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ABSTRACT

The opinions of 1,585 Iowa farmers about 8 emergent agricultural technologies (energy production from feed grains and oils; energy production from livestock waste; genetic engineering research on plants, livestock, and humans; robotics for on-farm use; confinement livestock facilities; and personal computers for farm families) were found to be essentially independent of the respondents' socioeconomic statuses and farm characteristics. The best set of explanatory variables were opinions about science and support for land grant college activities. The more firmly respondents possessed a faith in science to solve society's problems, the greater their support for these third-wave technologies. Given the generally low relationship obtained in this analysis for personal characteristics, farm-firm characteristics, and science orientations, it seems that public acceptance of these technologies is dependent upon yet unidentified factors. Although data were not available in this study, it is suspected that moral and ethical considerations may loom large in the relatively low levels of support received by some of these third-wave technologies and may prove pivotal to both how farmers react to the newer technologies and to the scientific endeavors that create them. (Author/NEC)

FARMERS' OPINIONS ABOUT THIRD-WAVE TECHNOLOGIES[1]

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INTRODUCTION

Much has been written about the structural transformation of U.S. agriculture, especially the expanded size of farm operations. A major source of this transformation has been the rapid diffusion and implementation of new, innovative agricultural technologies. The shift from labor-intensive to capital-intensive operations has had three distinct phases. The first, the "mechanical revolution" was brought about by labor scarcity, demands for greater efficiency, and a desire to reduce the drudgery of pioneer farm life. This phase generally is thought to have begun with Cyrus McCormick's reaper and continued through the early part of the 20th century. This revolution brought about the replacement of human and draft animal power with machines, such as the steam engine and, finally, gasoline-powered tractors.

The second phase of this structural transformation involved the substitution of energy and petro-chemicals for mechanical practices. The petro-chemical revolution began in the 1940's and reached its zenith in the 1970's. During this period, agriculture became highly dependent upon fossil fuels (Perelman, 1977). Key innovations included chemical fertilizer, especially nitrogen, and numerous herbicides and insecticides. Mechanical technologies also became more pervasive and refined, bringing both increased capital and energy intensification in agriculture.

It now appears that U.S. agriculture is on the threshold of a third wave -- a new revolution that will bring further mechanical and capital intensification. Through bio-technology, which permits a restructuring of genetic codes in plants and animals, there undoubtedly are even more dramatic structural changes in store. Nitrogen fixation in corn and other grasses, for example, may greatly reduce the need for chemical fertilizers, thus forcing major adjustments by chemical and fertilizer dealers. Remaking annual crops into perennials may eliminate the need for soil cultivation and reduce soil erosion. Citrus crops are being developed that can withstand cold snaps and cooler climates. The restructuring of genetic codes may make it possible for crops to be adpated to more harsher environments. Of course, an ability to grow oranges in Iowa may also permit Utah to grow corn, suggesting that such terms as the "corn belt" or "cotton belt" may someday be as antiquated as horse collars, neck yokes and bull rakes. Genetic engineering may also undermine the pure-bred livestock industry, relegating the status symbols of cattlemen to white coated laboratory scientists.

Historically, technology has been uncritically accepted as good -- it reduced drudgery and improved productivity. But some of the newest technologies pose numerous and complex ethical issues. Buttel (1985) has identified several questions about the potential adversity of bio-technology and the information age. Increased food production, for example, may be an important societal goal in times of scarcity, but becomes less desirable if there are large surpluses, low prices, and extensive off-farm migration. Robotics, or computer-assisted machinery, may be attractive to some farmers, but given high unemployment rates and a continued substitution of capital investments for labor, it could prove socially dysfunctional by contributing to additional layoffs.

