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*Full Length Research Paper*

# Participatory linkage of farmers, technology and agricultural researchers for improved wheat production in national capital region of India

**M. S. Nain*, Rashmi Singh, K. Vijayraghavan and A. K. Vyas**

Indian Agricultural Research Institute, New Delhi-110012, India.

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**An emphasis needs to be placed on location and time specific solutions when directing the efforts of researchers, policy-makers and extension workers. Farmer participatory research is used to improve the collaboration and communication between farmers and scientists in agricultural research so as to ensure that research findings are relevant to farmers' needs and applicable within their biophysical and socio-economic environments. With assistance from the moderators, farmers themselves discover answers and solutions during informal discussions for their problems. This study was undertaken following the sequential steps namely; participatory problem diagnosis, participatory search for solutions, testing of suitable technological interventions at farmers' fields, regular monitoring of the trials and assessing the impact of the interventions. Research interventions for adaptation and verification of potential technologies under local conditions were tested on participating farmers' fields jointly managed by researchers and farmers. The results in terms of spike length, number of grains/ spike, grain yield, and total dry matter produced were significantly higher in the tested technologies as compared to farmers' practices. The perceptions of participating farmers as well as non-participating farmers were sought on the methodology of technology refinement, and it was found that majority of the farmers were observed to be highly satisfied and expressed their willingness to participate in the process of on-farm research.**

**Key words:** Agricultural interventions, participatory rural appraisal, constraints in participation, on farm testing.

## INTRODUCTION

Innovation has gained enormous focus due to the shortened life span of technologies and new product development has become paramount as critical technologies are not readily available from the basket. Participatory research has assumed greater significance so as to ameliorate technology weakness, evolve new paradigm of technology generation and transfer, technology strategy planning, technology scanning, assessment and social aspects of technology adoption. The presence of technical inefficiency on farmers' fields implies that the right kind of technology is either not available or not adopted. Sanchez (1995) challenged social scientists that small farmer adoption of new technology was slow because social science does not know enough about human processes to mobilize the understanding of technical processes gained by natural scientists. That challenge reflected a frustration with the search for synergy between the achievements of the natural and social sciences. The key difficulties to achieve synergy between the natural and human sciences in technology transfer are found in the paradigm used in applied agricultural research, and the mandate, culture and organization of research institutions that underpins this (Collinson, 2001).

During the last two decades, an increasing amount of adaptive research, with participatory methods in farmers' fields by understanding farmers' priority problems, identifying a range of prototype solutions, working with farmers to choose among these alternatives and adapt

*Corresponding author. E-mail: msnain@hotmail.com. Tel: +919717264950.

chosen options to their local circumstances has been witnessed. Combination of on-farm research and procedures for on-farm experimentation, offers a system based approach to adaptive research and with facilitation from the moderators and farmers themselves discover answers and solutions during informal discussions for their problems.

The roles of extension as that of capacity development, which include training, strengthening innovation processes, build linkages between farmers and other agencies as well as institutional and organizational development to support the bargaining position of farmers (Hall et al., 2005), whereas, the partnership is to bring together different organizations with the purpose of increasing the acceptance, production and efficiency in handling technologies.

Khaliq et al. (2006) viewed partnership practitioners as an important group vital to effective delivery of partnerships. Clay (2004) emphasized the need to work through partnerships in order to strengthen farmers' associations around key economic opportunities to add value and market demand. Over time, different approaches to on-farm research have been developed involving varying degrees of farmer participation.

The major objective remained to improve production by understanding the biophysical, economic and social environment in which farmers operate, and then learning how this context, in addition to labour, machinery and cash endowments of farm families dictate their production priorities and management strategies within the constraints which cannot readily be ameliorated.

The present study utilized focused participatory rural appraisal in two villages of National Capital Region for problem census and problem solving the wheat production system followed by on-farm testing and monitoring by research team comprising of soil scientists, agronomists, crop breeders and social scientists from Indian Agricultural Research Institute (IARI), New Delhi.

## METHODOLOGY

The two villages identified for the purpose were: Partapur cluster near Pilkhua town of district Ghaziabad in the state of Uttar Pradesh, situated at 28.720098 N × 77.630768 E approximately 75 km from IARI campus and Badarpur Said cluster of district Faridabad in the state of Haryana, 28.398951 N × 77.41087 E, situated nearly 56 km from IARI campus. Both locations are part of the National Capital Region of India.

