
| **(X7)** | Selling to agent's who offer advance | .809 | -.233 | -.376 |
| **(X8)** | Selling to agents who provide payment immediately | .812 | -.290 | .092 |
| **(X9)** | Selling to agents who offer high price even though payment is late | .863 | .044 | -.029 |
| **(X10)** | Selling to agents who use standard weights | .696 | -.003 | .119 |
| **(X11)** | Selling to farmer clubs/FPO's | .469 | .770 | -.179 |
| **(X12)** | Selling to known deals | .740 | .177 | -.358 |
| **(X13)** | Selling to known deals in other stats | .776 | -.131 | -.410 |
| **(X14)** | Putting up in an open market | .501 | .499 | -.426 |
| **(X15)** | Processing and selling | .522 | .600 | .346 |
| **(X16)** | Value addition | .387 | .737 | .095 |

*Extraction Method: Principal Component Analysis. a 3 components extracted.*

Factor 1 has comprised variables X1 (Selling the produce within the farm), X2 (Selling nearby market), X4 (Selling without drying), X6 (Selling to middlemen who offer high price), X7 (Selling to agent's who offer advance), X8 (Selling to agents who provide payment immediately) X9 (Selling to agents who offer high price even though payment is late) X12 (Selling to known deals) and X13 (Selling to known deals in other states) showed in table 8.

Factor 2 comprises X11 (Selling to farmer clubs/ FPO's), X14 (Putting up in an open market), X15 (Processing and selling) and X16 (Value addition). Factor 3 comprises X3 (Selling to government agencies) and X5 (Selling after drying) depicted in table 8.

| Table: 8 Rotated Component Matrix (a) | | | | |
|---|---|---|---|---|
| **Statements** | | **Component** | | |
| | | **1** | **2** | **3** |
| **(X1)** | Selling the produce within the farm | .900 | -.024 | .161 |
| **(X2)** | Selling nearby market | .738 | -.038 | .476 |
| **(X3)** | Selling to government agencies | .348 | .543 | .607 |
| **(X4)** | Selling without drying | .879 | -.065 | .262 |
| **(X5)** | Selling after drying | .127 | .015 | .757 |
| **(X6)** | Selling to middlemen who offer high price | .753 | .099 | .125 |
| **(X7)** | Selling to agent's who offer advance | .869 | .245 | -.184 |
| **(X8)** | Selling to agents who provide payment immediately | .824 | .086 | .257 |

| | | | | |
|---|---|---|---|---|
| **(X9)** | Selling to agents who offer high price even though payment is late | .726 | .426 | .199 |
| **(X10)** | Selling to agents who use standard weights | .581 | .276 | .292 |
| **(X11)** | Selling to farmer clubs/FPO's | .060 | .916 | .051 |
| **(X12)** | Selling to known deals | .609 | .565 | -.130 |
| **(X13)** | Selling to known deals in other stats | .797 | .326 | -.211 |
| **(X14)** | Putting up in an open market | .260 | .754 | -.213 |
| **(X15)** | Processing and selling | .103 | .668 | .545 |
| **(X16)** | Value addition | -.039 | .786 | .288 |

*Extraction Method: Principal Component Analysis.*
*Rotation Method: Varimax with Kaiser Normalization.*
*a Rotation converged in 6 iterations.*

**Third dimension: Technology achievement index:**

There are two factors resulting from the analysis clarifying a total of 64.42 per cent of variations in the entire data set. The percentages of variation explained by the first and second factors are 37.332 and 27.091 per cent respectively after maximum rotation was performed and displayed in table 9. In this way acquired two factors.

**Table: 9 Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| **1.** | 5.796 | 52.689 | 52.689 | 5.796 | 52.689 | 52.689 | 4.107 | 37.332 | 37.332 |
| **2.** | 1.291 | 11.734 | 64.423 | 1.291 | 11.734 | 64.423 | 2.980 | 27.091 | 64.423 |
| **3.** | .924 | 8.404 | 72.827 | | | | | | |
| **4.** | .787 | 7.159 | 79.986 | | | | | | |
| **5.** | .705 | 6.405 | 86.391 | | | | | | |
| **6.** | .462 | 4.197 | 90.587 | | | | | | |
| **7.** | .391 | 3.552 | 94.140 | | | | | | |
| **8.** | .302 | 2.750 | 96.889 | | | | | | |
| **9.** | .169 | 1.539 | 98.429 | | | | | | |
| **10.** | .121 | 1.102 | 99.530 | | | | | | |
| **11.** | .052 | .470 | 100.000 | | | | | | |

