

Staff Paper

Whether and How to Invest in Site-Specific Crop
Management: Results of Focus Group Interviews in
Michigan, 1996

Scott M. Swinton, Stephen B. Harsh and Mubariq Ahmad

Staff Paper 96-37 (revised 12/97)

June 1996



Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY
East Lansing, Michigan 48824

MSU is an Affirmative Action/Equal Opportunity Institution

**Whether and How to Invest in Site-Specific Crop Management:
Results of Focus Group Interviews in Michigan, 1996¹**

by

Scott M. Swinton, Stephen B. Harsh and Mubariq Ahmad²
swintons@pilot.msu.edu, harsh@pilot.msu.edu

Staff Paper No. 96-37 (Revised)

Department of Agricultural Economics
Michigan State University
East Lansing, MI 48824-1039

June, 1996 (Minor revisions 12/97)

Copyright © 1996 by **Scott M. Swinton**. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

¹The authors acknowledge the financial support of the Michigan Soybean Promotion Committee for this research. The results reflect the opinions and findings of the authors only. We wish to thank MSU Extension field crop agents Rich Hodupp, Natalie Rector, and Brian Ehlert for their thoughtful comments and their help in planning and arranging the meetings reported here. We also thank Gerry Schwab and Sandra Batie for helpful review comments.

²The authors are, respectively, assistant professor, professor, and graduate research assistant in the Department of Agricultural Economics at Michigan State University.

Abstract:

**Whether and How to Invest in Site-Specific Crop Management:
Results of Focus Group Interviews in Michigan, 1996**

How do farmers and agribusinesses decide whether to adopt site-specific crop management (SSCM)? In spite of many agronomic experiments on variable rate fertilizer application, the broader adoption question has received little attention. In order to discuss SSCM adoption issues, five focus group meetings were held with 22 Michigan farmers in early 1996 plus a sixth focus group meeting with 6 agribusiness representatives. This report summarizes results, provides frequency counts of responses, and includes the questions that guided the focus group meetings.

The farmers interviewed were overwhelmingly concerned with profitability and risk of adopting SSCM. Yield monitors were the most widely adopted SSCM technology; several farmers had hired grid soil sampling, but only one farmer had used variable rate input application. Most farmers interviewed viewed grid soil sampling as very costly. They also reported a variety of unexpected, often non-monetary costs due to learning, incompatibilities among software and equipment, and delays in obtaining repairs and spare parts. Although benefits from SSCM were expected rather than realized, both farm and agribusiness managers identified a variety of potential benefits that went beyond the conventional expectations of input cost savings and yield gains. These benefits included carry-over of soil nutrients, off-field data sales, yield risk reduction, cheaper on-farm experimentation, and improved water quality. Most of the farmers believed that yield mapping would provide better information for all-around decision making that would pay off in unexpected ways.

Despite agreement that SSCM data was “owned by the farmer,” respondents differed in instances of rented land (renter vs. landlord ownership). Agribusiness representatives distinguished between ownership of raw data (farmer owned) and data interpretation and analysis (agribusiness owned).

Whether and How to Invest in Site-Specific Crop Management: Results of Focus Group Interviews in Michigan, 1996

“Is site-specific crop management profitable? If it is, how long would it take for an investment to pay off? What conditions determine profitability? Are there important non-financial benefits? What’s the best way to get into site-specific management?”

Questions like these abound among U.S. farmers and agribusiness representatives. Each month farm magazines report case studies of farmers using site-specific crop management (SSCM) practices, but the question remains: “If SSCM is site-specific, will it work for me?” This study targeted farmers and agribusiness representatives in southern lower Michigan. The purpose of the study was to learn about their experiences with SSCM and to find out what information they felt important for farmers who are considering investing in equipment or services to do site-specific crop management.

Site-specific crop management refers to the use of information technology to identify and manage agronomic conditions in space. It is the spatial part of precision agriculture, which also includes such time-dependent practices as pest scouting. SSCM includes all or some of three key components:

- 1) Site-specific agronomic information (usually stored in a geographic information system [GIS] database),
- 2) A means of locating those sites (usually using satellite global positioning systems [GPS]),
- 3) A way to use that information to control variable-rate inputs such as fertilizers while equipment moves across the field (variable rate technology [VRT]).

Yield monitoring, sometimes treated as a fourth area, actually combines the first and second components: It is site-specific yield information linked by GPS to the specific production location.

Focus Group Interviews

Six focus group meetings were held in southern Michigan between late January and early March, 1996. Three were held with farmers having some experience with SSCM, two with farmers interested but inexperienced with SSCM, and one with agribusiness representatives who provided or expected soon to provide SSCM services. The meetings ranged in size from four to seven participants (not counting MSU staff) and were arranged by Michigan State University Extension agents Rich Hodupp, Natalie Rector and Brian Ehlert, who invited participants and arranged for venues.³ The meetings were led by Scott Swinton and Steve Harsh of the MSU Department of Agricultural Economics, with aid from research assistant Mubariq Ahmad.

