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Determinants of Kansas Farmers' Participation in On-Farm Research

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ABSTRACT

On-farm research (OFR) has increased in popularity in the U.S. in recent years due to heightened interest in sustainability issues, the likely decline in resources available for agricultural research, and increasing pressures for accountability and responsiveness to state and local needs. Information relating to OFR was obtained from 431 commercial Kansas farmers. Data were analyzed to determine the degree of OFR being implemented, and three models were estimated to identify which farmer/farm characteristics influenced its implementation. The results indicate that OFR is commonly implemented, and that several farm/farmer characteristics are related to the degree of OFR initiated. It is proposed that to maximize the return from externally initiated OFR, there would be merit in focusing attention on farms/farmers with those characteristics.

Key Words: farmer attitudes, farmer participation, farming systems research, on-farm research, sustainable agriculture.

On-farm research (OFR) conducted or facilitated by farmers will be an increasingly attractive way to conduct agricultural research in coming years in the United States as well as in developing countries (Norman, Frankenberger, and Hildebrand). There are three factors likely to encourage OFR: (*a*) the probability of increasingly limited research funding in the public sector, (*b*) the growing need to justify continued funding through greater accountability and responsiveness to state and local needs (Dobson), and (*c*) the comparative advantage of conducting certain types of research on-farm.

Harnessing the potential power of on-farm trials provides a potentially low-cost way of performing some research on low-input production strategies, fertility techniques, integrated pest management strategies, minor crops, and other farm practices. There is mounting evidence to support the conclusion that if both fixed and variable costs are taken into consideration, then trials on experiment stations are more expensive than those on-farm (Norman, Frankenberger, and Hildebrand). In addition, tangible linkages with some farmers help satisfy the need for accountability and responsiveness to clientele interests. Some have argued that a farmer-driven approach is a more efficient way of developing

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relevant research and extension programs (Norman et al. 1994). This approach relies more heavily on farmers' experiences, management, ideas, and inputs, as illustrated by the Integrated Farming Systems Initiative (Hesterman and Thorburn). OFR is also attractive because it allows some issues to be accommodated more fully than they can be addressed on experiment stations. Sustainable agriculture issues are very difficult to investigate on experiment stations because the issues require a total systems approach that is management and location specific. The conventional station-based approach has been very successful in addressing the needs of highly specialized farms. However, farmer-based research with a strong systems perspective has been perceived to have merit where farmers are more diversified or where there are substantial differences between experiment station yields and farm yields (Norman, Frankenberger, and Hildebrand).

OFR adds another dimension to agricultural research by including issues relating to socioeconomic concerns rather than just considering the biophysical environment, which tends to be the major focus of experiment station research (Norman et al. 1995). Methodologies specifically geared to evaluation of OFR results have received a great deal of attention in recent years (see, e.g., Rzewnicki et al.; Shapiro, Parkhurst, and Krantz; and Hildebrand and Russell). OFR may increase the potential validity of the results to more farmers by evaluating the robustness of the results over multiple farms, representing more heterogeneous production environments than could ever be represented on experiment stations. Thus, the potential exists for making the overall research results relevant to more farmers by targeting specific situations (Hildebrand and Russell).

OFR is not a substitute for experiment station research, but is generally complementary to such work; thus there is a need for both frameworks. However, it may be advisable to concentrate OFR efforts on those farmers who are more committed to the OFR approach—one of the issues toward which this research is directed.

The objective of our study was first to ascertain the degree of experimental research (i.e., OFR) currently undertaken by Kansas farmers. In addition, our investigation was intended to identify the characteristics of farmers who have been more heavily involved in OFR on their farms. This study should provide a better understanding of the amount of OFR that is being undertaken currently, and should help identify characteristics of farms and farm operators that are related to greater commitment to OFR.

Conceptual Framework

The decision of whether to experiment with new production techniques can be considered within the same conceptual framework as any other adoption decision. Farmers will evaluate the expected utility associated with adoption of a new production or marketing technique and will choose the technique (or collection of techniques) that maximizes their respective expected utility. The experimental nature of the adoption decision that is evaluated in this study distinguishes the problem somewhat in that producers will typically choose a subset of their overall production activities upon which to evaluate alternative practices.

