Journal of Experimental Agriculture International
14(5): 1-9, 2016; Article no.JEAI.29405
Previously known as American Journal of Experimental Agriculture
ISSN: 2231-0606

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A Study on Comparative Economics of Grain and Seed Production of Groundnut in Karnataka, India

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Authors' contributions

This work was carried out in collaboration between all authors. Author GP designed the study, conducted the survey, wrote the methodology and the first draft of the manuscript. Authors GP and CR have made the data compilation. All authors have reviewed the methodology and all drafts of the manuscript. All the authors managed the data analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2016/29405
Editor(s):
(1) Maher Noaman, Barley Research Department, Field Crops Research Institute, Giza, Egypt.
(2) Lanzhuang Chen, Laboratory of Plant Biotechnology, Faculty of Environment and Horticulture, Minami Kyushu University, Miyazaki, Japan.
Reviewers:
(1) Mtaita Tuarira, Africa University, Zimbabwe.
(2) Valentin Kosev, Institute of Forage Crops, Bulgaria.
Complete Peer review History: http://www.sciencedomain.org/review-history/16973

Original Research Article

Received 8th September 2016
Accepted 14th November 2016
Published 19th November 2016

ABSTRACT

The present study was based on primary data collected for 100 farmers from Chitradurga district of Karnataka during the agricultural year 2013-14. Tabular analysis and discriminant function analysis was used in the present study. The analysis of data reveals that human labour occupied the major share (27.07%) of total cost in seed production and bullock and machine labour occupied the major share (29.38%) of total cost in grain production of groundnut. The higher human labour requirement in seed production was mainly due to activities like rouging, gap filling etc. The variable cost was comparatively higher in seed production (Rs. 25745.0 per ha) over grain production (Rs. 20752.0 per ha). The total cost of cultivation in groundnut seed production was around 18% higher than grain production. The gross return was about 27% higher in seed production than grain production and net return from seed production of groundnut was 44% higher than grain production. The BC

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ratio was 1.73 in case of groundnut seed production as compared to 1.60 in grain production. The discriminant analysis indicated that human labour with 45.56% followed by gross return (35.83%), seed (17.50%), manures and fertilizers (0.69%), bullock and machine labour (0.42%) contributed to discriminate between the seed and grain production of groundnut. The net return from groundnut seed production was encouraging, therefore the area under seed production may be increased for higher profitability and timely supply of quality seed to the farmers.

Keywords: Discriminant analysis; economics; groundnut; seed production.

1. INTRODUCTION

Seed is a crucial, vital, basic and important input for attaining sustained growth in agriculture production and productivity. Quality seed production is a specialised activity. The general farm produce retained for seed cannot be substituted for quality seed, as farm saved seed generally lacks genetic vigour and has poor germination [1]. A sustained increase in agriculture production and productivity has dependent on the development of new improved variety, timely and adequate supply of quality seed to the farmers. It is estimated that the direct contribution of quality seed alone to the total production is about 15-20% depending upon the crop and it can be further raised up to 40% with effective management of other inputs [2].

Groundnut (*Arachis hypogaea* L.) is the 6th most important oil seed crop in the world. It contains 48-50% oil, 26 -28% protein and 11-27% carbohydrate, minerals and vitamins [3]. According to FAO statistics, worldwide groundnut was grown in about 25.67 million hectares and its production was 42.31 million tons having productivity of 1648 kg/ha during the year 2014. India is the second largest producer of groundnut after China in the world [4]. Developing country share in global production of groundnut is around 95% while Asia's share is around 68% [5].

It is estimated that nine oilseed crops namely soybean, rapeseed-mustard, groundnut, sesame, castor, sunflower, niger, linseed and safflower accounted for an area of 28.05 million hectares with the production of 32.75 million tons during 2013-14. Groundnut ranks second in terms of production amongst all nine oilseed crops and it is an important leguminous oilseed crop grown in India. It occupies an area of 5.51 million ha with production 9.71 million tons and productivity 1764 kg/ha during 2013-14 [6]. It is grown in semi-arid regions, especially in the states of Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra [7]. In India, 80% of groundnut is grown during *kharif* season under rainfed conditions [8].

