FACTORS AFFECTING GROUNDNUT YIELD IN POTHWAR REGION OF PUNJAB, PAKISTAN

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ABSTRACT:- Groundnut being an important oilseed crop in the Pothwar region of Pakistan has the productivity level of 609 kg ha^{-1}, much lower from the potential yield of 3000 kg ha^{-1}. Present study was designed to explore factors affecting productivity of groundnut along with its profitability analysis. The sample farms were classified into small, medium and large farms. Farm-level crop data were gathered during two cropping seasons i.e., *rabi* 2008-09 and *kharif* 2009. One hundred and forty groundnut producers were selected for collecting data using the well-structured questionnaire from two important districts recognised for area and production of groundnut. Results showed that large farmers allocated significantly higher area (34%) to groundnut cultivation compared to other categories of farmers. The gross margins were also significantly higher at large farms. Ploughing frequency, seed rate and labor man-days have positive relationship with groundnut productivity. Therefore, the provision of improved groundnut production technologies package and improved seed to groundnut growers may enhance the productivity and area under this crop.

Key Words: Groundnut; Improved Seed; Technology Package; Productivity Affecting Factors; Productivity Analysis; Ploughing Frequency; Seed Rate; Labor Man-Days; Yield; Economic Analysis; Pakistan.

INTRODUCTION

About 97% area and 94% of world production of groundnut is associated with developing countries (FAO, 2011). Asia and Africa are major groundnut producing countries. In Pakistan, major production is concentrated in the rainfed areas. At the national level, the area of groundnut was 82.9 thousand hectares while the production remained 67.8 thousand tonnes and yield 609 kg ha^{-1} in 2009 (GoP, 2011). Punjab, Khyber Pukhtunkhwa and Sindh accounts for 76%, 7% and 16%, respectively, in total cultivated area under groundnut production.

The Pothwar plateau is situated between 33.38° N and 73.00° E. This region is famous for uneven and rainfed landscaping. Chickpea, mustard and wheat are major winter crops whereas mash bean, mung, groundnut, sorghum and maize are major summer crops. In the Pothwar region groundnut (*Arachis hypogea*) is a major cash crop sown during summer season, and it is mostly grown in the Southern Pothwar (Ali et al., 2002). The Pothwar tract has environment, which is diverse in temperature and rainfall. The agricultural productivity

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in this region is low due to various factors, such as non-availability of improved inputs (seeds), inefficient fertilizer use, weed infestation, shortage of irrigation water, drought and seasonal variation of rainfall, inadequate research efforts and inefficient extension services (Ashraf et al., 1999, Ashfaq et al., 2003 and Ashraf, 2004). Keeping in view the economic importance of groundnut in the rural economy of the region, the present study was conducted to find profit-ability level and determinants of groundnut productivity. The specific objectives of the study were to explore the cropping pattern of Pothwar region, to estimate cost of production and profitability of groundnut producers and factors affecting its yield in the Pothwar region.

MATERIALS AND METHOD

Data and Source

Based on farm operational holding, the sample farms were classified into three distinct size categories: small farms (<2 ha), medium farms (2 - 5 ha) and large farms (> 5 ha). The data were collected during two cropping seasons i.e., *rabi* 2008-09 (October 2008-April 2009) and *kharif* 2009 (May-September 2009). Information was gathered from selected 140 groundnut producers using the well-structured and pretested questionnaire from Rawalpindi and Chakwal districts, being the main groundnut producing districts.

Analytical Methods

Cropping pattern is calculated when farm households prefer to plant two or more species on the same farm in the same year. This is more common where farm size is small and the lack of capital has made it difficult to mechanize and expand. The cropping pattern in the study area was computed by using the following formula:

$$PA_i = \frac{AR_i}{\sum_{i=1}^{n} AR_i} \cdot 100$$

where,

PA_i = Percent of total cropped area under i^{th} crop in a cropping season

AR_i = Total area under ith crop in a cropping season

ΣAR_i = Total cropped area (sum of area under various crops) in a cropping season

Moreover, cropping intensity was used to indicate the extent to which the cultivated area is used for cropping. Yield and cropping intensity fluctuate year to year depending upon soil moisture and rainfall (Sheikh et al., 1988).

