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ANALYSIS OF SOCIAL, FISCAL, AND STRUCTURAL FACTORS AFFECTING INTEGRATED PEST MANAGEMENT PROGRAMS IN MISSOURI AND IMPLICATIONS FOR FUTURE PROGRAMS TO PROTECT WATER QUALITY

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FINAL REPORT

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Abstract

Integrated Pest Management (IPM) has experienced a resurgence of interest due in part to continuing reports of drinking water contamination by agricultural pesticides. In response to the decertification of certain pesticides used for soil insect control on corn, in the early 1970s federal programs established Cooperative Extension Service sponsored IPM programs in several midwestern States to promote insect scouting on corn and cotton. This report documents the various factors which facilitated the growth and decline of these programs in Missouri and the ongoing transformation of such services into the private sector and other agencies. The objective of this report is to provide policy prescriptions to enhance the future adoption of IPM in Missouri and other areas that will facilitate the protection of water resources.

Research in Missouri regarding pesticide use practices and water quality issues indicates that there is a considerably higher incidence of IPM use in counties that historically had, or still currently have, Extension sponsored programs. Interviews were conducted with University personnel responsible for implementing these programs, county Extension agents responsible for overseeing the programs, private sector businesspeople who are currently offering IPM services, and farm opeators who previously used, and/or now participate in, IPM Extension programs or private services. Interviewees were asked what factors contributed to the success, failure, and/or transformation of the county programs. Results indicate that these factors include quality and turnover of the scouts, committment of the Extension agent, economic and climatological variables, institutional support, and packaging IPM programs with other programs such as irrigation.

INTRODUCTION

There are increasing concerns that the current agricultural production methods are not sustainable and that new methods need to be adopted. Integrated Pest Management (IPM) has an important role to play within a more environmentally friendly agriculture. Beginning with the adoption of the pesticide DDT, agricultural producers have steadily increased their dependence on pesticides (Office of Technology Assessment 1979). This dependence has generated several negative impacts on agriculture. Pests are developing genetic resistances to frequently used pesticides which creates the needs for different chemicals (Dahlsten 1983; Dover and Croft 1986; Guiterrez and Wilson 1989). The relationship between pesticide use and health and environmental issues such as surface and ground water contamination, food safety, pesticide applicator safety, and agricultural field worker safety has come under increased public and scientific concern (Clark et al. 1977; Pimental 1986). IPM offers an alternative to the often indiscriminate, prophylactic chemical treatment of pests (CAST 1982; Flint and van den Bosch 1981).

The U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and Cooperative Extension Service (CES) see the immediate need to implement more holistic pesticide planning and to encourage the adoption of IPM practices that decrease pesticide use and the associated negative environmental and societal impacts. Currently IPM has been adopted on about 50 percent of the crop acres. The Clinton Administration has set a goal that 75% of total crop acres will be using IPM by the year 2000 (Vandeman et al. 1994). To that end, USDA and CES have proposed the "Strategic Plan for Implementation of USDA Integrated Pest Management Initiative" whose goal is to develop local and regional IPM councils that will tailor IPM programs to the needs of local producers.

Stricter regulation of pesticides due to environmental concerns is almost certain to occur in the next few years. EPA has already tightened the requirements for certification as a pesticide applicator, especially regarding restricted use pesticides, and ground water contamination by pesticides above the threshold level in some states indicates that certain pesticides that farmers are currently heavily reliant upon may be further restricted or banned. For example, in Iowa atrazine contamination of ground waters has resulted in the implementation of rules "restricting atrazine application rates in vulnerable areas" (Wintersteen and Higley 1993:10). There are currently several surface water reservoirs in Missouri also being monitored for atrazine contamination. Dramatic increases in pesticide resistance and the possible banning of several existing pesticides due to environmental issues calls into question the continued reliance on the chemical-control approach. These factors will limit farmers' options for managing pests and further substantiate the need for increased efforts in supporting the transition to IPM.

According to Cooley, "While IPM started primarily as a response to pesticide resistance and increasing crop damage, the emphasis in evolving toward environmental concerns" (1993:296). "In fact, IPM is experiencing a resurgence in interest because it is one of the best answers to the present-

day conundrum of reducing chemical contamination of the environment and improving the safety of food while maintaining agricultural viability" (Rajotte 1993:297). According to Leslie and Cuperus, "IPM programs have an outstanding track record of reducing pesticide use, thus ensuring safer food and water and wildlife conservation" (1993:1). "In particular, IPM seems to be the appropriate path to a more environmentally sound future agriculture" (Moffitt 1993:113).

This report presents the results of research in Missouri regarding the historical evolution and current status of USDA established IPM corn and cotton insect-scouting programs. First, a historical context describing the development of these programs is provided. Next, the results of quantitative analysis is used to establish the current level of IPM use in Missouri counties with high susceptibility to ground water contamination by farm pesticides. Then, the results of case study and qualitative analysis of the county corn and cotton IPM programs established in the early 1970s are presented to document the factors which led to the survival, demise, or transformation of these programs. Comparisons are then made between the two programs. Finally, some conclusions and discussion on the policy implications of our research related to water quality protection are presented.

HISTORICAL CONTEXT

IPM has a long history as a pest management system that can effectively minimize pest damage to crops with targeted and often reduced use of chemical pesticides. Many of the components of IPM such (e.g. cultural and biological practices) were developed initially in the field of economic entomology and utilized at the end of the 19th. century and beginning of the 20th century (see Edwards and Heath 1964; Smith et al. 1976; Sweetman 1958). The first efforts at "modern" IPM occurred in the late 1940s when Arkansas initiated scouting programs for cotton (Huckla 1981; Moffitt 1993). With the advent of low-cost effective pesticides such as DDT in the 1940s, the research on, and utilization of, IPM as a management tool declined. Farmers adopted the miracle chemicals because they were cheap, easy to apply, saved them time spent in the fields, and widely toxic to a broad spectrum of pests. The new chemical pesticides were so effective that most farmers simply discontinued their earlier pest control schemes based on IPM.

Farmers and growers' increasing dependence on the chemical control model of pest control suppressed research efforts on IPM and other alternative pest control methods that have less negative environmental impacts (Dahlsten 1983). Although IPM has a history that reaches back to the end of the 19th Century, it was rediscovered in the 1970s by entomologists who were concerned about the negative environmental aspects of pesticides such as DDT (Frisbie and Walker 1989). While IPM has received widespread support in the trade literature, many of its technologies have not been widely adopted (Wearing 1988). IPM requires more management flexibility and is therefore not conducive to the prophylactic "chemical routinism" practiced by many farmers and growers. Producers are often reluctant to change their traditional methods for more "intensive" IPM and continue to rely heavily on

pesticides to control their crop pests (Bottrell 1979; Spencer 1987). Farmers' adoption of IPM usually requires more management, time and labor.