In the present study, all the steps involved in technology adaptation research which aims at production technology testing and evaluation on the basis of agro climatic zones, soil fertility, rainfall pattern, biophysical constraints, management levels and socio economic parameters of farmers were followed.

At the first stage, description and diagnosis of production constraints in existing cropping system/ farming system of the targeted area were analyzed with the use of Participatory Rural Appraisal (PRA) techniques like formation of focused groups, identification of key informants, group interviews, problem cause analysis, crop matrix ranking, cropping pattern, venn diagram, seasonal calendar and seasonal analysis . During the diagnosis stage, due care was taken to deal with the heterogeneity in farming population effectively. The second step involving design/ identification of relevant technology intervention available technical know-how was brought to put up with identified farmer problems in an organized way. At the third stage, promising technologies identified at the design stage were systematically put for evaluation on farmers' field. The data on crop yield in terms of grain as well as total dry matter was recorded, also, the yield attributes like plant height, spike length, numbers of grains / spike, effective tillers/$m^2$ were recorded and the harvest index was calculated. Accordingly the statistical analysis and interpretation of results was made.

The problems were identified and accordingly prioritized for conducting on-farm research including varietal trials of wheat crop (both timely sown and late sown), site specific nutrient management and weed management in wheat crop. The farmers' reactions on their participation in on-farm research and their perceived constraints militating against participation were also sought. For this purpose, both types of respondents were selected namely; 1) those who participated in on-farm research and those who only observed the process and results without overt (active) participation in these trials.

Thirteen farmers' fields from each village making a total of 26 were selected for laying out of research verification trials after motivating them and seeking their willingness for active participation in the process. For seeking the reactions at the end of the cropping season, these thirteen participating farmers each from both the villages and 26 farmers from each village making a total of 52 from observer group of farmers that is, non participant farmers were selected.

## RESULTS AND DISCUSSION

The findings from the present survey study have been discussed in three different sections. In the first part, the problem census and problem prioritization technique through participatory techniques were ascertained. It is significant in the context of rural development to employ participatory techniques because the learning process itself has a great influence on the willingness to accept new ideas or behavioral changes.

Farmers readily accept new ideas if they evolve from dialogue and discussions rather than formal lectures or training sessions. The results presented here are pertaining to the findings of the focused participatory rural appraisal (PRA) conducted to analyze demographic and economic profile of the study villages, constraints in wheat production system and the cropping matrix of *rabi* season (*Rabi* and *Kharif* are the two major seasons of crop cultivation in India. One follows the other and usually has different crops. *Rabi* crop season starts from mid-October and ends in mid- April).

Second part is devoted to the results of on-farm research conducted in twin villages with respect to three interventions namely; varietal performance, weed control and site specific nutrient management (recommendation on the basis of soil tests).

Lastly, the third part includes the farmers' perceived constraints for participation in on-farm research. Farmers' perceptions on their willingness to participate in on-farm research were studied under four different categories as suggested by Merrill-Sands and Kaimowitz (1989) and Biggs (1989).