³Rich Hodupp (meetings in Lapeer on 1/26/96 and 3/4/96 and in St. Johns 2/8/96), Extension Agricultural and Natural Resources Agent, Lapeer County.

Natalie Rector (meetings in Tekonsha on 2/1/96 and 3/6/96), Extension Agricultural Agent, Calhoun and Branch Counties.

Brian Ehlert (meeting in Adrian on 2/26/96), Extension Agricultural and Natural Resources Agent, Lenawee County.

Each focus group session began with introductions of participants and background on the research project. It was explained that these interviews were the first phase of a project to develop a computer program intended to assist farmers in making decisions on whether and how to invest in SSCM equipment and services. The project was financed by the Michigan Soybean Promotion Committee. While it turned out to be largely unnecessary, some background on SSCM was provided to ensure that all participants had a shared basis for the discussion. Each focus group meeting was arranged around a lunch or supper meal. A sample agenda appears in Appendix I.

The focus group discussions were organized around a set of ten to twelve discussion points which were handed out to participants at the beginning of each meeting. Discussion was not limited to the points listed, nor was it forced to follow that order. However, the points were used as a flexible way to ensure that similar issues were discussed at each meeting.

The discussion points for experienced and interested agricultural producers were quite similar (Appendix II). The ones for experienced producers covered:

1. What factors motivated your interest in site-specific crop management technology?
2. How did you become aware of SSCM technologies?
3. What unexpected costs have you encountered in implementing this technology?
4. What have been some of the problems encountered in implementing this technology?
5. What actual benefits have you realized from this technology?
6. What information would you have desired if you were again faced with the decision to utilize or not utilize this technology?
7. Do you have any concerns relative to the data needed to utilize this technology?
8. What is needed to make this technology more useful and effective?
9. What will be your next steps in utilizing this technology?
10. Where do you think Michigan State University can be of greatest assistance relative to this technology?

Questions for the interested (but inexperienced) producers were almost identical, except they deal with expectations.

The questions for agribusiness persons were similar to the ones above (Appendix II), except for omission of question 6 and the addition of three questions:

- What actual benefits have your customers realized from this technology?
- What types of information are needed by your customers to help them decide to utilize or not utilize this technology?
- What concerns do you have with the emerging alliances being formed among the suppliers of this technology and related data sources?

The farmer participants in the focus groups were primarily cash crop producers, with only a couple dairy and other livestock producers (Table 1). All farms were larger than the 198-acre average for Michigan in 1995 (MASS). Farm sizes mentioned ranged from 380 to 3,000 acres.

Focus Group Results

The focus group discussions were largely free-form, prompted only occasionally by questions from the discussion leaders. Consequently, results do not bear comparison as directly as they might if they came from a fixed questionnaire format. Nonetheless, because an effort was made to touch on all discussion points in each meeting, we feel a frequency count of responses gives an accurate reflection of the kinds of responses by participants and their relative importance. These are presented in Tables 3a, 3b, 3c, 3d and 3e. They include frequency counts both of meetings in which a point was made and of individuals who made the point (in all meetings).

Focus group participants experienced with SSCM were mainly experienced with yield monitors. These were primarily yield monitors linked to GPS that recorded yield data on-the-go. However, there was also one farmer with a yield monitor who did not have GPS and simply watched the monitor as he combined his corn. Another farmer had a hopper-counter yield monitor that allowed him to track yields from each hopper full of clean grain. Apart from yield monitors, several farmers had hired grid soil sampling done, but had not yet used that information to apply variable rates of any input. Two farmers had purchased field mapping software; one was mapping results of grid soil sampling while the other was mapping soil types and other major features without any grid soil sampling. The sole farmer who was applying an input at variable rates had one year of experience with a nitrate nitrogen sensor which controlled nitrogen fertilizer application on-the-go and which spatially recorded recommendations and application rates.

Factors that motivated interest in SSCM

The factors that motivated interest in SSCM technology can be loosely organized into agronomic, profitability, environmental, and personal pride motivations (Table 3a). Agronomic reasons were the most widely cited. One farmer summed them up by saying “I want to manage better what I have.” In general, the agronomic reasons mentioned by producers (both experienced and inexperienced) were either: 1) to obtain better data on the cropping program (6 participants at 4 meetings) or 2) to achieve better soil nutrient management or fertilizer use efficiency (4 participants at 3 meetings). The desire to be progressive was cited by members of all three types of groups: interested farmers, experienced farmers and agribusiness representatives (3 participants at 3 meetings). Agribusinesses more frequently cited profitability and business competition as motivators, such as the need to use cutting-edge technologies to achieve business objectives (3 people at 2 meetings) and related ways to create new profit centers in their businesses. Agribusinesses also dominated in mentioning SSCM as a means to reduce potential damage to the environment (3 people). In general, it appeared that better agronomic management was the main motivator for farmers, while profitability and environmental benefits were the main motivators for agribusiness persons.

