REACCH
Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

VARIATIONS IN TILLAGE PRACTICES AMONG INLAND NORTHWEST PRODUCERS

AUGUST 2015

THIS MATERIAL IS BASED UPON WORK THAT IS SUPPORTED BY THE NATIONAL INSTITUTE OF FOOD AND AGRICULTURE, U.S. DEPARTMENT OF AGRICULTURE, UNDER AWARD NUMBER 2011-68002-30191

Conducted as a component of the *Regional Approaches to Adaptation and Climate Change for Pacific Northwest Agriculture (REACCH)* project, the Social Science Research Unit (SSRU) administered this survey. SSRU is a social science research laboratory within the Department of Agricultural Economics & Rural Sociology (AERS), College of Agricultural & Life Sciences (CALS), and University of Idaho (UI).

The University of Idaho Institutional Review Board approved this project with all survey respondents remaining anonymous (protocol #10-139).

This report and additional supplemental materials are available at socialscience.reacchpna.org.

The following members of the REACCH project team contributed to this report: J. Gray, S. Gantla, L. McNamee, L. Bernacchi, K. Borrelli, B. Mahler, M. Reyna, B. Foltz, S. Kane, and J.D. Wulfhorst.

Cover photo: Snehalatha Gantla

Introduction

The *Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH)* region lies within the inland Pacific Northwest (PNW) of the U.S. and extends across multiple counties in three states, all of which experience variable amounts of precipitation. This area has rich soils and annual rainfall totals that have consistently provided some of the highest yielding dry land grain and legume crops in the world. REACCH region cereal-grain producers utilize a diverse set of production practices that have allowed them to continually adapt throughout their years of operation. While agricultural producers have always been viewed as an adaptable group, increased heat and water stress, changes in disease and pest pressures, and weather extremes that are predicted to occur due to climate change, will pose new adaptation challenges for many producers in this region.

This publication reports on selected results from a producer survey in which respondents were specifically asked about their tillage practices. What tillage practice an agricultural producer chooses to implement on their operation can be influenced by various factors. Tillage practice can often be used in order to manage soil erosion, preserve or improve soil health, and mitigate use of herbicides or pesticides. Specific tillage practices are also associated with different environmental outcomes such as improving soil conditions or moisture. As such, beliefs or values around environmental outcomes of agricultural productions, as well as on-farm conditions such as managing for soil erosion due to hill slope, may play a key role in determining what tillage practices a producer implements. To that extent, this report focuses on relationships between tillage practice and key independent variables related to beliefs/values and farming conditions.

Methods

The Social Science Research Unit (SSRU) implemented the survey of agricultural producers from December 2012 through March 2013 using a random sample of producers in counties of the REACCH region[1] in the inland PNW. The SSRU defined the population of interest for this survey as individual farm operations that had 50 or more acres of wheat under production at any time between 2009 and 2011. The sample frame, drawn from the National Agricultural Statistics Service (NASS), consisted of 2,000 entries and represented a simple random sample of all eligible farm operations. After eliminating duplicate entries, the final sample frame used for the producer survey consisted of 1,988 unique operations.

For data collection, the SSRU utilized the full Dillman method (Dillman, Smyth, & Christian, 2009), including four mailings and a reminder postcard, all administered in partnership with NASS in order to maintain anonymity of respondents and the agency's sampling frame. Four non-deliverables and 38 ineligibles (no longer farming) were received and removed from analysis. A total of 900 completed surveys were received and included in analyses. The final response rate for the survey was 46.2% with a sampling margin of error of +/- 3% at the 95% confidence interval (AAPOR, 2011). The survey instrument

[1] The counties included in the sample for this survey were: 17 counties in the state of Washington, 7 counties in Idaho, and 9 counties in Oregon.

asked a variety of questions pertaining to agricultural practices, adoption of technology, sources of information, perceptions of risks associated with climate change, and producers' views on adaptive strategies. In this report, we explore relationships between farmers' tillage practices and their perceptions of environmental risks and on-farm conditions such as hill slope.

Results

In this section, we present descriptive results of survey questions that asked producers about their tillage practices, use of conservation practices, perceptions of risk, and hill slope. The frequencies were calculated with the "missing," or non-response, category included. However, this category is not represented in the charts below. Therefore, percentages may not total to 100% in each case.[2] All written descriptions of percentages have been rounded to the nearest percentile. All graphs show percent response to the nearest tenth of percent. In addition to frequencies, we also report crosstabular results to examine how producers' tillage practices may be related to their use of conservation practices, perceptions of risk, and on-farm conditions such as hill slope.

Tillage Practices Used

In the survey, respondents were asked to choose the category that best describes the tillage practice they use on their operation. Tillage scenarios can be described as an array of options along a continuum, or as a matrix of options. Thus, exact criteria of what conventional, conservation, and no-till practices translate to on the ground still vary and have not reached a single standardized and widely accepted set of definitions. For the purpose of this survey, we used definitions from the Conservation Technology Information Center (CTIC) as a common metric to ask producers which category best describes their own practices (see CTIC, 2015). The actual response categories in the survey included:

- "Leave less than 30% residue on surface after planting, followed by multiple secondary tillage and application trips" (referred to in this report as conventional tillage)
- "Leave more than 30% residue on surface after planting, followed by multiple secondary application trips" (referred to in this report as conservation tillage)
- "Leave more than 30% residue on surface after planting, and leave soil undisturbed harvest to planting" (referred to in this report as no-till).