ACCEPTABILITY OF THIRD-WAVE TECHNOLOGIES

Much of the research on farmers' psychological acceptance and adoption of past technologies has utilized the classical adoption-diffusion model (Rogers,1983). An implicit assumption of the model is that innovative technologies are desirable and that the speed of their adoption can be enhanced through knowledge of farmers' decision making processes and behavior. Individual adoption is typically viewed as being voluntary and instrumental to improved economic and social well-being. There is, however, growing evidence that adoption doesn't always reflect positive assessments or psychological acceptance; some technologies are adopted because of external pressures or necessity. Many dairy farmers, for example, were forced to install milk bulk tanks or exit the industry. The required adoption of bulk tanks had nothing to do with whether or not farmers liked the technology. Similarily, the use of chemical herbicides may reflect "reluctant adoption" as some farmers, despite concerns about health hazards and environmental degradation, feel chemical treatments must be adopted to remain competitive. Other examples of reluctant adoption include the use of medicated livestock feeds, because of an absence of companies that sell non-medicated feed, and cross-compliance, which requires farmers to adopt soil conserving practices to be eligible for other government assistance. It may be that some of the newest "third-wave technologies," will afford farmers little option as to their personal adoption; they may have to be implemented to ensure economic survival in farming.

The classical adoption model, as advanced by Rogers (1962, 1983) has shown two major classes of variables to be of importance in explaining farmers' adoption behavior -- personal characteristics and farm characteristics.

It is generally found that farmers who are younger, better educated, with higher incomes and operating larger farms are the most likely to adopt innovative technologies. Consistent with these findings we hypothesized that age, education, income, and farm size would be correlated with farmers' reactions to some third-wave technologies.

A less studied set of variables that were also posited to be associated with farmers opinions about third-wave technologies were their science orientations; that is their "faith in science." It seems that views such as willingness to spend public money for agriculture research, perceived need for science, and positive assessments of the missions of land grant colleges should be positively related to favorable opinions about the newer technologies.

SAMPLE AND PROCEDURES

These data are from a random statewide sample of Iowa farm operators. In the fall, 1984, 1.585 farmers were queried by mail questionnaires about their opinions toward eight new agricultural technologies. Opinions about each technology were recorded on a five-item, Likert scale that ranged from "strongly support" to "strongly oppose" (Table 1).

Technology Assessments

Responses to the eight technologies were subjected to a principal component factor analysis to determine if there were underlying factor structures. Three acceptable factors (eigen values greater than 1.0) were found (Table 2). The three factors were: (1) an "energy factor" that included two items; energy production from feed-grains and oils, and energy production from livestock wastes. Scores on this scale ranged from 2 (strongly oppose) to 10 (strongly support. Cronbach's alpha was .65). (2) A "DNA factor" that included three items about DNA research on animal, plants and humans. Scores on this scale ranged from 3 (strongly oppose) to 15 (strongly support, Cronbach's alpha was .69). (3) A "Hi-tech factor" that included three items about on-farm robotics (computer-assisted machinery), confinement livestock facilities, and personal farm computers. Scores on this scale ranged from 3 (strongly oppose) to 15 (strongly support, Cronbach's alpha .73).

Independent Variables

Three sets of variables -- personal characteristics, farm characteristics and science orientations -- were posited to be correlated with the respondents' opinions of the new technologies. Consistent with previous research, age was predicted to be negatively related to support for these technologies, and education and income were predicted to be positively related.

Farm-firm characteristics included acres owned, total acres operated (acres owned plus acres rented) and gross farm sales. Consistent with previous findings on agricultural innovation, it was predicted that each of these characteristics would be positively associated with supportive attitudes toward the technologies.

The respondents' orientations toward science constituted a third set of independent variables (Table ?). These attitudes were measured by 30 items that were consolidated into seven scales (see appendix).

(1) A "Science $" scale that included four statements about whether more, the same, or less public money should be spent on agricultural science (Cronbach's alpha was .66). Scores on this scale ranged from 4 (less money should be spent) to 12 (more money should be spent).

(2) A four-item scale on the perceived need for more "Animal" research (alpha was .85). Scores on this scale ranged from 4 (much less emphasis) to 20 (much more emphasis).

(3) The perceived need for more "Plant" research was tapped by a six-item scale (alpha was .88). Scores on this scale ranged from 6 (much less emphasis) to 30 (much more emphasis).

(4) A six-item "Resource" scale included opinions about the need for more natural and human resources research (alpha was .84). The scale ranged from 6 (much less emphasis) to 30 (much more emphasis).