Consider a representative farmer who produces a single commodity q, which is sold at price p upon harvest. A range of alternative production techniques is available to the producer. For simplicity, assume that each technique is separable from others, such that the production technologies applied using one method do not affect the productivity of alternative methods. The producer will allocate a bundle of productive inputs among alternative production techniques according to the expected returns and risk associated with each technique. Each technique has unique characteristics that make output uncertain, such that one technique may have an identical expected level of output, but may be much more variable. We assume that the output from each technique is of a homogeneous quality. For simplicity, assume that the expected value of output and the variance (and possibly higher moments) of output associated with production technique i can be represented by a single parameter, θ_i.[1]

Under these conditions, the producer will choose the weights α_i (where $i = 1, \ldots, n$, and $0 \leq \alpha_i \leq 1$) and the level of inputs x_i that determine the level of resources to devote to each alternative production technique. Expected profits are given by:

$$\pi = \sum_{i=1}^{n} pq_i - \sum_{i=1}^{n} C_i(\alpha_i x_i, \theta_i) - v,$$

where $C_i(\cdot)$ is the cost function associated with technique i, q_i is the output obtained from technique i, and v represents fixed costs of production. A Taylor's series expansion of the unknown utility of profits function about the mean of profits yields an expected utility of profits function with the mean, variance, and possibly higher moments of the profit function as arguments. The mean, variance, and higher moments of the distribution of profits in turn depend upon the producer's choice of production technologies, reflected in his or her choice of x_i and α_i and the risk and return characteristics associated with each technology, represented by θ_i. Thus, the expected utility of profits can be expressed as a function of producers' level and allocation of resources, the risk and return characteristics associated with alternative production techniques, and their risk attitudes which are assumed to be summarized by a single risk-aversion parameter ϕ:

$$EU(\pi) = f(\theta_1, \ldots, \theta_n; \alpha_1, \ldots, \alpha_n; x_1, \ldots, x_n; \phi).$$

Maximization of the expected utility of profits, subject to constraints associated with productive capacities and other restrictions, yields a series of expressions relating adoption levels of each alternative technique (α_i) to observable characteristics associated with farm and operator characteristics. In our empirical analysis, we are able to observe only the number of alternatives considered, and not the level of production devoted to each alternative technique. Thus, we will relate the total number of alternative factors adopted on an experimental basis to observable factors relevant to producers' risk attitudes and the structure of production. These factors include education, age, and farm characteristics, such as size, diversification, and cropping intensity.

Data Description

The data were derived from a 1993 survey mailed to all farmers involved in the Kansas Farm Management Association (KFMA) record-keeping system that is implemented through the Department of Agricultural Economics at Kansas State University. The questions that provided the basis for the dependent variables discussed in this article were included in a more wide-ranging study of issues and attitudes relating to crop insurance. Of the 1,963 survey questionnaires mailed, 31.5% were returned. A number of the returned surveys had to be dropped from the sample because of incomplete responses on items of interest to the present study. The final number of responses used in the empirical analysis was 431. Of the respondents, 91% stated that they performed on-farm experiments.

It can be argued that the KFMA farmers are representative of commercial farmers in Kansas. Featherstone, Griebel, and Langemeier found that, when compared to the U.S. Department of Agriculture's (USDA's) stratified farm costs and returns survey data, the KFMA data for 1986 were representative of commercial farming enterprises in Kansas (i.e., more than 500 acres). In the *1992 Census of Agriculture* (U.S. Department of Commerce), the average age of Kansas operators is 53.2 years. This compares to our study's 48.2 to 49.7 years. Freyenberger et al. found no significant differences between the Kansas random sample and KFMA farmers in terms of level of education or number of acres managed. There was no evidence that the 1993 sample of KFMA farmers included in our analysis differed from other farmers involved in the KFMA. This was ascertained through

[1] Note that this implies that the distribution of output associated with each production technique is dependent upon a single parameter, θ_i.