*Extraction Method: Principal Component Analysis.*


Figure-3

**Table: 10 Component Matrix (a)**

| Statements | | Component | |
|---|---|---|---|
| | | 1 | 2 |
| (X1) | Adoption of modern hybrid seeds | .789 | .115 |
| (X2) | Modern farm machineries for ploughting | .846 | .350 |
| (X3) | Modern farm machineries for sowing | .578 | .362 |
| (X4) | Modern farm machineries for irrigation | .705 | .573 |
| (X5) | Usage of information and communication technologies | .387 | .569 |
| (X6) | Use of social media to gain knowledge on latest developments/ technologies | .814 | .139 |
| (X7) | Use of internet to gain knowledge on latest developments/ technologies | .776 | .165 |
| (X8) | Drones for spraying | .155 | .706 |
| (X9) | Utilization of KVKs and DAATT centers information and technologies to improve farm productivity | .053 | .854 |
| (X10) | Using modern farm machineries for harvesting | .290 | .673 |
| (X11) | Adoption of post - harvest technologies for insects and pests control | .641 | .577 |

*Extraction Method: Principal Component Analysis.*
*Rotation Method: Varimax with Kaiser Normalization.*
*a Rotation converged in 3 iterations.*

Factor 1 has comprised variables X1 (Adoption of modern hybrid seeds), X2 (Modern farm machineries for ploughting), X3 (Modern farm machineries for sowing), X4 (Modern farm machineries for irrigation), X5 (Usage of information and communication technologies), X6 (Use of social media to gain knowledge on latest developments/ technologies) X7 (Use of internet to gain knowledge on latest developments/ technologies), X10 (Using modern farm machineries for harvesting) and X11 (Adoption of post - harvest technologies for insects and pests control). Factor 2 comprises X9 (Utilization of KVKs and DAATT centers information and technologies to improve farm productivity) described in table 11.

**Table: 11 Rotated Component Matrix (a)**

| Statements | | Component | |
|---|---|---|---|
| | | 1 | 2 |
| (X1) | Adoption of modern hybrid seeds | .694 | -.392 |
| (X2) | Modern farm machineries for ploughting | .883 | -.242 |
| (X3) | Modern farm machineries for sowing | .678 | -.067 |
| (X4) | Modern farm machineries for irrigation | .909 | .022 |
| (X5) | Usage of information and communication technologies | .655 | .213 |
| (X6) | Use of social media to gain knowledge on latest developments/ technologies | .729 | -.389 |
| (X7) | Use of internet to gain knowledge on latest developments/ technologies | .715 | -.345 |
| (X8) | Drones for spraying | .555 | .463 |
| (X9) | Utilization of KVKs and DAATT centers information and technologies to improve farm productivity | .565 | .643 |
| (X10) | Using modern farm machineries for harvesting | .641 | .354 |
| (X11) | Adoption of post - harvest technologies for insects and pests control | .860 | .063 |

*Extraction Method: Principal Component Analysis.*
*a 2 components extracted.*

**Fourth dimension: Labour productivity**

There are three factors resulting from the analysis clarifying a total of 76.189 per cent of variations in the whole data set. The percentages of variation explained by the first, second and third factors are 32.153, 23.252 and 20.784 per cent respectively after maximum rotation was performed and represented in table 12. In this way it became three factors.

**Table: 12 Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| **1.** | 8.022 | 53.477 | 53.477 | 8.022 | 53.477 | 53.477 | 4.823 | 32.153 | 32.153 |
| **2.** | 1.748 | 11.651 | 65.128 | 1.748 | 11.651 | 65.128 | 3.488 | 23.252 | 55.405 |
| **3.** | 1.659 | 11.061 | 76.189 | 1.659 | 11.061 | 76.189 | 3.118 | 20.784 | 76.189 |
| **4.** | .841 | 5.604 | 81.794 | | | | | | |
| **5.** | .679 | 4.530 | 86.323 | | | | | | |
| **6.** | .489 | 3.260 | 89.583 | | | | | | |
| **7.** | .384 | 2.561 | 92.144 | | | | | | |
| **8.** | .345 | 2.302 | 94.446 | | | | | | |
| **9.** | .264 | 1.762 | 96.208 | | | | | | |
| **10.** | .245 | 1.632 | 97.840 | | | | | | |
| **11.** | .121 | .808 | 98.648 | | | | | | |
| **12.** | .098 | .654 | 99.302 | | | | | | |
| **13.** | .056 | .372 | 99.673 | | | | | | |
| **14.** | .038 | .255 | 99.928 | | | | | | |
| **15.** | .011 | .072 | 100.000 | | | | | | |