Three of the growers experienced with SSCM obtained their experience at no cost through a cooperative or consultant who wished to get hands-on experience with SSCM. In one instance, the farmer bought a yield monitor but a consultant analyzed the data at no cost. In another, a cooperative purchased yield monitors for use on four farms and developed yield maps

and also made nutrient maps from grid soil samples; both services were to be billed to farmers at a reduced price (but no bill had yet been received).

How participants became aware of SSCM technologies

Focus group participants became aware of SSCM technologies primarily through trade shows (12 people in 6 meetings) and articles in farm magazines and newsletters (14 people in 5 meetings; see Table 3a). For experienced producers, information supplied by agribusinesses and extension educational meetings was also mentioned. While three agribusiness representatives mentioned using the Internet to keep up with SSCM developments, no farmers mentioned this information source.

Costs: expected and unexpected

When asked about costs, expected (for interested producers) and unexpected (for experienced producers), farmer participants pointed to the high cost of grid soil sampling above all else (9 people in 5 meetings; see Tables 2 and 3b). Their other major concern was the cost of additional equipment (e.g., more powerful computers, monitors, printers) and software upgrades needed to make the new components run (11 growers in 3-5 meetings). For example, growers with yield monitors found that if they wished to analyze their own data, it was not enough to buy a mapping program; they typically found it necessary also to purchase a computer with more random access memory (RAM), a high-quality color monitor, and a color printer. The alternative (or corollary) to buying such additional equipment is to purchase data processing and interpretation services from agribusinesses, an unforeseen cost mentioned by five producers. Another unexpected cost is the \$250-500 annual subscription fee frequently required to run GPS equipment with a differential correction signal (Table 2). (Such signals correct the periodic perturbations in the location signal introduced by the U.S. defense department.) The cost of learning to use the new technology was mentioned by four producers in three meetings (as well as one pair of agribusiness persons in a non-focus group setting).

Although variable rate technology (VRT) was used by only one grower for on-the-go control of variable inputs, three growers cited its high cost. Two agribusiness persons noted that their companies could not justify providing VRT fertilizer spreading with purpose-manufactured applicators like AgChem's Soilection™ spreader until they could be assured of spreading over some minimum area (around 10,000 acres). However, at least one agribusiness was preparing to retrofit a spinner spreader for SSCM application of dry fertilizers.

Indicative costs of SSCM equipment and services that were reported by focus group participants in early 1996 are reported in Table 2. Although two agribusinesses were contemplating offering VRT spreading services, focus group participants were not aware of any being offered in Michigan at that time.

Problems encountered in implementing SSCM

The problems encountered in implementing SSCM elicited more discussion than any other topic (Table 3b). While this topic does not necessarily involve direct costs, it typically entails indirect costs in the form of delays and missed work. Incompatibility of SSCM system components was the lead problem, mentioned at all six meetings as well as one agribusiness site

visit (19 people at 6 meetings). Facets of the problem included incompatibility among software types, backward incompatibility between new and old versions of the same software for a given piece of equipment, hardware incompatibility, and lack of overall system integration. Equipment obsolescence (7 farmers in 3 meetings) is a related problem in that the old equipment is often incompatible with the new equipment or software.

Equipment unreliability was the other problem encountered almost universally (18 people at 6 meetings, as well as agribusiness site visit). Many of the farmers experienced with SSCM had anecdotes about early yield monitors or other equipment that did not function properly or required excessive calibration or adjustment to work correctly. As a result, some farmers found SSCM to be a risky technology in the sense that breakdowns were more likely. Even when equipment functioned as expected, other technical problems surfaced, such as loss of the GPS signal and concern that yield monitors did not calibrate properly at all combine operating speeds.

Linked to the reliability problem were farmers' own mistakes (2 farmers in 2 meetings; 2 agribusiness persons in one site visit). Several cited the significant learning time required to make effective use of SSCM equipment and software (3 farmers in 2 meetings; 2 agribusiness persons in one site visit)--and these were nearly all cash crop farmers who had committed or planned to commit a portion of their off-season to learning about SSCM. Yet farmers complained that reliability and learning problems were aggravated by lack of local vendor support (5 farmers in 3 meetings). This lack of support was indirectly acknowledged by agribusiness representatives who noted the difficulty in becoming proficient at using the new SSCM technologies in the face of rapid technological change and system incompatibilities due to many different manufacturers.

Actual benefits realized or expected

The benefits of SSCM were expected more often than realized (Table 3b). Participants chiefly expected increased yield benefits from a) seed population and variety control (12 people in 6 meetings), b) better lime management to avert herbicide injury (9 people in 5 meetings, notably for soybeans), and c) better control of nitrogen and phosphorus fertilizers (6 people in 3 meetings). Several also cited the potential for cost savings on inputs not needed (4 people in 4 meetings). However, since only one farmer was currently using VRT, few of these input control benefits had been realized.