As seen in Figure 1, tillage practices among the REACCH region's agricultural producers are fairly diverse, with the largest percentage of producers (39%) reporting that they use conservation tillage on their farm. One quarter of respondents (25%) reported that they use conventional tillage, while 30% of producers reported that they use no-till practices.

[2] When appropriate, we also provide error bars for 95% confidence intervals for frequencies.

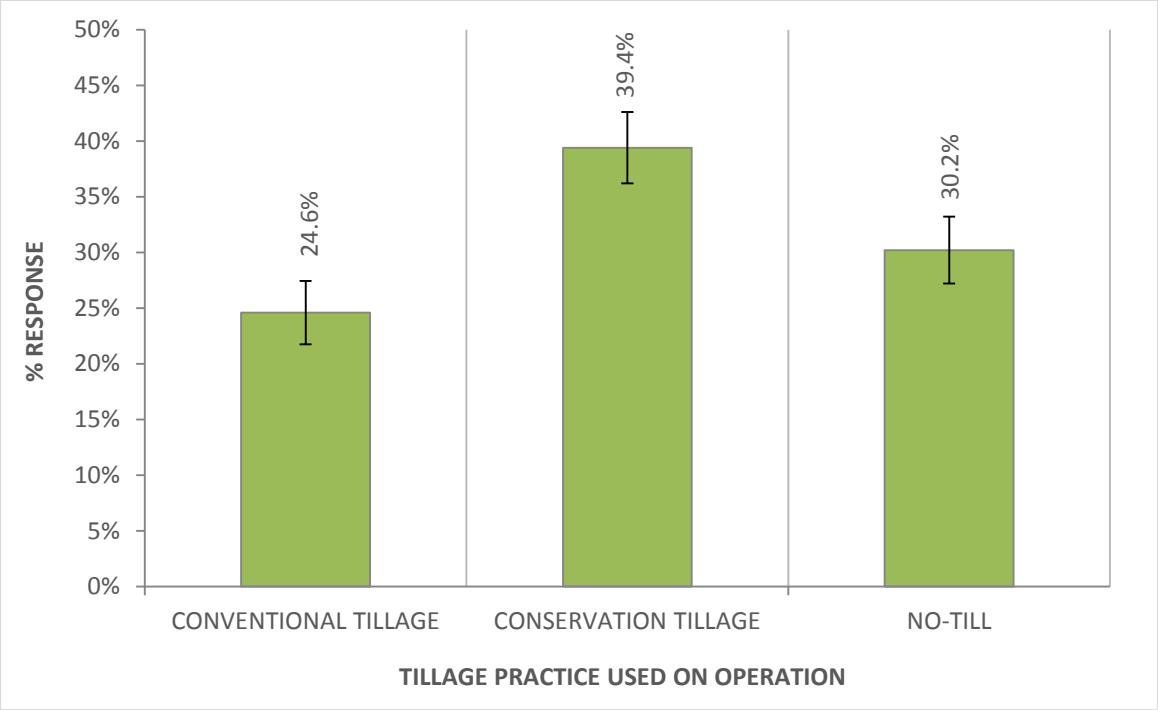

Figure 1. Distribution of tillage practices used by producers in the inland PNW.

Perceptions of Management Practices

The survey asked respondents the degree to which they agree or disagree with the statement, "I consider myself to be an aggressive adopter of conservation practices"

