Impact of adoption of winter-summer groundnut (*Arachis hypogaea* L.) production technology on the livelihood of farmers

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ABSTRACT

This study was carried out during 2009-10 in Gujarat and Andhra Pradesh states of India to assess the extent of adoption of groundnut (*Arachis hypogaea* L.) production technologies by groundnut growers and its impact in creation of various livelihood assets and improving their livelihood outcomes. The results showed that 96% of sampled farmers in Kutch and 40% of farmers in Chittoor adopted the improved varieties of groundnut. The improved technologies such as seed treatment with bio-fertilizers (81% farmers), use of optimum seed rate (71% farmers), soil test based fertilizer application (83% farmers), application of gypsum and micronutrients (74% each) and chemical weed management (71%) were not adopted by the farmers. The adoption of improved technologies resulted in creating human, natural/physical and financial assets thereby improving the livelihood outcomes of farmers. It is very important to create awareness among farmers on improved technologies by use of appropriate extension strategies and need based training programmes.

Keywords: Adoption, Groundnut, Financial assets, Human assets, Impact, Livelihood outcomes, winter-summer

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of India contributing about 24% and 29% to total area and production of oilseeds, respectively. About 86% of total groundnut area is sown during rainy season under rainfed conditions accounting to 78.3% of total groundnut production and remaining 14% is grown under assured irrigation conditions during winter-summer season accounting to 21.6% of total groundnut production (Damodaram and Hegde, 2010). The winter-summer productivity was higher at 1764 kg/ha as compared to rainy season (1063 kg/ha). Gujarat and Andhra Pradesh are the two most important groundnut-producing states of India contributing 60% to total groundnut area and production. The winter-summer groundnut in these states contributed 43% and 46% to total winter-summer area and production, respectively (Damodaram and Hegde, 2010). The winter-summer groundnut production is stable and less vulnerable to various stresses (biotic and abiotic) and can play an important role in increasing India's groundnut production.

The sustained research efforts of Directorate of Groundnut Research, State Agricultural Universities, ICRISAT and other institutes resulted in the development of improved varieties, production and protection technologies for winter-summer groundnut cultivation. These technologies have enormous potential of increasing the productivity of groundnut, which was evident from results of frontline demonstrations (FLDs). The winter-summer FLDs conducted in Gujarat and Andhra Pradesh during 2002-2008 indicated that the adoption of improved technologies increased the pod yield up to 30% compared to farmers' practices.

The present study was undertaken during 2009-10, winter-summer season with the objectives to assess the extent of adoption of improved technologies, its impact in creation of various livelihood assets and livelihood outcomes of farmers and farmers attributes influencing the variation in yield of groundnut.

MATERIALS AND METHODS

Two states *viz*., Gujarat and Andhra Pradesh and one district from each state *viz*., Kutch and Chittoor were, respectively selected based on significant area and production of winter-summer groundnut. Six taluks and four taluks were selected from Kutch and Chittoor, respectively based on reporting highest area of groundnut. From each taluk, 2-3 villages were selected randomly, making a total of 20 villages. From each selected village, six respondents were selected randomly, making a total sample size of 120.

For measuring extent of adoption of improved technologies, a list of improved practices (20 items) for winter-summer groundnut production was prepared in consultation with the scientists of crop improvement, production and protection. The respondents' responses were recorded as 'yes' and 'no' for each item based on adoption and non-adoption and scores were given as 1 and 0, respectively. The adoption score of each respondent was estimated by

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summation of scores of all items. To assess the impact of improved technologies, farmers were categorized into two groups based on mean and standard deviation of their adoption scores. Accordingly respondents were grouped into adopters with adoption score >10 and non-adopters with adoption score = or < 10. Sustainable livelihood framework (Scoones, 1998) was used. For all the variables, suitable indicators were identified and measured.

An interview schedule was developed incorporating all the indicators for measuring independent and dependent variables. It was pre-tested and standardized for data collection. The data were collected by face-to-face interviews of respondents. Apart from this, group discussions and direct observations were made to collect qualitative data. The data were analyzed using SPSS® 17.0. Descriptive statistics such as frequency, percentage and mean were calculated. Z test for unequal samples was estimated. Pearson's correlation and inter-correlations were estimated to check for multicollinearity among the indicators selected for the study by the method of Frisch's confluence analysis (Koutsoyiannis, 1977) and step-down regressions were estimated to know the effects of various livelihood assets on the livelihood outcomes.