Many of the farmers felt that a major benefit was simply having better data for decision making (8 farmers in 4 meetings), "to know right where we're at." One cash crop grower from the Thumb who had just ordered a combine with a yield monitor system said, "I don't see how *ever* it would pay you to have a yield monitor, but it could help plan inputs next year." That sentiment was echoed by others who felt that no single big decision would be changed on account of a yield monitor, but who anticipated that the new information would pay off in better decisions over the long term. At least two farmers planned to use their yield monitors to conduct experiments with crop varieties and lime applications. They felt that experimentation would contribute unanticipated benefits from yield monitors due to the ease of collecting yield data without resorting to weigh wagons. Farmers in another meeting appreciated being able to quantify crop losses to wildlife damage along field edges.

Yield monitor owners were mostly willing to wait for three to five years before using their yield information to manage inputs. As one Thumb area grower observed, "you've got to

remember that each year is different -- you can't develop tunnel vision." Some farmers hoped the yield monitor might pay off rapidly from a one-time discovery such as the need to subsoil part of a field to remedy soil compaction or to add drainage tile to improve drainage. Farmers who rented land felt yield monitor data would have value for bidding and negotiating rental contracts with landowners.

Information desired for future investments in SSCM technology

Profitability information was the leading kind of desired information cited by farmers in the focus groups (Table 3b). In the words of the one farmer doing variable-rate nitrogen application, "Technology is great -- it'll do whatever you want so long as you pour in enough money. The trick is to make the money come back to your pocket."

Specific kinds of economic information included a) profitability (6 farmers in 4 meetings), b) costs related to the system (including hardware, software, ancillary costs, learning time) (6 farmers in 3 meetings), and c) economies of scale for making SSCM profitable (4 farmers in 3 meetings). Because the discussions had dwelt so much on unexpected costs and problems associated with SSCM technologies --yield monitors in particular-- farmer participants were especially concerned with accurate up-front assessment of costs.

Producers who were interested in, but inexperienced with, SSCM were especially keen to assess its profitability. Said one Lenawee County grower, "We already know the problem spots in our fields. The new technology may help a bit, but can the benefits justify the costs?" The consensus in one group of growers interested in SSCM was that they would consider adopting yield monitors so long as the cost was less than \$5,000. But that if SSCM technology were too expensive (e.g., \$10,000 to \$15,000) and the payback period was unclear, then they would not adopt. By contrast, the experienced producers seemed to believe that it was the right thing to do regardless of short-term profitability. As noted above, they were more ready to spend time learning and experimenting with it for several years even if it did not pay off promptly. As one Branch County producer put it, "I look at the first year as tuition."

Accurate information was also desired on technical performance; several farmers were concerned about how accurately yield monitors measured yields (6 farmers in 2 meetings). Information on compatibility of system components was mentioned in several ways by six people, and constituted one of the leading suggestions for how Michigan State University could play a useful role.

SSCM data issues: Ownership and accessibility

Discussions about SSCM data revolved around who should own it and how access to it should be managed (Table 3c). There existed a near consensus in all meetings that the farmer owns the data (8 people in 5 meetings). But which farmer had ownership was an issue in the instance of rented land. Some felt that whoever pays for data collection owns the data, so this might be a renter rather than a landlord. One participant cited an example where a landlord had given a special break on rent in exchange for receiving copies of yield maps and/or nutrient maps of a field. Several farmers noted that yield maps could be a valuable tool for determining how much to bid for rent on a field.

Although it was widely believed by both farmers and agribusiness representatives that farmers own the raw data about their fields, a distinction was made between ownership of raw data and ownership of data interpretations. Since many farmers turn to agribusinesses for data processing and interpretation, this distinction is important. “If I make recommendations from data, I own the interpretation,” said one agribusiness representative. Several farmers and most of the agribusiness persons agreed that whoever processes and interprets the data owns the interpretation. Many farmers trusted their data more with independent consultants and farmer-owned cooperatives than with custom applicators or investor-owned input suppliers (9 farmers in 2-4 meetings). Many farmers also wanted to be able to store and use their data on their own farms, rather than have to rely on someone else to process it for them (8 farmers in 2-3 meetings).

Apart from data ownership and use, a few farmers expressed doubts about whether their data would prove a valuable long-term investment. However many others felt strongly that data about their fields had substantial value; also, government access to that data was a serious concern.

What is needed to make SSCM technology more useful and effective?

There was little consensus on steps needed to make SSCM technology more useful. Those items mentioned more than once included the need for local agribusinesses to improve SSCM service (3 farmers in 1-2 meetings), more learning about how to make use of the data gathered (2 farmers in 1 meeting), and more study of how to use and calibrate SSCM equipment effectively (2 farmers in 1 meeting).

Next steps in using SSCM

Among those farmers who did not already own one, the most common next step planned in using SSCM was to buy a yield monitor (5 farmers in 3 meetings; see Table 3d). Three of the experienced farmers planned to buy mapping software to manipulate their data. Four farmers and one agribusiness were ready to buy VRT equipment, including both map-driven VRT spreaders and sensor-based technology for nitrogen fertilizer management. GPS positioning equipment and software was mentioned by two other farmers (although GPS is bundled in with some of the yield monitors as well). Finally, there were farmer participants at both meetings of interested-but-inexperienced producers who were planning to do nothing with SSCM but wait and see how the technologies evolve for a while longer.