In the early 1970s IPM strategies received substantial funding from the federal government which facilitated the rapid expansion of IPM on cotton and other crops (Apple and Smith 1976; Klassen 1975; von Rumker et al. 1975). In February of 1972 President Richard Nixon outlined his environmental program which encouraged research and implementation of IPM. At the same time the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was modified and the Federal Environmental Pesticide Control Act (FEPCA) was enacted in the early 1970s to increase the regulation of agricultural chemical use, "especially where they may threaten human health and the environment. Thus the need for IPM programs became paramount" (Rajotte 1993:297). Two nationwide projects were funded to support the development of IPM. One project known as the "Huffaker Project" was a multi-agency initiative entitled "Integrated Pest Management: The Principles, Strategies and Tactics of Pest Population and Control in Major Crop Ecosystems". It was initiated in 1972 to ascertain the technical feasibility of IPM and was jointly funded by the National Science Foundation, USDA and EPA. The other project was the implementation of two pilot pest management programs which emphasized scouting for cotton and tobacco in 1971 funded by the USDA. This program was expanded to cover other commodities in 1972, again in 1973, and by 1979, the Cooperative Extension Service (CES) IPM programs were operational in all 50 states and three protectorates with 150 separate programs covering 45 commodities (Blair and Parochetti 1982; Rajotte et al. 1987; Smith 1978; Thomas 1973; von Rumker et al. 1975). The positive conclusions that IPM was feasible generated from the above research led to the Adkisson project in the late 1970s and early 1980s which subsequently became the Consortium of Integrated Pest Management (CIPM) whose purpose was to formulate IPM programs for several major agricultural crops. The CIPM "successfully promoted more efficient pesticide use by encouraging pest scouting and use of threshold decision making ("economic thresholds") for treatment decisions" (Moffitt 1993:115).

In response to the decertification of pesticides such as Aldrin, Dieldrin, and Heptachlor used for soil insects control in corn, in the early 1970s the Cooperative Extension Service in cooperation with the Department of Entomology at the University of Missouri initiated the development of an IPM insect scouting program on corn. Similar programs were initiated in five other cornbelt states. "The overall intent of these programs were to significantly alter present pest control practices for the benefit of the producer" (Huckla 1981:5). In other words, the overall goal was to use insect scouting to guarantee that only fields that needed to be treated were sprayed - this saved money for farmers.

Huckla (1981) documents the early history of the Extension sponsored IPM programs in Missouri from the pilot phase starting in 1973 which included 4 counties, 99 fields, 4270 acres, 2 scouts, and 55 growers through 1979 to the application phase which included 15 counties, 655 fields, 29,982 acres, 15 scouts and 175 growers (**see Figure 1 and Figure 2**). The major Missouri regions participating in the initial implementation of IPM programs were the northwest (Atchison, Buchanan, and Clinton), central (Carroll, Chariton,

Saline, Howard, Boone, and Audrain), and northeast (Lewis and Marion) counties, mostly along the Missouri and Mississippi Rivers, and a tier of counties (Bates, Vernon, and Barton) along the Kansas border south of Kansas City. During the pilot phase, 1973 to 1975, participating farmers were provided cost-free scouting services and the farmers also granted permission to the Extension trained scouts to conduct field-wide surveys for insect pests. During the implementation phase, 1976 through 1979, the farmers incrementally assumed responsibility for the total financial costs of the scouting. In 1979 a IPM program for cotton scouting was also initiated in the bootheel region (Pemiscot, Dunklin, New Madrid, Mississippi, Scott, Stoddard). Of the counties which initially participated in the Extension sponsored corn IPM programs: (1) a few counties still maintain their Extension coordinated IPM programs, (2) the majority of counties no longer have any coordinated IPM program, and (3) some counties' programs have transformed into private sector management (Fairchild 1994; Gentry 1994; Smith 1994; Sorensen 1994; Sobba 1994). The Extension coordinated cotton program lasted only a few years and had transformed into the private sector by the early 1980s although Extension continues to provide training and technical support.

The objective of this research is to document that factors that contribute to the persistance, demise, or transformation of the CES-sponsored IPM corn and cotton scouting programs in Missouri. This research focuses primarily on the corn scouting programs. The cotton scouting programs, which have been more successful in transforming into the private sector, are mainly used for comparison. This research is necessary to enhance the adoption of IPM in Missouri in support of the USDA Integrated Pest Management Initiative. Furthermore, results of this research will be used to inform local, regional, and state policies targeted at pesticide reduction and water quality protection.

RESEARCH METHODS

Two methods are utilized. First, quantitative approaches are used to established the current use of IPM in counties in Missouri with high susceptibility to ground water contamination by farm pesticides. Second, case studies of the corn and cotton IPM programs are used to document the histories of each county program to determine the factors which facilitate survival, demise, or transformation. Unstructured interviews with retired and current Extension agents who worked on CES-sponsored IPM insect-scouting programs on corn and cotton. For the corn program, farmers who participated in these programs, scouts who did the field work, and private consultants were also interviewed.

The Quantitative Component:

Using cluster analysis of cultural and biophysical variables, in previous research we identified Missouri counties most susceptible to groundwater contamination by farm pesticides (Constance and Rikoon 1992; 1993). We conducted our research in 1992 and 1993 in sixteen counties with high vulnerability. The counties chosen for research are indicated in **Figure 3**. Notice that there is considerable overlap between our research counties and

the IPM corn program counties. In our survey instrument, we addressed personal and biographical characteristics; farm operation characteristics; pesticide opinion sources, information needs, preferred information sources, and information conduits; pesticide practices used, discontinued, and planned to use; perceived economic benefits and ease of operational incorporation of pesticide practices; and other issues. We completed a total of 741 person-to-person surveys. We then compared farmers who use IPM and those who do not for selected demographic, farm structural, use of various pesticide practices and attitudes related to pesticide use.

The Case Study and Qualitative Component:

We made contacts with past and current directors of the University IPM programs to establish the historical context for the evolution of the CES-sponsored county programs and to identify the names of the extension agents that worked in those counties. Most of the agents were retired, some were deceased, and a few were still active. These agents were most often agronomists, but some were farm managers and agricultural engineers. For agents who has passed away, interviews were conducted with agents that worked with them. We arranged and taped interviews with agents for each of the counties that had programs. Names of farmers who served on the "farmer IPM boards" were solicited and telephone interviews were made with selected board members. Through this process, the names of certified crop advisors who worked in the region were obtained and interviews were arranged with them.

The interview followed an unstructured format but generally dealt with the following issues:

1) How did the county program get started?

2) How were farmers solicited to participate?

3) What was the structure of the farmer/extension relationship?

4) What was the structure of the scouting system?

5) Is/Was there a relationship between irrigation and IPM participation?

6) Is/Was there an informal "coffee shop" diffusion of information system?

7a) What factors helped to keep the program going?

7b) What factors contributed to the demise of the program?

7c) How did the program transform into the private sector?

8) How did it help the farmers?

9) Could I get the names of some farmers that are in or were in the program?

The interviews with the farmers who were most often members of the county IPM board followed an unstructured format but generally dealt with the following issues:

1) How did you get into the program?