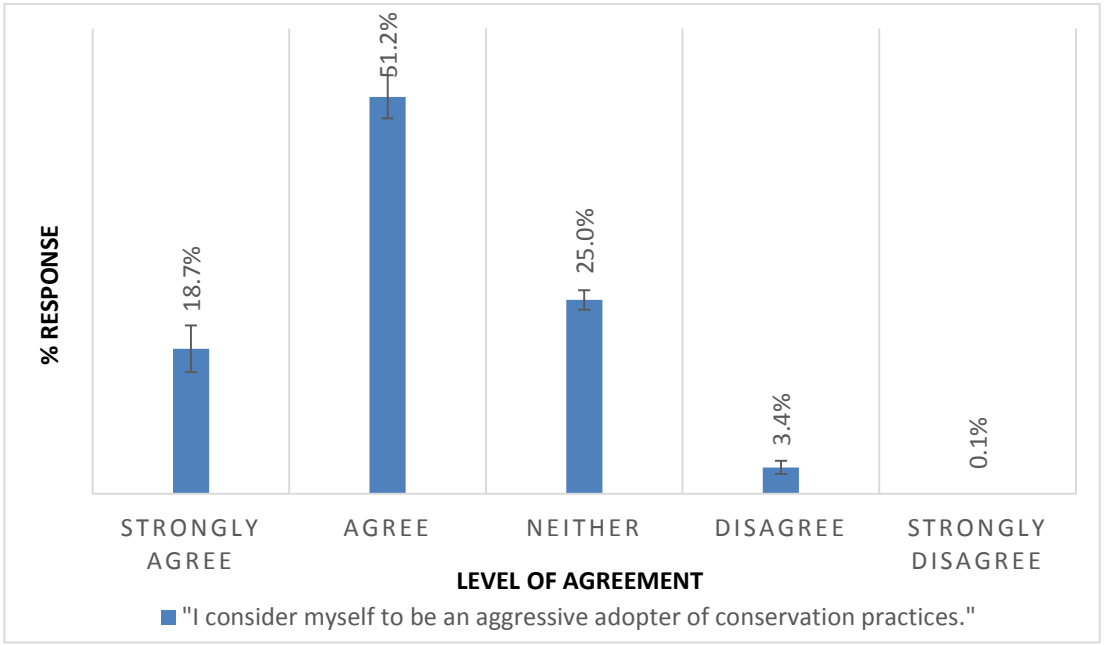

Figure 2. Beliefs regarding how aggressively producers adopt management practices.

As seen in Figure 2, a majority of respondents (70%) agree at some level, that they consider themselves to be an aggressive adopter of conservation practices; though less than 19% of respondents strongly agreed with the statement. Additionally, 25% of respondents neither agree nor disagree with that statement, showing some uncertainty. Overall, a majority of producers in the REACCH region appear to place value on conservation practices.

In Figure 3, we are able to see how respondents' tillage practices differ based on their level of agreement with the statement "I consider myself to be an aggressive adopter of conservation practices." Overall, the two factors are associated at a statistically significant level (p-value < .0001).

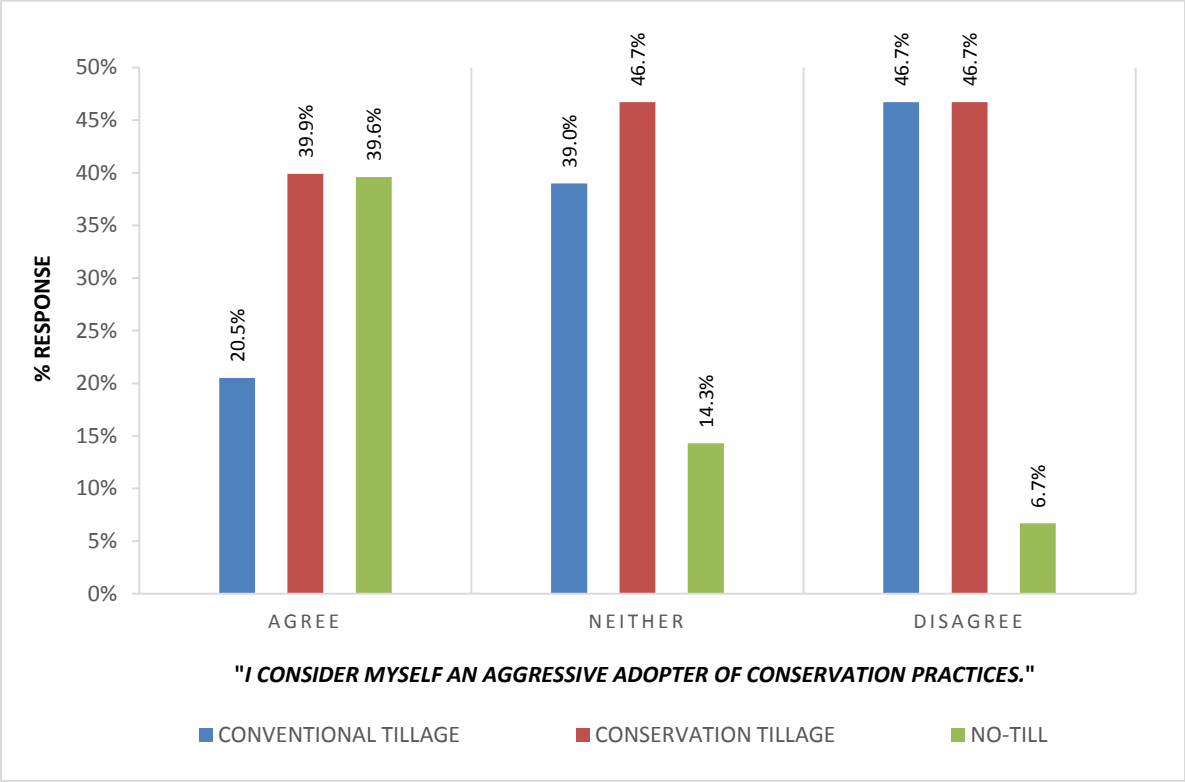

Figure 3. Cross-tabulation of adoption of conservation practices and tillage practices.