Agribusiness-specific responses on SSCM

The discussion points for the agribusiness representatives differed from the farmer ones in three questions (Appendix II, part b). The actual benefits of SSCM obtained by their customers (Table 3e) largely overlap with those cited by farmers (Table 3b). Asked what types of SSCM information they felt farmers needed, the agribusiness representatives responded that farmers should know to begin with a yield monitor and should be ready to grid soil sample every three years, unless fields were very homogeneous. They felt that agribusiness had an important role to play in improving farm information systems and interpreting SSCM data (Table 3e). But they stressed that their businesses live or die by their relationship with farmers, so they respect farmer

ownership of field data and the right to choose the best advisor to interpret the data. Said one Thumb-area agribusiness representative, “We’re just a hired man for the innovative farmer.”

Desired role for MSU relative to SSCM

Asked what role Michigan State University should play relative to SSCM, farmers and agribusiness representatives made a variety of responses. Pooling current information and providing technical advice on SSCM were common themes in most groups. Two farmer groups call for MSU to train farmers, agribusinesses, and extensionists in SSCM so that they can spread the knowledge. Bewildered with the number of different, changing SSCM equipment alternatives available, several farmers called upon MSU to evaluate equipment and software. A related (and more feasible) request was that MSU identify common standards for farmer consumers to follow in purchasing SSCM hardware and software, so as to reduce the risk of incompatibilities. One agribusiness representative recommended more applied research on farmers’ fields, where MSU researchers assist with experimental design and data analysis, letting agribusinesses share in using and interpreting the data.

Summary and Conclusion

Overall, the focus group meetings left a sense that many Michigan farmers and agribusinesses have an intense interest in site-specific management of agronomic crops. Although farmers and agribusinesses experienced with these technologies had found a number of unexpected costs, and although most of the expected benefits had yet to be realized, they were generally enthusiastic about the potential of SSCM to make them better managers. So long as cost is modest, these medium to large-scale cash crop farmers expressed a general willingness to adopt SSCM, at least to begin with a yield monitor. This willingness was particularly common among the younger, better educated members of the farmer groups.

Most farmers, however, were concerned with farm-level profitability and risk (especially risk of equipment incompatibility and obsolescence) with SSCM. Evidence of profitability appeared especially important to interested farmers who had not yet chosen to buy into the new technologies. This trait is consistent with previous research about early versus middle adopters of new technology (Rodgers). Agribusiness representatives supplemented the profitability perspective with concerns about regulatory compliance and environmental benefits.

The ample evidence of unexpected costs and benefits suggests that subsequent research into returns on investments in SSCM should incorporate these along with the standard cash costs and benefits associated with agronomic experiments in variable rate input application. The strong interest in measures of profitability among the farmers interested in (but not yet experienced with) SSCM also implied that there is a need for more thorough assessments of the likely profitability of new investments in these technologies.

Table 1: Key characteristics of businesses represented in focus group sessions (frequency counts).

Characteristic	SSCM-Experienced Farmers	SSCM-Interested Farmers	Agribusiness Representatives
Type of farm: Cash crops Mixed crop-livestock	9 2	11 1	
Acres farmed in 1995	380 to 3000	<500 to 2800	
Agribusiness organization form Cooperative Independent consultant Input supply (investor-owned)			3 1 2

Table 2: Costs of common SSCM equipment and services in Michigan as reported by focus group participants, January-March, 1996.⁴

Item	Cost range reported
<i>Equipment:</i>	
Yield monitor alone	\$3,000 - \$4,000
Yield monitoring system (includes yield monitor & GPS)	
- Satellite-based	\$7,000 - \$9,000
- AM signal-based	\$6,500
Mapping software	\$200-1,200
GIS and mapping software	\$500-1,200
GPS differential correction equipment	\$1,200 - \$3,000
Soil Doctor™ nitrate sensor system	\$11,000
Soilection™ VRT spreader	\$250,000
Retrofit pull-type VRT spreader	\$20,000 - 40,000
<i>Services:</i>	
Satellite/GPS correction fee	\$250-500/year
Yield monitor lease	\$2,500/year for 3 years
Soil testing with GPS	\$4.75 - \$10.00/acre
Mapping with GIS	\$1.00/acre
Yield monitoring	\$1.50/acre
Record keeping	\$1.00/acre
Computer time	\$40.00/hour

⁴For a more current and comprehensive equipment price list, see: Mangold, Grant. "Side by Side: Yield Monitors and Precision Farming System Integrators." **Successful Farming** 94:7(May-June 1996):37-40.

Table 3a: Summary Focus Group Comments on Motivation and Awareness of SSCM (frequency counts).