2) What was the organization of the program?

3) How long did you stay in the program?

4) Why did you stay in the program?

5) What contributed to the demise, persistence, or transformation of the program?

The interviews with the certified crop advisors centered around questions related to how they got into the business and what services they offered. Questions about the strengths and weaknesses of the Extension-sponsored programs were also included.

RESULTS

Results are presented in three sections. First, data from the quantitative surveys is presented to establish the current level of use of IPM practices and related issues. Second, we report the results of the interviews with the county agents responsible for oversight of the corn programs. This section includes a summary of the factors which facilitated the persistence, demise, or transformation of the various county programs. Also included in this section is an overview of the views of farmers who participated in the IPM programs and crop consultants who now provide services in the areas where there has been a transformation into the private sector are provided. Finally, section three presents results of research on the implementation and tranformation of the cotton programs is documented.

Section 1: Quantitative Farmer Surveys

While there are too few farmers in the survey who reported that they used IPM in 1992 or 1993 to do valid statistical analyses of differences between those farmers who do and do not use IPM in Missouri, for descriptive purposes we provide comparisons of the two groups to get a better sense of just who the Missouri farmers are who use IPM and how they differ from other Missouri farmers. These tables compare the 14 farmers who used IPM to the 727 who did not use it. **Table 1** illustrates that farmers who IPM tend to have much larger operations (1929 acres compared to 755 acres) and also tend to rent about twice as much land as other Missouri farmers (820 acres versus 392 acres). IPM farmers tend to have a higher crop base and are more likely to use irrigation. Similarly, their corn, soybean, wheat, milo/sorghum and pasture/hay acreages are all substantially larger than their counterparts. IPM farmers also tend to be younger and have higher levels of education.

Data in **Table 2** reveal that IPM farmers are more likely to use a variety of pesticide related practices that could be part of a comprehensive IPM

program. Their increased use of rotations could indicate a proactive effort to limit corn rootworm damage (86% versus 58%). IPM farmers are also more likely to use postemergence options (79% versus 42%), do their own scouting (71% versus 50%), use lower rates of pesticide application (57% versus 31%), use professional scouting (43% versus 7%), utilize split pesticide application (36% versus 14%), band their pesticides (29% versus 18%), use companions crops (21% versus 13%), and use biological controls (21% versus 4%). These results are not unexpected due to the more specialized, large crop operations characteristic of IPM operations and indicate a sophisticated system of crop and pest management.

Table 3 illustrates that Missouri farmers who use IPM tend to like it. They report it as the pesticide practice that had the best financial effect on their operation, was easiest to work into their operation, had done the most to reduce health/safety risks, and they would recommend to other area farmers. For IPM farmers, postemergence options had the worst financial effect on their operations and were the hardest to work into their operations.

Table 4 compares IPM farmers views on pesticide use, natural resource quality, banning, farmer stewardship, and perceived risk to water quality issues with farmers who do not use IPM. Both groups don't think that more pesticide regulations are needed but see them as inevitable. Both groups disagree that farmers use too much pesticides on their cropland, but start to diverge on the issue of pesticide use and natural resource quality. This divergence continues on the issue of banning. IPM farmers are less likely to be concerned about pesticide contamination of natural resources and are less likely to support banning of such pesticides found to in drinking water above EPA standards. Both groups agree that banning harmful pesticides will result in higher food prices with IPM farmers more sure of this outcome. Both groups feel similarly that farmers are relatively good resource stewards and that the general public is overly concerned about water quality issues. While both groups agree that there is too much public attention about the potential harmful effects of pesticides and not enough about their benefits to farmers, IPM farmers feel very strongly that this is the case. Neither groups feels that there is much risk to their drinking water from farm pesticides nor is there much risk to Missouri waters in general. These data reveal that both groups, and especially IPM farmers, exhibit little concern regarding pesticide contamination of natural resources, especially water quality issues. Again, this is not surprising considering that these are in general large operations that frequently use large amounts of pesticides as a common tool of their trade. Indeed, they are economically dependent on this tool to survive economically. Both groups feel that they are good environmental stewards and that stricter regulations are not necessary but are forthcoming. This data seems to indicate a sense of dread on their part that the tools they need to do their job may be taken away from them for unsound reasons.

Section 2: The Corn Programs

Extension Agent Interviews

All but one of the Extension-sponsored county programs started in the later 1970s or early 1980s, the other started in the later 1980s in a county next to an existing program. The director of the University of Missouri IPM program solicited established Extension-agents working in counties with large corn bases to help him hold meetings and discuss the possibility of establishing programs. By 1980 there were 15 counties with programs; by 1995 the number had dwindled to 3. These three programs have about 35 farmers and 8000 acres enrolled. Number of farmers and acres were down because of a cool, wet spring and floods.

All IPM Extension-sponsored programs are coordinated by some form of a "Board of IPM Farmers". Extension oversaw the training of the IPM scouts and handled the bookwork, including paying the scouts. The Board is made up of three to eight volunteers who have acres signed up in the program. The maximum number of acres in a program is about 6000 but most counties had about 2000 to 2200 acres in the program Most of these are corn acres with some milo acres. In the early days of the implementation phase, farmer signed their crop acres at a rate of $1/acre to participate in the program. Currently the fee is from $2.00 to $2.25. The program is a "self-running" - not including the Extension contribution. In other words, the farmers $2/acre fee covers the costs of scouting. On average a full time scout can cover 2000 acres and a part time scout 1000. The scouts are employees of the "Board" and the "Board" decides on the fee per acre and pay per hour for the scout. The scout was originally paid minimum wage and is pay is currently about $5.50/hr. to $6.00/hr. Sometimes a bonus was provided for scouts who finished out the year. The scout must provide their own transportation and liability insurance. They are currently paid .26/mile for mileage costs.

In late winter the Agent often advertises in local medias that it is time to sign up for the IPM program. Fees are paid by a certain deadline. Scouts were advertised for or found by word of mouth. The Agents and members of the Board interviewed the scouts. Most often the scouts were high school students between their junior and senior year and college students. Scouts who are hired are sent to the University of Missouri for IPM training. Scouting starts in April for cutworms (once a week) and continues through August for second generation corn borers and weed populations. Other pests such as army worms, grasshoppers, and white grubs are also scouted. Two or three weed surveys are also carried out. Scouts leave a report for the farmer in a designated place and also report back to the Agent which pests are found and the associated level of the infestation. Scouts are not supposed to give treatment recommendations to the farmers. If there is a problem, the Agent notifies the IPM farmer of the scouting information and indicates whether the infestation has reached the "economic threshold" as established by Extension. Generally, the Agents do not tell the farmers to spray, they just inform them of the pest problem and the level of infestation.

In many areas there was a link between IPM and irrigation program participation; in other areas IPM existed without irrigation. Some Agents packaged the two programs together which allowed for chemigation when a rescue was needed. Farmers who utilized both IPM and irrigation tend to be the progressive farmers that often work with Extension and are willing to investigate options, i.e. the innovators and early adopters. Irrigation increases the cost of inputs but also increases the potential of higher yields. IPM can act as a relatively low-cost insurance policy to protect the greater investment.

