Farmers' Perceptions of Experiment Station Research, Demonstrations, and On-Farm Research in Agronomy

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ABSTRACT

Research priorities have recently been developing in alternative or sustainable agriculture. These new priorities have produced increasing discussion regarding on-farm research. Information is needed to develop research programs that incorporate greater farmer participation than is currently the norm. The objectives of this study were to assess the involvement of farmers in on-farm testing and their opinions concerning experiment station trials, demonstration plots, and on-farm research. A mail survey of a random sample of Nebraska crop producers and two special interest farmer groups was conducted. Comparisons of response frequencies were made by educational level, age, area farmed, percent of land rented, and between sample groups using Chi-square (X^2) tests of association. Seventy-one percent of the Nebraska random sample participants conducted on-farm comparisons of new technology with their current farming practices. Willingness to participate in university-based, on-farm research using field-length strip plots was most evident among young participants and those who rented a portion of the land they farmed. Approximately one-third of the random sample participants were willing to use an experimental design involving replication and randomization for their own on-farm tests. In general, producers highly valued on-farm testing for both their own testing and university-based research.

AGRONOMY RESEARCHERS in the USA primarily use experiment station trials for testing new ideas. Verification of promising results is normally made by further testing on experiment stations. When university research is conducted on a farmer's field, the experiments often use small plots and are largely managed by the researcher.

Increasing interest in alternative agricultural practices has resulted in a corresponding increase in discussion of on-farm research. However, much of the on-farm research discussion involves whole farm applications or the use of standard farm equipment and farmer management.

Field-length strip plots as large as 4.05×10^3 m^2 for each treatment replication and accommodating standard farm machinery can be used for on-farm experiments if certain conditions are met. Statistical reliability is achieved using large plots if the number of treatment levels is kept low and at least five or six replicates are used in a randomized complete block design (Rzewnicki et al., 1988). For large plot research a randomized complete block design has less experimental error than nonreplicated strips using a "tester" in every second or third plot (Schmitt and Openshaw, 1988).

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On-farm research with farmers as active collaborators may expedite the transfer of technology to producers. In developing countries on-farm research with farmer involvement is recommended for increasing the adoption of technological alternatives (Byerlee et al., 1982). Farmer involvement in on-farm research at international research centers ranges from attaining farmer permission to use land to scientists interacting with informal research systems developed by farmers themselves (Biggs, 1989). However, the involvement of farmers in the management of research trials is not often done in the USA. Widespread adoption of technological advances from experiment station to farmers in the USA may be delayed as much as 20 to 30 yr because of the time needed for adapting results to a wide array of farm conditions (Ruttan et al., 1980).

Questions remain about the degree of interest U.S. farmers have in conducting on-farm testing and their willingness to use experiment designs that allow statistical analysis. The objectives of this study were to assess: (i) current levels of farmer-conducted field tests; (ii) farmer willingness to be involved in on-farm testing using a replicated, randomized experimental design; and (iii) opinions regarding experiment station trials, demonstrations, and on-farm research. Such information would be useful for future technology transfer programs and the planning of on-farm research strategies.

METHODS

A mail survey was conducted in the summer of 1989. A random sample of 750 Nebraska farms with 32.4 ha or more in row crop production was selected from a data base maintained by the Nebraska Crop and Livestock Reporting Service. Two mailings of the questionnaire were made with a reminder postcard sent between the mailings.

Questionnaires were also sent to two special interest groups for comparisons to the random population. Surveys were sent to 125 members of The Practical Farmers of Iowa (PFI) and to 132 members of the Nebraska Sustainable Agriculture Society (NSAS). The PFI had been involved in on-farm testing using field-length strip plots for 3 yr prior to the study. Their experience with large plots using replication and randomization provided a comparison to Nebraska producers who generally have no knowledge of this testing method. The NSAS was a relatively new organization at the time of the study, consisting of farmers across the state who advocate sustainable agricultural practices. The NSAS had no organized on-farm research program at the time of the survey.