Groundnut is an important crop of Karnataka contributing around 13% and 7% to area and production of groundnut in the country respectively during 2011-12 [9]. Seed of groundnut has major share in its cost of cultivation, therefore the economics of groundnut seed production has impacted both seed producers as well as its users. There are several studies pertaining to cost of cultivation of groundnut for grain production [10-16]. But only a few studies related to cost of groundnut seed production [17]. Hence, the present study is undertaken with the objective to analyze the economics of groundnut seed production *vis-à-vis* grain production and to specify the variables that are discriminating the seed production from grain production.

2. METHODOLOGY

The study is based on primary data collected from Chitradurga district of Karnataka. The district Chitradurga has been selected purposively as the district has highest area under groundnut cultivation in the state which was 15.15% of total area under groundnut cultivation in the state during 2009-10 [18]. The list of certified seed growers of groundnut in Chitradurga district have been obtained from Karnataka State Seed Certification Agency, Bangalore. From the list fifty certified seed growers of groundnut have been selected randomly from five villages. For comparison study with grain production of groundnut again forty one grain producers of groundnut selected randomly from the above selected five villages and nine from other two neighbouring villages as sufficient groundnut grain producers were not available in the said villages. Thus, the total number of selected farmers (grain and certified seed producer of groundnut) was one hundred.

2.1 Data Collection

Primary data were collected by personnel interview with the respondents using a well-structured and pre-tested interview schedule. Data on socio-economic parameters, various inputs used in the grain and seed production of groundnut and their costs and returns were collected for the agricultural year 2013-14. Tabular analysis was used to compare the different values of farm economy and other aspects of farm business and weighted average was used for average analysis.

2.2 Cost Concept

Cost A_1 = All the variable costs excluding family labour cost and including interest on working capital

Cost A_2 = Cost A_1 + Rent paid for leased in land

Cost B_1 = Cost A_1 + Interest on value of owned fixed capital (other than land)

Cost B_2 = Cost B_1 + Rental value of owned land + Rent paid for leased in land

Cost C_1 = Cost B_1 + Imputed value of family labour

Cost C_2 = Cost B_2 + Imputed value of family labour

Cost C_3 = Cost C_2 + 10% of cost C_2 to account for the value of management input of the farmers.

2.3 Income Measures

Net income = Gross income - Cost C_3

Family labour income = Gross income - Cost B_2

Farm business income = Gross income – Cost A_1

Farm investment income = Farm business income – imputed value of family labour

Benefit cost ratio = Gross income / Cost C_3

2.4 Discriminant Function Analysis

The linear discriminant function analysis (LDA) was used to identify the variables that are important in discriminating between two groups of production *i.e.* seed and grain production. In multivariate analysis, linear discriminant function, which is better than any other linear function, will discriminate between any two chosen classes [19]. The concept underlying the discriminant function analysis is that, linear combinations of the independent variables are formed and serve as the basis for classification. Thus, the information from multiple independent variables is summarized in a single index.

In the present study linear discriminant function of the following form was employed to know the relative importance of different variables in discriminating between the two groups of farms of equal size, *viz.*, seed and grain production of groundnut.

$$Z = \sum_{i=1}^{n} Li\ Xi$$

Where,

Z = Total discriminant score for seed and grain production,

X_i = Variables selected to discriminate the two groups (i = 1,2,3,……, n),

L_i = Linear discriminant coefficients of the variables estimated from the data.

Mahalanobis D^2 statistic was used to measure the discriminating distance between the two groups.

$$D^2 = \sum_{i=1}^{n} Li\ di$$

Where,

n = Total number of cases,

L_i = Inverted matrix of the coefficients of the discriminant function,

d_i = Mean difference of the variables.

The significance of D^2 was tested by applying the following F test.

$$\frac{(n-1-p)(n1\ n2)}{(n-2)(n)}\ D^2 \sim F \propto (p, n-p-1)$$

Where,

n_1 = Number of individuals in the seed production,

n_2 = Number of individuals in the grain production,

$n = n_1 + n_2$.