Crop diversity means developing a larger number of crops mix to avoid the risk of crop failure. For calculating diversity index, the following inverse Herfindahl Index (Patil and Tailllie, 1982) was used:

$$CDI = \frac{1}{\sum_{i-1}^{n} S_i^2}$$

where,

CDI = Crop diversity index

S_i = Share of individual crop in total cropped area

Similarly, production function was estimated to determine the effects of various factors on groundnut productivity. The general form of the model used in the present study can be written

as:

$$LnY = \alpha + \beta_i \sum_{j=1}^{n} LnX_i + \gamma_i \sum_{k=1}^{n} D_i + e_i$$

LnY = Groundnut yield (Dependent variable)
X_i = List of independent continuous variables
D_i = List of independent dummy variables

$\alpha, \beta_i \& \gamma_i$ = Production function parameters to be estimated
e_i = Disturbance term

RESULTS AND DISCUSSION

Cropping Pattern

This indicates the relative share of each crop in the total cropped area in a cropping season. In the study area due to shortage of water and occurrence of cyclic severe drought attacks, farmers prefer to grow only one crop a year. The share of leguminous crops in Pothwar tract cropping pattern was minimum but they had very high potential for growth in the area (Manaf and Fayyaz, 2006). The common trend was to keep almost half of the land fallow during summer and monsoon seasons. During this period, the farmers used to prepare their land by frequent tillage practice. The planking was applied to conserve the soil moisture for coming *rabi* (winter) season crops. More area was under crops during winter season as compared to summer season. Wheat, chickpea, lentil and mustard were major *rabi* crops occupying 65.58% (52.39%, 5.30%, 3.97% and 3.92%, respectively) of the total farm area during *rabi* season. Almost one third (31.75 %) of the operational holding was left fallow in *rabi* season 2008-09. In *kharif* season (summer), groundnut sorghum and millet accounted for almost half (28.77 + 12.76 + 8.10 = 49.63%) of total farm area (Table 1). The major cash crop during summer was groundnut for all the three farm size categories. During summer almost half (48.4%) of the operational holding remained uncultivated.

Cost of Production of Groundnut for Sampled Respondents

Groundnut crop is grown on 29% of the cultivated area during summer season in the study area. This is the main cash crop of the summer season. The other major crops are fodder crops like sorghum and millet. The overall groundnut yield of the study area was 609 kg ha^{-1}. Usman et al. (2012) and Win et al. (2007) estimated a little higher average yield of 800 kg ha^{-1} in Nigeria and Myanmar. Hussain et al. (2004) estimated the groundnut yield comparatively higher as

Table 1. Cropping patterns (% area by season) by farm size

Crop	Small	Medium	Large	Total	F
Winter season					
Wheat	65.08	51.30	46.24	52.39	12.848***
Chickpea	3.75	4.54	7.00	5.30	2.081
Lentil	4.59	4.46	3.08	3.97	0.626
Mustard	2.73	3.85	4.68	3.92	1.068
Oat	0.71	1.01	0.94	0.92	0.216
Berseem	0.04	0.11	0.12	0.10	0.322
Barley	0.72	0.15	0.16	0.28	1.743
Taramera	0.00	0.68	1.28	0.76	1.558
Winter vegetables	2.17	0.03	0.31	0.61	1.473
Fallow *rabi*	20.20	33.80	36.19	31.75	10.442***
Summer season					
Groundnut	20.70	27.99	34.22	28.77	5.156***
Sorghum	21.51	13.23	7.22	12.76	26.293***
Millet	11.59	9.17	4.98	8.10	11.456***
Maize	1.78	0.58	0.79	0.92	1.622
Guar seed	0.00	0.00	0.06	0.02	0.811
Mung	0.00	0.05	0.96	0.39	3.346**
Summer vegetables	1.70	0.07	0.66	0.65	1.426
Fallow *kharif*	42.71	48.80	51.16	48.40	2.080

*** and **** = Significant at 5% and1% level, respectively.*
Source: Author's Survey data 2009

864 kg ha^{-1} in Pothwar region by using 2002-03 data. The overall yield of the area was lower than the national average yield due to low rainfall during 2009 as compared to previous years. Other reasons of low groundnut yield might be the non-availability of improved seed varieties insect and pest diseases, poor crop management and low soil fertility (Ahmed et al., 2000). Results revealed that yield of small farmers was highest (676 kg ha^{-1}) followed by large farmers (603 kg ha^{-1}) while medium farmers (589 kg ha^{-1}) obtained the lowest yield. The reason might be the intensive use of inputs farmers as the land preparation and cash input costs were higher at these farms. There was inverse relation between seed rate and farm size category. Small farmers used the highest seed rate (44 kg ha^{-1}) than medium (39 kg ha^{-1}) and large farmers (35 kg ha^{-1}). Overall, farm households incurred less land preparation and cash inputs cost on this crop. On an average, land preparation cost was Rs. 5448 ha^{-1}. Usman et al. (2012) estimated land preparation cost of Rs. 3300 ha^{-1} in Nigeria. Land preparation cost showed decreasing trend with the increase in the farm size. Land preparation cost of small farmers was significantly higher (Rs. 6702 ha^{-1}) as compared to medium (Rs. 5961 ha^{-1}) and large (Rs. 4432 ha^{-1}) farmers. The main reason for high land preparation cost for small farmers was most of them were using rented tractors. Moreover, the economies of scale also play on important role in reducing the cost for land preparation. Ploughing with heavy machinery in the small fields required higher costs as compared to larger fields.

