2004 *Agricultural Economics Research Review*
Vol. 17 (Conference No.) 2004 pp 85-90

Impact of Technological Intervention on Groundnut Productivity

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Abstract

The productivity change due to application of bio-fertilizer in groundnut production has been studied using the partitioning model. The study has been conducted in Koratagere taluk of Tumkur district in Karnataka. The data pertaining to *kharif* season of 1998 have been collected from 30 farms each with and without bio-fertilizer application, growing JL-24 variety and TMV-2 variety of groundnut crop, selected randomly from three villages. The algebraic definition of yield has been used to formulate the productivity differential decomposing model in terms of bio-fertilizer and biological innovation and technology interaction. The results have shown a productivity change of 497.60 kg/ha, of which 36.41 per cent has been due to use of bio-fertilizer in groundnut production. The study has suggested that there is a scope to raise productivity through application of eco-friendly technologies like bio-fertilizers.

Introduction

Groundnut (*Arachis hypogea* L.) is a major oilseed crop grown during the *kharif* season in India. It occupies an area of 6.4 million hectares producing 7.21 million tonnes annually. Karnataka is one of the important groundnut-growing states with 13.36 per cent share in the total area under groundnut in the country. Groundnut has the largest area amongst oilseed crops in the state. It is grown in 0.9 million hectares with an annual production of 0.6 million tonnes. The increase in production of oilseeds by horizontal expansion is ruled out due to limitations on land expansion and increase in productivity is the only alternative. Due to the vagaries of monsoon and crop shifts in favour of remunerative crops, the productivity of the groundnut is decreasing in some areas. The quickest possible way of increasing productivity of groundnut is the replacement of variety and use of bio-fertilizer technology.

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Indian farming during the pre-green revolution period was dependent mainly on cattle dung manure with limited inorganic fertilizer. Modern agriculture has been heavily depending on the fossil fuel-based inputs such as inorganic fertilizers, pesticides, herbicides and energy-intensive farm machinery. The introduction of high-yielding varieties increased the demand for inorganic fertilizers, as these varieties were fertilizer-responsive with high-yielding potential. Thus, the use of inorganic fertilizers has become an essential part of crop production.

A balanced form of fertilizer use is a pre-requisite to obtain higher yields, but these fertilizers are costlier. The large scale use of chemical fertilizers causes the problem of environmental pollution and deterioration of soil structure. There are also problems of losses of applied fertilizers by way of leaching, volatilization and denitrification of nitrogen and fixation of phosphorous. Only 50 per cent of the available nitrogen is being used and the remaining 50 per cent goes as waste and is an environmental hazard. Hence, efforts have been made to trap the newer sources of nutrient, which may create a pollution-free environment. Bio-fertilizers fit best into the role of nutrient providers that restore higher productivity in addition to being environment-friendly.

In the dry farming areas, the application of fertilizers is limited because of inadequate moisture conditions. In a country like India, where a large number of farmers are poor having smallholdings, the use of bio-fertilizers in combination with chemical fertilizers and organic manures offers a great opportunity to increase the crop production at low costs. The concept of sustainable agriculture emphasizes the manipulation and management of biological systems not only to maximize yields but also to stabilize the agro-systems and to minimize industrial input demands. It thus represents an integrated approach of the appropriate modern technology with the traditional techniques. However, the bio-fertilizers should be of right type and are to be applied at the right time to derive the maximum benefits (Alagawadi and Kulkarni, 1993).