There also exists a "coffee-shop" system that diffuses scouting reports through a wider audience which triggers some scouting and spraying. Several Agents indicated that to a certain degree, this is how Extension is designed to work, but showed concern that often farmers do not thoroughly scout their fields. They also commented that a crop plane flying low over a field could trigger a number of farmers' calls to the local agricultural dealer.

Agents report that the success of the existing programs is mainly due to the long-standing relationship between the Agent and his cooperators and the commitment of the "Board" to help keep the program together. Two of the existing programs are associated with older Agents getting near retirement who have been with their cooperators for several years. In the third county, the Agent who originally built the program and linked it to irrigation has recently passed away. This county has a strong "Board" and is contiguous to one of the other existing programs. The new Agent is continuing the IPM program services with the help of the Agronomist in the neighboring county.

The other major contributing factor of success is the quality and oversight of the scouts. Scouts are often teenagers and young adults in high school or college and often require regular diligent oversight to keep the program running smoothly. Scouting is a tough job, especially in the hot summer in tall corn. There is a high rate of turnover; rarely do scouts work more than two years. Furthermore, due to the "school" terms, student scouts cannot report for work until early May for college students and late May for high-school students. This early absence is often made up by the Agent doing the necessary scouting for cutworms. Spring is a high demand time for many Agents and several projects must be balanced. Similarly, the students return to class in late August and are therefore not there for scouting the last corn borer hatch and weed surveys to see what might be the pest problems next year.

Some Agents remarked that they liked the program the size it was and did not go out and beat the bushes for more people. As mentioned above, spring is a time of high demand and other projects require their time. Agents also remarked that the fact that one full time scout could scout about 2000 acres structured the "comfortable" size of some programs. More acres translates into more scouts which equals more time and oversight. Similarly, more acres means more time that the Agent is scouting fields in spring before the scouts come to work.

The quality and oversight of the scouts is also a major factor in the demise of several programs. One bad experience with an inferior scout can be

disastrous for a program. A common scenario is that the first few scouts are good and the farmers get accustomed to a high standard of both technical and social skills. Then a lesser quality scout is hired who is often neither as thorough technically nor as mature socially. When the farmer feels he is not getting what he is paying for, he often drops out of the program.

How much time the Agent has to oversee the scout contributes to the quality of the program. In general these programs were initiated without only one new IPM specialist and limited additional resources and at a time when the structure of Extension was changed from generalist County Agents in each county to "Areas" with specialists such as agronomists, livestock specialists, farm managers, and agricultural engineers in each area. While the agronomist was often best suited to oversee the scouting and make recommendations to the farmers about rescue treatments, sometimes the agronomist was not in the county with the program. More often than not the Agents who oversaw these programs were old County Agents and were therefore generalists and had a wide range of expertise. In some counties, the move to an "Area" system made it harder to keep the programs running.

Another factor that contributed to the contraction of the program is the reduction of funding. For a short while an IPM specialist was funded and placed to oversee four counties. This area was later expanded to seven counties that covered the northwest corner of the state. There was also a statewide IPM staff at the University of Missouri. The long term plan was to have such an IPM specialist in each corner of the state. Due to staffing and funding changes, this plan did not obtain and the IPM specialist was moved back to the University of Missouri. The Agents' move combined with a history of problems with scout quality and a "weak Board" effectively contributed to the termination of all but one of the programs in this area.

As mentioned above, the commitment of the Farmer Board contributes to the survival or demise of the programs. In some areas Board members assist the Agent in a number of ways by finding scouts, interviewing scouts, making calls to get previous cooperators to get signed up and pay their fees, while in other areas this job fell more heavily on the Agent. Technically the scout works for the board but the Agent oversees his/her work. Therefore the combined commitment of the Agent and the Board are crucial in determining whether a program fails or prevails.

For one area that had three programs together, the combination of some bad scouts, several years of drought, and then the farm crisis of the 1980s resulted in the demise of those programs. Some of the larger farmers are contracting with certified crop advisors or scouting themselves. This is one of the examples of the transition to private IPM services. In another area with three counties together, a person who helped set up the county programs and provide technical assistance early in the programs' history set up his own consulting firm and solicited people in the Extension-program to contract with him. One year after this new business started up, two of the Extension-programs were dropped through a mutual agreement between the Board and the Agents. A year later the other program was discontinued. Some of the people that were in the program contracted with the certified crop advisor to scout their acres.

Farmers

Farmers reported that their county programs started because aldrin, dieldrin, and heptachlor were decertified in the 1970s. Several had some outbreaks of cutworms and a new pest had been found in the state, western corn borer. At the same time their local Extension-Agent was seeing if some cooperators would be interested in a corn scouting program. They formed "Boards" and started hiring scouts.

Farmers in the program generally see IPM as spending their money more wisely. All report that they have had to do very little treating or "rescuing" over the years they were in the programs. Scouting often does often "make them" or "save them" money. For example, it costs about $14/acre to treat prophylactically with Lorsban or Counter, but in most years the cost is only $2.00/acre for scouting because no rescue is needed. Several farmers said it is not the money they save or make, but the peace of mine to know someone is watching over the crop. As operations get larger, are made up of owned and rented land, and are spread across a wider geographic it become impossible for farmers to scout for themselves. Similarly, many larger operators follow their corn planing with soybean planting and do not have the time to go back and scout the corn for cutworm, which can decimate a stand in a few days. Several farmers did say that they "save big on chemicals".

Farmers also mentioned that more scouting was needed on no-till land because the extra residue provide habitat for pests. They also mentioned that with the floods of 1993 and 1995, many had cut back on their IPM use because of tight economics. The low price of corn was often mentioned as a barrier to more IPM use on corn.

Farmers in existing programs all contributed the success of their programs to high quality oversight and commitment by their Agents. Statements such as "he would not let it die" were common. A sense of admiration and long term trust was also evident. The main reason given for the demise of their programs was the high variability and turnover of scouts. After a few years in the program farmers could tell if a scout was doing their job or not. They could tell by how long a scout was in a big field or whether there were footprints across a field. There is the example of one farmer who was in an existing program that did not get his corn scouted early for cutworms and lost most of his stand. He dropped out of the program the following year and tried a private consulting firm. He was not satisfied with their services either and now scouts his own corn on his four-wheeler.

Certified Crop Advisors

Two certified crop advisors that offer services in the northern and western areas of the state with large crop bases were interviewed. One was a former University employee that had worked on the development of the original IPM programs and then started his own business. He had been in business for about 12 years. The other has started his business more recently. Both offer a wide range of services including soil and tissue testing which are used to make fertility recommendations and scouting on several crops including corn,

soybeans, milo, and wheat. Field trials for chemical companies were also a source of income. They give recommendations but do not sell the products. The farmer takes their recommendations and goes to the chemical dealer. Both consultants also commented on the wide variety of relationships between farmers and their chemical dealer. They indicated that in many instances the chemical dealers have "knee jerk" reactions to information about pest outbreaks and call their farmers up and tell them they had better spray. One commented that the dealers have a "strong hold on farmers".

