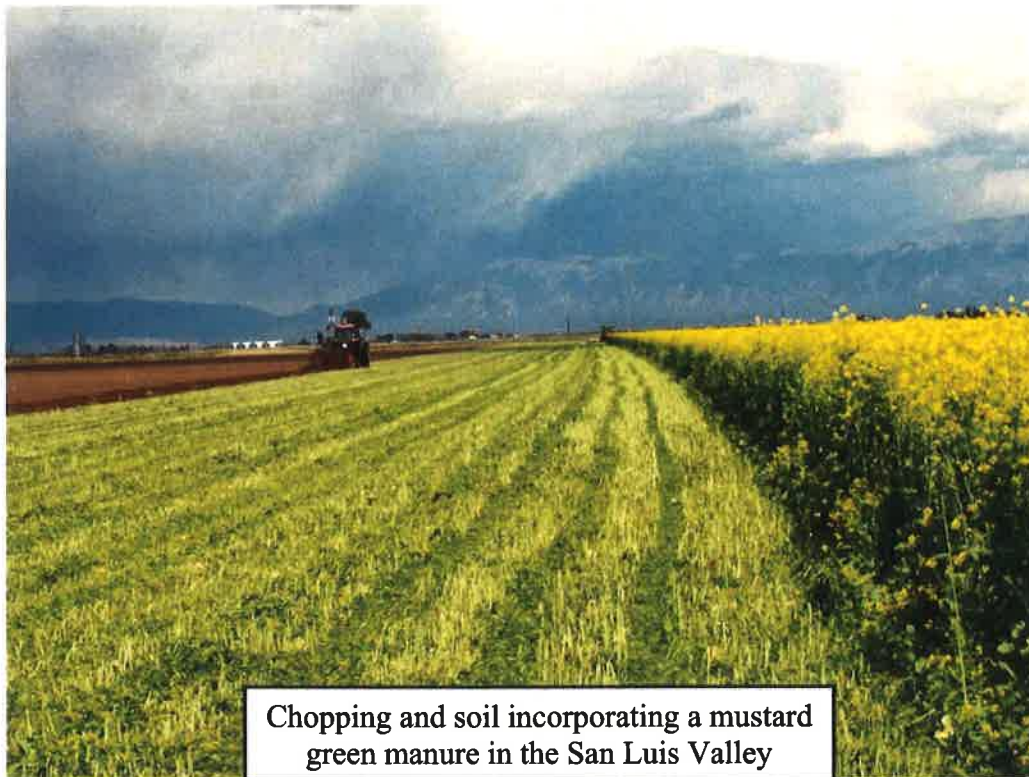


2009



Chopping and soil incorporating a mustard green manure in the San Luis Valley

San Luis Valley of Colorado

Management Practices Potato Producer Survey Report

Conducted as part of the EPA-Funded Study:

“Reducing Pesticide Use in Potatoes by Using Biocontrol Crops and Compost Tea”

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EXECUTIVE SUMMARY

As part of the EPA-funded study “Reducing Pesticide Use in Potatoes by Using Biocontrol Crops and Compost Tea”, a survey of San Luis Valley potato growers was conducted in the summer and early fall of 2009. The Colorado Potato Administrative Committee assisted with survey call distribution and announcement among the organizations 176 members. A total of 41 participants provided survey information, allowing for statistical summary of current production practices, future production practices, and motivations for and against the adoption of a variety of “green” practices including application of compost tea, growing green manure and winter cover crops, and conservation tillage.

The survey findings indicate that the respondents are a diverse group in terms of operation size in acres, gross income, and groundwater pumping. Uniformly, producers had significant farming experience (an average of 30 years). Most producers are late middle-age with an average age of 51 years. Diversity of demographics enriches the survey findings and allows for cross-sectional analysis of survey results.

Collected information on current production practices indicates that all respondents have recently engaged in at least one “green” practice. Conservation tillage is observed most commonly with 81% of the sample claiming regular usage. Nearly 64% of respondents planted green manure crops, 25% planted winter cover, and 22% applied compost tea to their fields. Notably, more than 40% of survey respondents engaged in two or more “green” production activities.

Changes in production practices between 2008-2004 are documented and indicate that the number of growers planting green manure crops, winter cover crops, and using conservation tillage has generally increased over time. Likely adoption rates over the next three years are highest for conservation tillage and lowest for compost tea application.

Grower motivations for and against adoption of each of the four “green” practices are tracked and summarized. In general, the addition of soil organic matter and reduction of soil erosion ranked highly as important motivations for adoption across all practices. Uncertainty of benefits, costs, and unfamiliarity with the method are noted as significant impediments to adoption and imply a potential role for research on cost vs. benefits and grower education to reduce information asymmetries and to potentially improve adoption rates.

SOIL FUMIGANT SALES OVERVIEW:

In the San Luis Valley potato growing-region of Colorado, Telone and Vydate are both used to control nematodes. Vydate additionally works to control some insects including the Colorado potato beetle. Many versions of Telone also work to control soil diseases such as fusarium, verticillium, phytophthora, and others. Two area chemical dealers were contacted for comments on sales trends of Telone and Vydate.

Dale Becker of Schall Chemical, located in Monte Vista, supplies a large volume of the Vydate applied to potatoes in the area. Over the last five years, Mr. Becker believes that sales of Vydate insecticide/nematicide have increased slightly. Last year in particular, sales were up due to a delay in Dow's production of Telone.