Table 1. Rationalization of Independent Variables in the Regression Equations

Independent Variables	Measurement	Expected Sign	Rationale[a]
Farm and Farm Operator Characteristics:			
Age	Years	–	Within age range of sample, older farmers have less interest in experimentation.
Area farmed	Acres	+	Operators of larger farms (likely to have greater resources) are more willing and able to engage in OFR.
Net income	$1,000 units (mean over previous 10 years)	+	Farmers with higher incomes are more able to engage in OFR. Alternatively, higher incomes represent an innovative tendency, and therefore increased probability of OFR.
Crop efficiency	Crop revenue/variable costs	+	More efficient farmers are likely to be interested and able to engage in OFR.
Debt/asset ratio	Debts/assets	–	A higher level of relative indebtedness is likely to discourage ability and willingness to engage in OFR.
Distance to town	Miles	+	More remotely located farmers are more likely to engage independently in OFR.
Farmer Information Sources and Preferences:			
Education	Years of school	+	Education is likely to encourage positive attitude toward new ideas, the examination of more informational sources, and OFR.
Read farm magazines	Hours per week	+	An enquiring mind through relevant reading is likely to encourage a positive attitude toward OFR.
Market seminar participation	0 = no; 1 = yes	+	Seeking information is likely to imply a positive attitude toward OFR.
Crop consultant use	0 = no; 1 = yes	+	Seeking information implies a positive attitude toward OFR.
Business risk preference	0 = does not; 1 = prefers	+	Reluctance to take risk is likely to imply a negative attitude toward OFR.
Farming System:			
% total acres in crops	(Crop acres/total acres) × 100	+	Because most OFR is related to crops, greater concentration on crops will encourage OFR.
% total acres irrigated	(Irrigated acres/total acres) × 100	–	More controlled production and predictable environment are likely to reduce need for and interest in OFR.

Table 1. (Continued)

Independent Variables	Measurement	Expected Sign	Rationale[a]
Herfindahl index[b]		–	The more diversified the farm is in terms of revenue from crops and livestock-related activities, the more likely the farmer is to be interested in OFR; the reductionist station-based research approach is intrinsically better suited to more specialized farming systems.
Crop diversity index[c]		–	The more diversified the farm is in terms of crops grown, the more likely the farmer is to be interested in OFR; the reductionist station-based research approach is intrinsically better suited to more specialized farming systems.

[a] Rationalization of all variables assumes ceteris paribus conditions.
[b] The Herfindahl index is defined as:

$$\left[\sum_{i=1}^{n} R_i^2\right] \Big/ \left[\sum_{i=1}^{n} R_i\right]^2,$$

where R_i = revenue from crop or livestock enterprise i, and n = number of crop and livestock enterprises. (See Kelly, or Michelini and Pickford for discussion of the Herfindahl index.)
[c] Crop diversity index is defined as:

$$\left[\sum_{i=1}^{n} C_i^2\right] \Big/ \left[\sum_{i=1}^{n} C_i\right]^2,$$

where C_i = acres of crop i, and n = number of crops.

comparing statistics from the sample used in this study (Goodwin and Kastens) with the results for the KFMA as a whole (DeLano). Therefore, we are confident that the KFMA sample does permit valid conclusions to be drawn about the determinants of OFR among conventional farmers in Kansas who farm more than 500 acres.

The relationship between characteristics of farms and farm operators and OFR-related variables was analyzed. Three dependent variables, based on questions asked in the survey, were defined as: (*a*) the frequency with which the farmer experimented with new production methods or inputs per year on average over the previous three years (i.e., 1990–92); (*b*) the number of trials/demonstrations set up by the farmer during the previous three years to try new inputs on a small plot or portion of a herd (i.e., farmer-initiated OFR); and (*c*) the number of trials/demonstrations set up by the farmer during the previous three years in which he/she worked with an outside person(s) (i.e., collaborative OFR).

The 15 independent variables presented in table 1 were selected in an effort to identify the determinants of the dependent variables. The rationale for inclusion of these independent variables and hypothesized directions of their influence are included in the same table. We believe the variables can be classified appropriately into three broad groups. The first group consists of farm and farm operator characteristics. Characteristics of the farm and farmer, in terms of age and economic wellbeing, will likely influence the ability and mo-