**Table 1.** Demographic and economic profile of the selected villages.

| Parameter | Value | |
|---|---|---|
| | **Badarpur Said** | **Partapur** |
| Total population (Number) | 2800: (Scheduled castes 18%, backward castes 12% general 70%) | 6000 (20% SC, 30% BC, 50% General) |
| No. of houses | 370(260 of general,70 of Schedule Castes{SC}, 40 of Other Backward Classes {OBC}) | 650 (350 of general,125 of SC, 175 of OBC)) |
| Education status | Total literacy 99% {5th (13 %) 8th (25%) 10th (40%) 12th (17%), Graduates (4 %) PG (.01%)} | Total literacy 99% {5th (3%) 8th (26%) 10th (42%) 12th (20%), Graduates (7%) PG (02%)} |
| No. of school | Up to 8th (1), Aganwadi (Integrated Child Development Service centre} (2) | Up to 10th ( 1), Aganwadi (2) |
| Employment status(Numbers) | Government service 102 {Male 90, Female 12) }, Private service 301 {Male 270, Female 31) | Government service 325 {Male 260, Female 65} Private service 900 {Male 850, Female 50} |
| Total land of the village | 240 ha | 480 ha |
| No. of farming families | 240 | 400 |
| Land distribution | Marginal that is, below one hectare (60%), Small that is, one to two hectares of land (15%), Medium that is, two to five hectares of land (13%), Big that is, more than five hectare of land (2%) | 30% Marginal, 20% Small, 45% Medium, 5% Big |
| Perceived quality of underground water | Good | Good |
| Type of soil | Sandy loam | Loam |
| Irrigation sources | Tube well (50), One canal | Tube well (150), One canal |
| Cropping system | Potato (*Solanum tuberosum*)/Wheat(*Triticum aestivum*)-Jowar/sorghum (*Sorghum bicolor)*<br>Paddy (*Oryza sativa* )-Wheat/Potato<br>Wheat-Moong (*Vigna radiata*)- Bhindi (*Abelmoschus esculentus*)/ Kheera (*Cucumis sativus )*/ Tomato (*Solanum lycopersicum* ) /Pumpkin (*Cucurbita maxima)*<br>Wheat - Pearl millet (*Pennisetum glaucum)* / sorghum/ maize(*Zea mays)*<br>Potato - Wheat - paddy<br>Wheat - paddy<br>Wheat – Arhar (*Cajanus cajan)* | Paddy - Potato - Wheat<br>Paddy - Potato - Tomato<br>Paddy - Potato - Onion<br>Paddy – Berseem *(Trifolium alexandrinum)*<br>Paddy - Potato - Tomato<br>Paddy - Potato - Kheera<br>Fodder - Wheat<br>Paddy - Wheat<br>Paddy-Potato–Muskmelon (*Cucumis melo)* |
| Number of tractors | 50 | 65 |
| Animal population number | 2058: Buffalo 2000,Cross bred cows 40, Bullock 8, Donkey 10 | 10430:Buffaloes 10000, Cross bred cows 300, Pigs100, Donkeys 20,Miscellaneous 10 |
| Village amenities | Post office, newspaper availability, electrification, toilet facilities and telephone connectivity, nearness to Faridabad, a bustling industrial township offering abundant opportunities | One co-operative society, newspaper availability, electrification, toilet facilities and telephone connectivity, nearness to Pilkhua town famous for linen work especially bed covers |

## Profile of the villages studied and problem prioritization

### *Profile*

The results in Table 1 revealed that the primary source of livelihood of both the villages is farming and the employment rate was found to be below 20%. The average land holding was nearly one hectare with slight number variations in the type. The soil and underground water in both the villages were reported of good quality for farming. Both villages being in National Capital Region were found to have adequate basic village amenities and overwhelmingly 99% were educated. Dairying was a subsidiary occupation. In the village of Partapur, the cropping pattern in *rabi* (winter) season was dominated by potato crop

with almost 60% of the area occupied by potato cultivation during December and January (Figure 1). The late sown wheat was cultivated after the harvesting of potato crop. The farmers sow the wheat crop even up to 20th January which is quite late as per scientific recommendations, thus, implying that they are in dire need of wheat varieties which can perform in very late sown conditions. Traditional varieties normally used for such very late sown condition does not yield satisfactorily. Secondly, the wheat crop thus, grown is for the purposes of providing fodder to animals rather for obtaining the grain. On the other hand, Badarpur Said was dominated by wheat crop during *rabi* season (Figure 2) and almost twice in total land and population as compared to the village Partapur. The animal population of *Badarpur Said* was also very high. Water and soil quality were reported to be congenial for the cropping system in both the villages.

Tables 2 and 3 showed the matrix ranking by the farmers for various crops in both the villages. The farmers were asked to give higher weightages on a five point continuum to the favouring parameter and lesser to unfavouring parameter of the respective crop. It is clear from the data that farmers ranked wheat crop at first as a whole on ten different parameters ranging from availability and cost of inputs, management of the crop, risk, market and net income. The parameters of ensured market, price through minimum support price, preference for its by-product and part of food basket in this part favoured the crop matrix. The net income in the case of potato, tomato, cabbage and sweet pepper were higher than wheat but their cost of cultivation, input cost and crop management were found to be disfavoured in the crop matrix. Barseem (*Trifolium alexandrinum*) and Oats (*Avena sativa*) were being grown for the livestock fodder usages. Although, the crop matrix of potato, peas and tomato in Partapur and potato and tomato at Badarpur Said were ranked slightly lower but the farmers preferred to cultivate these crops for higher returns taking calculated risks.