Chris Sittler of Stone's Farm Supply in Center, Colorado commented on Telone sales trends. According to Mr. Sittler, Valley sales of the nematocide were negligible in 2009 owing to a near total lack of supply. Telone is manufactured using byproducts of the automobile production process. The decline of automobile production in the U.S. in 2008 and 2009 resulted in a significant lack of Telone production inputs. Dow-Tech, the fumigant's manufacturer, opted to halt production until more raw supplies became available. It is anticipated the Telone will again be available for purchase and application during the 2010 season.

Although 2009 was an anomalous year for Telone sales, according to Mr. Sittler, purchased volumes do fluctuate significantly from year to year in response to the previous year's potato prices. Precise sales figures in terms of volume and dollars were not made available due to proprietary concerns. Mr. Sittler does not feel that Telone purchases have been affected by adoption of "green practices" and that sales fluctuations over his tenure as a Dow representative, are entirely a function of economics. If an operation is profitable in the previous year, sells certified seed, and anticipates good prices in the coming year, the grower will purchase Telone. Mr. Sittler contends that the product is viewed by many users to be a "luxury" item and one that has a niche market, namely certified seed growers and any growers that export product to Mexico.

In Mr. Sittler's opinion, substitutability between Vydate and Telone is limited and a "band-aid" or "short-term" solution. Valley growers had little choice but to apply Vydate to impede transfer of corky ringspot via nematode vectors during the 2009 season. However, according to Mr. Sittler, Vydate serves only to slow down nematode growth as opposed to eliminate the vector altogether, in contrast to Telone's ability to eradicate the nematodes completely. Mr. Sittler cited research out of the Pacific Northwest that indicates successively increasing amounts of Vydate are needed to control nematodes over time. In light of Vydate's limitations and the high cost of Telone, Mr. Sittler feels that the market for both products will remain limited in the future and Telone, in particular, will continue to be a desired, though mainly niche product in the years to come.

SURVEY BACKGROUND

An online and paper survey of San Luis Valley (SLV) potato producers was conducted between June 5th and August 30th 2009. The first phase of the data collection began with widespread distribution of postcard invitations to participate in the online survey. Postcards were printed at Colorado State University and shipped to the office of the Colorado Potato Administrative Committee (CPAC) in Monte Vista. Once received, CPAC staff addressed and distributed the mailing to member-growers. Two postcards mailings were distributed prior to the final mailing of printed surveys and cover letters to the target population. CPAC hosted a link to the survey-monkey.com online survey for the duration of the collection period and short calls for participation were included in two separate CPAC newsletters. Finally, printed surveys were made available at the SLV Research Center Field day. As a result of these efforts, a total of 41 usable surveys were collected from the 176 registered operations that pay CPAC assessments for a response rate of 23%.

Demographics and Operation Overview:

In this section of the survey, respondents provided general information on their age, years of farming experience, acres farmed, gross income, and other details that allow for cross-sectional analysis in later parts of the summary.

Figure 1: Please answer a few short questions about your operation:

Answer Options	Response Percent	Average Response
Operation/Organization Name:	92.7%	39
Age of Primary Farm Manager:	80.5%	51
Number of years of Farming Experience:	80.5%	30
Acres farmed in 2008:	82.9%	1243
Acres in Potatoes in 2008:	82.9%	477
3-Year Average Annual Farm Income	58.5%	\$1,457,826

Figure 1 provides an overview of basic background information about the survey sample. The youngest manager was 29 years of age, the oldest, 79 years. The modal and median ages were both 52 years. In terms of years of farming experience, 11 years was the minimum and 65 the maximum. With 30 years being both the modal and median years of experience, we can conclude that the typical survey respondent has significant farming experience.

Respondents also indicated that, on average, about 37% of farmland was planted to potatoes in 2008. Within the sample, a maximum of 62% and a minimum of 2% of total farmed acres were planted to potatoes in the same year.

Annual “gross” farm income from farming operations as a three year average was also collected from the sample. Significant variation was observed in the sample and strongly correlated with operation size as measured by acres farmed (correlation coefficient of 0.749). The largest opera-

tion reported annual average gross income from farming operations of \$6,000,000 and the smallest claimed just \$300,000, providing for significant heterogeneity in the data set.

Figure 2: Please describe your current rotation practices (example: potato/barley):

Answer Options	Response Count
Potato/Barley	17
Potato/Barley/Alfalfa	2
Potato/Other Crop(s)	16
<i>answered question</i>	35

Most of the survey respondents provided information on current crop rotation practices. The predominate rotation involves alternating plantings of potatoes with barley, however, a number of respondents rotated potato plantings with other crops including wheat, sudangrass, green manure, canola, and quinoa as well as using fields as cow pasture.

Figure 3: Please estimate your operation's groundwater pumping usage for the 2008 crop year(inches X acres):

Answer Options	Response Count
Average Total Amount of Ground Water Pumped (acre/inches)	16777
Average Amount of Water Pumped per Acre (acre/inches)	13
Max Average per Acre (acre/inches)	50
Min Average per Acre (acre/inches)	0
<i>answered question</i>	28

Figure 3 provides information about groundwater pumping activities during the 2008 crop year and indicates significant differences between max and min users. While the sample average groundwater pumping level is 13 inches to the acre, one grower reported past usage of 50 inches per acre while fully six growers used none. The differences are likely explained by access to surface water and cropping practices. For example, if a grower is following a significant portion of his fields in 2008, groundwater pumping estimates may be quite low. After the upper-end outlier and non-pumping operations were removed, groundwater pumping estimates averaged 15.8 inches/acre with a standard deviation of 4.64 inches/acre.