Question and comments	All farmers		Agribus	TOTAL	
	Farmers Meetings		Reps	People Meetings	
1. What factors motivated your interest in Site Specific Crop Management technology ?					
Means for obtaining better data on the cropping program	6	4	0	6	4
Means to improve soil nutrient mgmt. & efficiency of fertilizer use	4	3	0	4	3
Desire to be progressive/looking for alternative farming method	2	2	1	3	3
Need cutting-edge technology to achieve business objectives	1	1	2	3	2
To meet farmers' needs/create new profit center in company	0	0	1	1	2
Means to reduce potential damage to the environment	1	1	2	3	2
Other	2	2	0	2	2
2. How did you become aware of site specific crop management technologies?					
Trade shows	9	5	3	12	6
Popular press articles (farm magazines, commodity newsletters)	11	4	3	14	5
Information supplied by agribusiness (equipment /fertilizer dealer)	4	2	0	4	2
Educational meetings (MSU Extension)	2	1	0	2	1
Internet	0	0	3	3	1

Table 3b: Summary Focus Group Comments on Costs & Problems, Benefits of SSCM and Desired Investment Information (frequency counts).

Question and comments	All farmers		Agribus.	TOTAL	
	Farmers Meetings		Reps	Peopl	Meetings e
3. What unexpected costs have you encountered in implementing this technology ?					
Soil testing costs	8	4	1	9	5
Added equipment must be purchased (computer upgrades, etc)	5	2	1	6	3
Cost related to upgrading system components	5	2	1	6	3
Need for additional services to make systems functional	5	2	0	5	2
High cost of VRT equipment and software	5	3	2	7	4
Learning costs & equipment calibration time	5	3	0	5	3
4. What have been problems encountered in implementing this technology?					
Incompatible or inflexible software and/or equipment	10	4	9	19	5
Equipment obsolescence	7	3	0	7	3
Equipment reliability (sometimes does not work)	9	5	2	11	6
Technical difficulties	7	3	0	7	3
Learning time needed to effectively use equipment & software	3	2	0	3	2
Too much time spent calibrating yield monitor or making soil map	4	3	0	4	3
Mistakes made & poor understanding of how to use data	3	2	0	3	2
Lack of vendor support/repair problems - lack of trained technician	5	3	0	5	3
5. What actual benefits have you or do you expect to realize from this technology?					
Better data for decision making	8	4	0	8	4
Expect better yields due to fertilizer, lime, seed control, etc.	24	5	5	29	6
Better cost control/Potential cost saving from input	3	3	1	4	4
Less damage to the environment	1	1	1	2	2
Other (experimentation, yield monitor saves need for soil test)	3	3	1	4	4
6. What information would you have wanted before investing in SSM technology?					
Economics benefit/profitability of SSCM (cost and benefit)	7	4	n.a.	7	4
Total system cost (hardware, software, unexp. costs, learning)	6	3	n.a.	6	3
Accuracy of measurement from SSM hardware	6	2	n.a.	6	2
Compatibility of software & equipment over time	8	4	n.a.	8	4
Environmental benefit	2	2	n.a.	2	2

Table 3c: Summary Focus Group Comments on Data Concerns Related to SSCM (frequency counts).

Question and comments	All farmers		Agribus.	TOTAL	
	Farmers	Mtgs.	Reps.	Peopl	Mtgs.
7. Do you have any concerns relative to the data needed to utilize this technology?					
Data ownership: - Farmer should own the data	6	4	2	8	5
- Whoever pays for the collection owns the data	1	1	0	1	1
Sharing data: - Can share it w/ service provider for mutual benefit	1	1	2	3	2
- Provider owns interpretation, farmer owns data	4	1	1	5	2
- Only farmer & indep. consultant should use data	6	2	0	6	2
- Custom applicators & input suppliers can be biased	3	2	0	3	2
- Incompatible software may limit data sharing	0	0	1	1	1
Where data reside: - Data should stay at farmer's place	2	1	0	2	1
- Farmers prefer to use it at home	6	2	0	6	2
Main use of data: - Annual management decisions	4	1	0	4	1
- Making long-term investments	1	1	0	1	1
Adequate skill to manage the large amount of data collected	1	1	0	1	1
Land rental: - Yield potential information will dictate land rents	6	3	0	6	3
- Yield monitor info. could cause mgmt. conflicts	1	1	0	1	1
Government may acquire and use data for tax or env. regulation	2	1	1	2	1

Table 3d: Summary Focus Group Comments on Next Steps with SSCM (frequency counts).

Question and comments	All farmers		Agribus. Reps.	TOTAL	
	Exper- ienced	Inter- ested		People	Meetings
9. What will be your next steps in utilizing this technology?					
Buy yield monitor	1	4	0	5	3
Buy mapping software	2	1	0	3	3
Buy VRT equipment	2	0	1	3	2
Grid soil sampling	1	1	0	2	2
Buy SoilDoctor	1	1	0	2	2
Buy computer	1	0	0	1	1
Buy printer	1	0	0	1	1
Buy scanner	1	0	0	1	1
Buy GPS equipment and software	2	0	0	2	1
Subscribe to remote sensing for continuous field monitoring	0	0	1	1	1
Buy on-the-go weed sensor	0	0	1	1	1
Wait and see	0	2	0	2	2

Table 3e: Agribusiness Focus Group Comments on Questions Specific to Them.