RESULTS AND DISCUSSION

Adoption of variety and agronomic practices: The FLDs on improved varieties of groundnut under irrigated conditions showed 26% higher pod yield compared to old varieties (Venkattakumar *et al.*, 2009). But, in summer season, in Kutch, 85% of sampled farmers were growing groundnut cv. GG-2 (15 years old variety), 11% were growing western-44 and the remaining farmers were growing TATA Sumo and even J-11 (Table 1), whereas in Chittoor, 60% farmers were growing old varieties TMV-2 and/or JL-24 (30 years old varieties) and 40% were growing improved varieties *viz*., Narayani, TPG-41 and ICGV-91114. In Kutch, few farmers (20%) were aware of the recently released varieties *viz*., GG-5, GG-7, and GG-9. In Chittoor, many of the farmers did not adopt the improved varieties. Ingle *et al.* (1995) reported that improved varieties of groundnut (UF-70-103, TAG-24, ICGS-11) were not known to 85% farmers. The important reason for non-adoption of recently released varieties in two districts was non-availability of seed in the existing seed system.

During summer, 53% farmers in Kutch and 60% in Chittoor purchased seed from informal sources *viz*., neighbouring farmers, farmer seed traders, private seed agencies and oil millers. In Kutch, 26% farmers used their own seed and 21% purchased from the formal sources (public sector agencies), whereas in Chittoor only 10% farmers used their own seed, while 30% purchased from formal sources. Farmers of Chittoor preferred to purchase seed from formal sources mainly to avail subsidy on the seed.

Seed treatment with fungicides and bio-fertilizers are 'low cost- no cost' technologies, which can increase seed yield by 40% and 19%, respectively as compared to farmers practice of 'no seed treatment' (Venkattakumar *et al.*, 2009). All the farmers in Kutch and 90% farmers in Chittoor followed the practice of seed treatment with fungicides (Carbendazim/Dithane M-45/Thiram) for protection against diseases. Nagaraj *et al.* (2001) reported lower adoption of chemical seed treatment. Only few farmers (18% in Kutch and 12% in Chittoor) adopted seed treatment with *Rhizobium* cultures. Many of the farmers (86% in Kutch and 80% in Chittoor) performed timely sowing, but did not care to maintain optimum spacing. The recommended seed rate was followed by only 30% farmers and conversely 70% used higher than the recommended seed rate. The seed rate used by the farmers was in the range of 150-300 kg/ha with spacing in the range of 20 cm x 5 cm to 75 cm x 5 cm. Farmers perceived that higher seed rate was required to compensate for poor germination and seedling mortality. In Kutch, sowing was done with tractor drawn seed drill by 36% of farmers and farmers with small and marginal land holding (64%) did manual sowing behind the plough, whereas in Chittoor, as high as 94% farmers adopted manual sowing behind the plough. In Kutch and Chittoor, 23% and 28% of the farmers, respectively applied organic manures. In Kutch, 17% farmers and in Chittoor, 12% farmers applied fertilizers on the basis of soil test values. A vast majority of farmers of both the districts applied higher than recommended doses of fertilizers, while only 17% farmers in Kutch and 20% in Chittoor applied recommended doses of fertilizers. Farmers perceived that higher the rate of application of fertilizer, higher the yields of groundnut.

In both the districts, farmers practised manual weeding and only 28% in Kutch and 14% in Chittoor applied herbicides. Nagaraj *et al.* (2001) reported lower adoption of herbicides. In Kutch, 26% farmers and 16% in Chittoor applied gypsum and almost an equal number of farmers adopted suitable micronutrient management practices by spraying commercially available micronutrient mixtures (Groth, Mahaphal and Mazik). These results were not in conformity with the findings of Ingle *et al.* (1995), where they had reported that gypsum and micronutrients were not adopted by farmers due to their non-availability.

Adoption of plant protection practices: Though many of the farmers believed that the insect pests and diseases were not a major problem for summer groundnut, yet they resorted to spray of insecticides and fungicides. Farmers (36% in Kutch and 32% in Chittoor) adopted appropriate spraying of insecticides. These results were not in agreement with that of Nagaraj *et al.*, (2001) where they had reported higher adoption of intercultivation practices compared to plant protection practices.