The questionnaire was designed to use structured responses with occasional opportunities for personal comments. After reading each statement, respondents were asked to circle or check the number that best indicated their reaction to the statement. Producers were given the following description of several topics within the questionnaire to assist them in their comparison of experiment station trials, demonstrations, and on-farm strip plots:

> Two important factors in research are the random arrangement of plots and repetition. By using random assignment of plots, one makes sure that a favorite treatment is not placed purposely on a more productive piece of ground. Replication is achieved when the same treatment appears more than once in the process of the experiment. With replication, one makes sure that the treatment differences are real and not due to chance.
>
> Some basic differences between experiment station trials, demonstration plots, and on-farm strip plots are:
>
> 1. Experiment station trials usually use small plots, special equipment, randomization, and replication.
> 2. Demonstrations usually use larger plots and regular farm machinery, but there is no randomization and replication.
> 3. On-farm strip plots usually use field-length strips, regular farm machinery, randomization, and replication.

Frequencies were calculated on the basis of completed responses for each question. Statistical analysis was conducted using chi-square (X^2) and analysis of variance for comparisons of the sample groups. Chi-square was used to analyze responses of the random sample group to selected questions by educational level, age, area farmed, and percent of land rented. Probability levels of 1, 5, and 10% were used to denote significant differences among comparisons.

RESULTS AND DISCUSSION

Rate of Return and Respondent Characteristics

The random sample of Nebraska producers returned 37% of the questionnaires with a final count of 33% usable. Rates of return for the two special interst groups were 75%, with 71% usable for PFI, and 65% return with 58% usable for NSAS.

The age profiles of the random sample and the PFI were significantly different ($P = 0.01$). Sixty-eight percent (68%) of the PFI were under 45 yr of age as opposed to the majority of the Nebraska random resondents being 45 or over. The age profile of the NSAS respondents was not significantly different from either of the other two groups.

The random group's educational profile was significantly different ($P = 0.01$) from both of the special groups. Only 50% of the random group completed studies beyond high school as opposed to 78% of the PFI and 72% of the NSAS. A higher percentage of NSAS members (44%) were college graduates than either the PFI (32%) or the random group (22%).

Mean area farmed by the random sample was 306 ha. This was significantly different ($P = 0.01$) from area farmed by the PFI and NSAS members at 219 ha and 189 ha, respectively. Of the random respondents, 77.5% reported renting some of the land they farmed with an average of 206 ha rented. Land was rented by 85.7% of the PFI with a mean of 153 ha reported, which was significantly ($P = 0.10$) less than the random group. Renting was done by only 56% of the NSAS producers with a mean of 143 ha being significantly ($P = 0.05$) less than the random sample.

On-farm Testing by Producers

A large proportion of the row crop producers surveyed performed some experimentation on their own before applying new technology to an entire field. In all three sample groups (Table 1), 70 to 80% of the respondents compared new varieties or cropping practices with their current system within a single field (first two responses). Seventy-one percent of the Nebraska random group conducted comparisons with their current systems. However, their level of on-farm testing was significantly different ($P = 0.10$) from both special interest groups, which reported higher levels. For all three groups more than half of these on-farm comparisons were made by applying the innovation on more than 4.05 ha in a particular field.

Most of the random sample and PFI respondents who chose the last response "Other (please specify)" indicated that they observe the results of other producers. Most of the NSAS members who chose the last response commented that they depend on university research results.

Attitudes on University Research and Recommendations

A very large proportion of all the producers surveyed considered university research and resulting recommendations useful and current as shown by responses to questions one and three in Table 2. There were no significant diffrences in this regard among the three groups.

Experiment station plots were not considered too small to provide useful information for farmers by 73% of NSAS respondents and 68% of the random sample (Table 2). However, significantly ($P = 0.05$) fewer farmers from the PFI (57%) did not think station plots were too small indicating a less favorable attitude toward the value of small plot research.

Most of the respondents in all three groups responded positively to the concept of testing experiment station results on working farms before recommendations are made. Approximately three-fourths of all three groups placed a high level of importance on the use of on-farm testing as part of a university's research process.

Involving farmers in identifying farm-level constraints to agriculture and in planning measures to alleviate them has become increasingly important to farming systems research scientists in developing countries (Matlon et al.,

Table 1. Questionnaire statement and responses regarding level of on-farm testing conducted by farmers.

When you decide to make a change in one of your agricultural practices, such as a new variety or a different herbicide, do you usually (check one):

Answer	Random	PFI	NSAS
		%	
___ Use it on 4 ha (10 acres) or less so you can compare it to your present cropping system	32	37	35
___ Use it on a large part of a field [more than 4 ha (10 acres)] so you can compare it to the system you are presently using on the rest of the field	39	43	42
___ Use it on an entire field without using your present system on that field	26	14	13
___ Other (please specify)	3	6	10
X^2	—	5.0†	4.6†

† Indicates significance at $P = 0.10$.