Overall cash inputs cost was Rs. 4000 ha^{-1}. Cash input costs included the cost incurred on seed and fertilizers as no irrigation and pesticides were applied for the production. The cash input cost also decreased with the increase in the farm size. The cash inputs cost of small farmers was significantly higher (Rs. 4450 ha^{-1}) as compared to medium (Rs. 4076 ha^{-1}) and large (Rs. 3747 ha^{-1}) farmers. Overall labor cost was Rs. 3625 ha^{-1},It was significantly higher (Rs. 4306 ha^{-1}) among small farmers as compared to medium (Rs. 3869 ha^{-1}) and large farmers (Rs. 3111 ha^{-1}). Both labor and threshing costs were also decreased with the economies of scale.

The variable cost for this crop remained at Rs. 15468. Total revenue and gross margins were Rs. 49825 and 34357 ha^{-1}, respectively. Hussain et al. (2004) estimated the cost of production, total revenue and gross margins for groundnut as PKR 5997 ha^{-1}, PKR 17147 ha^{-1} and PKR 11149 ha^{-1}, respectively. These were lower due to decrease in the value of Pakistani rupee during 2002-09. The overall variable costs of production were decreasing with increase in the farm size. These costs for small farmers were significantly higher (Rs. 18453 ha^{-1}) as compared to medium (Rs. 16491 ha^{-1}) and large farmers (Rs. 13255 ha^{-1}). Total reve-nue ha^{-1} for small farmers was highest (Rs. 54999 ha^{-1}) while for medium and large far-mers it was almost same (Rs. 48769 and 48904 ha^{-1}, respectively). The overall percent gross margins of the production costs for groundnut were 222% (Table 2). Gross margins for large farmers (268.9 %) were very high as compared to medium (195.7 %) and small farmers (198.0 %). The main reason for higher percentage of gross margins was lower costs of production for large farmers.

Determinants of Groundnut Production

Groundnut is the only summer

season cash crop in the area and is sown on more than one fourth of the operational land holding of agricultural households. It has lowest cost of production per hectare as compared to other major crops of the study area and yields highest percentage gross margins due to fewer requirements of chemical fertilizers and frequency of ploughings (Qasim, 2012). The ample rainfall during summer monsoon saved the cost of production for this crop which was required for winter crops in the form of excessive ploughing/tillage for soil moisture conservation. This resulted in the minimization of cost of production for this crop and ultimately gave highest percentage gross margins.

Overall 11 independent variables were used in the production function to determine their relationship with groundnut production (Table 3). These variables were explaining 82% variation in the dependent variable (R_2 =0.82). Out of 11 variables, 3 had significant effects on the groundnut yield. All the possible input factors that may affect the yield were included in the model to have the relationship of these inputs with the groundnut yield. Moreover, the age and education of the farmers were included in the model to estimate the effects of crop management aspects on yield. Dummies for the farm size and the ownership of tractor were included to find out the possible effects of the farm size and farm mechanization on the yield. The less number of variables were statistically significant in having relationship with groundnut. The main reason for this was relatively adverse climatic conditions during data collection. The rainfall remained significantly lower in the study area in 2009. The model

Table 2. Groundnut cost of production by farm size

Farm category	Small	Medium	Large	All	F
Groundnut area (ha)	00.46	1.10	3.99	2.19	20.420***
Groundnut area (%)	020.7	2.0	34.2	28.8	2.048
Yield (kg ha^{-1})	676.2	589.4	603.2	609.0	1.059
Seed rate (kg ha^{-1})	044.3	39.1	35.1	38.8	2.219
Costs and Ravenues					
1. Land preparation cost	6702	5961	4432	5448	5.269***
2. Cash inputs cost	4450	4076	3747	4000	1.146
3. Labor cost	4306	3869	311	3625	3.525**
4. Threshing cost	2068	1751	128	1610	7.697***
5. Interest cost	927	834	677	784	4.411**
6. Variable cost (VC=1+2+3+4+5)	18453	16491	13255	15468	5.082***
7. Total cost (6+Land Rent)	28690	26729	23493	25705	5.082***
8. Total revenue	54999	48769	48904	49825	1.025
9. Gross margins(8-6)	36546	32278	35649	34357	0.633
10. Net profit (8-7)	26309	22040	25411	24120	0.633
11. Gross margins (%)	198.0	195.7	68.9	222.1	5.219***

*** and *** = Significant at 5% and1% level, respectively. Source: Author's Survey data 2009.*
Note: All costs and revenues/profit are in Pak Rs. ha^{-1}

was overall highly significant with F value of 66.57.