Table 1 Practise-wise of adoption of improved practices by groundnut farmers

Improved practice	Adoption	
	Kutch (n = 70)	Chittoor (n = 50)
Optimum tillage	65 (92.9)*	48 (96.0)
Suitable variety	67 (95.7)	20 (40.0)
Source of seed	-	-
I. Own	18 (25.7)	5 (10.0)
ii. Formal sources	15 (21.4)	15 (30.0)
iii. Informal sources	37 (52.9)	30 (60.0)
Optimum seed rate	20 (28.6)	15 (30.0)
Seed treatment: Fungicides	70 (100)	45 (90.0)
Seed treatment: Bio-fertilizers	13 (18.6)	06 (12.0)
Timely sowing	60 (85.7)	40 (80.0)
Depth of sowing		
I. Behind the plough in furrow	45 (64.3)	50 (100.0)
ii. Tractor drawn seed drill (Optimum)	25 (35.7)	3 (06.0)
Optimum spacing	30 (42.7)	10 (20.0)
Application of organic manures	14 (22.7)	14 (28.0)
Soil test based fertilizer application	12 (17.1)	6 (12.0)
Fertilizer management	-	-
I. Optimum	12 (17.1)	10 (20.0)
ii. Lower	4 (05.7)	15 (30.0)
iii. Higher	54 (77.1)	25 (50.0)
Weed management (chemical)	20 (28.6)	07 (14.0)
Application of gypsum	18 (25.7)	8 (16.0)
Micro nutrient management	18 (25.7)	7 (14.0)
Management of insect pests	-	-
I. Optimum	25 (35.7)	16 (32.0)
ii. Lower	12 (17.1)	14 (28.0)
iii. Higher	33 (47.1)	20 (40.0)
Management of diseases	-	-
I. Optimum	22 (31.4)	5 (10.0)
ii. Lower	8 (11.4)	16 (32.0)
iii. Higher	40 (57.1)	29 (58.0)
Timely harvesting	60 (85.7)	38 (76.0)
Optimum drying	68 (97.1)	48 (96.0)
Storage at optimum conditions	25 (35.7)	5 (10.0)

Table 2 Quantitative values of human and physical/natural assets between adopters and non-adopters

Asset	Mean			
	Pooled	Adopters (n=38)	Non-adopters (n=82)	*Z* value
Human asset				
Age	42.7	40.6	47.2	3.44**
Farmer education	7.3	7.5	6.8	0.87
Children education	16.8	24.8	13.1	6.64**
Household size	5.0	5.7	4.7	3.43**
Number of effective workers	2.2	2.5	2.0	2.31*
Dependency ratio	2.5	2.5	2.4	0.30
Natural asset				
Material possession	19.7	24.3	17.6	8.50**
Farm size	2.5	3.8	1.9	5.71**
Irrigated area	1.4	2.3	0.9	6.18**
Live stock	0.7	0.9	0.6	5.16**

*=significant at P=0.05; **=significant at P=0.01

Adoption of harvest and post-harvest practices: Many of the sampled farmers (86% in Kutch and 76% in Chittoor) harvested their crop at 'right maturity state'. The harvesting was done mostly by tractor in Kutch, whereas the same was done manually in Chittoor. Farmers (36%) generally followed sun-drying their produce in open fields. The threshing was done with the help of mechanical threshers in Kutch, whereas it was done manually in Chittoor. All the farmers practised collection of left over pods from the field after harvesting the crop and most farmers (68%) mixed these left over pods with main lot. Many of the farmers (85%) were not aware of aflatoxin contamination in groundnut and hence did not adopt any management practices. In Kutch, farmers (75%) stored the produce for 2-4 months in the form of pods until they could realize better market prices, whereas in Chittoor most of the farmers (73%) sold their produce immediately after harvest to traders/middlemen approaching their fields in order to repay the loans and for immediate family needs.

These results show that in both the districts, the extent of adoption was lower for practices such as use of bio-fertilizers, optimum seed rate, soil test based fertilization application, gypsum, micronutrient application and chemical weed management.