Indian soils are of poor-to-medium status in the case of available phosphorus for plant growth. Only about 30 per cent of applied 'Phosphorus' in soils is available to crops and the remaining portion gets fixed into insoluble phosphorus. Some heterotrophic bacteria and fungi are known to have the ability to solubilize inorganic phosphorus from insoluble sources. In this regard, the phosphate-solubilizing microorganisms (PSM) play a vital role. In this back drop, the Extension Education Unit of the University of Agricultural Sciences, Hebbal, Bangalore, organized demonstrations using Rhizobium and phosphate-solubilizing microorganisms (PSM) in dry land groundnut. For the demonstration plots, PSM at 7.5 kilograms per hectare was incorporated into the soil along with farm yard manure (FYM) just before sowing of groundnut. The seeds of JL-24 and TMV-2 varieties of groundnut treated with Rhizobium at 950 grams per 100 kilograms of seeds were sown.

The studies conducted by Lal *et al.* (1985), Mishra (1986) and Sreenivasamurthy and Bisalaiah (1988) have indicated that per unit yield was higher in tractor farms than bullock farms. The present study is an attempt to partition the productivity change between farms with and without bio-fertilizer use in the dry tracts of southern India.

Methodology

The study was conducted in Koratagere taluk of Tumkur district in Karnataka. The data pertaining to the *kharif* season of 1998 were collected from 30 farms selected at random from three villages each with and without bio-fertilizer use, growing JL-24 variety and TMV-2 variety of groundnut crop.

A review of literature on agricultural output / productivity growth suggested two major lines of methodology. The first stream pertained to accounting of production / productivity growth using time series data; the study by Minhas and Vaidyanathan (1965) belong to this stream. The second stream focused on accounting for productivity differential at a point of time (cross-sectional approach) using production function framework; the studies by Bisalaiah (1977), Gundurao *et al.* (1985), and Umesh and Bisalaiah (1990) fall under this stream. But the studies based on production function frame suffer from the restrictive assumption underlying the theoretical construct, even though the theoretical elegance of this approach is quite appealing.

In the present study, the algebraic definition of yield was used to formulate a productivity differential partitioning model. The decomposing differential model in terms of bio-fertilizer use and change of variety (improved variety of groundnut associated with the needed cultural practices), and technology interaction were used for the cross-sectional data collected.

The basic definitions of the coefficients used in the formulation of the model@ are given below. These coefficients were developed for one hectare of land:

P_B	=	Proportion of area with bio-fertilizer use
$1 - P_B$	=	Proportion of area without bio-fertilizer use

@ refer Sreenivasamurthy and Bisalaiah (1988) for the details of methodology

V_1	=	Proportion of area under JL-24 variety
$1 - V_1$	=	Proportion of area under TMV-2 variety
$V_1 P_B$	=	Proportion of area using bio-fertilizer under JL-24
$(1 - V_1) P_B$	=	Proportion of area using bio-fertilizer under TMV-2
$(1 - P_B) V_1$	=	Proportion of area without using bio-fertilizer under JL-24
$(1-P_B)(1-V_1)$	=	Proportion of area without using bio-fertilizer under TMV-2
Y_1	=	Yield of JL-24 with bio-fertilizer use
Y_2	=	Yield of TMV-2 with bio-fertilizer use
Y_3	=	Yield of JL-24 without bio-fertilizer use
Y_4	=	Yield of TMV-2 without bio-fertilizer use
Y_1^*	=	Yield of groundnut in i^{th} farm.

With these definitions, the yield per hectare of the i^{th} farm is given by Equation (1):

$$Y_1^* = P_B V_1 Y_1 + P_B (1 - V_1) Y_2 + (1 - P_B) V_1 Y_3 + (1 - P_B)(1 - V_1) Y_4 \quad ...(1)$$

It is obvious from the above that the increment change has to emanate from technological innovations, i.e. bio-fertilizer and biological innovations. Change in productivity (yield) due to these innovations is specified by relationship (2):

$$(Y_1^* + D Y_1^*) = \{[(P_B + DP_B) + (V_1 + DV_1)]\} Y_1 + \{[(P_B + DP_B)][1 - (V_1 + DV_1)]\} Y_2 + \{[1 - (P_B + DP_B)][(V_1 + DV_1)]\} Y_3 + \{[1 - (P_B + DP_B)][1 - (V_1 + DV_1)]\} Y_4 \quad ...(2)$$