Figure 4: Do you regularly engage in any of the following activities (please check all that apply):

Answer Options	Response Percent	Response Count
Telone Application	19.4%	7
Vydate Application	55.6%	20
Growing Winter Cover	25.0%	9
Compost Tea Application	22.2%	8
Conservation Tillage	80.6%	29
Early Blight Fungicide	83.3%	30
Growing Green Manure	63.9%	23

Figure 4 summarizes growers' current production activities. While more than half of the sample regularly applies either Telone or Vydate and fully 86% regularly apply an early blight fungicide, 100% of the sample population also engages in at least one "green" production practice. The most popular "green" practice is conservation tillage (81%) followed by growing green manure crops (64%) growing winter cover crops (25%) and compost tea application (22%). All but one respondent that practiced conservation tillage also applied an early blight fungicide and all growers using Vydate also applied an early blight fungicide. Only half of growers who applied compost tea also grew winter cover crops. More than 88% of those who grew winter cover crops in 2008 also grew green manure.

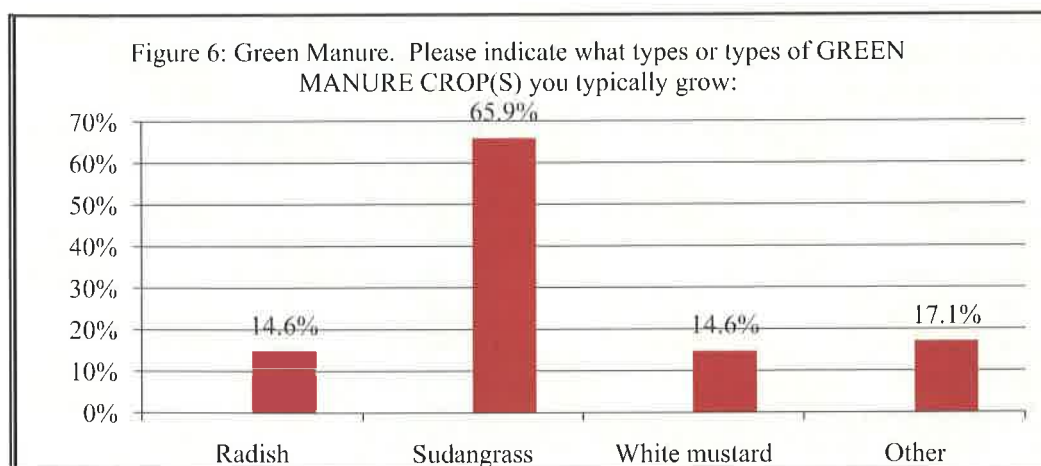
Green Production Practices:

For specific "green" production practices, growers were asked to detail their experiences over the previous five years: 2008-2004. These questions are designed to demonstrate changes in production practices over time and provide more detail on method employed.

Figure 5: Green Manure. Please estimate the number of acres your operation planted to GREEN MANURE CROPS(S) in the following years (when applicable):

Answer Options	Response Percent	Response Count	Average Acres
2008	73.2%	30	109
2007	73.2%	30	151
2006	70.7%	29	191
2005	58.5%	24	168
2004	58.5%	24	136

Figure 5 summarizes the number of acres operations planted to green manure crops in the past five years. Fully 63% of the sample had planted green manure crops at least once between 2004 and 2008. Although the average number of acres planted to green manure decreased in 2008 and 2007, the total number of growers planting green manure has increased from 24 to 30 between 2004 and 2008.



In Figure 6, the various types of green manure crops grown by the survey sample are summarized. Most popular by far is sudangrass; a green manure that is known to increase soil microbial activities, increase mineralizable N, organic P, K, Mn, in addition to the percent of organic matter; all factors are likely to contribute to increases in yield and potato quality (Davis, et al., 2004). Radish and white mustard are planted by 15% of the sample and are thought to reduce populations of nematodes, weeds, and other pests. For all but one observation, both radish (oil-seed) and white mustard were planted by individual operators. Other green manure crops including rye, oats, and peas were planted by 17% of the population.

In 2008, only 19% of the sample reported growing winter cover; far fewer than the number of producers who grew green manure crops. However, between 2004 and 2008 the number of acres planted and the number of growers planting winter cover had increased significantly. In 2004, just three producers reported planting an average of 100 acres with winter cover. By 2008, eight producers reported planting an average of 247 acres to winter cover.

Figure 7: Winter Cover Crops. Please estimate the number of acres your operation planted to WINTER COVER CROPS in the following years (when applicable):

Answer Options	Response Percent	Response Count	Average Number of Acres
2008:	19.5%	8	247
2007:	17.1%	7	114
2006:	14.6%	6	101
2005:	9.8%	4	124
2004:	7.3%	3	100

Figure 8 provides a summary of the number of growers applying compost tea and the average number of acres on which tea is applied. Unlike plantings of green manure and winter cover crops, the number of growers using compost tea has increased only slightly over time. Notably, the average number of acres on which each operator is applying compost tea has generally been declining between 2004 and 2008. A deeper look at the data reveals that most operators were applying teas on the same number of acres over time; however, two larger operations reduced usage significantly and permanently in 2006, driving the observed reduction during the period in question.