(5) "Greater need" for more agricultural science was measured by the respondents' opinions on four statements (alpha was .78). The scale ranged from 4 (strongly disagree) to 16 (strongly agree).

(6) A three-item scale about the "Creativity" of land grant college research (alpha was .68). The scores ranged from 3 (strongly disagree) to 12 (strongly agree).

(7) A three-item scale on the benefits of "Extension." The extension scale had an alpha of .58 and ranged from 3 (strongly disagree) to 12 (strongly agree).

It was predicted that the respondents orientations toward science", as measured by these seven scales, would be positively related to their support of each of the three technology sets.

FINDINGS

As shown in Tables 1 and 2, the third-wave technologies were generally well accepted by the respondents. The least popular technologies were on-farm robotics (opposed by 41 percent), DNA research on humans (opposed by 36 percent), and confinement livestock facilities (opposed by 30 percent). The most popular technologies, supported by over two-thirds of the respondents, were energy production from feed grains and livestock wastes, and DNA research on plants and livestock. Taken as sets, the two energy innovations had the greatest appeal, followed by DNA research and, lastly, hi-technology (Table 2).

It is interesting, especially in light of the general popularity of most of the technologies, that the respondents' displayed considerable hesitancy about endorsing the merits of expanded scientific endeavor, as is shown in the generally low mean scores on each of the seven scientific orientation scales (Table 3). They were especially reluctant to commit more public monies for research, and many expressed reservations about the need for more agricultural research. Perhaps their hesitancy to more fully embrace the scientific enterprise lies in the fact that the economic viability of many farmers has been undermined in the past by scientific advancements that ultimately proved financially expensive and served to speed the exodus of farm families from agriculture.

Tests of the hypothesized relationships of personal characteristics to the respondents' acceptance of the technologies are reported in Table 4. Statistically significant relationships were found for only three of the nine tests. As predicted, age was negatively related to acceptance of two of the technologies -- alternative energy sources and hi-technology. Education was positively related to support for hi-tech innovations. No significant relationships were found for income.

Contrary to expectations, the three farm characteristics displayed little or no relationship to farmers' acceptance of the three technology sets (Table 4). Only total acres farmed and gross farm sales were significantly related in the predicted direction to the "hi-tech" scale, but these relationships were weak.

The science orientations of the respondents proved more powerful than either personal or farm characteristics in explaining the acceptability of these technologies. As shown in Table 5, statistically significant relationships were obtained in 19 of the 21 tests. As expected, persons who favored spending more public money on research were the most supportive of the new technologies. Similarily, those who endorsed greater research emphasis on animals, plants and natural/human resources were also most supportive of the new technologies, although a significant relationship was not found between resource orientation and support of hi-technology.

The more the perceived need for agricultural science the greater the support for the new technologies. Opinions that the agricultural colleges were more creative than private research efforts were also associated with the respondents' endorsements of energy and DNA techologies, but not hi-technology. The posited relationships between commitment to agricultural extension programs and support for the new technologies were fully supported.

Summary and Conclusion

The opinions of Iowa farmers about the eight emergent agricultural technologies were found to be essentially independent of the respondents' socio-economic statuses and farm characteristics. The best set of explanatory variables were opinions about science and support for land grant college activities. The more firmly respondents posessed a faith in science to solve society's problems, the greater their support for these third-wave technologies.

This analysis suggests the need for additional study of factors that shape farmers' opinions about the third-wave technologies. Given the generally low relationships obtained in this analysis for personal characteristics; farm-firm characteristics, and science orientations, it seems that public acceptance of these technologies is dependent upon yet unidentified factors. Although data were not available in this study, we suspect that moral and ethical considerations may loom large in the relatively low levels of support received by some of these third-wave technologies. These considerations, which have been sorely neglected in previous adoption research, may in fact prove pivotal to both how farmers' react to the newer technologies and to the scientific endeavors that create them.

Table 1. Farmers' Opinions About Innovative Technologies.

What are your views about these recent technological developments?