In other words, it is likely that producers in this region who agree that they are aggressive adopters of conservation practices will also use conservation tillage (40%), or no till (40%). Comparatively, only 7% of those who disagree that they are aggressive adopters of conservation practices use no-till practices. However, 47% of producers who disagree that they are aggressive adopters of conservation practices selected that their tillage practice falls under the category of "conservation tillage." These results reveal an interesting dynamic, suggesting that beliefs about conservation practices may be more influential to those who place themselves on the two ends of the tillage spectrum (conventional till versus no-till). In turn, many who employ conservation tillage practices may be considering a multitude of factors such as regional climate and farming conditions more than beliefs or values as measured by adoption of conservation practices.

Risk Posed by Changing Environmental Conditions

Producers were also asked to indicate the level of risk posed to their farm operation by various environmental conditions. As illustrated in Figure 4, producers in the REACCH region perceive the greatest threats from long-term drought and less reliable precipitation. Overall, respondents perceived low or no risk from increased intensity of precipitation and fewer days with frozen soil, despite potential deleterious effects on soil conservation and erosion. Interestingly, 30% of respondents perceive moderate risk from increased intensity of precipitation. This may be reflective of the tremendous amount of variability in precipitation zones across the REACCH region.

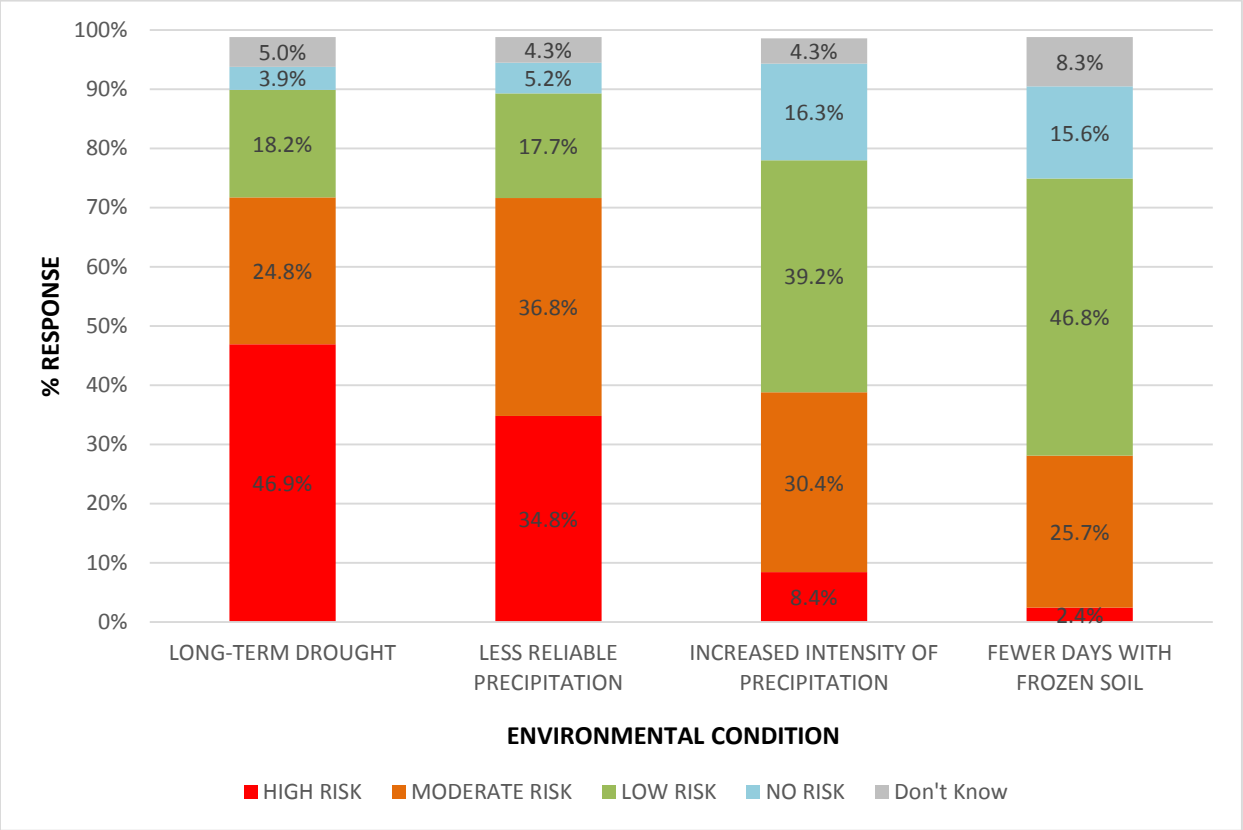

Figure 4. Producers' perceived risks posed by environmental conditions.

Seventy-two percent of respondents perceived long-term drought as posing high or moderate risk to their operation, with 47% of producers perceiving it as posing a high risk. Similarly, 72% of respondents also perceived less reliable precipitation as posing high or moderate risk to their operation. However, compared to long-term drought, a smaller percentage of respondents (35%) perceived less reliable precipitation as posing a high risk to their operation. Overall, these results suggest that *generally,* producers may be most sensitive to the availability of water resources and related effects in their operations.

When we cross-tabulated this series of risk variables with tillage practices, we identified that less reliable precipitation does not have a statistically significant association. However, the association

between tillage practice and risk perception of long-term drought is statistically significant (p-value < .01). Among producers who perceived high risk from long-term drought, 47% reported that they used conservation tillage, while 31% used no-till practices. In other words, producers who view long-term drought as a high risk, appear to also be more likely to use conservation or no-till practices (Figure 5).

