application of fly ash and FYM alone. These yields were similar to that obtained with application of 100% recommended dose of NPK. Maximum yields of rice (3.8 t ha^{-1}) and groundnut (1.4 t ha^{-1}) with high shelling outturn (70%) and oil content (42.3%) were obtained with integration of 40 t ha^{-1} fly ash, 5 t ha^{-1} FYM and 50% recommended dose of NPK. Perhaps increase in yields of crops due to application of fly ash may be due to increase in water-holding capacity and pH of acid soil (5.66 to 6.0) and decrease in the bulk density of lateritic soil. Also, supplementation of B to the deficient soil also contributed to the yields.

Reference

Sahu SK. 1999. Soils of Orissa and their management. Orissa Review 19:10ñ13.

Socioeconomics

Improved Production Technology in Rainfed Groundnut Helps Reap Rich Benefits by Resource-poor Farmers of Andhra Pradesh

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The drought-prone districts (Kurnool, Mahbubnagar, Nalgonda, Anantpur and Prakasam) of Andhra Pradesh state of India are characterized by low soil fertility, inappropriate soil and water management practices causing land degradation, lack of improved varieties, pest and disease attack, declining land:man ratio, resource-poor farmers and rural poverty. In Andhra Pradesh 42% of total land area is degraded. The problem of land degradation is particularly serious where local food production cannot adequately provide survival options for the rural poor. Low agricultural yields and high population pressure have forced small and marginal farmers to cultivate fragile marginal lands and clear forests thus causing soil erosion and further land degradation. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Government of Andhra Pradesh have initiated a collaborative project with the Andhra Pradesh Rural Livelihoods Programme (APRLP) to help reduce poverty through increased agricultural productivity and improved livelihood opportunities through technical backstopping and convergence through a consortium of institutions.

Nucleus watersheds for undertaking on-farm research were selected in Karivemula and Devanakonda villages of Kurnool district, based on representative typology of the watershed, extent of rainfed areas, current crop productivity and willingness of community to participate in the on-farm research activities. The strategy adopted is knowledge-based bottom-up and participatory approach, which involved close interactions with the project implementation agencies (PIAs) and the farmers from the beginning. The detailed participatory rural appraisal (PRA) in each nucleus watershed helped us to understand the constraints for increasing the productivity from the farmerís perspective. Systematically collected soil samples from thirty farmersí fields in Karivemula and Devanakonda villages on a toposequence were analyzed for physical and biological parameters and various nutrients. The results indicated that all the fields are low in nitrogen (N) (599 mg kg^{-1} soil), low to medium in available phosphorus (P) (9.8 mg kg^{-1} soil) (Olsenís P), high in exchangeable potassium (K) (133 mg kg^{-1} soil), and low in available zinc (Zn) (0.4 mg kg^{-1} soil), sulfur (S) (3.2 mg kg^{-1} soil) and boron (B) (0.3 mg kg^{-1} soil). Information on soils along with historical rainfall and minimum and maximum temperature data enabled us to calculate the length of growing period (LGP). This critical information assisted us in identifying best-bet options to improve the productivities and managing natural resources sustainably.

Thirty on-farm trials were conducted during the rainy season in 2002 and 2003 with the objective to demonstrate the beneficial effects of improved production technologies on groundnut (*Arachis hypogaea*): improved cultivar (ICGS 11), seed rate of 125 kg ha^{-1}, seed treatment with a mixture of captan and benlate (3 g kg^{-1} seed) and inoculation with *Rhizobium*, a fertilizer dose of 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1}, basal application of micronutrient mixture (0.5 kg B ha^{-1}, 10 kg Zn ha^{-1}), split application of gypsum at 500 kg ha^{-1} (200 kg ha^{-1} as basal and 300 kg ha^{-1} as top dressing at pegging stage), and appropriate need-based pest and disease control measures. Improved production technology was compared with the farmersí method in an area of 1000 m^2 each. The farmersí method included a seed rate of 90 kg ha^{-1} and a fertilizer dose of 12 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} at planting. All other practices were the same. The crop experienced a long dry spell of 28 days from the beginning of pod initiation to pod maturity in 2002 and of 16 days from the beginning of peg initiation to the beginning of pod development in 2003. However, the season was more congenial for crop growth in 2003 as rainfall distribution was more uniform. The rainfall in both the years (480 mm) was below the mean long-term annual rainfall (572 mm).

The improved production technologies gave higher yield at all the locations. The pod yield was 1.22 t ha^{-1} in 2002 and 1.64 t ha^{-1} in 2003 compared to 0.77 t ha^{-1} and 1.02 t ha^{-1}, respectively with farmersí practice (Table 1). The increase in pod yield was 58% in 2002 and 61% in 2003. The increased pod yields with improved practice were mainly because of significant increase in number of filled pods $plant^{-1}$, shelling outturn (%), 100-seed mass and harvest index. Pod yield increases in response to balanced fertilization were also reported by Balasubramanian et al. (1988). The additional mean cost incurred in the improved package was US$25 ha^{-1} (1 US$ = Rs 45) as compared to increased mean income of US$158 with a benefit-cost ratio of 1.6. The improved production practices gave higher pod yields in both the years and evidently demonstrated the potential of improved technology.