*Extraction Method: Principal Component Analysis.*

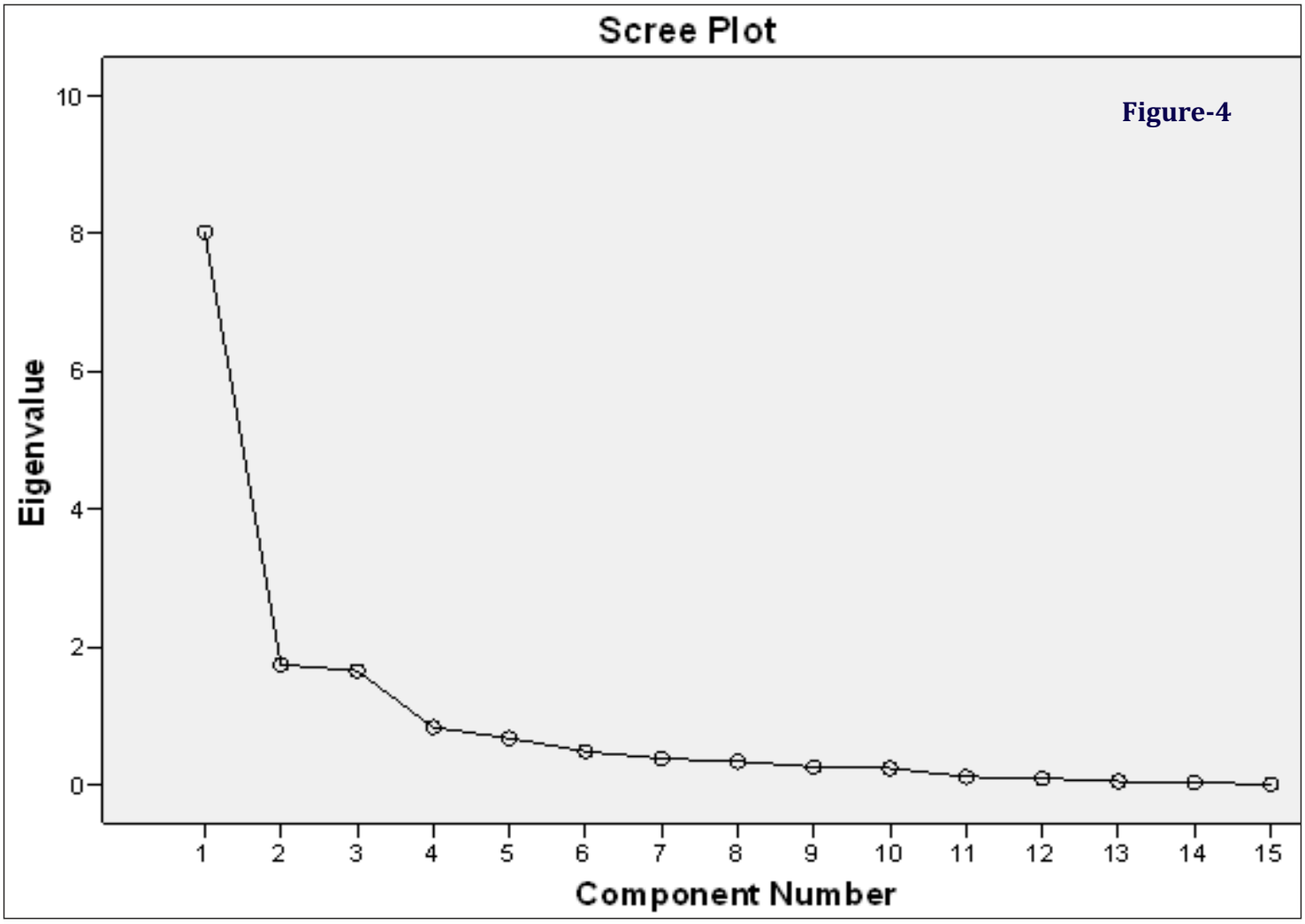


**Figure-4**

| Table: 13 Component Matrix (a) | | | | |
|---|---|---|---|---|
| **Statements** | | **Component** | | |
| | | **1** | **2** | **3** |
| **(X1)** | Hiring the same labour for different activities as they work properly | .660 | .369 | -.368 |
| **(X2)** | Hiring the labour by providing salary instead of wages for a crop period | .656 | .103 | .487 |
| **(X3)** | Hiring middlemen for bringing labor for a specific activities and paying a wholesome cost irrespective of number of days and hours worked | .407 | .623 | .179 |
| **(X4)** | Hiring the labour by providing same wage as others along with transportation | .841 | .203 | -.086 |
| **(X5)** | Hiring the labour by providing same wage as others along with lunch | .706 | .448 | .367 |
| **(X6)** | Motivating the labour to work hard by paying higher wages compared to others | .582 | .585 | -.197 |
| **(X7)** | Good relationship | .744 | .168 | -.207 |
| **(X8)** | Providing safe drinking water and toilet facilities nearby the farm | .707 | -.168 | .517 |
| **(X9)** | Providing necessary facilities for the children of labourers | .750 | -.290 | .544 |
| **(X10)** | Providing appropriate farm tools with respect to the activity | .876 | -.288 | -.253 |
| **(X11)** | Providing latest farm tools whenever and wherever required | .778 | -.251 | -.447 |
| **(X12)** | Providing short breaks during their work hours | .805 | -.286 | -.224 |
| **(X13)** | Providing personal protective equipment (PPE) to the labourers | .839 | -.314 | -.273 |
| **(X14)** | Involving own family members | .746 | .072 | -.082 |
| **(X15)** | Using neighbour farm members as an exchange policy | .742 | -.396 | .270 |

*Extraction Method: Principal Component Analysis.*
*a 3 components extracted.*

Factor 1 has comprised variables X10 (Providing appropriate farm tools with respect to the activity), X11 (Providing latest farm tools whenever and wherever required), X12 (Providing short breaks during their work hours) and X13 (Providing personal protective equipment (PPE) to the labourers).
Factor 2 has includes X2 (Hiring the labour by providing salary instead of wages for a crop period), X8 (Providing safe drinking water and toilet facilities nearby the farm), X9 (Providing necessary facilities for the children of labourers) and X15 (Using neighbour farm members as an exchange policy)
Factor 3 has contains X1 (Hiring the same labour for different activities as they work properly), X3 (Hiring middlemen for bringing labor for a specific activities and paying a wholesome cost irrespective of number of days and hours worked), X4 (Hiring the labour by providing same wage as others along with transportation) and X6 (Motivating the labour to work hard by paying higher wages compared to others) presented in table 14.