To some degree, both see the Extension-sponsored programs as unfair competition. Their services average about $5.00/acre for corn scouting compared to the $2.00/acre for Extension programs. Although most of the old Extension-programs are gone and these consultants are now working in those areas, those programs remaining are in counties with large corn bases. Their businesses have recently been hurt by the floods of 1993 and 1995 which took out large areas of production in the river bottoms.

One of the consultants does all of his work and scouting himself while the other one has a partner and hires scouts. Both commented on the difficulty in getting good scouts and keeping them. This difficulty is the reason why one of them does not hire anyone. Sometimes as soon as a scout has some experience, they start their own business and take some customers with them. As one consultant said, "scouts are a real problem, you don't know what you've got until the season is half-over and then it is too late to change".

In the early 1990s both consultants participated in a federal cost share program which encouraged farmers in five counties to reduce their pesticide usage. The program covered 75% of the cost of scouting. Both consultants obtained some of these contracts and agreed that government money would be best spent on similar programs that provide local demonstrations of how IPM works and can save/make farmers some money. One consultant remarked that in one area "all people except one that I picked up from the program are still using IPM services today" and that the "story is out that it makes money".

In summary, as operations grow larger and are often in multiple locations, farmers do not have the time to scout and keep track of their crops. Often soybean planting follows corn planting and there is no time to go back and scout the corn for cutworms. Farmers have three choices: (1) treat prophylactically; (2) don't treat and listen to pest information sources and then go scout; and (3) pay for a scout. Prophylactic treatment is costly, not treating and not scouting is risky, and scouting is less costly but more risky than treating. Since Missouri is on the edge of the corn belt, our yields are generally lower than surrounding corn belt states. Because the low price of corn in general, farmers are forced to make tough decisions as to what kinds of investments to make in pest management. Scouting has historically only been available through Extension in some of the larger agricultural counties. The number of crop consultants who provide scouting services is now rising. Some agricultural dealers have offered scouting services but in general these efforts "have not pencilled out".

Farmers do like IPM and the Extension-sponsored IPM programs. The surviving programs exists because of a strong commitment by the Agent and the Board to

keep the programs alive. Farmers in the Extension-sponsored programs get their scouting services at about 1/2 the price of private consultants. As long as there is not a disaster, i.e. a major scouting breakdown, the existing programs will likely continue until at least the Agents retire. When the existing Agents do retire, it will depend on the commitment of the Board and of the replacement agent as to whether the programs will continue. In areas where Extension-sponsored programs have been discontinued and other areas with substantial crop bases, crop advisors are offering a variety of services. The quality and oversight of scouts will continue to be a major factor contributing to the success or failure of IPM whether in an Extension-sponsored format or private system.

Section 3: The Cotton Program

Extension Agent Interviews

In 1956 University of Missouri entomologists started training scouts in the bootheel to scout cotton for farmers. This was a natural expansion of the work already being done in Arkansas on cotton. University of Missouri scientists trained the scouts and then the local county agents oversaw the scouts. In relation to other cotton growing areas further to the south, pest pressure in Missouri is relatively light due to the fact that Missouri is on the northern edge of the cotton belt and the short seasons and cold winters suppress pest populations. Still, cotton is susceptible to many more pests than corn and typically requires more chemical treatments. In Missouri, often cotton only had to be sprayed once a year as compared to up to 15 times per year in Mississippi. Cotton was a high value crop and was very amenable to both scouting and spraying to protect that value.

Previous to the infusion of federal money in the early 1970s, an extensive scouting program existed whereby the farmers paid for the full cost of the program, except for the University training and oversight. Entomologists stationed at the Delta Center would hire scouts from mostly Arkansas, Tennessee, and Kentucky because of their better backgrounds in entomology. Most of these scouts were college students. Training would last about a week. First, they would sweep alfalfa to identify the beneficial insects. Then they would go down to Louisiana and Mississippi, where the cotton was already planted and pests were emerging, to do the field training. The first task was "to border the fields" to check for pests moving in from the edges of the fields. The retired Extension agent commented that "after a week living with these boys you would get to know them and could tell who would be a good worker and who would not". After this time the crew would go back to the bootheel and each scout would be assigned an acreage to cover. At that time the local county agent would also participate in the oversight of the scouts.

On average 12 to 18 scouts worked over a crop season. One year in the late 1960s, there were 20 scouts working about 30,000 acres. The farmers paid about $2.00/acre. Scouts were responsible for up to 100 fields which totaled up to 2000 acres. Total acres per scout was less if more fields, and therefore smaller fields, had to be scouted. Scouts were required to cover the fields each week, regardless of weather conditions. In the bootheel,

"those boys (farmers) watch with their glasses (binoculars) to see if the scouts are doing their job"..... "you can't fool nobody" down there.

During this period, i.e. prior to federal dollars for programs, problems with the "college student" character of the scouts were already evident. Often the county agent, or the Delta Center entomologist, had to cover for the scouts early and late in the season when school schedules prevented the scouts from working. The retired agent commented that he "averaged about 17 miles a day of scouting" when he was covering for the college students. This problem would only get worse as the years went on and school started earlier and earlier.

For most of the period prior to the infusion of federal dollars there were no certified crop advisors providing scouting services. In the late 1960s a few of the better scouts who got their college degrees started private businesses and some local chemical dealers also started to hire some scouts to offer IPM scouting services.

After the infusion of federal dollars in the early 1970s, the scouting arrangement changed in the bootheel. This change was largely due to the increased requirements for record keeping. Scouts had to keep more detailed records to be analyzed by computers. This requirement cut down on the number of acres the scouts could cover by about one-half which required that more scouts be hired to monitor the same number of acres. There were some difficulties with this transition. Often the scouts did not like, and were not well qualified to handle, the expanded paper work requirements. Scouts were required to document the field histories of each field. This was a difficult task. Often the farmers were either reluctant to discuss this issue, did not know the field history, or could not remember the field history. The tenant system in place in the region exacerbated these difficulties. The increased number of scouts also added to the oversight requirements and associated personnel managements problems characteristic of larger staffs.

Federal dollars were provided to subsidize the scouting programs for a few years and then, as in the corn program, farmers were weaned from federal support and expected to solely fund the scouting. Initially the fees were about $2.00 per acre and eventually got up to about $4.00 per acre. The scouts were paid minimum wage plus mileage. Scouts reported to both the farmer and Extension agent and the agent made recommendations about rescue treatments. Some farmers allowed the Extension agent to directly order rescue treatments from the chemical dealers. During this time the chemical companies provided training and technical support to Extension related to appropriate chemicals for particular problems.