In on-farm trials conducted by Prabhakaran et al. (1996), 24% higher pod yields and higher benefit-cost ratio of 1.72 were recorded with improved practices compared to a ratio of 1.48 with farmersí practice. Nguyen Thi Lien Hoa et al. (1996) reported 25% higher pod yields and 29% reduction in production cost with improved package (usage of locally available coconut ash instead of costly inorganic fertilizers, need-based chemical sprays for insect and pest control) in on-farm trials conducted in southern Vietnam. The results from this study clearly indicate the potential benefits of improved production technology in enhancing groundnut

Table 1. Economics of groundnut production in on-farm trials in Kurivemula and Devanakonda nucleus watersheds, Kurnool district, Andhra Pradesh, India, rainy season 2002 and 2003[1].

	Yield ($t\ ha^{-1}$)			Cost of cultivation (Rs ha^{-1})			Net return (Rs ha^{-1})			Benefit-cost ratio		
Cultivation method	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
Improved production technology	1.22	1.64	1.43	8770	9505	9138	11934	16694	14314	1.4	1.8	1.6
Farmersí practice	0.77	1.02	0.89	7967	8026	7997	6144	8275	7210	0.8	1.0	0.9
SE±	0.05	0.10		140.00	164.30		726.00	1434.00				
CV (%)	27	29		8.40	7.7							
LSD (5%)	0.14	0.27		398.16	473.40		2064.40	4130.80				

1. Data are means of 30 trials in each year.

yield and net returns in the dry ecoregions of Andhra Pradesh.

Acknowledgment. We gratefully acknowledge APRLP/ and the UK Department for International Development (DFID) for financial assistance and all the farmers for their overwhelming support in conducting the trials.

References

Balasubramanian V, Singh and **Naadi L.** 1988. Effect of long term fertilizer treatments on groundnut yield, nodulation and nutrient uptake at Samaru, Nigeria. Plant and Soil 55:174ñ180.

Prabhakaran NK, Madhiyazhagan R, Sridharan CS and **Venkataswamy.** 1996. Effect of improved production technology in groundnut in India. International *Arachis* Newsletter 16:48ñ49.

Nguyen Thi Lien Hoa, Nguyen Bao Cuong and **Phan Lieu.** 1996. Comparison of an improved package with farmersí groundnut production practices in southern Vietnam. International *Arachis* Newsletter 16:46ñ48.

On-farm Evaluation of Groundnut and Pigeonpea Intercropping System Using Participatory Rural Appraisal Techniques in the Saurashtra Region of India

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The advances in agricultural technology have contributed to increased productivity at research stations. However, it appears from the socioeconomic surveys that this is not reflected in raising the income and prosperity of the farmers in general and farmers belonging to the small production system in particular. The non-adoption of modern technologies by small and resource-poor farmers was attributed to the inadequate support system, such as extension, credit and input supplies, etc.

Saurashtra region of Gujarat state in India is characterized by typical semi-arid climate. Junagadh district, which lies between 71∞13í E longitude and 21∞1í N latitude was selected for the study. Based on the preliminary survey of 24 villages, four villages, viz., Vadhavi, Zanjarda, Nandarkhi and Umatwada were selected depending on area under groundnut (*Arachis hypogaea*) and transportation facilities. A detailed survey using different participatory rural appraisal (PRA) techniques was conducted by the core team scientists of the National Research Centre for Groundnut (NRCG) and participating scientists from Gujarat Agricultural University (GAU), Junagadh during 1995. Different PRA methods (Chambers 1992) like transect walk, mapping (resource, agroecology and household), seasonality analysis, livelihood analysis, venn diagrams (use of circles of paper or card to represent real linkages and distance between people, groups and institutions), matrix ranking and wealth ranking were used.

Monocropping of groundnut in set furrows 90 cm apart was a general practice in all the four villages. The PRA exercise with farmers indicated low yields of groundnut due to wide row spacing of 90 cm, high plant density ha^{-1} (2ñ5 cm plant to plant spacing within a row) and high seed rate (120ñ140 kg ha^{-1}), which resulted in interplant competition for light, nutrients and moisture. Mid-season drought, which affects the groundnut yield adversely, occurs frequently in the project area. To avoid risk of such crop failure and to increase the yield per unit area and resource-use efficiency, groundnut + pigeonpea (*Cajanus cajan*) intercropping was tried in the four villages. One hundred and twenty-five on-farm trials (OFTs) were conducted over a period of two years (1996ñ97). Each farmer was guided to lay out 1000 m^2 area under groundnut + pigeonpea intercropping system in rows of 1:1, 2:1 and 3:1. The rest of the field was cultivated according to the farmersí conventional practice (sole crop of groundnut). The idea was to provide an opportunity for the farmers to assess and compare the intercropping system with that of their own practice. Different methods were used to facilitate evaluation of the trials by the farmers themselves and elicit constructive feedback. The varieties tested were GAUG 10 [124 days to maturity (DTM)], GG 2 (104 DTM) and GG 20 (122 DTM) of groundnut and BDN 2 of pigeonpea. The staff of NRCG visited the villages and conducted farm walks several times during each season to promote discussions amongst farmers about the advantages of groundnut + pigeonpea intercropping system. All farmers agreed that groundnut + pigeonpea intercropping increased the gross monetary returns per