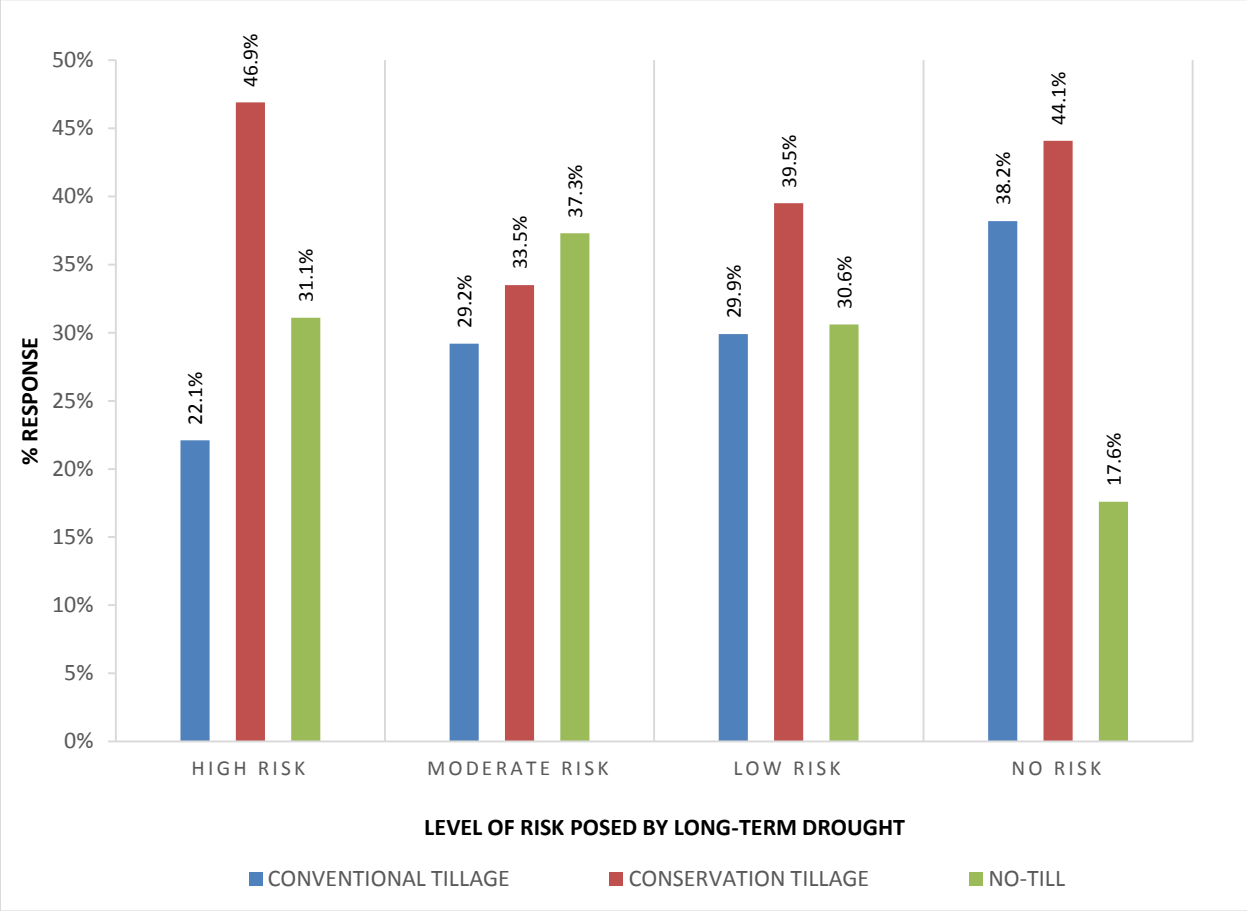

Figure 5. Cross-tabulation of risk posed by long-term drought and tillage practices.

Conversely, producers who view long-term drought as posing no risk are more likely to use conventional tillage practices (38%), as compared to no-till practices (18%). This suggests that risk perception does play a role in tillage choice for producers who use conventional tillage and no-till practices. Interestingly, the pattern for use of conservation tillage as it relates to risk perception is more complex. As displayed in Figure 5, conservation tillage is the most common practice across three of the four risk categories - high risk: 47%; low risk: 40%; and no risk: 44%. This suggests that risk perception of long-term drought varies and is likely just one of a multitude of factors that producers consider when making tillage practice decisions.

Hill slope

Survey respondents were asked what percentage of their land falls within each of the following hill slope categories: 1) less than 5% slope; 2) 6-14% slope; and 3) more than 15% slope. Figure 6 presents a summary of percentages of farms, as well as what portion of each producer's land falls in the three different categories.