## Problem prioritization in study area

Participatory diagnosis is important for an understanding of farmers' problems, the understanding of their priorities, management strategies and resource constraints is vital for the identification and subsequent shaping of solutions, including improved technologies. The need for solutions to 'fit farmers' systems', that is, to be congruent with their priorities and strategies and appropriate for their resource endowments, puts an onus on flexibility. This need for flexibility to permit adaptation to the system has repercussions on the applied research paradigm. Table 4 depicts the identified constraints and their seriousness in wheat production system in both villages. It is clear from the data that the type of constraints and their strength is almost similar in both villages with slight variations. The availability of quality seed material with proper germination and seed treatment related chemicals and their method of application were viewed as very serious constraint related to seed. Secondly, the availability of spurious herbicides and the poor knowledge regarding their mode of action was viewed very serious and serious respectively. Regarding nutrient management, it was highlighted that the potassic and phosphatic fertilizers are not readily available in the market and viewed as very serious along with the high cost charged by the suppliers. It was observed that farmers felt that wheat crop is less susceptible to insects and diseases, hence, the problem of disease and insect management was reported to be of slight seriousness but the infestation of termite and its control was rated as serious in one village (Badarpur Said) and very serious in second village (Partapur). The findings are in line with the study of Sharma et al. (2010) where management and control of termite in wheat crop was found to be one of the important areas for research. Other major problems emphasized by the farmers were the damage by *neelgai* (*Boselaphus tragocamelus*) and the erratic power supplies to fetch underground water for irrigation. Lack of proper marketing infrastructure and poor knowledge regarding post harvest handling of the produce were also felt as other constraints.

## Impact of on-farm testing intervention on the yield of wheat crop

Applied research needs to recognize that its recommendations for growing a commodity represent a technically ideal system. Farm systems produce a range of outputs, including those from off-farm employment to meet a complex of family objectives and manage risks from both markets (price uncertainties, uncertainties in both input supply and physical access to markets) and climate, particularly, within and between season variations, with rainfall levels and patterns of particular importance. Exploring and comparing their plasticity and variability in performance may revolutionize the adaptation of prototypes to fit into ongoing farming systems. Available technical know-how was brought to bear on identified farmer problems in an organized way in the light of the understanding gained from initial diagnosis. The concept that small farmers evolve by steps away from their existing farming system was central to the discussions of technological packages and taken care of. Three types of interventions namely; varietal testing, site specific nutrient management and weed management were finally considered for adaptation research in the selected villages. Table 5, 6 and 7 showed the impact of on-farm testing of technologies/ interventions laid out during Rabi 2010 to 2011 in both villages. In total, three technologies were laid out for their testing on the field' of 26 participants (13 in each village). As depicted in

**Table 2.** Matrix ranking of rabi season crops in Badarpur Said.

| Parameters / Crop | Seed availability | Seed costs | Food requirements | Crop Duration | Cost of cultivation | Pest and diseases | By product | Risk | Market availability | Net Income | Total | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat (*Triticum aestivum*) | 4 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 5 | 3 | 36 | i |
| Cabbage (Brassica oleracea) | 4 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 4 | 25 | vii |
| Cauliflower (Brassica oleracea var. botrytis) | 4 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 3 | 4 | 27 | vi |
| Tomato (*Solanum lycopersicum* ) | 3 | 2 | 3 | 4 | 3 | 2 | 1 | 4 | 4 | 4 | 30 | iii |
| Potato (Solanum tuberosum ) | 3 | 2 | 4 | 4 | 4 | 2 | 1 | 3 | 4 | 3 | 30 | iii |
| Barseem *(Trifolium alexandrinum)* | 4 | 4 | 1 | 2 | 4 | 4 | 1 | 4 | 4 | 3 | 31 | ii |
| Fodder Oats *(*Avena sativa) | 4 | 4 | 1 | 3 | 4 | 4 | 1 | 3 | 3 | 2 | 29 | iv |
| Carrot *(Daucus carota)* | 3 | 3 | 2 | 4 | 3 | 3 | 1 | 3 | 3 | 3 | 28 | v |