Table 2. Opinions of respondents regarding experiment station research, farmer input, and on-farm testing.

Group	n	SA†	A	D	SD	NO	X^2
				%			
1. Agricultural recommendations based on university experiment station research are useful to farmers.							
Random	244	19	73	5	<1	3	—
PFI	88	14	75	8	2	1	2.4 NS‡
NSAS	76	22	66	4	3	5	0.2 NS
2. University experiment station research plots dealing with agricultural practices are generally too small to produce useful information for farmers.							
Random	240	4	20	58	10	7	—
PFI	89	9	27	49	8	7	4.6*
NSAS	76	5	15	57	16	8	0.7 NS
3. Current agricultural research on university experiment stations has little application to farmers.							
Random	240	<1	8	67	17	6	—
PFI	89	2	12	64	17	5	2.3 NS
NSAS	76	4	8	51	28	9	0.7 NS

* indicates significance at $P = 0.05$.
† A = strongly agree; A = disagree; SD =strongly disagree; NO = no opinion.
‡ NS = Comparison with random group not significant at P = 0.10.

1984). Increasing the involvement of U.S. producers in planning research can be just as important. To include farmer input in planning university-based research was rated very to extremely important by 71% of the random group, 88% of PFI, and 83% of NSAS.

Opinions on Demonstration Plots and Their Location

University demonstration plots placed in farm fields away from experiment stations were highly favored by all three sample groups. There were no significant differences among all three groups where 90 to 95% of the producers in each group gave a positive rating to the usefulness of off-station demonstration plots (Table 3).

Distance of a demonstration plot from home or farm was a significantly more serious consideration for the random sample group than it was for the PFI or NSAS. For 15% of the random respondents who find demonstrations useful, distance is "always" a consideration when deciding on the usefulness of a demonstration plot and, for 44%, it is considered "most of the time" (Table 3). This was significantly different ($P = 0.01$) from the PFI and from the NSAS respondents ($P = 0.05$).

Table 3. Respondents' opinions regarding demonstration plots.

	Random	PFI	NSAS
		%	
1. Many university demonstration plots of agricultural research are located in farm fields throughout the state, away from experiment stations. In your opinion, do such plots provide useful information to farmers? (check one)			
Answer	$n = 245$	$n = 89$	$n = 77$
___ 1. Yes, definitely	46	49	46
___ 2. Yes, usually	49	41	49
___ 3. No opinion	3	5	5
___ 4. Usually not	2	5	0
___ 5. Definitely not	<1	0	0
If you selected 1 or 2, go to the next question; if you selected 3, 4, or 5, go to section G (next section in questionnaire).			
2. Is distance from your farm a consideration in deciding whether or not a demonstration plot can provide useful information for your farm? (check one)			
Answer	$n = 233$	$n = 82$	$n = 73$
___ 1. Always	15	5	3
___ 2. Most of the time	44	35	48
___ 3. Sometimes	39	55	49
___ 4. Never	2	5	0
X^2	—	12.0**	9.1
If you selected 1, 2 or 3, go to the next question; if you selected 4, go to section G.			
3. Assuming the soil type is similar, what is the maximum number of miles a demonstration plot can be from your farm and still provide useful information for you? (check one)			
Answer	$n = 221$	$n = 77$	$n = 71$
___ 1. 0 to 10	14	4	9
___ 2. 11 to 20	29	10	16
___ 3. 21 to 30	26	26	27
___ 4. 31 to 40	6	14	14
___ 5. 41 to 50	20	24	22
___ 6. other (please specify)	5	22	12
X^2	—	34.2**	12.5*
4. What is the maximum number of miles you typically would travel from your home to observe a demonstration plot? (check one)			
Answer	$n = 220$	$n = 74$	$n = 72$
___ 1. 0 to 10	11	3	10
___ 2. 11 to 20	35	15	21
___ 3. 21 to 30	26	19	33
___ 4. 31 to 40	8	19	11
___ 5. 41 to 50	15	19	17
___ 6. other (please specify)	5	25	17
X^2	—	42.7**	6.8 NS†

*,** Indicates significance at $P = 0.05$ and $P = 0.01$.
† NS = not significant at $P = 0.10$.