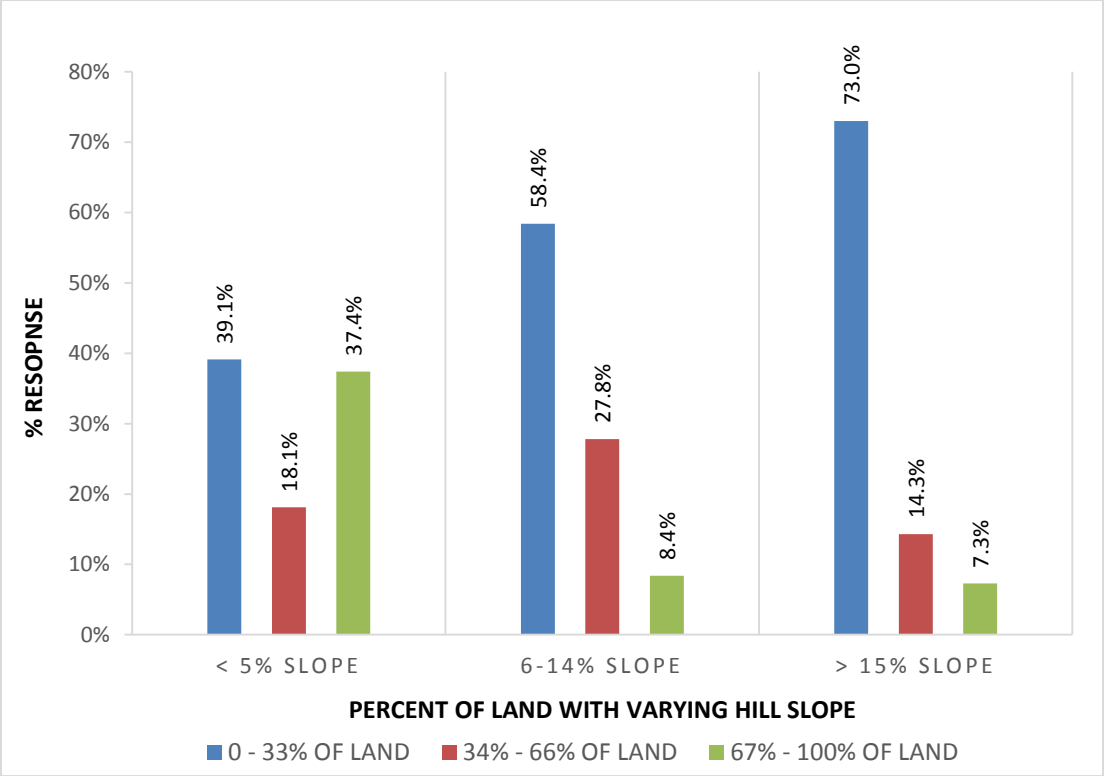

Figure 6. Percent of land in each category of hill slope.

Most notably, the highest percent of respondents have less than one-third of their land in each hill slope category. Overall, these results indicate that the hill slope of respondents' land varies across the categories and it is common for some portion of land to be on steeper slopes.

Less than 5% Hill Slope and Tillage Practices

The cross tabulation of tillage practice by percent of land on <5% slope yields a statistically significant p-value (<.0001), indicating a strong association between the two variables. Use of conventional tillage is lowest among respondents who have less than one third of their land on <5% slope, and highest among respondents who have more than two-thirds of their land on <5% slope. In other words, these results suggest that the more land that producers have on <5% slope, the more likely they are to use conventional tillage. The flipside of this is that use of no-till practices decreases as respondents have more of their land on <5% slope (Figure 7).