| Table: 14 Rotated Component Matrix (a) | | | | |
|---|---|---|---|---|
| **Statements** | | **Component** | | |
| | | **1** | **2** | **3** |
| **(X1)** | Hiring the same labour for different activities as they work properly | .541 | -.039 | .643 |
| **(X2)** | Hiring the labour by providing salary instead of wages for a crop period | .131 | .714 | .387 |

| | | | | |
|---|---|---|---|---|
| **(X3)** | Hiring middlemen for bringing labor for a specific activities and paying a wholesome cost irrespective of number of days and hours worked | -.061 | .197 | .737 |
| **(X4)** | Hiring the labour by providing same wage as others along with transportation | .104 | .554 | 0.718 |
| **(X5)** | Hiring the labour by providing same wage as others along with lunch | .565 | .327 | 0.574 |
| **(X6)** | Motivating the labour to work hard by paying higher wages compared to others | .301 | -.001 | .793 |
| **(X7)** | Good relationship | .581 | .188 | .501 |
| **(X8)** | Providing safe drinking water and toilet facilities nearby the farm | .255 | .838 | .171 |
| **(X9)** | Providing necessary facilities for the children of labourers | .316 | .914 | .082 |
| **(X10)** | Providing appropriate farm tools with respect to the activity | .878 | .342 | .160 |
| **(X11)** | Providing latest farm tools whenever and wherever required | .911 | .123 | .152 |
| **(X12)** | Providing short breaks during their work hours | .811 | .326 | .128 |
| **(X13)** | Providing personal protective equipment (PPE) to the labourers | .875 | .312 | .121 |
| **(X14)** | Involving own family members | .546 | .314 | .414 |
| **(X15)** | Using neighbour farm members as an exchange policy | .514 | .718 | -.009 |

*Extraction Method: Principal Component Analysis.*
*Rotation Method: Varimax with Kaiser Normalization.*
*a Rotation converged in 6 iterations.*

## CONCLUSION

The present study was aimed at constructing a scale to measure the agricultural performance of small and marginal farmers. The effective aspect of agricultural performance scale consisted of 49 statements with high reliability and more predictive validity. This scale can be used in future studies to measure the agricultural performance of farmers. It will be helpful to the policy makers and administrators to develop suitable measures towards improving agricultural performance of farmers by providing good amenities to sell their produce and improve their land fertility etc.

### Conflict of interest

We do not have conflict of interest as authors.

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