Figure 8: Compost Tea Application. Please estimate the number of acres on which you applied COMPOST TEA in the following years (when applicable):

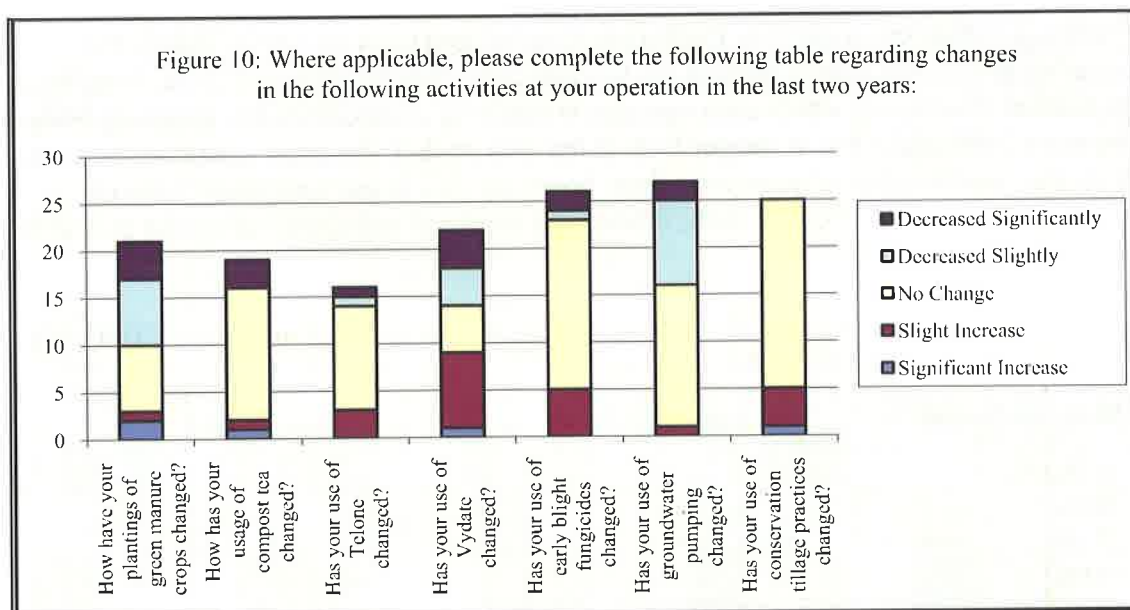
Answer Options	Response Percent	Response Count	Average Acres
2008:	19.5%	8	319
2007:	22.0%	9	331
2006:	22.0%	9	330
2005:	14.6%	6	503
2004:	17.1%	7	497

Conservation tillage is the most popular “green” practice employed by survey respondents with more than 80% reporting regular practice (Figure 4). Both numbers of growers practicing conservation tillage and the average number of acres on which conservation tillage is performed, increased between 2004 and 2007, with a slight decline in average acres observed in 2008 (Figure 9). Multiple studies including Carrera et al. (2005) have demonstrated the benefits of conservation tillage on soil structure and soil organic matter. Although some economic analyses have been performed that describe the financial benefits that may be attained as a result of conservation tillage, it remains to conduct a study that accounts for the specific land use practices and soil conditions observed in the San Luis Valley. If the results of such research are favorable and publicized, more wide-spread adoption of conservation tillage may result.

Figure 9: Conservation Tillage. Please estimate the number of acres on which CONSERVATION TILLAGE practices were employed in the following years (when applicable):

Answer Options	Response Percent	Response Count	Average Acres
2008:	65.9%	27	1042
2007:	63.4%	26	1073
2006:	63.4%	26	1073
2005:	58.5%	24	1055
2004:	58.5%	24	1030

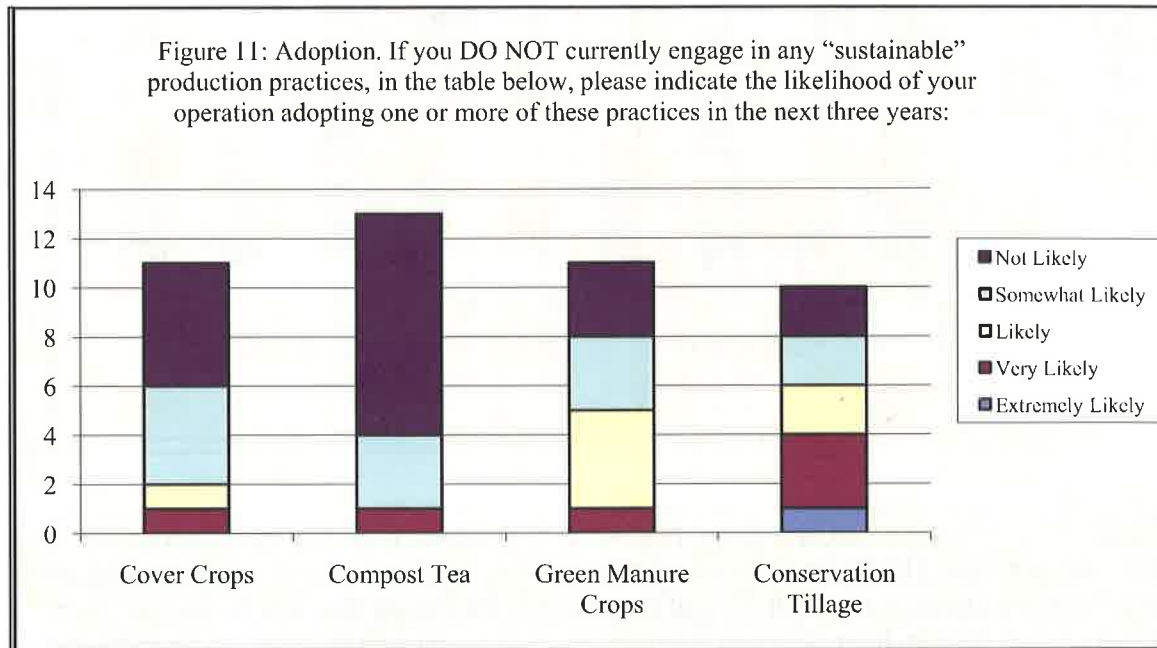
Figure 10 provides additional information on selected production practices of responding growers in the last two years (2008 and 2007). For most activities, no production changes are reported for the previous two years; however, plantings of green manure crops have either decreased slightly or significantly for 52% of the full survey sample. Groundwater pumping has also declined for 41% of reporting growers.