Eventually the increased data gathering requirements of the federally sponsored program combined with the "college student" nature of the scouts brought an end to the direct Extension involvement in scout oversight. According to a retired supervisor of the cotton program, "You might as well not have it as to have it and then when you really need it, the scouts are all gone to school. And then you go out there and find out that some guys field got eat up two weeks after the scouts went back to school."

Towards the end of the federal program, i.e. the early 1980s, the number of private consultants continued to grow. Often these consultants were previous scouts that had gotten advanced degrees and started their own businesses. Additionally, chemical companies continued to staff IPM scouts and consultants. This transition from Extension-sponsored to private enterprises impacted the use of pesticides. Self-employed consultants and scouts, as well as chemical company employed scouts, tended to use more pesticides than those associated with the Extension programs. Because these people were directly economically dependent on their crop decisions, they could not take as many chances and sprayed more often to guarantee that no pests problems would emerge.

The IPM system in the bootheel today is dominated by a strong core of private consultants. A large percentage of the cotton acres are scouted for between $5.00 to $11.00 per acre depending on the services offered. The consultants or agricultural dealers hire the scouts and the University trains them. Typically there is one granular pesticide application at planing and then one or two foliar sprayings depending on the pest pressure. Mild winters increase the frequency of sprayings because hard winters tend to suppress pest populations.

The large numbers of consultants, who also provide soil testing services and scouting services for other crops such as vegetables, creates a strong competition for growers. Some new consultants often "undercharge" to try to attract growers and get more acreage. This sometimes leads to a situation whereby new consultants acquire more acres than they can handle, get over-extended and their scouts start missing things. .

University personnel working in the bootheel today attribute the success of the private consultants in the bootheel to the historical involvement of the Extension service, especially their role in training the scouts. Due to the continuing problems with college scouts and the emergence of private consultants, eventually Extension stopped offering the sponsored programs and just provided training. "We got out of the business, we were not supposed to compete with the private sector." Today Extension only trains the scouts and provides technical and research back-up; they do not oversee the scouts. Training is equivalent to a 3 hr. college course. and is done in February and March. Individuals pay to take the course and chemical dealers pay to have their scouts trained. Most of the training is for farmers to scout their own fields, or for their sons or nephews.

Farmers with less than 1000 cotton acres can scout their own fields. These farmers also have other crops. It usually pays to pay for scouting on cotton and corn in the bootheel but not for soybeans where you may only have a problem once in 3 to 5 years. Additionally, farmers cannot afford more than $3.00/acre for corn scouting, on cotton they can afford up to $6.00 or $7.00 per acre. Here again, the lower value of corn inhibits the amount of professional scouting than can be contracted for. The higher the dollar value of the crop, the more IPM is feasible.

Extension Agents associated with program both before and after the federal dollars commented that girls/women make better scouts than do men. This was

especially true for "female school teachers about 35 years old ... who are more serious, meticulous, intelligent, and can scout the early and late stuff after school or on weekends."

There has been a steady growth in the use of irrigation in the bootheel area and sometimes chemigation is used for rescue treatments.

CONCLUSIONS AND IMPLICATIONS

The Corn Programs

1) The success of Extension-sponsored IPM corn-scouting programs is primarily a function of the commitment of the Board and the Agent. While this program was initiated without any substantial amount of extra funds or new Agents, some Agents would "not let it die" while others relied more strongly on the Board to keep the program going.

2) The time commitment of the Agent to scout oversight is a crucial factor in the success and demise of these programs. Scouts tend to be high-school or college students and seldom work for more than two years. High time demands on Agents for other program participation forces the agent to manage the amount of time they can contribute to this program.

3) The fact that many scouts are students and cannot report for work early enough and must leave to get back to school in the fall is a major problem for the program. The Agents must do much of the early cutworm scouting and fall scouting for the last corn borer hatch and fall weed populations are often neglected.

4) The reorganization of Extension from a system of County Agents to specialists in an area contributed negatively to the success of these programs. How close a county was to the area agronomist factored into the success or failure of the program. While other Agents such as farm managers and agriculture engineers also managed successful programs, the agronomist was best suited for this job. County Agents were generalists and usually had the range of skills necessary while newer agents in the area system were specialists and often did not have the required range of skills.

5) Other external factors such as floods and drought, the farm crisis of the early 1980s, and the low price of corn have also contributed to the demise of county programs.

6) The transformation of these programs into the private sector is facilitated by the emergence of certified crop advisors in Missouri. While there are several such advisors in the bootheel, there are still few in the northern area of the state. The advent of Extension-sponsored IPM corn-scouting programs has sensitized some farmers to the benefits of IPM and several of these farmers now hire private crop consultants to scout for them as well as provide other services.

The Cotton Program

1) The long history of Extension involvement with IPM on cotton, mostly based out of Arkansas, combined with high value nature of cotton enhanced the early adoption of IPM and the rapid transformation into private sector management. These are the key factors related to the success of IPM on cotton.

2) Similar to corn, the college nature of the scouts hindered the efficiency of the pre-federal dollar system as well as the post-federal dollar programs. The requirement that the local Extension Agent cover for the for student scouts early and late in the season hampered the efficiency of the programs. Although private consultants experience similar constraints, they are better situated to provide full season services.

3) The advent of federal dollars appears to have actually made it more difficult, at least for a period of time, to scout the same number of acres. The increased recording keeping requirements lowered the number of acres individual scouts could cover. Agents expressed some dismay at all the time spent on record keeping with little to show for all the work, as least as far as they could tell.

4) The reduction of Extension oversight might also mean an increase in the use of pesticides. Private consultants tend to use more preventative and rescue treatments to limit pest outbreaks. The heightened competition for acres and the resulting over extension of some consultants exacerbates this problem. In other words, if you don't have the time to cover all the acres, go ahead and spray to make sure there are no disasters.

This research indicates that the cotton programs have been more successful mainly because of their enhanced crop value. Because it is a more valuable crop than corn, farmers are much more willing to protect their investment with IPM. Similarly, the historical development of crop IPM was centered in Arkansas around cotton which provided an existing infra-structure of entomologists working on cotton pests and training scouts.

The implications of this research are valuable for the further adoption of IPM in Missouri. Missouri farmers who use IPM like it, it makes them money. These farmers also tend to be the early adopters or innovators in an area. As farms become larger, the use of IPM is more necessary than ever. The Extension-sponsored programs will probably soon die out on corn as they have already done so on cotton. Extension will continue to provide the training and research back-up necessary for quality IPM systems. Whether farmers will be able to afford regular IPM corn scouting and thereby support a private consultant system in the corn area is yet to be seen. The testimony of the private consultant regarding the recent ASCS cost-sharing program indicates that many farmers who are shown the benefits will continue to use the practice. Such programs should be supported. While IPM has historically "not pencilled out" for agricultural dealers, their role in the adoption of IPM needs to be better researched to enhance IPM use in Missouri.