Those for whom distance was a consideration at least some of the time were asked two more specific questions about distance. More than two-thirds (69%) of the random respondents to the next question indicated that the demonstration plots should be within 48 km (30 miles) of their farms to be applicable to them, even if soil type was similar (Table 3). This was significantly different ($P = 0.01$) from the PFI (40%) and significantly different ($P = 0.05$) from NSAS respondents (52%). Most of the respondents of all three groups who answered "other (please specify)" commented that distances of 80.5 to 161 km (50-100 miles) would be satisfactory. A few of the PFI members were willing to consider distances up to 322 km (200 miles) as acceptable.

Table 4. **Producer comparisons of experiment station trials, demonstration plots, and on-farm strip plots.**

Please compare the usefulness of these three methods (experiment station trials, demonstration plots, and on-farm strip plots) of testing new agricultural practices to your farming operation (circle one number for each comparison).

	MMU†	SMU	EQU	SLU	MLU	
Strip plots are...	1	2	3	4	5	...than demonstrations
			%			
Random	27	36	30	6	1	X^2
PFI	57	32	9	2	0	18.8**
NSAS	40	38	18	4	0	4.7‡
Demonstrations are...	1	2	3	4	5	...than experiment station trials
			%			
Random	12	31	36	18	3	X^2
PFI	8	32	21	23	16	10.8**
NSAS	6	33	31	27	3	2.1 NS§
Experiment station trials are...	1	2	3	4	5	...than strip plots
			%			
Random	3	17	41	32	7	X^2
PFI	1	7	33	43	16	11.4**
NSAS	3	12	44	38	3	0.9 NS

** Indicates significance at $P = 0.01$.
† MMU = much more useful; SMU = somewhat more useful; EQU = equally useful; SLU = somewhat less useful; MLU = much less useful.
‡ Indicates significance at $P = 0.10$.
§ NS = not significant at $P = 0.10$

The next question was specific as to how far producers would be willing to travel to view a demonstration plot. Only 28% of the random sample of producers would travel more than 48 km (30 miles) to see a plot (Table 3). This was significantly different ($P = 0.01$) from the PFI group where 63% were willing to travel such distances. The NSAS respondents were not significantly different from the Nebraska random group. Producers from all three groups who chose the last response "other (please specify)" cited distances ranging from 80.5 to 322 km (50–200 miles) with a few PFI producers even willing to travel 402 to 1207 km (250–750 miles).

Comparisons of Experiment Station Plots, Demonstrations, and Strip Plots

Producers were asked to make pairwise comparisons of experiment station trials, demonstration plots, and on-farm strip plots (Table 4). Comparisons were based on their opinions of usefulness to them of these methods of testing new agricultural practices. In the comparison of strip plots with demonstrations, 63% of the random group gave a positive response ("Much more useful" and "Somewhat more useful") for strip plots. This was significantly less ($P = 0.01$) than the PFI (89%) and the NSAS (78%) ($P = 0.10$).

Comparing demonstration plots with experiment station trials, 54% of the Nebraska random sample gave a positive response for demonstrations with 21% favoring station trials (Table 4). This was significantly different ($P = 0.01$) from the PFI. The PFI responses were equally balanced for (40%) and against (39%) demonstrations when compared with experiment station trials. The NSAS responses were not significantly different from either of

Below is an example of an on-farm strip plot test comparing two different fertilizers, A and B. Randomizing the applications and using six replications (Rep.) would require about 4 to 4.8 ha (10 to 12 acres). Field length is usually 0.4 km (0.25 miles). Each fertilizer strip below is eight rows wide.

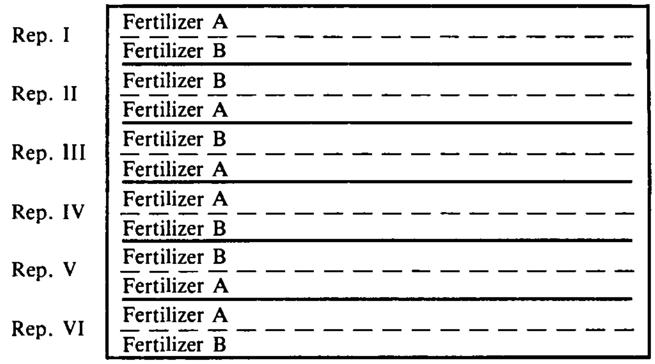

Fig. 1. Description and illustration used in questionnaire to present example of an on-farm experiment design.

the other two groups; however, there were more members in favor of demonstrations (39%) than those who preferred station trials (30%).