Question and comments	Agribusiness reps.
<p>6. What actual benefits have your customers realized from this technology?</p> <p>Better pH management Better control on seed variety Better control on seed density (population) Better organic matter management Fertilizer saving Better environmental management</p>	<p>2 2 2 1 1 1</p>
<p>7. What types of information are needed by your customers to help them decide whether to utilize this technology?</p> <p>Farmers should know they need to start with a yield monitor 2½-acre grid soil test is necessary every 3 years, unless the soil type is continuous Agribusiness should help farmers set up their data base and fine-tune their operation with data interpretation and recommendations Agribusiness owns the interpretation and recommendation and farmers own the data, so farmers still have full flexibility in choosing consultant Maintaining good relationship with farmers over data use is important for agribusiness</p>	<p>2 3 2 1 1</p>
<p>9. What concerns do you have with the emerging alliances being formed among the suppliers of this technology and related data sources?</p> <p>Flexibility & compatibility among software & hardware should be maintained across alliances</p>	<p>2</p>

APPENDIX I: Sample Focus Group Meeting Agenda and Background Sheet

**Farmer Focus Group on Choosing Whether & How to Invest
in Site-Specific Crop Management**

Scott Swinton, Steve Harsh and Mubariq Ahmad, MSU Ag. Economics
Rich Hodupp, MSU Extension

Agenda

March 4, 1996 (Lapeer)

Introductions of all participants

Background on this research project & consent to participate

Lunch

Background on Site-Specific Crop Management

Focus group discussion on Site-Specific Crop Management

Adjourn meeting

APPENDIX II: Discussion Points Used in Focus Groups with Farmers and Agribusinesses

DISCUSSION POINTS
SITE SPECIFIC CROP MANAGEMENT
(Experienced Producer)

1. What factors motivated your interest in Site Specific Crop Management technology?
 - Cost control to achieve higher profits
 - Increased production to achieve higher profits
 - As a means to reduce potential damage to the environment
 - A method for obtaining better data on the cropping program
 - The need to use cutting-edge technologies to achieve business objectives
 - The desire to be progressive and to project a leader image
 - _____
 - _____

2. How did you become aware of site specific crop management technologies?
 - Trade shows
 - Popular press articles (farm magazines, commodity newsletters)
 - Information supplied by agribusinesses (equipment manufacturer, fertilizer dealer)
 - Educational meetings (extension service)
 - _____
 - _____

3. What unexpected costs have you encountered in implementing this technology?
 - Additional items of equipment you had to purchase (monitors, computer upgrade)
 - Need for additional services to make systems functional (installation fees, purchase of supporting databases, lab fees, licence fees)
 - Cost related to upgrading system components to make the overall system functional
 - _____
 - _____

4. What have been some of the problems encountered in implementing this technology?
 - Amount of learning time needed to make effective use of this technology
 - Mistakes made
 - Equipment reliability
 - Lack of flexibility in the system (software)
 - Lack of overall system integration
 - Equipment obsolescence and lack of vendor support
 - _____
 - _____

5. What actual benefits have you realized from this technology?
- Better cost control
 - Higher yields
 - Less damage to the environment
 - Better data for decision making
 - _____
 - _____
6. What information would you have desired if you were again faced with the decision to utilize or not utilize this technology?
- Costs related to the system (hardware, software, unexpected costs, learning time)
 - Benefits of the system (economic, environmental, others)
 - _____
 - _____
7. Do you have any concerns relative to the data needed to utilize this technology?
- Usefulness of data for management decisions
 - How to manage the large amount of data collected and generated
 - Ownership of the data
 - _____
 - _____
8. What is needed to make this technology more useful and effective
- Additional hardware items (monitors, variable rate applicators)
 - New or better software to better manage and utilize the data collected and generated
 - Better system integration
 - Better service (vendor support, educational programs)
 - _____
 - _____
8. What will be your next steps in utilizing this technology?
- _____
 - _____
9. Where do think Michigan State University can be of greatest assistance relative to this technology?
- _____
 - _____

DISCUSSION POINTS
SITE SPECIFIC CROP MANAGEMENT
(Agribusiness)

1. What factors motivated your interest in Site Specific Crop Management technology?
 - Provide requested service to customers
 - It appears to be a good profit center for the business
 - As a means to expand customer base
 - As a means to tie customers more closely to the business
 - As a means to reduce potential damage to the environment
 - A method for obtaining better data cropping programs for the region
 - The need to use cutting-edge technologies to achieve business objectives
 - The desire to be progressive and to project a leader image
 - _____
 - _____

2. How did you become aware of site specific crop management technologies?
 - Trade shows
 - Popular press articles (farm magazines, commodity newsletters)
 - Information supplied by companies (equipment manufacturers, suppliers)
 - Educational meetings (extension service)
 - _____