Possibly in response to the limited availability of Telone in 2008, Vydate use has increased for 40% of the sample (33% report a decline in use). Further, 20% of respondents (11% of total sample) report an increase in use of conservation tillage.

Adoption:

In an effort to gauge future adoption of “green” production practices in the San Luis Valley, operators were asked to describe the likelihood of employing individually or collectively each of four activities in the next three years (Figure 11).



Most respondents to the adoption question indicated that they are “not likely” or only “somewhat likely” to adopt a previously unemployed “green” practice. Only for conservation tillage did more than 50% of respondents indicate that adoption in the next three years was “very” or “extremely likely”. Planting green manure crops is the second most likely practice to be adopted by the respondents with approximately 40% reporting that adoption is at least “likely”. In general, a low response rate reduces the explanatory power of the statistical results and may limit their applicability to the larger Valley grower population.

Motivations:

To further understand operators’ reasons for and against the adoption of a specific “green” practices, respondents were asked to indicate their level of agreement with a number of statements specific to the application of compost tea, growth of green manure and winter cover crops, and use of conservation tillage.

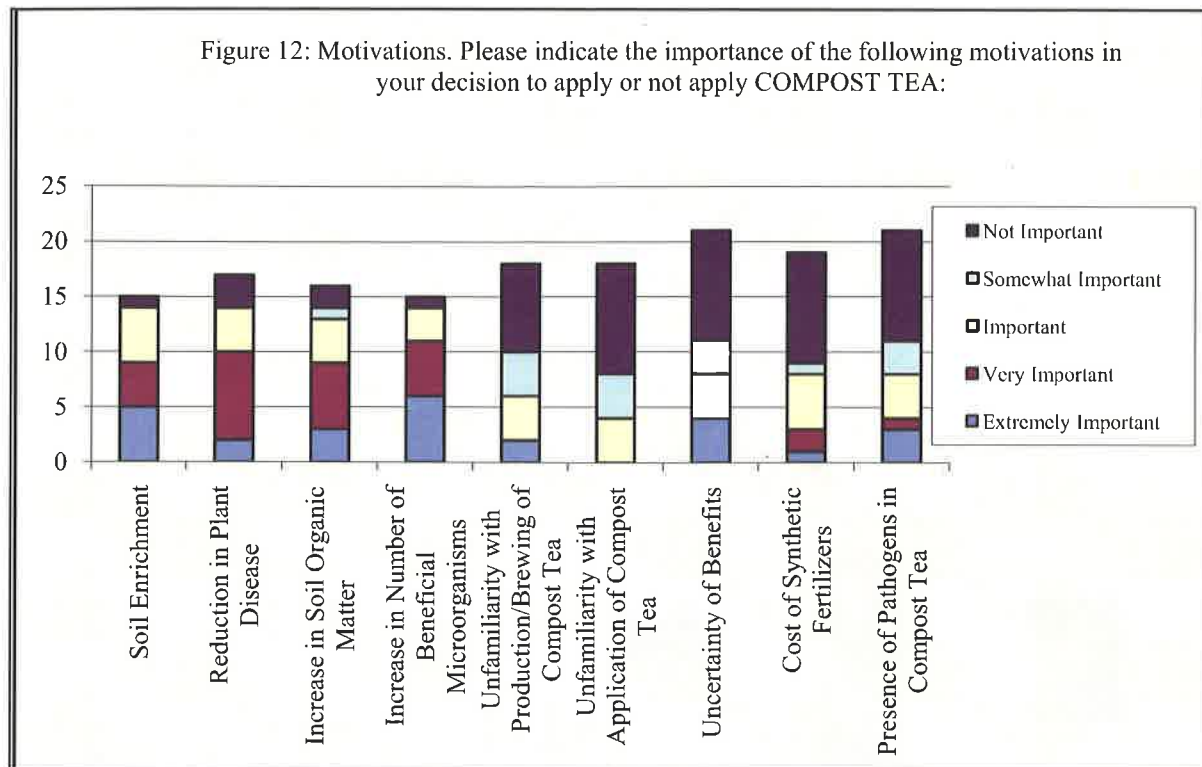
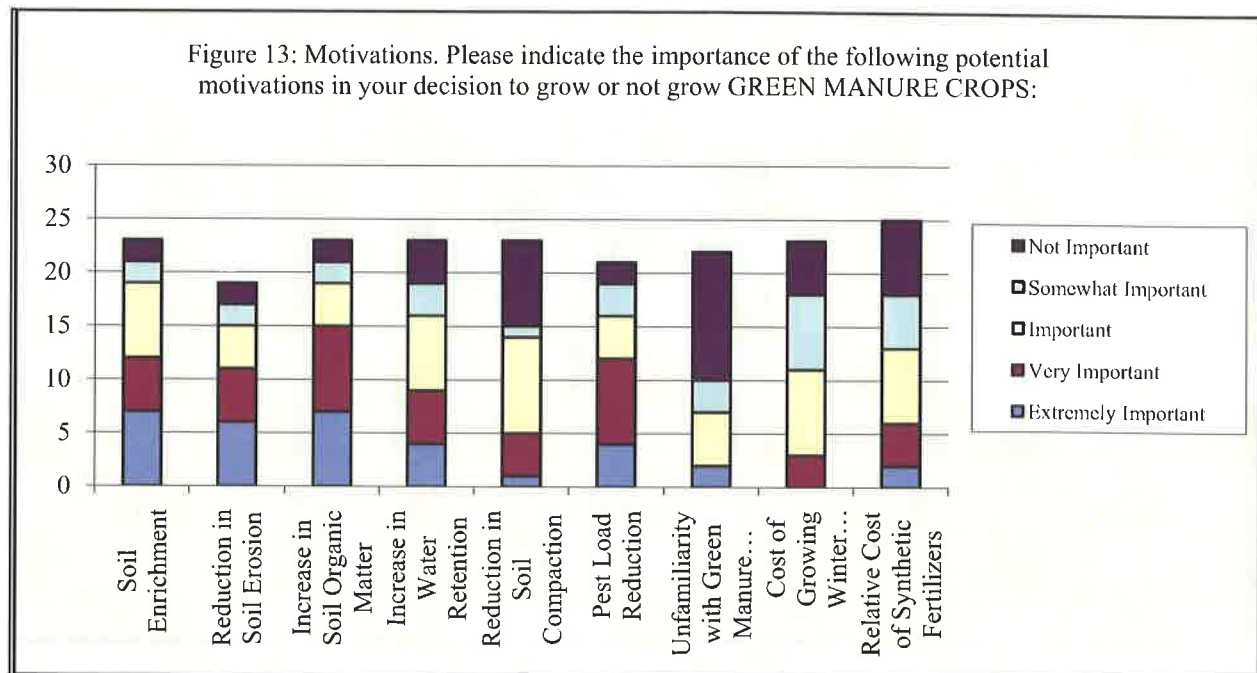