The next comparison was made between experiment station trials and on-farm strip plots. All three groups favored strip plots over station trials for usefulness to their farms for comparisons of new agricultural practices (Table 4). There was a significant difference ($P = 0.01$) between the random sample and the PFI members. Fifty-nine percent of the PFI consider strip plots more useful for comparing agricultural practices as opposed to 39% for the random group and 41% for the NSAS. The random sample and the NSAS were not significantly different from each other.

Opinions on an On-Farm Experiment Design

The randomized complete block experiment design is recommended for on-farm research, which uses plots large enough to accommodate standard farm machinery (Rzewnicki et al., 1988; Schmitt and Openshaw, 1988). A two-treatment side-by-side strip plot design randomly arranged and replicated is recommended by the Rodale Institute (Janke et al., 1990). Producers were presented an example (Fig. 1) of a randomized complete block experiment. The example contained two treatments which were replicated six times. Land requirement for such an experiment using 0.40 km (0.25 mile) long strips were mentioned specifically to clarify area needs.

The first question concerning the randomized, replicated experiment (Table 5) was directed toward the willingness of the producers to participate with university staff to conduct such on-farm research. Only 26% of the Nebraska random sample was willing to do so. This was significantly ($P = 0.01$) less than both special interest groups (PFI = 65%, NSAS = 53%).

Eighty-eight random sample respondents wrote an explanation of their negative response to the above question. Nearly 55% of these commented that it was too time

Table 5. Responses of producers to questions regarding willingness to participate or to use an on-farm replicated, randomized experiment design.

	Random	PFI	NSAS
	%		
1. Given some technical assistance from University staff would you be willing to participate in on-farm research trials using this strip plot method?			
Answer	n = 238	n = 88	n = 75
___ 1. Yes, definitely	5	24	13
___ 2. Yes, probably	21	41	40
___ 3. Undecided	34	21	13
___ 4. Probably not	32	11	25
___ 5. Definitely not	9	3	8
X^2	—	44.8**	24.4**
If you selected 4 or 5, please comment why not: ___			
2. Would you be able to contribute time at planting and harvest with the strip plot method?			
Answer	n = 236	n = 87	n = 72
___ 1. Yes, definitely	4	22	14
___ 2. Yes, probably	27	49	43
___ 3. Undecided	26	17	19
___ 4. Probably not	34	9	19
___ 5. Definitely not	10	2	4
X^2	—	45.4**	17.5**
3. If easy-to-follow instructions were available to plan this type of test and calculate results, would you use the strip plot method by yourself to test new ideas on your farm?			
Answer	n = 235	n = 87	n = 72
___ 1. Yes, definitely	4	26	10
___ 2. Yes, probably	33	45	47
___ 3. Undecided	34	16	25
___ 4. Probably not	24	9	13
___ 5. Definitely not	5	3	6
X^2	—	29.2**	9.4**
If you selected 4 or 5, please comment why not: ___			

* Indicates significance at P = 0.01.

consuming or they had no time to participate. The next most frequent reason given by 11% of those giving comments was that it was too much of a "hassle." Another 11% thought it was not applicable to them because of hilly land, contours, or terraces. None of the random sample respondents remarked that too much land was being risked for experimentation. The most frequently mentioned reasons given by nonparticipants of both PFI and NSAS were small farm size, contoured fields, and time.

Responses to the ability of the producers to contribute time were very similar to those of the previous question (Table 5). Thirty-one percent of the random sample indicated they could contribute time for the experiment. Proportionally, the two special interest groups were more than twice as willing as the random group (P = 0.01) to contribute time for participating in an experiment using strip plots.

The last question about the proposed experimental design was used to determine producers' interest in using it for their own on-farm testing if clear instructions were available. Thirty-seven percent (37%) of the random sample reacted positively to the question (Table 5). Responses by the PFI and NSAS were significantly (P = 0.01) more positive at 71 and 57%, respectively.

Two-thirds of 36 comments offered by the random group respondents who gave negative responses indicated that the design was considered too time consuming or the respondent didn't have enough time. Other comments were varied and infrequently mentioned. Comments by the relatively few negative respondents of the two special groups were also varied. Lack of time was the most common reason given about one out of four times.