**Table 3.** Matrix ranking of Rabi season crops in *Partapur.*

| Parameters / Crop | Seed availability | Seed costs | Food requirements | Crop Duration | Cost of cultivation | Pest and diseases | By product | Risk | Market availability | Net Income | Total | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat (*Triticum aestivum*) | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 5 | 3 | 34 | i |
| Mustard (*Brasicca compestriss*) | 3 | 3 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 2 | 29 | iv |
| Sweet Pepper (*Capsicum spp)* | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 4 | 4 | 28 | v |
| Cabbage (Brassica oleracea) | 4 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 4 | 27 | vi |
| Cauliflower (*Brassica oleracea var. botrytis* | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 3 | 4 | 25 | vii |
| Tomato (*Solanum lycopersicum*) | 3 | 2 | 3 | 4 | 3 | 3 | 1 | 4 | 4 | 4 | 30 | iii |
| Potato (Solanum tuberosum) | 3 | 2 | 3 | 5 | 3 | 3 | 1 | 3 | 4 | 4 | 31 | ii |
| Barseem *(Trifolium alexandrinum)* | 4 | 4 | 1 | 2 | 4 | 4 | 1 | 4 | 4 | 3 | 31 | ii |
| Fodder Oats *(Avena sativa*) | 4 | 4 | 4 | 3 | 4 | 4 | 1 | 4 | 1 | 2 | 31 | ii |
| Table peas *(Pisum sativum)* | 4 | 3 | 4 | 3 | 3 | 3 | 1 | 3 | 3 | 4 | 31 | ii |
| Muskmelon (*Cucumis melo)* | 3 | 3 | 3 | 3 | 4 | 3 | 1 | 3 | 3 | 3 | 29 | iv |
| Carrot *(Daucus carota)* | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 28 | v |
| Gaurds (Cucurbitaceae spp) | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 23 | viii |

Table 5, the grain yield performance of all the three varieties subjected for adaptation research under timely sown conditions yielded significantly higher than the local practice (PBW 343) as a whole. The variety HD2967 yielded highest (22% higher than local check) followed by HD2894 and HD 2733. In the case of late sown varieties, WR544 yielded highest (29% higher than local check that is, *Indra*) followed by HD3016 and HD2985 respectively. The results are in conformity with the study of Chaudhary et al. (2010) where it was reported that the newly developed cultivars performed better in terms of productivity and profitability over conventional varieties grown in mid hill region.

Table 6 shows the effect of nutrient management practices on grain and straw yield and it is clear from the data that the application of

**Table 4.** Identified constraints in wheat production.

| Constraint | Degree of Seriousness | |
|---|---|---|
| | Partapur | Badarpur Said |
| Low germination percentage of the seed | Very serious | Very serious |
| Non availability of good quality seed on time locally | Very serious | Very serious |
| Lack of knowledge of the chemicals and method of seed treatment | Very serious | Very serious |
| Inadequate knowledge of herbicides | Serious | Serious |
| Availability of spurious herbicides in market. | Very serious | Very serious |
| Non availability of potassic and phosphate fertilizers in the market. | Very serious | Very serious |
| Lack of knowledge about diseases and their control | Slightly serious | Slightly serious |
| The high cost of input charged by suppliers | Slightly serious | Slightly serious |
| Lack of proper marketing infrastructure leading to less output. | Slightly serious | Slightly serious |
| Erratic power supply | Very serious | Slightly serious |
| Damage by blue bull (*Boselaphus tragocamelus*) | Serious | Very serious |
| Lack of knowledge regarding post-harvest handling of produce | Slightly serious | Slightly serious |
| Management and control of termite infestation | Very serious | Serious |