Table 2. Statistics on the Variables Included in the Regression Models

	Dependent Variable Concerning Experiments/Trials Over 1990–92					
	Avg. Yearly Frequency of Experimentation		Total No. Farmer-Initiated Trials		Total No. Collaborative Trials	
Variables[a]	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent	2.28	0.67	2.75	2.89	1.28	1.77
Farm and Farm Operator Characteristics:						
Age	49.74	12.20	48.16	12.19	48.47	11.88
Area farmed	1,597.40	1,295.90	1,647.70	1,317.20	1,601.10	1,230.40
Net income	39.46	45.78	38.75	36.55	44.58	53.30
Crop efficiency	1.73	1.60	1.81	1.80	1.78	1.69
Debt/asset ratio	0.43	0.43	0.44	0.46	0.44	0.46
Distance to town	7.68	14.22	8.16	17.29	6.81	4.41
Farmer Information Sources and Preferences:						
Education	14.05	2.08	14.24	2.02	14.37	2.01
Read farm magazines	4.09	3.04	4.18	3.09	4.14	3.21
Market seminar participation	0.69	0.46	0.71	0.45	0.73	0.45
Crop consultant use	0.25	0.43	0.26	0.44	0.28	0.45
Business risk preference	0.26	0.44	0.26	0.44	0.31	0.46
Farming System:						
% total acres in crops	73.5	26.3	73.7	23.7	77.3	23.1
% total acres irrigated	6.25	15.0	6.42	15.3	7.30	15.7
Herfindahl index	0.57	0.20	0.57	0.20	0.60	0.21
Crop diversity index	0.55	0.21	0.54	0.20	0.54	0.20
Sample Size[b]	431		281		151	

[a] Refer to table 1 for definitions of independent variables.
[b] The differences in the sample size reflect the number of respondents who participated in the different types of trials, together with the possibility of many nonresponses with respect to the second and third models. There is no reason to suspect any particular biases since there was considerable similarity in the mean values of the independent variables used in the different models.

tivation to undertake OFR. The second independent variable group consists of variables related to farmer information sources and preferences. Farmers with enquiring minds tend to be more interested in undertaking OFR. This is likely to be influenced by the level of formal education and amount of effort devoted to obtaining information from media, seminars, and other sources, which constitute types of informal education. The third group consists of variables related to the type of farming system. The type of farming system is expected to have a major influence on the prevalence of OFR. Because of methodological problems in implementing OFR relating to livestock (Norman et al. 1995), by default, OFR relating to crops has been much more common. This has been the case in developing countries and also was found to be the case in a recent survey of Kansas farmers (Freyenberger et al.). Thus, farmers who operate farming systems that place relatively greater emphasis on crops are more inclined to implement OFR. Also, a systems perspective is likely to be more important in a more diversified farming system because the reductionist experimental approach emphasized on experiment stations (which is often commodity based) intrinsically fits in better with more specialized farming systems. Information on the values for the variables included in the regression models is given in table 2. The statistics provide no surprises, and generally reflect the characteristics of farms and farming systems that exist in Kansas.

Econometric Methods

Three distinct dependent variables are used to measure on-farm experimentation. The first is the frequency of experimentation. Farmers were asked to indicate, within various ranges, how often they experimented on the farm. The fact that their options were limited to particular ranges (0 times/year, 1–2 times/year, 3–5 times/year, or more than 5 times/year) implies a complete form of censoring. The other two measures of on-farm experimentation included the number of times that farmers set up trials/demonstrations to try new inputs and the number of times the farmer worked with outside persons to arrange experiments.

These variables are nonnegative integers that relate the observed frequencies of experimentation to a number of conceptually relevant explanatory variables. The form of the empirical models is:

$$\text{Prob}(y_t = Y \mid X_t) = f(X, \beta),$$

where $\{y_t = 0, 1, \ldots, N\}$ corresponds to the observed frequency of experimentation. Two approaches to empirically evaluating the relationship are conceivable. The first would be to assume a continuous distribution for the dependent variable (observed frequency) and take account of the censoring of the distribution implied by the fact that negative realizations of the dependent variable are not observed. The second approach would involve the application of integer count data estimators. Continuous distribution estimators do not recognize the discrete nature of the data. The importance of respecting the count data nature of the dependent variable may depend on the problem at hand. Creel and Loomis note that one should be cautious in using normal maximum-likelihood estimation (MLE) techniques to model a count data process for which small values of the dependent variable are common. While a continuous distribution may be reasonable if the dependent variable takes on large values, count data estimators may be more appropriate—because they explicitly acknowledge the discrete distribution of the data. In addition, they restrict positive probability assignment to possible events. Poisson count data estimators have been used in other studies (Hausman, Hall, and Griliches). In the case of the Poisson model, the relationship between the frequency of on-farm experimentation, y_i, and the explanatory variables is assumed to be:

$$\text{Prob}(y_t = Y \mid X_t) = e^{-\lambda_t}\lambda^{\lambda_t}/y_t,$$

where $\ln(\lambda_t) = X_i\beta$.