Finally, this research clearly shows that the reason farmers use IPM is not out of concern for the environment or natural resources. They use it because it (1) saves them money or helps them spend their money more wisely, and (2) gives them "peace of mind" that someone is watching their crop when they don't have time to do it. Attempts to enhance the future adoption of IPM on corn should focus on the economic benefits of IPM primarily and highlight the environmental benefits secondarily. Additionally, the possible trend that private consultants and chemical dealers may use more pesticides than necessary to protect themselves from "disasters" needs to be addressed as the future of IPM moves from an Extension model to a private model.

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TABLE 1 Comparison of Selected Farm Structure and Demographic Variables for Missouri Farmers Who Use and Who Do Not Use IPM

	Farmers Who Use IPM	Farmers Who Do Not Use IPM
Acres Farmed	range 430 - 9500 mean 1929	range 10 - 9200 mean 755
Acres Rented	range 0 - 2120 mean 820	range 0 - 5400 mean 392
Percent of Operation in Crops	85%	65%
Percent of Operation in Livestock	15%	35%
Percent Using Irrigation	50%	19%
Corn Acres	range 165 - 2000 mean 530	range 0 - 3200 mean 168
Soybeans Acres	range 185 - 4500 mean 794	range 0 - 3300 mean 254
Wheat Acres	range 0 - 1050 mean 228	range 0 - 1500 mean 86
Milo/Grain Sorghum Acres	range 0 - 1000 mean 90	range 0 - 2100 mean 32
Pasture/Hay Acres	range 0 - 520 mean 157	range 0 - 2120 mean 123
Education Level Less High School High School Vocational/Trade Some College College Degree Advanced Degree	 0.0% 15.4% 7.7% 38.5% 38.5% 0.0%	 10.1% 52.0% 3.9% 17.7% 13.2% 3.2%
Age	range 36 - 52 mean 44	range 20 - 88 mean 50

TABLE 2 Comparisons of Farming Practices Used in 1992/1993 for Missouri Farmers Who Use and Do Not Use IPM

Practices:	Farmers Who Use IPM (%)	Farmers Who Do Not Use IPM (%)
Change rotations to reduce pesticide needs	85.7	57.9
Rely on postemergence	78.6	42.2
Do own scouting	71.4	50.3
Use rates of application lower than suggested	57.1	31.2
Use professional scouting	42.9	7.2
Split pesticide application	35.7	13.9
Banding pesticides	28.6	17.6
Use companion crops	21.4	12.5
Increased cultivation	21.4	29.8
Biological insect control	21.4	4.0
Use degree days	7.1	6.9

TABLE 3 Evaluation of Financial Effects, Ease of Incorporation into Their Operation, Risk and Safety Contribution, and Possible Recommendation to Other Area Farmers of Missouri Farmers Who Use and Who Do Not Use IPM

	Farmer Who Use IPM		Farmer Who Do Not Use IPM	
Best Financial Effect of Operation	IPM	42%	Rotations	56%
	Rotations	28%	Own Scouting	35%
	Lower Levels	28%	Postemergence	27%
	Pro. Scouts	21%	Cultivation	23%
	Own Scouting	21%	Lower Levels	21%
Worst Financial Effect on Operation	Postemergence	35%	Low Levels	36%
	IPM	14%	Postemergence	35%
	Cultivation	14%	Banding	27%
	Split App.	14%	Cultivation	24%
	Lower Levels	14%	Split App.	24%
Easiest to Work into Operation	IPM	42%	Rotations	58%
	Pro. Scout	28%	Postemergence	32%
	Rotations	28%	Own Scouting	31%
	Low Levels	28%	Cultivation	21%
	Own Scouting	14%	Lower Levels	20%
Hardest to Work into Operation	Postemergence	48%	Cultivation	38%
	IPM	7%	Split App.	31%
	Banding	7%	Postemergence	26%
	Pro. Scouts	7%	Own Scouting	23%
	Rotations	7%	Rotations	21%
Done Most to Reduce Health/Safety Risks	IPM	28%	Rotations	61%
	Pro. Scout	28%	Cultivation	28%
	Low Levels	28%	Low Levels	25%
	Rotations	21%	Own Scouting	24%
	Postemergence	14%	Postemergence	17%
Recommend to Other Area Farmers	IPM	48%	Rotations	63%
	Pro. Scout	48%	Own Scouting	27%
	Rotations	48%	Cultivation	25%
	Low Levels	14%	Postemergence	23%
	Postemergence	7%	Low Levels	22%

TABLE 4 Comparisons of Attitudes Related to Pesticide Use for Missouri Farmers Who Use and Do Not Use IPM

Attitudes:	Farmers Who Use IPM	Farmers Who Do Not Use IPM
Farm pesticide use should be more regulated.	2.00	2.81
Farm pesticide use will be more regulated.	4.36	4.11
Farmers use too much pesticides on their cropland.	2.29	2.57
Less use of pesticides is needed to maintain the quality of our natural resources.	2.29	3.05
Any pesticide found in drinking water at levels exceeding EPA health safety standards should be banned.	2.36	3.31
Banning potentially harmful pesticides will result in higher food prices for consumers.	3.86	3.36
If left alone, most farmers would avoid practices that pollute water resources.	3.21	3.26
The general public is overly concerned about water quality issues.	3.43	3.39
There is too much public attention about the potential harmful effects of pesticides and too little attention to their benefits to farmers.	4.50	3.84
Risk to Missouri Waters from Farm Pesticides**	2.11	2.58
Risk to Personal Drinking Water From Farm Pesticides**	1.79	2.12

Scales: 1 = strongly disagree to 5 = strongly agree;
** 1 = very low to 5 = very high