The Z scores for each group have been calculated as:

For seed production:

$$Z1 = \sum_{i=1}^{p} Li\ X1i$$

For grain production:

$$Z2 = \sum_{i=1}^{p} Li\ X2i$$

The critical mean discriminant score was obtained as

$$Z = (Z_1 + Z_2)/2,$$

For each individual Zi value was calculated as follows:

$$Zi = \sum_{i=1}^{p} Li\ Xi$$

If the individual Zi value is more than Z, the individual belongs to the seed production, otherwise grain production.

3. RESULTS AND DISCUSSION

Economic comparison is essential to test the profitability and viability of any activity. Therefore, economics of seed production *vis-à-vis* grain production has been calculated and compared, so as to analyze the feasibility of seed production over grain production. The present analysis on cost of cultivation was worked out on per hectare basis separately for seed and grain production of groundnut.

The item-wise cost of cultivation of seed and grain production of groundnut has been presented in Table 1. The table reveals that human labour occupied the major share (27.07%) of total cost of Rs. 33245.0 per ha in seed production and bullock and machine labour occupied the major share (29.38%) of total cost of Rs. 28252.0 per ha in grain production of groundnut. The higher human labour requirement in seed production was mainly due to activities like rouging, gap filling etc. It was reported in a study [15] that due to knowledge and adoption gap, its results in lower yield and higher cost of cultivation. The other items involved in production of groundnut seed was bullock and machine labour (26.47% of total cost), cost of seed (10.95%), manures and fertilizers (8.42%), and seed certification charges (3.01%). The higher share of bullock and machine labour was due to less mechanization at field level and this can be reduced by increasing mechanization in cultivation operation. In total cost of cultivation, variable costs took major share of 77.44% in seed production as compared to 73.45% in grain production. The higher share of fixed cost in total cost of cultivation is mainly due to rental value of own land (opportunity cost). The variable cost was comparatively higher in seed production (Rs. 25745.0 per ha) over grain production (Rs. 20752.0 per ha). The total cost of cultivation in groundnut seed production was around 18% higher than grain production. One study in this regard [20] showed that the total cost of cultivation per ha. of rainfed groundnut crop was Rs. 34638.86 on seed farm and Rs. 26827.0 on commercial farm. The seed and commercial farm realized a gross income of Rs. 48701.0 and 36412.0 per ha. respectively. The net income was high on seed farm (Rs. 14062.14) compared to Rs. 9585.0 per ha. on commercial farm.

Table 1. Item-wise cost comparison of seed and grain production in groundnut (Rs./ha)

Sl.	Items	Seed production	Grain production
1	Seed	3640 (10.95)	3115 (11.02)
2	Human labour	9000 (27.07)	5880 (20.81)
3	Bullock and machine labour	8800 (26.47)	8300 (29.38)
4	Manures and fertilizers	2800 (8.42)	3050 (10.08)
7	Seed certification charges	1000 (3.01)	00 (0)
8	Interest on working capital	505 (1.52)	407 (1.44)
9	Total variable cost (Rs.)	25745 (77.44)	20752 (73.45)
10	Total fixed cost (Rs.)	7500 (22.56)	7500 (26.55)
11	Total cost	33245 (100.00)	28252 (100.00)

Note: Figures in parentheses indicate % to total cost

Cost of cultivation according to various cost concepts was presented in Table 2 which reveals that all the costs were higher in seed production over grain production in groundnut. The seed grower has to strictly adhere to the recommended cultural practices to ensure genetic purity as laid down by the seed certification agency. Seed production plot must be weed free and off-type plants need to be removed manually to maintain genetic purity. Proper drying of seeds and preliminary processing is another special operation in seed production. All these operations required additional labour. Moreover, certification charges are an additional expense in seed production. Hence, cost of cultivation was higher in seed production as compared to the commercial production. The cost C_1, C_2 and C_3 were higher by around 23, 18 and 18% in groundnut seed production in comparison to grain production respectively. The family labour income, farm business income and farm investment income were higher by around 35, 27 and 30% in groundnut seed production in comparison to grain production respectively. Seed production gives higher returns with higher BC ratio compared to grain production. The gross return was about 27% higher in seed production than grain production and net return from seed production of groundnut was 44% higher than grain production. The BC ratio was 1.73 in case of groundnut seed production as compared to 1.60 in grain production.