A limitation of the Poisson regression model involves its assumption that the conditional mean of the dependent variable λ_i is equal to the conditional variance of the dependent variable. In many cases, it might be suspected that the variance of the dependent variable exceeds the mean, a condition known as "overdispersion." Overdispersion is a form of heteroskedasticity and will result in biased maximum-likelihood parameter estimates. Cameron and Trivedi have suggested two regression-based tests for overdispersion in the Poisson regression model. The first test has, as its alternative hypothesis, that the variance is equal to the mean plus some scalar multiple of the mean. The second test has, as its alternative, the case of the variance being equal to some quadratic function of the mean. The tests are conducted in a regression framework by regressing the following variable,

$$z_t = ((y_t - \mu_t)^2 - y_t)/(\sqrt{2}\mu_t),$$

on $g(\mu_t)/(2^{0.5}\mu_i)$, where $g(\mu_t)$ is equal to the conditional mean μ_t in one case, and is equal to the squared value of the conditional mean in the second. The regressions omit a constant term. If parameters on $g(\mu_t)$ are statistically significant using a standard t-test, overdispersion is indicated.

An alternative to the Poisson regression model that allows overdispersion is the negative binomial regression model. The negative binomial regression model assumes that λ_i follows a gamma distribution described by the parameters (γ, δ), where $\gamma = e^{X\beta}$. Following this modification, the expected value of λ_t is equal to $e^{X\beta}$, but the variance of λ_t is equal to the expected value of λ_t scaled up by $(1 + \delta)/\delta^2$. Thus, in the negative binomial model, the variance is equal to $1/\delta$ times the mean. As δ approaches one, the negative binomial model approaches the Poisson specification. The probability model implied by the negative binomial model is:

$$\text{Prob}(y_t) = \frac{\Gamma(\gamma + y_t)}{\Gamma(\gamma_i)\Gamma(y_t + 1)} \times (\delta/(1 + \delta))^{y_t}(1 - \delta)^{-y_t}.$$

In this analysis, we test our empirical models for overdispersion using the tests of Cameron and Trivedi. If overdispersion were absent, the Poisson model would be appropriate. However, as will become apparent below, the results suggested the presence of overdispersion in both count data models, and thus we report estimates obtained from the negative binomial model.

The normal distribution is a good approximation of the Poisson distribution, if the dependent variable can take on relatively large values. Recall that the dependent variable associated with the first model (i.e., the frequency of experimentation) is completely censored in that we are only able to observe a range within which a particular producer's level of experimentation fell. Analysis of the fully censored observations is complicated by the censoring as well as by their integer nature. As noted, the consequences of ignoring the integer nature of count data are minimized when the range of possible values becomes large. In this analysis, the fully censored observations are evaluated using a censored dependent variable estimator that assumes a continuous normal distribution—not unreasonable since the variable is censored at the three levels mentioned earlier. Estimation of grouped dependent variable models is discussed by Stewart. It is certainly possible that the frequency variable could take on values much greater than 5, but we do not see such values here.[2]

Discussion of Results

The results presented in table 3 indicate that seven of the 15 independent variables were related significantly to one or more of the dependent variables. Collinearity diagnostics did not reveal a harmful level of collinearity among the independent variables. According to Belsley, Kuh, and Welsch, a rule of thumb for identifying a collinearity problem is the association of more than 50% of the variance of two or more coefficients with a single high condition index. Five of the 16 condition indices were greater than 10, with the highest being 39.7, but none of these indices were associated with more than 50% of the variance of two or more coefficients. For the statistically significant variables—and in fact for most of the nonsignificant variables—the signs were consistent with expectations (compare tables 1 and 3). Also, for the three different regression models, the same three dependent variables were statistically significant. Three of the four overdispersion test statistics indicate the presence of overdispersion in the count data models. Thus, the parameter estimates were obtained using the negative binomial regression model. Marginal effects for the negative binomial models are given by the product of the expected value of the dependent variable and the parameter estimates. These marginal effects are reported for each variable using the mean values of the predicted dependent variables. In order to permit inferences regarding marginal effects, standard errors were generated by performing a bootstrapping exercise. Under the bootstrapping approach, a large number of pseudo-samples of data with sample size equal to that in the data used for

[2] The data contain a fully censored integer count variable. Thus, there are two problems—censoring and the discrete nature of the data. To address the first, we are ignoring the second. We are aware that inferences may be affected by this assumption. Inferences and interpretation of results for this equation are conditional on these assumptions, and thus should be interpreted with care.