Ploughing frequency for preparation of seed bed and the seed rate had significant effects on groundnut yield. One percent increase in ploughing application was causing 2.56% increase in yield. These results imply that growers were well aware of benefits associated with good land preparation for groundnut. Moreover, the productivity of major inputs depends on availability of sufficient soil moisture which is restored through well prepared lands before rainy season. Similarly, farmers were using appropriate seed rate. Regression results revealed that 1% increase in seed rate was causing 0.64% increase in yield. Third variable affecting groundnut yield positively was labor man-days. Results showed that 1% increase in labor man-days was causing 0.12% increase in yield, as the crop is highly labor intensive. So, this demand was being easily met due to availability of labor in both hired and family labor. Moreover, as compared to inputs like fertilizer, irrigation and disease management practices, the role of labor is highly significant in *barani* area. Contrary to the study results, Katundu et al. (2013) found that family labor has no significant effect on groundnut yield. However, positive effect of labor on crop production as found by Kapopo and Assa (2012) are in accordance with the results of present study. The farm size category did not have significant variation in the yield. The negative sign of small and medium farms may be due to the reason that owners of large farm being more resourceful use higher inputs and adopt improved production technologies.

Table 3. Groundnut Yield in Ln-Ln Production Model

Variables	Coefficients	Std. Error	t stat
Constant	-0.279	1.511	-0.184
Age (yrs)	0.262	0.327	0.801
Education (yrs)	-0.062	0.123	-0.503
Area Owned (ha)	-0.055	0.115	-0.480
Area groundnut (ha)	-0.029	0.179	-0.159
No. of ploughing	2.567	0.189	13.572***
Seed rate (kg ha^{-1})	0.640	0.067	9.519***
Fertilizers (kg ha^{-1})	-0.084	0.120	-0.706
Small farms (D)	-0.056	0.364	-0.153
Medium farms (D)	-0.083	0.263	-0.316
Ownership of tractor (D)	0.021	0.204	0.101
Labor (man days)	0.128	0.051	2.517**

*** and **** = Significant at 5% and1% level, respectively.*
Source: Results are based on author's survey data during 2009

On the other hand, certain variables like age and education of farm household head, land owner-ship, area under other crops and area under groundnut as well as fertilizer input had no significant effects on groundnut yield. The possible reason for insignificant effect and negative sign of the groundnut area on yield may be less intensive input usage as the area of groundnut increases. Katundu et al. (2013) and Appleton and Balihuta (1996) also found that age and education had no significant effects on groundnut yield. The reason may be the slow adoption of the improved production technologies by household heads with higher age and lesser education.

CONCLUSION AND RECOMMENDATIONS

Present study shows that small farmers' costs are higher and percent gross margins are lowest. The main reason may be lack of farm machinery and diseconomies of scale. Their costs

can be reduced and percent gross margins can be raised by providing them tractors and other farm machinery on subsidized rates through government schemes like "green tractor scheme". This may also enhance small farmers income as they may provide farm machinery on rental services to their fellow farmers. Pothwar region is rainfed and solely depends on rainfall for crop production. The year when it recieves fairly good rainfall, the rural economy of this region comes in better condition. The yield of groundnut may significantly be enhanced through better land preparation, provision of quality seed of groundnut, and using labor properly. This may improve the rural economy and farm income of rural households of the region through enhanced agricultural productivity. As groundnut is major summer crop in this area and Chakwal is the district with higher area under groundnut. This district should be declared as groundnut district and farmers of this district should be given groundnut production technologies package and improved seed to enhance the productivity and area under this crop. Therefore, goverment patronage of groundnut may enhance the groundnut area and yield in the region.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Dr. Muhammad Qasim	Conceived the idea, Wrote abstract, Methodology, Data entry in SPSS and analysis,
2.	Dr. Khuda Bakhsh	Did SPSS analysis, Methodology, Conclusion, Overall management of the article
3.	Mr. Sultan Ali Tariq	Introduction, References, Data collection
4.	Mr. Mahmood Nasir	Data entry, Result and discussion, References
5.	Mr. Rashed Saeed	Conclusion, Data entry in SPSS analysis
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