**Table 5.** Yield performance of different varieties at farmers' field.

| Timely sown variety | Average grain yield (t/ha) | Late sown variety | Average grain yield (t/ha) |
|---|---|---|---|
| HD 2967 | 6.049 | WR544 | 5.755 |
| HD2894 | 5.047 | HD2985 | 4.575 |
| HD2733 | 5.183 | HD3016 | 5.215 |
| Farmers' practice | 4.915 | Farmers' practice | 4.456 |

**Table 6.** Effect of nutrient management on grain, straw and dry matter yield of wheat.

| Treatment | Grain yield (t/ha) | Straw yield (t/ha) | Dry matter yield (t/ha) |
|---|---|---|---|
| Farmers' practice | 4.972 | 11.125 | 16.097 |
| Recommended dose of fertilizer (120Kg N,60Kg $P_2O_5$ and 40 Kg $K_2O$) | 5.458 | 12.096 | 17.554 |
| Site specific nutrient management (150Kg N,60Kg $P_2O_5$ and 60 Kg $K_2O$) | 6.230 | 13.467 | 19.697 |
| Critical Difference (P=0.05) | 0.304 | 0.686 | 0.969 |

**Table 7.** Effect of weed control interventions on yield attributes and yields of wheat crop.

| Treatment | Plant height (cm) | Effective tillers/$m^2$ | Spike length (cm) | Grains /spike | Grain yield (t/ha) | Straw yield (t/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|---|
| Farmers' practice | 85.0 | 302.1 | 8.80 | 49.8 | 3.49 | 5.43 | 39.2 |
| Control | 83.6 | 283.3 | 8.20 | 43.2 | 2.92 | 4.39 | 39.9 |
| Clodinofop (60 g/ha) +metsulfuron (4 g/ha) | 90.6 | 354.9 | 9.95 | 61.3 | 4.49 | 6.75 | 40.0 |
| Sulfosulfuron(30 g/ha) | 88.9 | 344.7 | 9.55 | 56.9 | 4.09 | 6.09 | 41.7 |
| Critical difference (P=0.05) | 2.64 | 23.08 | 0.64 | 5.49 | 0.40 | 0.60 | NS |

fertilizers on the basis of soil test yielded significantly higher quantities of grain and straw than the farmers practice and general recommendations of fertilizers. Furthermore, Table 7 showing effect of weed control interventions on yield and yield attributes clearly indicates that the weed control with Clodinofop (60 g/ha) +

**Table 8.** Farmers' perceptions on their willingness to participate in on farm research.

| Types of participation | Participant farmers (n=26) | | Non participant farmers (n=52) | |
|---|---|---|---|---|
| | Yes (%) | No (%) | Yes (%) | No (%) |
| **A Contract participation** | 96.15 | 3.85 | 63.73 | 36.27 |
| Farmers provide land ,labour, irrigation , machinery and other inputs for on farm research | 24(92.31) | 02(7.69) | 29(55.77) | 23(44.33) |
| Management of the trials with farmers and provision of some services | 26(100.00) | 0(0.00) | 36 (69.23) | 16(30.77) |
| **B Consultative participation** | 100.00 | 0.00 | 82.05 | 17.95 |
| Problems identification and development of solutions with farmers | 26(100.00) | 0(0.00) | 50(96.15) | 02(03.85) |
| Diagnose priority problems with farmers | 26(100.00) | 0(0.00) | 45(86.54) | 07(13.46) |
| Evaluation of proposed solution with the farmers | 26(100.00) | 0(0.00) | 33 (63.46) | 19(36.54) |
| **C Collaborative participation** | 95.19 | 04.81 | 58.65 | 41.35 |
| Intensive and continuous interaction of scientist and farmers on execution of research programme | 26(100.00) | 0(0.00) | 34(65.38) | 18(34.62) |
| Monitoring of progress and joint review of research results by scientists and farmers | 24(92.31) | 02(7.69) | 41(78.85) | 11(21.15) |
| Farmers and scientist investigating the relationship between productivity and interventions jointly | 23(88.46) | 03(11.54) | 28(53.85) | 24(46.15) |
| Research observation, data taking, Recording and keeping with farmers | 26(100.00) | 0(0.00) | 19(36.54) | 33(63.46) |
| **D Collegiate participation** | 48.71 | 51.29 | 23.72 | 76.28 |
| Seminars and discussion sessions with farmers to strengthen farmers' capacity to carry out research on their own | 15 (57.69) | 11(42.31) | 15(28.85) | 37(71.15) |
| Participation in informal research and development programmes | 13(50.00) | 13(50.00) | 12(23.08) | 40(76.92) |
| Farmers training in carrying out their own research | 10(38.47) | 16(61.53) | 10(19.23) | 42(80.77) |

Metsulfuron (4 g/ha) gave better results in terms of plant height, effective tillers/$m^2$ spike length, grains/spike, grain and straw yield. It superseded the control with sulpfosulfuron (30 g/ha) and the practices followed by the farmers in the form of recommended herbicides like 2, 4-D.