Table 3. Limited Dependent Variable (Grouped and Negative Binomial) Regression Coefficients for Characteristics of Farms Surveyed Regarding Involvement in On-Farm Experimentation

	Dependent Variable Concerning Experiments/Trials Over 1990–92		
Independent Variables	Yearly Frequency of Experimentation	No. of Farmer-Initiated Trials	No. of Collaborative Trials
Constant	3.3725	0.7601	0.9166
Farm and Farm Operator Characteristics:			
Age	−0.0154**	−0.0111**	−0.0194*
Total acres farmed	0.00001	0.00002	0.00004
Mean net farm income	0.0030*	0.0029**	0.0040***
Crop efficiency	−0.0179	0.0067	0.0228
Debt/asset ratio	−0.0952	−0.0795	0.0113
Distance to town	0.0010*	0.0037	0.0072
Farmer Information Sources and Preferences:			
Education	0.0078	0.0439	−0.0012
Read farm magazines	−0.0079	0.0067	0.0226
Market seminar participation	0.7249***	0.3724***	0.3664
Crop consultant use	0.0813	−0.1203	0.2216
Business risk preference	0.0452	0.1116	−0.0086
Farming System:			
Proportion of total acres in crops	0.6377**	0.5336*	0.8396
Proportion of total acres irrigated	−0.0744	−0.1644	0.5638
Herfindahl index	−0.8262**	−0.9155***	−0.9268*
Crop diversity index	−1.2273***	−0.4005	−1.3632**
Summary Statistics:			
Adjusted R^2	0.1015***	0.0511**	0.1738***
t_1 test statistic for overdispersion		3.380***	3.992***
t_2 test statistic for overdisperiosn		0.837	3.141
Mean predicted value of λ		2.7552	1.3793
Estimate of overdispersion parameter δ		0.3544***	0.1524***

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 10%, 5%, and 1% level, respectively. Exact specification of the variables is given in table 1.

estimation were generated by randomly sampling with replacement from the estimation data. For each pseudo-sample, the negative binomial models were estimated and marginal effects were calculated. Standard errors were then calculated from the replicated marginal effects. Table 2 reports the mean marginal effects along with the standard errors. Three-hundred replications were used in the bootstrapping exercise.

The results imply that once the farmer has made the decision to engage in OFR activities, the same factors influence the frequency of such activities and the mode under which they are initiated (i.e., farmer or collaborative). In terms of the group of variables representing farm and farm operator characteristics, two were consistently statistically significant: age of the farmer, and the mean net income in the last 10 years. The significant negative relationship with reference to age is consistent with the results of the survey mentioned earlier, which found that OFR was practiced more by younger farmers (Freyenberger et al.). A survey of Nebraska farmers also found that older farmers were less likely to participate in researcher-replicated, randomized, on-farm test plots (Rzewnicki). The logic for this is not unreasonable, given the notion of the life cycle in which younger people tend to be more innovative, motivated, and energetic, whereas older people become more satisfied with the status quo. Nevertheless, it is important to recognize that risk taking by younger farmers may be inhibited because they have more dependents. However, if done carefully (i.e., on small parts of the farm) and in moderation, OFR does not automatically constitute a high-risk strategy.

The significant positive relationship concerning mean net farm income for the period 1981–90 was expected. Higher income farmers are better able to be flexible and, being relatively successful, are perhaps more predisposed to search for ways to improve their farming system. Distance to town also was correlated significantly with OFR in one of the three regression models, although only at the 10% level. The farther the farm is from the town, the greater is the frequency of experiments/trials. Because of their remote locations, farmers farther away from towns (where experiment stations/fields are usually located) are likely to be more independent in determining what best fits their specific production environment. Distance was not statistically significant in the case of OFR done in collaboration with outsiders, or for farmer-initiated OFR (i.e., number of trials on small plots).

Turning to the group of variables representing the information sources and preferences of farmers, market seminar participation was statistically significant in two models. Such participation reflects farmers' interest in improving their farming operations, which also could be reflected in greater experimentation. It may also indicate a broader perspective of farming in which farmers view both the production and the marketing components as being important in determining the success of the farming enterprise.