Table 6. Analysis by age of the 160 random sample respondents who decided yes or no on being willing to participate with University researchers using replicated, randomized on-farm strip plots.

	n = 160	
Age	Yes	No
	%	
20 to 34	6	10
35 to 44	15	13
45 to 54	9	15
55 to 64	7	14
65 or above	1	10
Total	38	62
	X^2 = 14.1†	

† Indicates significance at P = 0.10.

Characteristics of Participants or Potential Users

Comparisons of response frequencies of the random sample group for the questions in Table 5 were made by educational level, age, land area farmed, and percent of land rented. This was done to assess the characteristics of potential participants or users of replicated, randomized designs among the general population of farmers as represented by the random sample of respondents. The X^2 test of association revealed no significant differences by educational level or farm size for willingness (or resistance) to participate in on-farm university research (question 1, Table 5) or to use strip plots for self testing (question 3, Table 5). There was no significant difference by age for self use of the strip plot method. In terms of cooperation with university researchers there was a significant difference (P = 0.10) by age (Table 6). Among respondents 55 yr old and over there were twice as many or more who did not care to participate as those who were willing to try. In the 35 to 44 yr old category there was a slightly higher positive response than negative. All respondents were actively farming.

Differences between those who own all the land they farm and those who rent some land were significant (P = 0.01). Producers who lease land (78% of random respondents) were found to be more willing to do on-farm testing with researchers or to use the strip plot method themselves. Thirty-five percent of renters would probably cooperate with researchers and 37% indicated they would not. Among those who own all their own cropland, only 21% would cooperate and 63% would not.

Forty-four percent of renters would probably use the on-farm strip plot method for their own testing, whereas 25% indicated they would not. Among those who own all their land, the trend is reversed with 44% not willing to use the method and 21% who were. The distribution of renter responses for and against cooperation or using the method themselves was similar whether levels of rented land were low or high.

SUMMARY AND CONCLUSIONS

The results of the study provide a basis for several conclusions. The findings indicate that, in general, three out of four farmers conduct their own on-farm comparisons of new technology with their current systems. These on-farm tests tend to be made on more than 4 ha (10 acres) per comparison.

All three farmer groups expressed very strong support of current university research programs. Experiment station research trials and resulting recommendations were given highly favorable ratings by most of the producers.

The data suggests that in the transfer of technology from experiment station to producer, comparisons which use field-length strip plots have at least twice the farmer support as demonstrations or experiment station type plots. Active producer participation is also recommended because very strong support was shown for developing university-based research programs that incorporate farmer input during the planning stages and on-farm testing as part of the research process.

Demonstration plots located away from experiment stations were considered very useful by nearly all producers. They should continue to be an essential component in the technology transfer process. For comparative studies of practices for farm use, they were preferred well above experiment station plots by the general population of farmers. However, PFI members regard experiment station plots as useful as demonstration plots. This may be a result of this group's experiences and appreciation for replication and randomization.

Over two-thirds of the general population of farmers would not travel more than 48 km (30 miles) to a demonstration site. About the same proportion would not consider a demonstration plot more than 48 km away as providing useful information even if the soil type was similar. These results suggest that extension programs or other educational interests that demonstrate a particular agricultural practice on an area-wide basis should implement plots that are no more than 48 km apart.

Field-length strip plots using randomization and replication are highly favored by farmers who have experience with them such as the PFI. These same farmers demonstrated a very strong willingness to cooperate with university researchers using such designs and to use these designs for their own testing.

The data indicate that members of the NSAS hold a better potential for being collaborators in on-farm research than the general Nebraska farm population. They were more willing to cooperate with university staff and to use randomization and replication for their own testing.

Although the random sample of producers was similar to the special interest groups in advocating on-farm testing as part of a university's research process, only about one out of four would probably cooperate. Using a randomized, replicated design with only two treatments and six replicates was perceived as being too time consuming. In future efforts to seek participation by average farmers, it is recommended that the issue of the producer's time should be given high priority in planning on-farm research.

More than one-third of randomly selected Nebraska farmers would probably use the proposed experimental design, although there has been very little use of the technique by farmers within the state. This positive response is contingent on the providing of easy-to-follow instructions for planning and calculations.

The random group was significantly less educated and larger in farm size than the two special interest groups. However, the demographic analysis of the random group indicated that farmer participation and personal use of randomized, replicated experiments would not be associated with a producer's education or farm size. The data suggest that early participants in the development of university on-farm research programs would more likely be less than 55 yr of age and be among those farmers who rent some of their farm land.

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