3.1 Discriminant Analysis

Groundnut is an important oilseed crop of India and quality seed production aspect of groundnut requires more thrust due to its importance in contributing towards the nutritional security of the country. Groundnut seed production was found to be profitable enterprise, which was evident from current data analysis on comparative economics of both grain and seed production, which showed a higher profit margin in case of seed production. Karnataka in India is one of the Indian states, where quality seed production in groundnut is getting more and more adoption among the farmers. But still the use of farm saved seeds are significantly high in this region and thus this study also aimed to understand contribution of each independent variables in determining the adoption of seed production enterprise using discriminant analysis. In the above context, it is important to identify the factors that are associated with adoption of seed production enterprise and their contribution in discriminating the choice towards the two *i.e.* seed production and grain production. In order to find out the relative importance of various factors associated with seed and grain growers, the data collected from 100 groundnut growers of Chitradurga district for the year 2013-14 were used in discriminating between the two groups of farmers using discriminant analysis i.e. Mahalanobis Distance (D^2).

Table 2. Cost and returns in groundnut seed and grain production according to cost concept and income measures (Rs./ha)

Sl.	Items	Seed production	Grain production
Cost concepts			
1	Cost A_1	21305	16636
2	Cost A_2	21305	16636
3	Cost B_1	21805	17136
4	Cost B_2	28805	24136
5	Cost C_1	26245	21252
6	Cost C_2	33245	28252
7	Cost C_3	36570	31077
Income measures			
8	Yield		
a	Seed / Grain	60800	47600
c	By-product	2400	2000
9	Gross income	63200	49600
10	Net income	26630	18523
11	Family labour income	34395	25464
12	Farm business income	41895	32964
13	Farm investment income	37455	28848
14	Benefit cost ratio	1.73	1.60

There are a number of statistical criteria for selection of independent variables in the linear discriminant function, which means towards determining the addition or the removal of variables from the discriminant function. The most common ones are namely, Wilk's Lambda (Λ), Mahalanobis Distances (D^2) and Rao's V. This study used Mahalanobis distance method, in which we computed the D^2 using the given formula in methodology section of this paper and interpretation followed in which the smaller the Mahalanobis distance, the closer the member is to the group mean and the more likely it is to be grouped as a member in that group. The signs of coefficients of estimate of linear discriminant function from data were used for interpreting their positive or negative role in contribution and for ascertaining the contribution, the signs are ignored, and based on their absolute value the coefficients are ranked.

Linear Discriminant Analysis (LDA) considered as a statistical classification method for classification of observations into predefined groups, in this study there are two groups viz. grain producers and seed producers. Main aim of this method is to predict values of a categorical dependant variable using one or more continuous and or categorical independent variables. We used this method to identify which continuous variable best discriminate between grain producers and seed producers. This means identifying the most influential predictors and building a good classification function that is linear combination of these variables. This method helps in minimizing the possibility of miss classifying cases into the known groups [21]. Present study applied two-group linear discriminant function, in which dependent variable have two groups, where linear combination of the two or more independent variables that discriminate best between these groups. The estimate obtained maximizes in between groups variation relative to the within groups variation. This method helps researchers to assess the relative importance of the independent variables in classifying the dependent variable and to examine whether significant differences exist among groups [22].

The results of discriminant function analysis of two different groups *i.e.* seed production and grain production has been presented in Table 3. The variables considered in the analysis are useful in distinguishing the two groups of farms in groundnut cultivation as the D^2 value was found to be statistically significant at one per cent level of probability. The relative importance of the discriminators as calculated through their per cent contribution to total distance reveals that human labour with 45.56% followed by gross return (35.83%), seed (17.50%), manures and fertilizers (0.69%), bullock and machine labour (0.42%) contributed to discriminate between the seed and grain production of groundnut. It can be inferred that seed, human labour and gross returns were the major contributing factors to discriminate between the two groups of production. This indicates that there were significant differences in gross return between seed and grain production of groundnut.