3. What unexpected costs have you encountered in implementing this technology?
 - Additional items of equipment you had to purchase (monitors, computer upgrade)
 - Need for additional services to make systems functional (installation fees, purchase of supporting databases, lab fees, licence fees)
 - Cost related to upgrading system components to make the overall system functional
 - _____
 - _____

4. What have been some of the problems encountered in implementing this technology?
 - Amount of learning time needed to make effective use of this technology
 - Equipment reliability
 - Lack of flexibility in the system (software)
 - Mistakes made
 - Lack of overall system integration
 - Equipment obsolescence and lack of vendor support
 - Data not being in digital format
 - Turn-around time of laboratory results
 - _____
 - _____

- 5. What actual benefits have you realized from this technology?
 - More satisfied customers
 - Higher profits
 - Less damage to the environment
 - Larger customer base
 - More tie-in sales
 - _____
 - _____

- 6. What actual benefits have your customers realized from this technology?
 - Better cost control
 - Higher yields
 - Less damage to the environment
 - Better data for decision making
 - _____
 - _____

- 7. What types of information is needed by your customers to help them decide to utilize or not utilize this technology?
 - The type and magnitude of benefits
 - The costs associated with using this technology
 - _____
 - _____

- 8. Do you have any concerns relative to the data needed to utilize this technology?
 - Usefulness of data for management decisions
 - How to manage the large amount of data collected and generated
 - Ownership of the data
 - _____
 - _____

- 9. What concerns do you have with the emerging alliances being formed among the suppliers of this technology and related data sources?
 - _____
 - _____

- 10. What is needed to make this technology more useful and effective
 - Additional hardware items (monitors, variable rate applicators)
 - New or better software to better manage and utilize the data collected and generated
 - Better system integration
 - _____
 - _____

9. What will be your next steps in utilizing this technology?

- _____
- _____

10. Where do think Michigan State University can be of greatest assistance relative to this technology?

- _____
- _____

APPENDIX III: List of SSCM Focus Group Participants

LAPEER, January 26th, 1996: Experienced farmers.

Kendall English	Breckenridge, Gratiot County
Mike Hirschman	Ithaca, Gratiot County
Ron Rodzos	Memphis, Macomb County
Dave Wronski	Smith's Creek, St. Clair County

TEKONSHA, February 1st, 1996: Experienced farmers.

Doug Bloom	Coldwater, Branch County
Eric Hiscock	Climax, Calhoun County
Lane Landis	Homer, Calhoun County
Doug Myers	Marshall, Calhoun County

ST. JOHNS, February 8th, 1996: Agribusiness representatives.

Chuck Baldwin	Star of the West, Bay City, Bay County
Rob Blackwell	Vigoro, St. Johns, Clinton County and Pompeii, Gratiot County
Jim Bollencher	Star of the West, Bay City, Bay County
Ralph Leach	Terra International, Frankenmuth, Saginaw County
Neil Miller	Agri Business Consultants Inc., Brighton, Shiawassee County.
Keith Schwark	Southern Thumb Coop, Lapeer County

ADRIAN, February 26, 1996: Interested farmers

Matt Carpenter	Adrian, Lenawee County
Jeff Ehlert	Blissfield, Lenawee County
Mitch Knierim	Jasper, Lenawee County
Lois Mason	Blissfield, Lenawee County
Gary Service	Clinton, Lenawee County
Lee Uloth	Jasper, Lenawee County
Jason Woods	Deerfield, Lenawee County

LAPEER, March 4, 1996: Interested farmers.

Jim Dorr	Birch Run, Saginaw County
Dennis Esper	Richmond, Macomb County
Chris Grekowicz	Harbor Beach, Huron County
Bill Hunt	Davison, Genessee County
Bob Nelson	Lapeer, Lapeer County

TEKONSHA, March 6, 1996: Experienced farmers.

Chris Donbrock	Coldwater, Branch County
Ed Groholski	Burlington, Calhoun County
Jerry Hubbard	Union City, Branch County
Scott Simington	Union City, Branch County
Gordon Wuethrich	The Gordy Wuethrich Co., Adrian, MI

References cited

- Lowenberg-DeBoer, J. and S. Swinton (1995). "Economics of Site-Specific Management in Agronomic Crops." *Staff Paper 95-62*, Department of Agricultural Economics, Michigan State University, East Lansing, MI. (Subsequently published in F.J. Pierce and E.J. Sadler, eds., *The State of Site-Specific Management for Agriculture*, Madison, WI: ASA-CSSA-SSSA, 1997, pp. 369-396.)
- Michigan Agricultural Statistics Service (MASS) (1995). *Michigan Agricultural Statistics 1995*. Michigan Department of Agriculture and U.S. Department of Agriculture National Agricultural Statistics Service, Lansing, MI.
- Rodgers, Everett M. (1983). *Diffusion of Innovations*. 3rd edition. New York: Free Press.