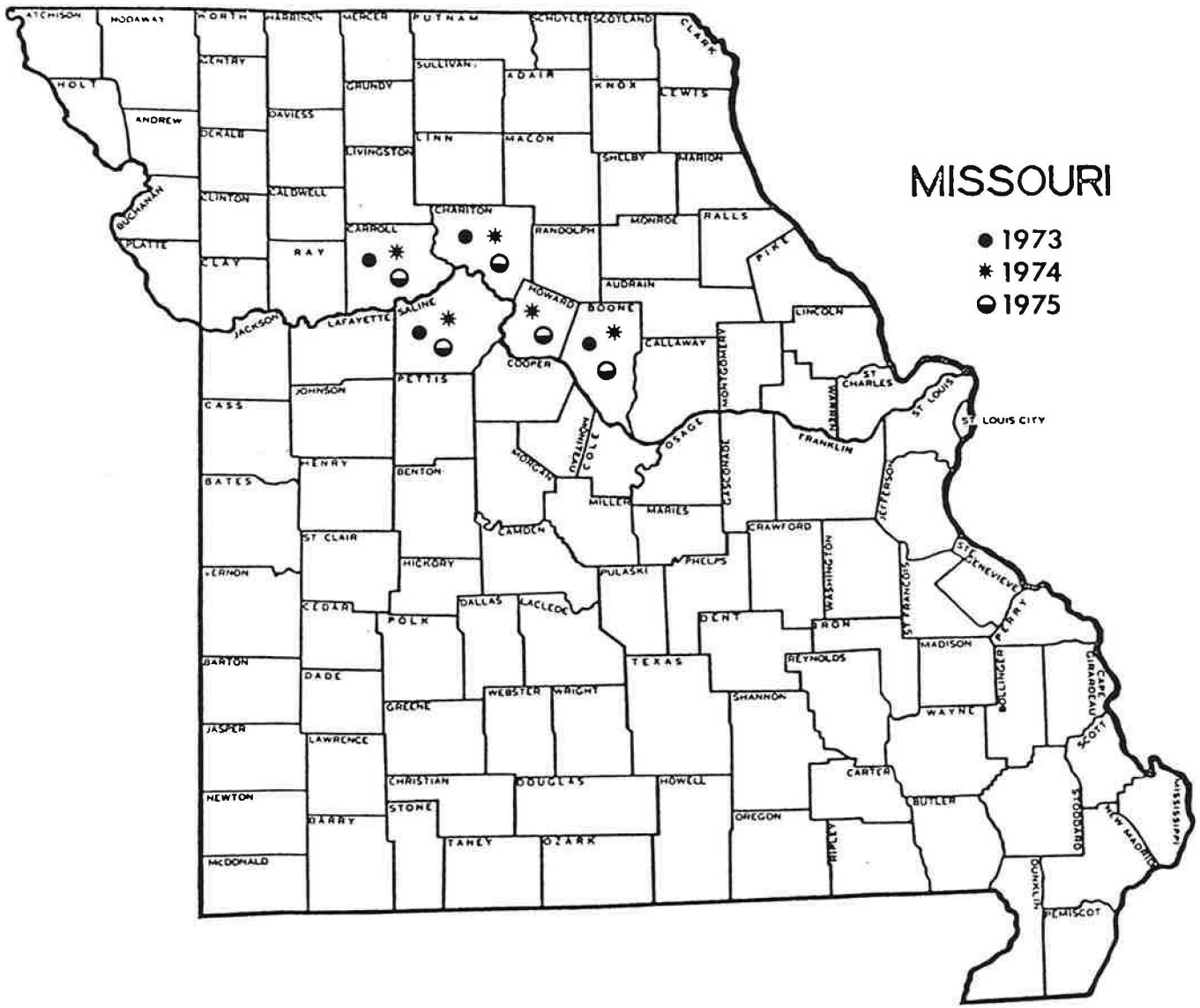

Figure 1 **Counties in the Missouri IPM program during the pilot project phase, 1973-1975.**

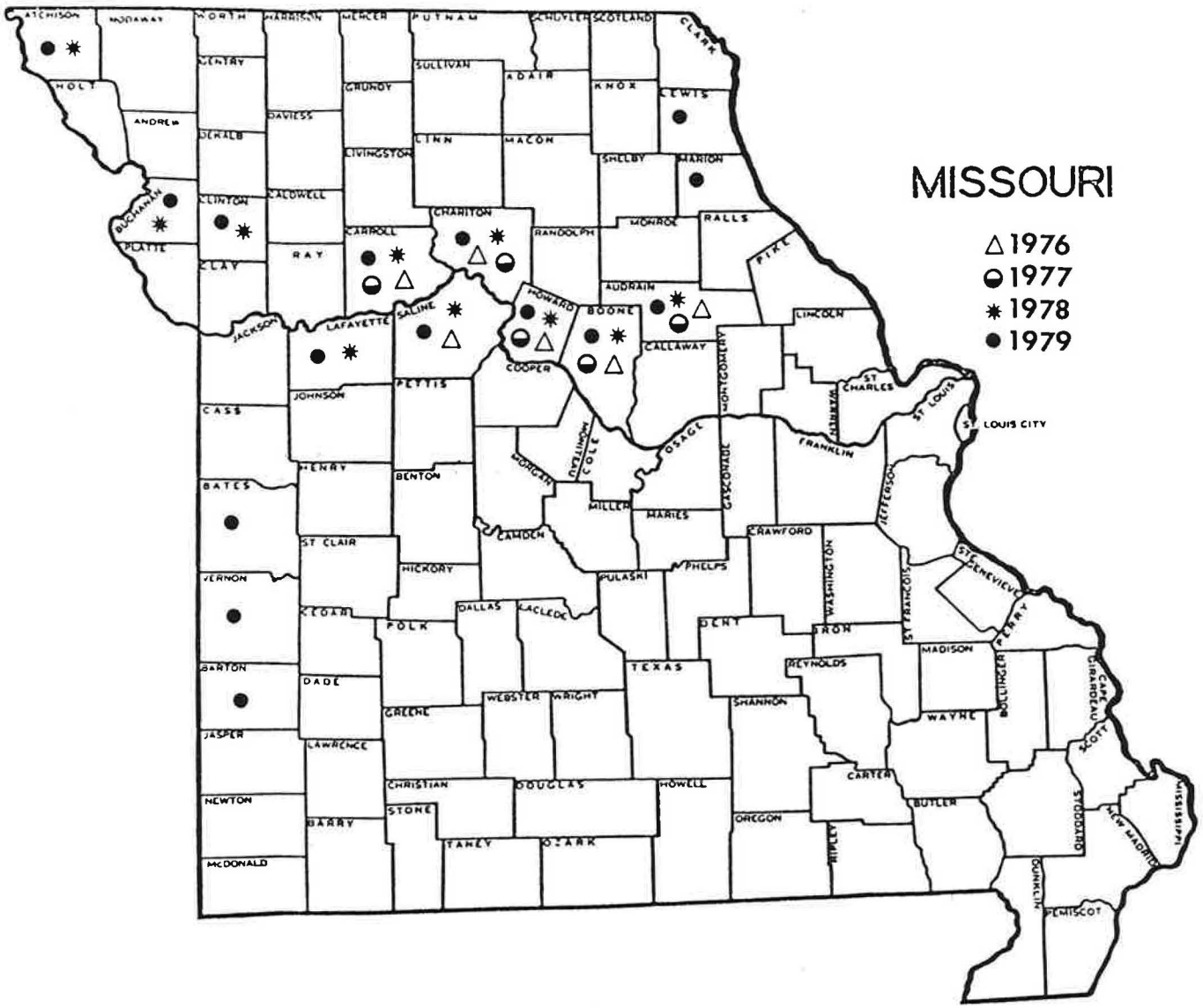

Figure 2 Counties in the Missouri IPM program during the application project phase, 1976-1979.

Figure 3 Quantitative Farmer Survey Research Counties

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To: Melissa Peterson
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From: Douglas H. Constance
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re: submission of final report

Dear Melissa,

Find attached the final report for project No. 4 entitled "Analysis of Social, Fiscal, and Structural Factors Affecting Integrated Pest Management Programs in Missouri and Implications for Future Programs to Protect Water Quality". I want to thank the Center for its support over the past year. I have enjoyed the research and hope that we might work together again someday.

Regards,

Douglas H. Constance

Douglas H. Constance