Figure 12 provides a summary of operators' responses to potential motivations related to the application of compost tea. The increase in the number of beneficial organisms is the most oft cited motivation for using compost tea with 73% of respondents indicating that this factor was "very" or "extremely" important in their decision to apply teas. On a percentage basis, soil enrichment, reduction of plant disease, and increase in soil organic matter were comparable; each motivation was identified as "very" or "extremely" important to approximately 60% of respondents. Uncertainty of benefits (38%) and the potential presence of pathogens (38%) were cited as the most important motivations against the adoption of the practice. Unfamiliarity with the production and brewing of compost tea also appears to impede adoption by some producers with one-third of respondents indicating that this factor was at least "important" in their decision to refrain from adopting the practice.

Based on the above findings, demonstrations of techniques for preparing and applying compost teas as well as provision of factual information about the production and economic benefits stemming from tea application may encourage greater adoption of the practice.

Figure 13 summarizes operators' responses to various motivations in favor and against growing green manure crops. The ability of green manure crops to potentially increase soil organic matter is a "very" important or "extremely" important factor in the adoption decision for 65% of responding growers, reduce soil erosion (57%), and reduced pest loads (57%), and potential to enrich soil (52%) are the next most influential motivations in favor of adopting the practice fol-

lowed by an increase in water retention (39%), relative cost of synthetic fertilizers (24%), and reduction of soil compaction (22%).¹



Unfamiliarity with growing green manure crops was found to not be an important motivation in the adoption decision by the majority (54%) of responding growers, however, a few respondents (2) indicated that lack of knowledge about green manure production was an “extremely” important impediment in their adoption of the practice. Although significantly more respondents indicate a level of familiarity with green manure production, there appears to be room for improvement in grower education on this particular “green” production practice. Both respondents who indicated a lack of familiarity with green manure production have more than 30 years of farming experience and farm an average of 550 acres of potatoes. Growers indicating that unfamiliarity with green manure production methods was an “important” motivation in their decision to not adopt the practice also have greater than 30 years of farming experience, range in age from 51 to 70, and planted 565 acres to potatoes in 2008 (max of 1250, min 120).

A greater impediment to the adoption of green manure production was the cost of cultivation. Just 21% felt that cost was “not important” while the majority of respondents (79%) felt the cost was at least an “important” motivation in the decision to adopt the practice or not. Notably, growers who indicated that cost was “not important” were significantly younger (45 years) on average relative to the sample average (51 years). These farmers also placed greater importance on the potential benefits of green manure production, implying that this relatively younger group of farmers found the benefits of green manure cultivation to outweigh the financial costs of production.

¹ Percentages are measured as number of respondents indicating a practice is very important or extremely important in their decision to or not to adopt.