The final group of variables that apply to the type of farming system perhaps provides the most interesting results. Only the Herfindahl index, which measures diversification of crop and livestock revenue sources, was related significantly and negatively to all three measures of OFR. This variable, along with the crop diversity index, which measures diversification of crops based on acreage (and which was related significantly and negatively to two measures of OFR),[3] suggests that the more specialized the farm is in terms of revenue or cropping pattern, the less experimentation is undertaken. As indicated earlier, it is quite reasonable to expect that a farmer implementing a relatively diversified farm will have a greater tendency to engage in OFR, since under such conditions the need for a systems perspective is critically important (something that is not easily simulated or assessed in reductionist experiment station-based research). A result of the Freyenberger et al. study indirectly supports this assertion. Most farmers in that study, especially those with an explicit interest in sustainable agriculture, indicated that formal research (i.e., done by researchers) should give more attention to diversified agriculture. The positive and significant coefficient for the variable of proportion of total acres in crops (i.e., active cropland) for two dependent variables indicates that OFR also is related positively to the farm being more heavily involved in crops than in livestock production. As noted earlier, this is hypothesized to relate more to the relative ease of conducting OFR with respect to crops (and soils) than with livestock.

The remaining eight variables were not significant in influencing OFR. The farm and farm operator characteristics that were not related to OFR included total acres farmed, crop efficiency, and debt/asset ratio. Crop efficiency was used rather than total efficiency because of experiences referenced above that OFR is not nearly as common with respect to livestock. Also, the nonsignificance of the debt/asset ratio is interesting in that it was somewhat higher than the general debt/asset ratio which, for Kansas farmers in 1991, was 0.18 (USDA). The level of the debt/asset ratio

[3] In fact, in the Poisson regression model, both variables were also statistically significant in the third measure for OFR.

is not surprising given that the farms in the sample were larger than average in Kansas, and as a result tend to be more highly leveraged (Featherstone, Griebel, and Langemeier). However, in spite of these higher ratios, statistically there was no significant negative influence on the degree of OFR. With reference to the farmer information sources and preferences variables, education level, reading farm magazines, crop consultant use, and business risk variables were not significant. The finding that formal education was not significant may be related to the fact that not a great deal of variation occurred in the level of education of the sample of farmers (table 2). Most had finished high school and had at least some vocational or university training. However, a Nebraska study found no correlation between education and participation in collaborative OFR (Rzewnicki). Finally, the farming system variable that was not related to OFR was the proportion of total acres irrigated.

Summary and Conclusions

The results of this study identify some characteristics of farms that are already involved in OFR. It is likely that experiment station staff and extension staff will be more successful in recruiting cooperation from those farmers who are already involved in such activities. The types of farmers who seem to be more involved in OFR include younger farmers, those with greater incomes, those already participating in marketing seminars, and those who implement more diversified cropping systems with a greater portion of their acreage in crops. We conclude that efforts should be concentrated on increasing OFR participation by working with farmers having these characteristics. These results represent a significant percentage of farmers (the larger farms) in Kansas. OFR is also common among farmers having a strong sustainable agriculture orientation (Norman et al. 1995). Focusing attention of OFR efforts on receptive farmers is important given the increasing importance of OFR in the agendas of institutions in both the private and public sectors.

Our results indicate that OFR is commonly conducted by the farmers surveyed, and that they were more likely to participate in farmer-initiated OFR than they were to work in collaboration with outsiders. Information gleaned from the OFR already in progress could have a more positive influence on agricultural producers if it were formalized and shared across a broader audience with some coordination by experiment station or extension service personnel. The costs and benefits of such an effort should be evaluated given the changes occurring in the agricultural research environment, such as likely constraints on research resources, increasing pressures for accountability and responsiveness to local needs, and increasing interest in sustainability issues. Nevertheless, such a shift will involve some compromises on the part of both researchers and farmers if the benefits of OFR, particularly farmer-initiated OFR, are to be maximized. The issues that require compromises for their resolution are discussed elsewhere (Lockeretz and Anderson; Rzewnicki et al.; Shapiro, Parkhurst, and Krantz; Norman, Frankenberger, and Hildebrand; Norman et al. 1997).

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