The results showed that not only did the crop yield increase significantly but also the quantity of the herbicides used reduced significantly.

The result of the interventions laid out for adaptation are clear indications for the extension agencies working in the area for their concentrated efforts to repeat the interventions with farmers to make the final choice on technology adoption.

Farmers results evaluation by several criteria selected from a wide range that was considered and they are: profitability, returns to the investment of scarce cash, returns to the labour at seasonal peaks of the system, the risk of losses, the complexity of the changes in management required for implementation and the impact on social and cultural factors which has to go a long way in adoption of the tested technologies.

**Perceptions on willingness and constraints in participation in on farm testing**

All the developments require some kind of behavior change on the part of stakeholders. Research shows that changing knowledge and attitudes does not necessarily translate into behavior change. In order to effect behavior change, it is necessary to understand why people do what they do and understand the barriers to change or adopting new practices. It is not enough to raise awareness of the "benefits", it is critical to understand peoples' barriers or the "costs" they perceive such a change would entail. Tennyson (2005) reviewed three different partnerships and used the findings to explore what happens beyond the early negation and building phases of partnership. Present study explored willingness of farmers on four types of participation namely: contract, consultative, collaborative and collegiate participation in on-farm testing (adaptive research) and these are presented in Table 8. The data showed that more than 96% of participants and 64% of the observer farmers showed their willingness to participate in the contract

**Table 9.** Distribution of respondents by constraints militating against participation in on farm research.

| Farmers constraints | Participant farmers (n=26) | Non participant farmers (n=52) | Total N=78 | Rank |
|---|---|---|---|---|
| Nonexistence of encouragement, unfavourable attitude and low level of motivation | 0.86 | 1.22 | 1.04 | xii |
| Inadequate knowledge and skills in research methods | 1.06 | 1.84 | 1.45 | v |
| Farmers do not have the formal training to enable them participate | 1.13 | 1.68 | 1.41 | vi |
| No remuneration to farmers in participating in OFR | 1.24 | 1.78 | 1.51 | iv |
| Conflicts with other farm activities | 1.26 | 1.38 | 1.32 | vii |
| Extra time is required to participate in OFR | 1.02 | 1.25 | 1.14 | x |
| Requires extra energy and efforts | 1.05 | 1.24 | 1.15 | ix |
| Unfavourable attitude and lack of interest of farmers to participate in OFR | 1.54 | 1.69 | 1.62 | ii |
| Inferiority complex in working with learned researchers | 1.02 | 1.15 | 1.09 | xi |
| Farmers lack capacity to take risk | 1.65 | 1.75 | 1.70 | i |
| No monetary advantage to farmers for participation in OFR | 1.40 | 1.68 | 1.54 | iii |
| Small and marginal farmers cannot spare land and other resources for OFR | 0.90 | 1.45 | 1.17 | viii |

**Figure 1.** PRA exercise to depict crop wise area distribution in Partapur during November and December.

by providing land, labour, irrigation, non-critical inputs, machinery and management of trials. Regarding the consultative participation, 82% of observers and 100% of participating farmers expressed their willingness to participate through problem identification, prioritization and evaluation of proposed solution. As far as collaborative participation is concerned, 95% of participating farmers and 59% of observer farmers were willing to participate in continuous interaction, joint record keeping, monitoring the progress and finding the relationship of productivity with interventions. Only 49% of participating farmers and 24% of observer farmers expressed their willingness for collegiate participation through seeking formal training as partners in action research, participation in group discussions and informal participation in research and development.