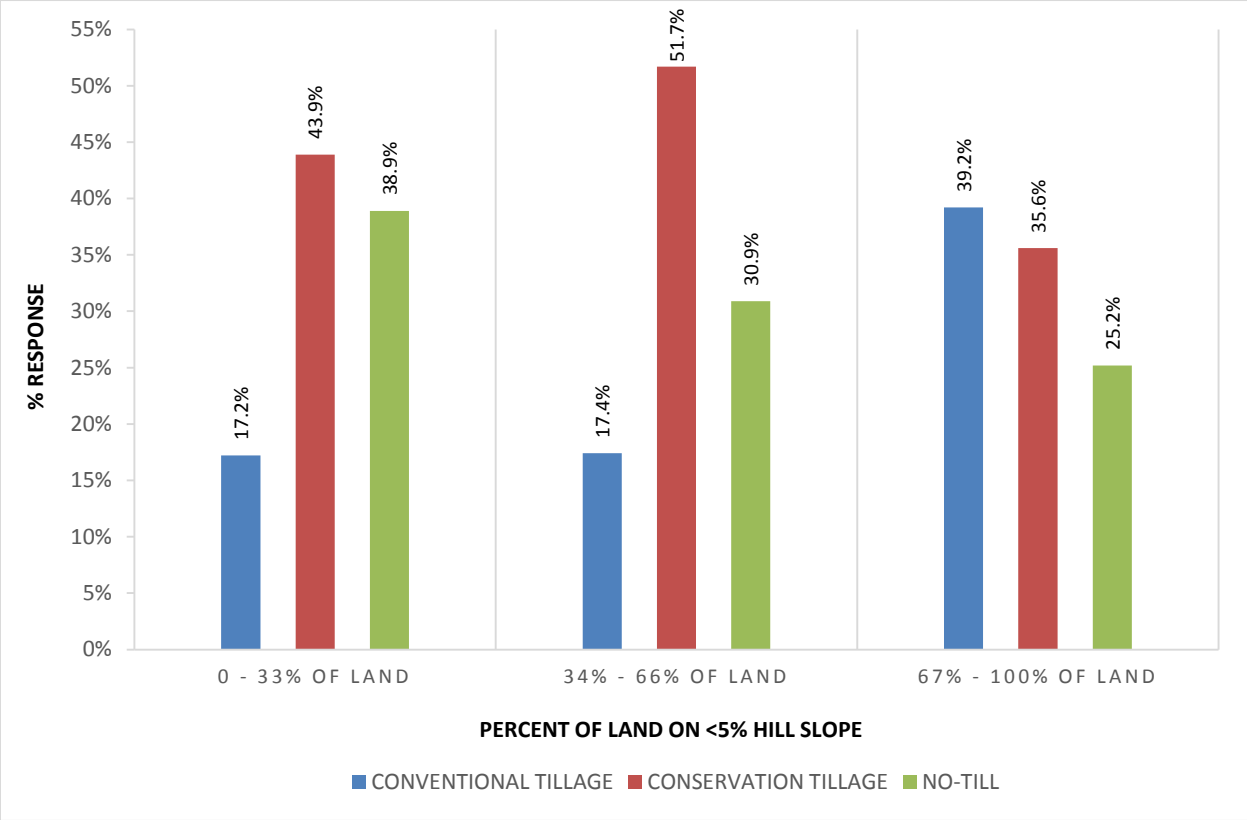

Figure 7. Cross-tabulation of percent of land on <5% slope and tillage practices.

Finally, similar to patterns highlighted earlier in this report, the pattern for conservation tillage is more complex. As displayed in Figure 7, conservation tillage is the most common tillage practice among respondents with less than two-thirds of land on <5% slope. Overall, conservation tillage practices are fairly common among producers, regardless of what proportion of their land is on <5% hill slope.

6 - 14% Hill Slope and Tillage Practice

The association between percent of land on 6-14% hillslope and tillage practice is also statistically significant, with a p-value <0.0001. As seen in Figure 8, use of conventional tillage practice is lowest among respondents who have one to two-thirds of land on 6-14% slope and highest among those with less than one-third of land on 6-14% slope.

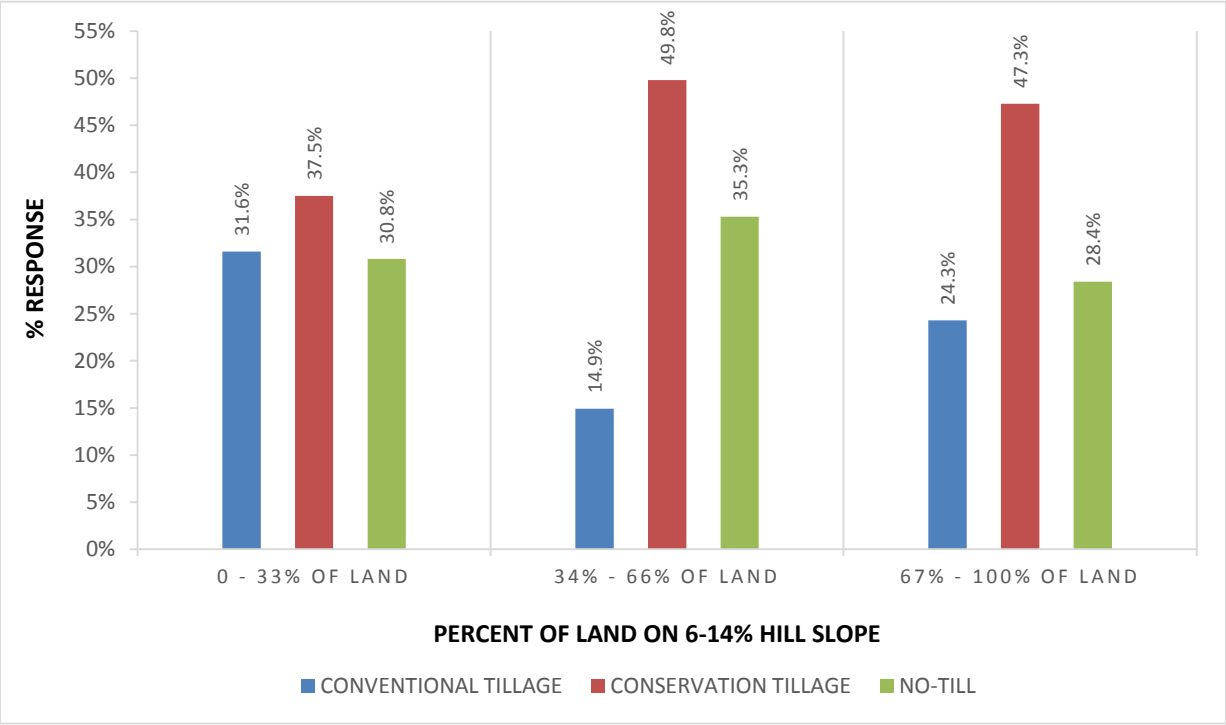

Figure 8. Cross-tabulation of percent of land on 6%-14% hill slope and tillage practices.