Figure 14: Motivations. Please indicate the importance of the following potential motivations in your decision to adopt or not adopt CONSERVATION TILLAGE PRACTICES:

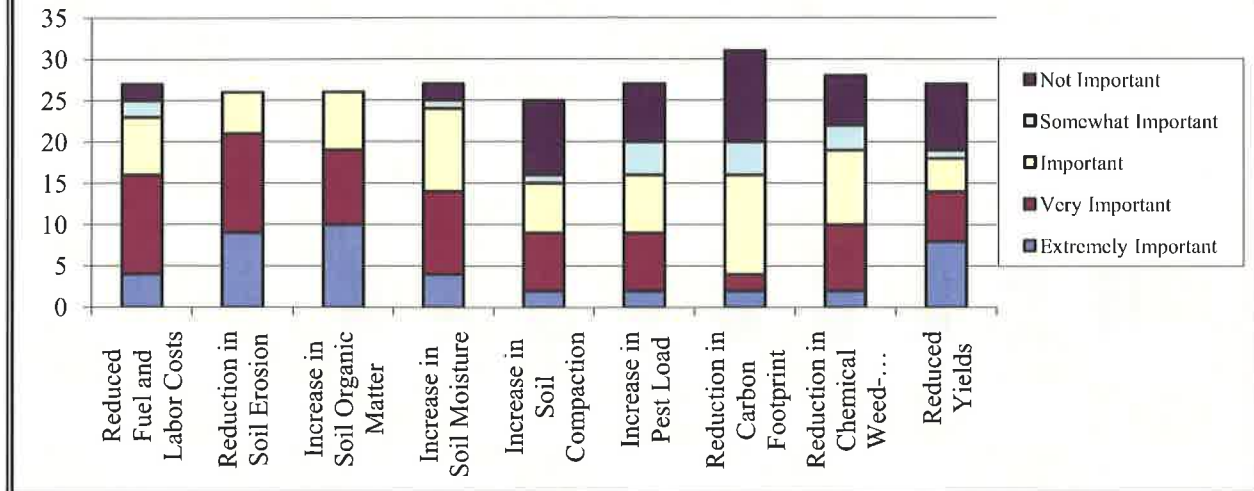
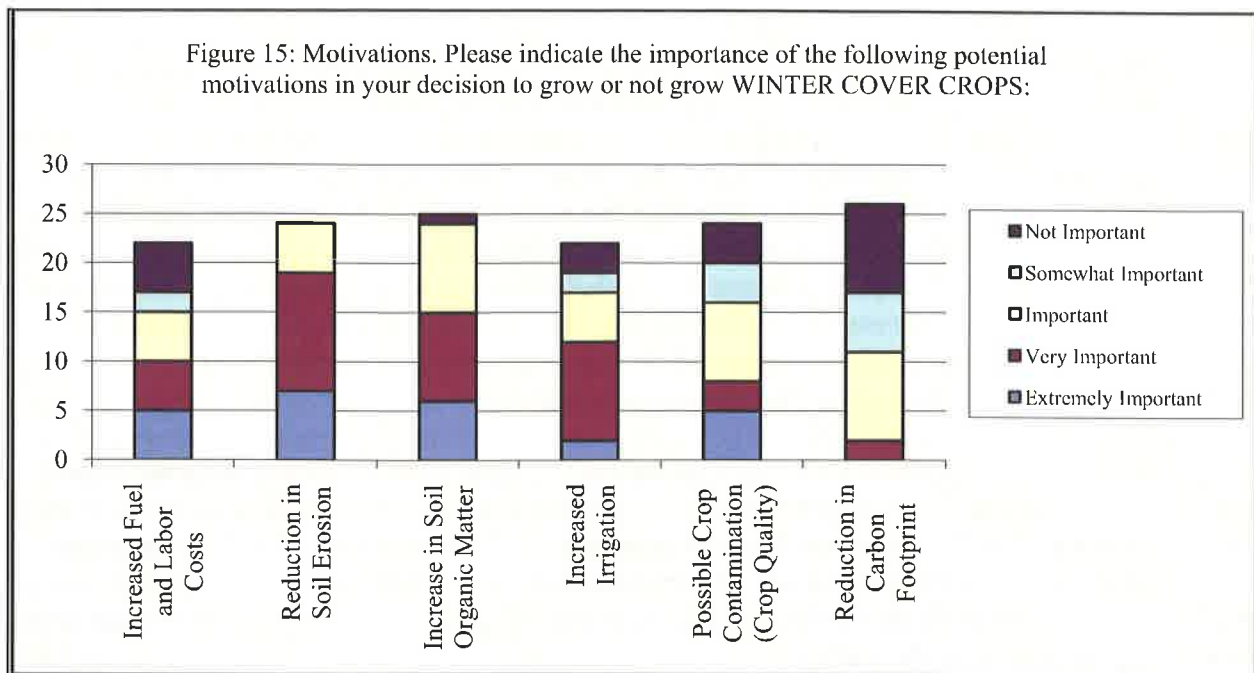


Figure 14 provides a summary of the importance of various motivations on producers' decision to adopt the practice of conservation tillage. The majority of respondents (81%) indicated that they regularly engage in this particular "green" practice, implying that the associated economic costs (such as those described in Figure 14) are outweighed by the economic benefits. Potential benefits that garnered the most support as indicated by the number of "very important" and "extremely important" rankings included the reduction of soil erosion (80%), an increase in soil organic matter (73%), reduction in fuel and labor costs (59%), and an increase in soil moisture (52%).