The expression for productivity change is separated out as per Equation (3):

$$DY_1^* = \{[(P_B + DP_B) + (V_1 + DV_1)]\} Y_1 + \{[(P_B + DP_B)][1 - (V_1 + DV_1)]\} Y_2 + \{[1 - (P_B + DP_B)][(V_1 + DV_1)]\} Y_3 + \{[1 - (P_B + DP_B)][1 - (V_1 + DV_1)]\} Y_4 - P_B V_1 Y_1 + P_B (1 - V_1) Y_2 + (1 - P_B) V_1 Y_3 + (1 - P_B)(1 - V_1) Y_4\} \quad ...(3)$$

On expanding and simplifying Equation (3), we get Equation (4):

$$DY_1^* = DP_B [V_1(Y_1 - Y_3) + (1 - V_1)(Y2 - Y_4)] + DV_1 [P_B (Y_1 - Y_2) + (1 - P_B)(Y_3 - Y_4)] + DP_B DV_1 [(Y_1 - Y_2 - Y_3 + Y_4)] \quad ...(4)$$

Expression (4) is the final output decomposition model to partition the total change in productivity ($D Y_1^*$) into three major components, viz. bio-fertilizer use effect (the first bracketed expression), change of variety effect (the second bracketed expression), and interaction effect (the third bracketed expression).

Table 1. Mean yield of groundnut under four technological situations

Symbol	Description of technology	Mean yield (kg/ha)
Y_1	Yield of JL - 24 with bio-fertilizer use	1405
Y_2	Yield of TMV - 2 with bio-fertilizer use	1130
Y_3	Yield of JL - 24 without bio-fertilizer use	1240
Y_4	Yield of TMV - 2 without bio-fertilizer use	935

Table 2. Changes in area proportions reflecting technological change in groundnut production

Symbol	Description	Non-bio-fertilizer farms	Bio-fertilizer farms	Change
P_B	Proportion of area under bio-fertilizer	0.00	1.00	1.00
V_1	Proportion of area under JL-24 variety	0.46	0.62	0.16

Note: 1. In the case of non-biofertilizer farms, groundnut crop was taken in the entire area without applying biofertilizer, and hence the value is zero.
2. In the case of biofertilizer farms, groundnut crop was taken with application of biofertilizer and hence the value is one.

Results and Discussion

The yields of groundnut with and without applications of bio-fertilizer are depicted in Table 1. The mean yield of the variety JL - 24 and TMV - 2 with the application of bio-fertilizers was 1405 and 1130 kg/hectare, respectively. It was higher by 13 and 21 per cent, respectively compared to that of without application of biofertilizers.

Area proportions reflecting technological interventions, i.e. bio-fertilizer use and change of variety are given in the Table 2. The change in area proportions reflecting bio-fertilizer use was 1.00 whereas for change of variety, it was 0.16.

The productivity change due to technology intervention was partitioned using Equation (4). The results are presented in Table 3. In absolute terms, the total change in productivity was 497.60 kg with 181 kg resulting from bio-fertilizer use. The interaction effect of bio-fertilizer and variety contributed 30 kg to the total change. In relative terms, bio-fertilizer contributed 36.41 per cent to the productivity change and the variety 57.56 per cent.

Conclusions

There is a scope for increasing the productivity in a sustained manner through application of eco-friendly technologies like bio-fertilizers. Bio-

Table 3. Contribution of technological innovation to productivity change in groundnut output

Technological innovation	Change in productivity (kg/ha)	Percentage contribution
Biofertilizer use	181.20	36.41
Change of variety	286.40	57.56
Interaction effects of use of biofertilizer and change of variety	30.00	6.03
Total change in productivity	497.60	100.00

fertilizer acts as a catalytic agents in enhancing the nutrient uptake. The need is to popularize the technology among farmers through extension education activities.

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