The results of discriminant analysis can be used for predictive purpose that we can assign objects to one of a number of known groups of objects or also it can be used as a descriptive in the sense to assess the adequacy of classification, given the group memberships of the objects under study [23]. It is the first multivariate statistical classification method used for decades by researchers and practitioners in developing classification models [22]. Discriminant analysis allows one to understand the differences of objects between two or more groups with respect to several variables simultaneously [24]. The parametric technique used to determine which weightings of variables best discriminate between two or more groups of cases and this method creates discriminant function, which is a linear combination of the weightings and scores on these variables [25].

After computing the value of D^2 *i.e*. 0.72, the significance of D^2 was tested by applying the F test which showed significance at 1 % level of probability. From the results Z scores for each group were calculated and Z score for seed producers (Z_1) and grain producers (Z_2) were found to be 3.007 and 2.289 respectively and Z (critical mean discriminant score) was found to be 2.648, used for discriminating into two groups. The comparison of the variables ascertains that major share in (D^2) is due to the asset or resource richness of the farmer in terms of his income which need to be spent as expenditure for hiring human labour (skilled) or to put in the form of imputed family labour (which means availability of family members as skilled laborers for seed production). It was found about 45.66 % contribution to the total distance from the predictor variable on expenditure on human labour. Second most important factor was

Table 3. Discriminant variables in groundnut production

Items	Mean (000 Rs.)		Mean difference (d_i)	Discriminant coefficient (L_i)	L_i*d_i	Per cent contribution to the total distance
	Seed production	Grain production				
Seed (X_1)	3.640	3.115	0.525	0.239	0.126	17.50
Manures and fertilizers (X_2)	2.800	3.050	-0.250	-0.019	0.005	0.69
Human labour (X_3)	9.000	5.880	3.120	0.105	0.328	45.56
Bullock and Machine labour (X_4)	8.800	8.300	0.500	0.005	0.003	0.42
Gross return (X_5)	63.200	49.600	13.600	0.019	0.258	35.83

*D^2 = 0.72****

Z = 2.648

Z_1 = 3.007

Z_2 = 2.289

F statistics = 50.51

**** indicates significance at 1% level of probability*

variable on gross return from production with a positive discriminant coefficient. This showed that higher profit potential of seed enterprise when compared with that of grain production was highly contributed to the total distance (35.83 % contribution). Expenditure on seed input was contributed around 17.50% towards the total distance (D^2). Other factors such as expenditure on manures and fertilizers, and expenditure on bullock and machine labour found to have a lower contribution and was less than one per cent because both groups under study have adopted them to large extent. The study showed that to increase the adoption of groundnut seed production among farmers in Karnataka, there need to be an improvement in the resource status of the farmer in terms of financial strength to afford the cost towards purchase of inputs such as seed and skilled human labour. This implies for considering widening and strengthening of farmer support programmes to resource poor farmers through subsidizing various inputs, technology and related infrastructure, also through promoting lending institutions to advance low cost loans to quality seed production farmers. As the LDA results on variable on gross return shows that awareness regarding technology benefits in terms of higher profit potential among farmers to be strengthened to impart knowledge, where farmers need to be educated regarding quality seed production technology in groundnut.

4. CONCLUSIONS AND IMPLICATIONS

The analysis showed that the total cost of cultivation in groundnut seed production was around 18% higher than grain production. Further, the gross return was about 27% higher in seed production than grain production and net return from seed production of groundnut was 44% higher than grain production. The discriminant analysis indicated that human labour with 45.56% followed by gross return (35.83%), seed (17.50%), manures and fertilizers (0.69%), bullock and machine labour (0.42%) contributed to discriminate between the seed and grain production of groundnut. The net return from groundnut seed production is encouraging, therefore the area under seed production may be increased for higher profitability and timely supply of quality seed to the farmers. The farmers may be encouraged to grow quality seed of groundnut.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/16973