Impact of adoption of improved practices in creation of livelihood assets and outcomes: The results (Table 2) showed that there were significant differences between adopters and non-adopters in respect of livelihood assets such as human assets, natural/physical assets, financial and social assets. Adopters recorded higher mean scores than non-adopters for all the selected indicators. In case of human and physical assets, significant differences were observed in age ($Z = 3.44$, $P = <0.01$), children education ($Z = 6.64$, $P = <0.01$), household (hh) size ($Z = 3.43$, $P = <0.01$), effective workers in the family ($Z = 2.31$, $P = <0.01$), material possession ($Z = 8.50$, $P = <0.01$), farm size ($Z = 5.71$, $P = <0.01$), irrigated area ($Z = 6.18$, $P = <0.01$), and ownership of live stock ($Z = 5.16$, $P = <0.01$). However, there were no differences in the farmers' education and dependency ratio. Significant differences were observed in income from live stock ($Z = 6.34$, $P = <0.01$), which indicated that the live stock was an important component of income of the household and particularly to the adopters households and credit availed ($Z = 5.12$, $P = <0.01$, Table 3). Significant differences were also observed between adopters and non-adopters in respect of formal institutional contacts for inputs ($Z = 5.10$, $P = <0.01$) and advisory ($Z = 9.94$, $P = <0.01$) and livelihood outcomes pod yield ($Z = 21.09$, $P = <0.01$) and haulm yield ($Z = 18.24$, $P = <0.01$, Table 4). The differences in human assets *viz*., age, house hold size, number of effective workers, farm size, irrigated area and ownership of livestock indicate that the adoption of improved technologies was influenced by these factors. The mean adoption scores were 14.4 and 6.1 for adopters and non-adopters, respectively ($Z = 14.83$, $P = <0.01$, Table 3). Gowda *et al*. (2002) reported significant relationship between adoption and education, social participation, mass media use, economic motivation of big farmers and between adoption and mass media use, extension participation of small farmers.

Adoption of improved practices resulted in higher pod yield (3185 kg/ha) and income (₹ 1, 88, 078/hh) as recorded for adopters compared to pod yield (2112 kg/ha) and income (₹ 60,041/hh) recorded for non-adopters (Table 4). Adisarwanto and Muchlish (1998) reported that adoption of groundnut production technology was significantly influenced by profits and farmers' ability to purchase inputs. The increased income resulted in higher allocation for children education, which was evident from high mean score of 24.8 as compared to non-adopters (mean score=13.1). The material possession also increased in adopter households (24.3) as compared to non-adopters households (17.6).

Farmers' attributes influencing the variation in pod yield: The inter-correlation analysis among the variables (Table 5) indicated the existence of Multicollinearity between farm size and irrigated area, total income and agricultural income, livestock income, pod yield and haulm yield. Hence, only farm size and total incomes were included in fitting the multiple linear regression equation. Furthermore, based on correlation between pod yield and other variables, age and dependency ratio were also not considered, as correlation was non-significant. The step-down regression analysis indicated that various attributes such as house hold size, material possession, total income, institutional contact for advice and adoption of improved technologies significantly influenced the pod yield. The adjusted R^2 was 0.929 (Table 6) indicating that these variables accounted for almost 93% variation in pod yield. Adoption of improved technologies emerged an important variable influencing the yield of groundnut.

In Kutch, farmers adopted most of the critical practices for summer groundnut cultivation. Low adoption was observed for seed treatment with bio-fertilizers, use of optimum seed rate, soil test based fertilizer application, application of gypsum, micronutrients and chemical weed management in both the districts. It is very important to create awareness among farmers on these technologies by use of appropriate extension strategies and need based training programmes. The significant differences in livelihood assets and outcomes of the adopters indicated that improved technologies could definitely improve the livelihood of groundnut farmers. The contact of farmers with formal institutions *viz*., KVKs, agriculture departments, non-government organizations have to be increased for improving the adoption of improved technologies and thereby increasing the yield of groundnut.

Table 3 Quantitative values of financial and social assets between adopters and non-adopters

Asset	Mean			Z value
	Pooled	Adopters (n=38)	Non-adopters (n=82)	
Financial assets (₹/house hold)				
Income from agriculture	1,00,586	1,88,078	60,041	9.02**
Income from livestock	8,818	13,650	6,579	6.34**
Other income	4017	12,830	976	2.89**
Total income	1,13,421	1,19,246	43,708	8.80**
Credit availed	5,758	13,737	2,061	5.12**
Social assets				
Membership in organization	0.5	0.9	0.2	13.80**
Extension participation	0.5	0.9	0.3	7.99**
Adoption score	8.2	14.4	6.1	14.83**

*=Significant at P=0.01

Table 4 Quantitative values of formal institutional contacts and livelihood outcomes between adopters and non-adopters