	Strongly Oppose (1)	Somewhat Oppose (2)	Uncertain (3)	Somewhat Support (4)	Strongly Support (5)	Mean Score
			percent			
Energy production from feed grains and oils (E)	1	1	7	34	57	4.4
Energy production from livestock wastes (E)	2	3	16	40	39	4.1
Recombinant DNA research (genetic engineering research):						
on plants (DNA)	2	5	25	42	26	3.9
on livestock (DNA)	4	6	27	43	20	3.7
on humans (DNA)	23	13	35	20	9	2.8
Robotics (computer assisted machinery) for on-farm use (HT)	20	21	28	24	7	2.8
Confinement livestock facilities (HT)	10	20	20	38	12	3.2
Personal computer for farm families (HT)	9	12	26	40	13	3.4

(E) items included in the "energy" scale
(DNA) items included in the "DNA" scale
(HT) items included in the "high technology" scale

Table 2. Summary of Technology Scales

Scale	Number of Items	Alpha	Range	Average Score
Energy	2	.65	2-10	8.6
DNA	3	.69	3-15	10.3
Hi-Tech	3	.73	3-15	9.4

Table 3. Summary of Science Orientation Scales

Scale	Number of Items	Alpha	Range	Average Score
Public money for research Science $	4	.66	4-12	6.6
Agricultural Experiment Station needed future direction				
Animal	4	.85	4-20	9.7
Plant	6	.88	6-30	13.3
Resource	6	.84	6-30	14.3
Land Grant Colleges				
Greater need		.78	4-20	8.5
Creative	3	.68	3-15	8.2
Extension	3	.58	3-15	7.2

Table 4. Relationships Between Personal and Farm Characteristics To Opinions About New Technology.

Characteristics	Alternative Energy Sources	DNA Research	High Technology
	Dependent Variables Mean Scores		
OPERATOR			
Age	(N=1092)	(N=1067)	(N=1054)
Less than 35	9.0)	10.8	11.3)
35-54	8.6)	10.2	9.7)
55 and older	8.5)	10.5	8.7)
Zero order correlations+	-.12**	.02	-.31**
Education	(N=1094)	(N=1070)	(N=1054)
Less than 12	8.4	10.2	8.3)
12	8.6	10.3	9.1)
13-15	8.6	10.5	10.1)
16 or more	8.7	10.8	11.1)
Zero order correlations	.06	.07	.27**
Income	(N=798)	(N=786)	(N=768)
Less than $20,000	8.6	10.3	9.5
$20,000-$49,999	8.5	10.3	9.3
$50,000 or more	8.5	10.6	9.9
Zero order correlations	.01	.02	.04
FARM			
Acres owned	(N=1086)	(N=1060)	(N=1042)
Less than 115	8.6	10.3	9.3
115-196	8.4	10.4	9.2
197-319	8.5	10.3	9.2
320 or more	8.6	10.4	9.7
Zero order correlations	.00	.03	.08
Total acres farmed	(N=562)	(N=548)	(N=543)
Less than 285	8.6	10.2	9.1)
285-438	8.7	10.3	9.8)
439-660	8.7	10.9	10.0)
660 or more	8.6	10.2	10.1
Zero order correlations	.04	.04	.19**
Gross farm sales	(N=1237)	(N=1210)	(N=1190)
Less than $40,000	8.5	10.3	8.6)
$40,000-$99,999	8.7	10.4	9.3)
$100,000 or more	8.5	10.4	10.4)
Zero order correlations	.03	.01	.26**

) denotes statistically significant difference at the .05 level.
* denotes statistical significance $P \leq .05$ level
** denotes statistical significance $P \leq .01$ level
\+ zero order correlations were calculated using uncategorized data

Table 5. Relationships of Science Orientations to Farmers' Opinions About New Technologies