The reduction in an individual operation's carbon footprint garnered the least support among the listed potential benefits of conservation tillage. However, five operators felt this attribute was "very" or "extremely" important. The demographics of this sub-group are not significantly different than the sample average, implying that differences in motivational rankings are based on psychographic or attitudinal variations that are not captured by the survey instrument.

Various factors that may impede adoption of conservation tillage were also ranked by the producers in terms of importance. Motivations that garnered the most ratings as "very" or "extremely" important include reduction in yields (52%), reduction in chemical weed control efficacy (36%), and an increase in pest load (33%). Relative to other "green" practices, the negative impacts of conservation tillage were given much greater weight in the decision making process. However, it is important to note that despite the acknowledgement and existence of the costs, producers have, by and large, adopted the practice. Through education and need, it appears that growers have come to value the practice in great numbers. As such, education may play an important role in encouraging the adoption of other "green" practices.

Figure 15: Motivations. Please indicate the importance of the following potential motivations in your decision to grow or not grow WINTER COVER CROPS:



Many of the motivations for planting winter cover crops are identical to those related to growing green manure crops. However, growers' rankings of the various motivations are found to differ somewhat across practices. In particular, a reduction in soil erosion was felt to be a "very" or "extremely" important factor in the decision to plant winter cover crop by 79% of responding growers followed by an increase in soil organic matter (60%); with regard to green manure plantings, the importance of these motivations were reversed. Increased irrigation as well as increased fuel and labor costs were noted as at least "important" by 77% and 68% of respondents, respectively. Growers that cited increased irrigation as an "extremely" important motivation in their adoption decision pumped, on average, 2.5 more inches of water per acre than the full sample average of 13 inches/acre. Given their already above average groundwater pumping needs, an increase in pumping appears to be a significant deterrent.

Possible soil contamination was an "important" impediment in the adoption of winter cover crop cultivation for 67% of respondents; however, fewer respondents felt that it was "very" or "extremely" important relative to other factors. In light of these findings, grower education programs that are designed to encourage planting of winter cover crops may benefit from a discussion of the empirical costs of adoption, means of minimizing associated expenses, and quantification of financial benefits stemming from soil enhancement.

SUMMARY

In order to better understand the current scope of green practices in the San Luis Valley, both growers and soil fumigant salesmen were contacted in 2009. Sales representatives for Vydate and Telone, both indicated that demand for their products fluctuates more closely with the previous year's price of potatoes than with any other factor. Salesman Chris Sittler, reported that sales of Telone are limited to a "niche" clientele that includes certified seed potato growers and those growing for the Mexican export market. Mr. Sittler further indicated that growth in the use of his product is dependent upon the same factors that drive adoption of "green" production practices: cost vs. benefits. If growers feel an application or practice will enhance their financial position, they are more likely to adopt. The ability to influence grower perception of costs vs. benefits therefore, is key to changing grower production practices.

Potato growers in the San Luis Valley of Colorado were asked to participate in a survey regarding current conventional and "green" production practices in the summer and early fall of 2009. With the assistance of the Colorado Potato Administrative Committee, all 176 of the organization's members were solicited by postcard, newsletter announcement, and finally paper survey to participate. These primary data collection efforts netted 41 useable surveys from individual potato-growing operations in the Valley.

Demographically, this sample represents a diverse cross section of San Luis Valley potato producers in terms of age, experience, operation size, and gross income, indicating heterogeneity of the sample population. Operator respondents differed in terms of production methods used including rotation practices (though most rotated with a mix of barley, wheat, or sudangrass) and groundwater pumping. Furthermore, growers reported significant differences in use of "green" practices including conservation tillage, growth of green manure and winter cover crops, and the application of compost teas.

All operators regularly engaged in at least one "green" production activity with most (81%) using conservation tillage on at least a portion of their farmland. Nearly 64% grew green manure, 25% grew winter cover crops, and about 22% applied compost teas to their fields. Many producers (about 40%) practiced at least two or more of these activities. Over time, the number of growers planting green manure crops, winter cover crops, and employing conservation tillage has generally increased. Based on survey responses, conservation tillage is likely to experience the greatest increase in adoption in the next three years; compost tea application is likely to experience the least.

Growers' thoughts on the importance of various motivations for and against the adoption of each "green" production practice was collected and summarized. The benefits and costs of each activity are different; however, across activities it is clear that growers value the ability to enhance soil organic matter levels and reduce soil erosion. A common impediment to adoption is uncertainty of benefits (likely both in terms of soil health and economics), cost of adoption, and lack of knowledge of the activity. Importantly, in the case of the popular practice of conservation tillage, negatives or costs of the practice were noted as being of significant concern; however, despite resistance towards using the practice, the importance of benefits stemming from adoption out-

weighed concerns. Education about the benefits, in terms of land/production enhancements and economics are likely to have contributed to increased adoption in the presence of limitations. The implication being that accurate knowledge about the benefits of other “green” practices may encourage adoption by outweighing the relatively lower ranked costs.

Based both on findings from the survey and interviews with area soil fumigant salesmen, it appears that growers have changed their production practices over the last several years (and since 2006) and that many having adopted “green” practices. The outlook for future adoption and sustained application depends on the perceived costs and benefits associated with each activity. Education can serve to reduce transactions costs and reduce barriers to adoption. In addition, research and outreach efforts may work to elucidate the benefits, both long- and short-term, of employing soil-enhancing measures. Appealing to an operator’s desire to be more profitable will likely prove to be the most effective means of expanding the scope and scale of “green” practices observed in potato production in the San Luis Valley.

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