Variable	Mean			Z value
	Pooled	Adopters (n=38)	Non-adopters (n=82)	
Institutional contact				
a. Inputs	0.6	0.8	0.4	5.10**
b. Advisory	0.5	0.9	0.3	9.94**
Livelihood outcome				
Pod yield (kg/ha)	2452	3185	2112	21.09**
Haulm yield (kg/ha)	3490	3975	3265	18.24**

**=significant at P=0.01

Table 5 Inter-correlation analysis among the variables

Variable	Age	Farmers' education	Children's education	House-hold size	Effective workers	Depen-dency ratio	Material posse-ssion	Farm size	Irrigated area	Live-stock	Agricul-tural income	Income from livestock	Other income	Total income	Credit availed	Organization membership	Extension partici-pation	Govt. sources for inputs	Govt. sources for advisory	Pod yield	Haulm yield
Farmers' education	-0.62	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Children's education	0.55	-0.28	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Household size	0.55	-0.33	0.67	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Effective workers	0.51	-0.30	0.50	0.67	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dependency ratio	-0.11	0.17	-0.02	0.04	-0.55	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Material possession	0.37	-0.03	0.69	0.50	0.33	0.08	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Farm size	0.38	-0.19	0.47	0.41	0.30	0.00	0.58	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Irrigated area	0.31	-0.19	0.44	0.34	0.16	0.13	0.55	0.73	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Livestock	0.44	-0.15	0.35	0.40	0.39	-0.14	0.36	0.46	0.34	1.00		-	-	-	-	-	-	-	-	-	-
Agricultural income	0.30	-0.08	0.54	0.35	0.28	-0.08	0.57	0.35	0.21	0.36	1.00	-	-	-	-	-	-	-	-	-	-
Income from livestock	0.49	-0.22	0.48	0.49	0.43	-0.08	0.51	0.65	0.53	0.71	0.48	1.00	-	-	-	-	-	-	-	-	-
Other income	0.22	-0.10	0.37	0.15	0.10	-0.01	0.36	0.41	0.41	0.16	0.31	0.38	1.00	-	-	-	-	-	-	-	-
Total income	0.38	-0.20	0.60	0.41	0.24	0.06	0.69	0.79	0.90	0.42	0.54	0.67	0.61	1.00	-	-	-	-	-	-	-
Credit availed	0.38	-0.23	0.45	0.32	0.13	0.16	0.52	0.66	0.72	0.36	0.20	0.57	0.46	0.72	1.00	-	-	-	-	-	-
Organization membership	0.25	-0.10	0.46	0.25	0.11	0.11	0.59	0.39	0.48	0.25	0.62	0.39	0.23	0.61	0.36	1.00	-	-	-	-	-
Extension participation	0.07	-0.02	0.33	0.18	0.12	0.02	0.44	0.30	0.40	0.22	0.32	0.34	0.14	0.46	0.35	0.50	1.00	-	-	-	-
Govt. sources for inputs	0.04	0.01	0.31	0.26	0.27	-0.11	0.42	0.36	0.42	0.26	0.39	0.40	0.17	0.50	0.27	0.43	0.42	1.00	-	-	-
Govt. sources for advisory	0.11	-0.05	0.40	0.30	0.19	0.04	0.49	0.25	0.37	0.24	0.40	0.34	0.20	0.48	0.33	0.57	0.77	0.38	1.00	-	-
Pod yield	0.28	-0.04	0.54	0.33	0.23	0.04	0.69	0.61	0.69	0.36	0.59	0.51	0.34	0.80	0.57	0.66	0.52	0.51	0.54	1.00	-
Haulm yield	0.27	-0.02	0.53	0.37	0.30	0.01	0.64	0.55	0.62	0.36	0.61	0.49	0.32	0.75	0.48	0.60	0.49	0.48	0.53	0.94	1.00
Adoption	0.29	-0.08	0.49	0.33	0.27	-0.03	0.62	0.64	0.66	0.38	0.52	0.50	0.27	0.74	0.56	0.60	0.49	0.50	0.47	0.95	0.88

Table 6 Step-down regression analysis of independent variables with pod yield

Variable	*b*-value	SE of *b*	*t*-value
(Constant)	1602.264	62.242	25.743**
Household size	-20.283	9.126	-2.280*
Material possession	10.397	3.845	2.704**
Total income	0.001	0.001	3.890**
Institutional contact for advisory	81.293	28.309	2.872**
Adoption	80.813	40.32	20.045**

Adjusted R^2 = 0.929; F = 313.200**, SE of estimate = 130.25; * indicates significance at P < 0.05; ** indicates significance at P < 0.01

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