Science Orientation	Energy	DNA mean scores	High Technology
Science $	(N=978)	(N=960)	(N=946)
Low (4-7)	8.2	9.6	7.8
Med (8-9)	8.5	10.4	9.2
High (10-11-12)	8.8	10.7	10.3
Zero order correlations+	.17**	.16**	.32**
Animal	(N=1107)	(N=1087)	(N=1071)
Low (4-12)	8.3	9.8	8.8
Med (13-15)	8.5	10.1	9.4
High (16-20)	8.7	10.9	9.8
Zero order correlations	.14**	.15**	.17**
Plant	(N=1093)	(N=1075)	(N=1056)
Low (6-19)	8.0	9.7	8.4
Med (20-24)	8.5	10.2	9.5
Hi (25-30)	8.9	10.9	9.9
Zero order correlations	.21**	.17**	.19**
Resource	(N=1071)	(N=1052)	(N=1038)
Low (6-19)	8.2	9.9	9.3
Med (20-24)	8.7	10.5	9.5
High (25-30)	8.8	10.6	9.6
Zero order correlations	.20**	.13**	.11
Greater Need	(N=1278)	(N=1246)	(N=1231)
Low (4-12)	8.1	9.2	7.6
Med (13-15)	8.4	10.1	9.3
High (16-20)	8.7	10.8	9.9
Zero order correlations	.19**	.26**	.29**
Creative	(N=1286)	(N=1254)	(N=1238)
Low (3-8)	8.4	9.9	9.3
Med (9-10)	8.6	10.5	9.3
High (11-15)	8.7	10.5	9.6
Zero order correlations	.10**	.11**	.06
Extension	(N=1278)	(N=1247)	(N=1232)
Low (3-9)	8.4	10.2	8.4
Med (10-11)	8.5	10.2	9.2
High (12-15)	8.7	10.6	10.1
Zero order correlations	.10**	.09*	.22**

) denotes statistically significant differences between individual subgroups at .05 level
* denotes statistical significance $P \leq .05$ level
** denotes statistical significance $P \leq .01$ level
\+ zero order correlations were calculated using uncategorized data

APPENDIX

Operationalization of the Science Orientation scales

	Spend Less (1)	Spend the Same (2)	Spend More (3)
Science $ (Cronbach's alpha .66)			
Research on crop and livestock production			
Research on better marketing methods			
Expansion of international markets			
Cooperative Extension programs			

What should be the Experiment Station's emphasis in the next 10 years?

	Preferred change in emphasis				
	Much Less (1)	Some Less (2)	No Change (3)	Some More (4)	Much More (5)
"Animal" (Cronbach's alpha .85)					
Animal breeding and performance improvement					
Animal production facilities					
Improved or new animal products					
Animal health					

	Preferred change in emphasis				
	Much Less (1)	Some Less (2)	No Change (3)	Some More (4)	Much More (5)
"Plant" (Cronbach's alpha .88)					
Plant breeding and performance improvement					
Plant production methods and machinery					
Crop production and management systems					
Soil fertility and fertilizer placement					
Disease, insect and weed control					
New and improved plant products					

	Preferred change in emphasis				
	Much Less (1)	Some Less (2)	No Change (3)	Some More (4)	Much More (5)
"Resource" (Cronbach's alpha .84)					
Soil conservation techniques and systems					
Water supply and quality					
Impacts of weather and climate					
Fish, wildlife and climate					
Nutrition					
Community development					

	Strongly Disagree (1)	Somewhat Disagree (2)	Uncertain (3)	Somewhat Agree (4)	Strongly Agree (5)
"Greater Need" (Cronbach's alpha .78)					
The need is greater than ever for vigorous agricultural research programs at agricultural colleges and universities					
The need for the College of Agriculture is becoming more important than ever					
We should encourage enrollments to increase in the College of Agriculture					
Extension should be providing educational materials to both farm and nonfarm people					
"Creative" (Cronbach's alpha .68)					
Research by private agribusiness firms can never replace the need for University experiment station					
Research at agricultural colleges is years ahead of private industry					
Creative ideas more often come from the university than from private corporations					
"Extension" (Cronbach's alpha .58)					
Extension programs have been very beneficial to my family					
Most of the Cooperative Extension Service's programs complement rather than compete with private firms					
Extension education has responded to the needs of rural America					

References

Perelman, Michael
1977 Farming For Profit in a Hungry World. New York: Allanheld, Osmun.

Buttel, Frederick H.
1985 Biotechnology and genetic information: implications for rural people and the institutions that serve them. The Rural Sociologist (5) 2:68-78.

Rogers
1983 Diffusion of Innovations, 3rd edition. New York: The Free Press.

Rogers, Everett
1962 Diffusion of Innovations. New York: The Free Press.