Data presented in Table 9 revealed the constraints at farmers' level associated with participation in on-farm research. The farmers were asked to express their perceptions regarding various constraints on three points namely; very serious (2), serious (1) and not a constraint (0). Low risk taking ability, unfavourable attitude, and lack of interest due to absence of monetary advantage, no provision of remuneration and poor knowledge and skills in research methods were found to be serious constraints. Relatively, less serious constraints in the list

**Figure 2.** PRA exercise to depict crop wise area distribution in Badarpur Said during rabi season.

were; small land holdings, requirement of extra time bound effort, conflict with other farm activities, inferiority complex in working with scientists, low level of motivation and non-existence of encouragement.

## Conclusion

New challenges such as climate change, agricultural innovations and food crises have emerged in agricultural and rural development and they require new approaches to foster sustainable solutions. Communication for development is a people-centered communication approach which integrates participatory methods and social media, focusing on social processes rather than on media and aims primarily at giving a voice to the people to put them in control of their own development. It has been suggested that the research and development team needs to remain involved during the adaptation phase to nurture the learning process by filling the knowledge gaps amongst the key stakeholders, selecting beneficial modifications and promulgating them, and in carrying out their own field learning. The partnership is to bring together different organizations with the purpose of increasing the acceptance, production and efficiency in handling technologies.

The present study provides new insights into development of a mechanism to create a valuable synthesis between local and research awareness probably leading to a more appropriate modern technology, and increase key stakeholder capacity to interact with new technology. The study confirms the learning selection model of the early adoption process (Douthwaite et al., 2002) which explains evolution of technology during adoption as a result of modifications by stakeholders, and then selecting and promulgating some of them. The model further recognizes that the technology may not work well enough to be motivated to persevere when unforeseen problems arise during the initial adoption of a publicly-developed technology and the key stakeholders may not know enough about the new technology for this learning selection to improve the fitness of the new technology. Hence, researchers need to be active participants in the early adoption process to nurture new technology until market selection begins to work.

## REFERENCES

Biggs S (1989). Resource Poor Farmers Participation in Research: A Synthesis of Experiences in Nine National Agricultural Research Systems. OFCOR Comparative Study Paper No. 3, ISNAR, The Hague, Netherlands.

Clay D (2004). The PEARL Model for Successful Agriculture Outreach and Technology Transfer. Institute of International Agriculture, Michigan state university, Michigan.

Chaudhary AK, Singh A, Yadav DS (2010). On Farm Testing of wheat cultivars for site specific assessment under Bio-physical regimes in mid hill conditions of Mandi district of Himachal Pradesh. J. Commun. Mobilization Sustain. Dev. 5(1):1-6.

Collinson M (2001). Institutional and professional obstacles to a more effective research process for smallholder agriculture. Agric. Syst. 69(1-2):27-36.

Douthwaite B, Keatinge JDH, Park JR (2002). Learning selection: an evolutionary model for understanding, implementing and evaluating participatory technology development. Agric. Syst. 72(2):109-131.

Hall A, Sulaiman RV, Raina R (2005). From dissemination technologies to promoting innovation. p.15. In: Sulaiman R (ed.), Implications for

Agricultural Extensions in New Insight on Reforming Agricultural Extension. National Bank for Agriculture and Rural Development, Mumbai.
Khaliq SH, Stibbe D, Tennyson R (2006). Facing the facts: Realities of partnering in practice. survey of views and experiences of frontline partnership practitioners. The Prince of Wales International Business Leaders Forum. http://thepartneringinitiative.org/docs/tpi/FacingtheFacts.pdf.
Merrill-Sands D, Kaimowitz D (1989). ″The Technology Triangle -- Linking Farmers, Technology Transfer Agents and Agricultural Researchers″. The Hague: ISNAR.
Sanchez PA (1995). Science in agroforestry. Agroforestry Syst. 30:5–55. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (206)
Sharma JP, Dubey SK, Sharma N, Kishore N, Jiyawan R, Maurya PP, Sah P, Dubey AV (2010). Participatory analysis of agri-rural situation for research, development and policy interventions. J. Commun. Mobilization Sustainable Dev. 5(2):28-36.
Tennyson R (2005). The Brokering Guidebook. The Partnering Initiative, London. www.iblf.org/docs/BrokeringGuidebook.pdf.