Comparatively, use of conservation tillage and no-till practices is highest among producers who have one to two-thirds of land on 6-14% slope. Overall, regardless of proportion of land on 6-14% slope, conservation tillage is the most common practice. This is similar to the results from the <5% slope category.

Greater than 15% Hill Slope and Tillage Practice

The cross tabulation of tillage practice by percent of land on >15% slope also yields a significant p-value (.0002), indicating a strong association between the two variables. Overall, use of conventional tillage is lowest among respondents who have more than one-third of their land on >15% slope and highest among those with less than one-third of land on >15% slope. Similarly, use of conservation tillage is greatest among those with less than one-third of land on >15% slope. In this instance, use of conservation tillage decreases as percent of land on >15% slope increases. This pattern is notably different from what we observed in the other hill slope categories.

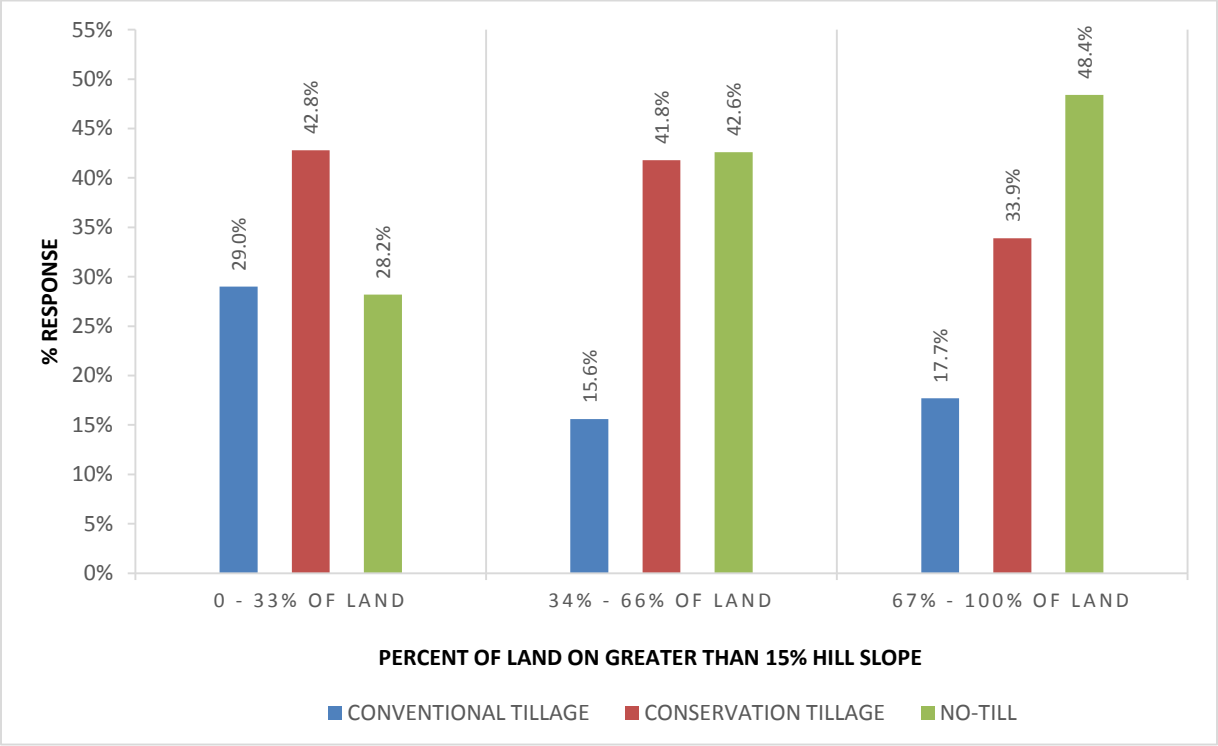

Figure 9. Cross-tabulation of percent of land on >15% slope and tillage practices.

Conversely, use of no-till practices among respondents demonstrably increases as a greater proportion of land is on >15% slope. As such, use of no-till practices is notably higher among those with more than two-thirds of their land on >15% hill slope. This result indicates that with steeply sloped land, many producers are more carefully controlling for soil erosion by minimizing tillage.

Conclusion

Among REACCH region agricultural producers, a majority consider themselves to be aggressive adopters of conservation practices, as supported by the fact that nearly 70% of survey respondents utilize conservation or no till practices. In terms of risk posed to their operation by changing environmental conditions, survey respondents were most concerned with long-term drought and less reliable precipitation. Interestingly, respondents perceive much less overall risk from increased intensity of precipitation and fewer days with frozen soil. This result likely means that dry-land agricultural producers in the REACCH region may be most sensitive to the availability of water resources. In the context of climate change and variability, producers do not anticipate all the potential effects equally.

The most notable result to emerge in this analysis is that the associations between tillage practice and the independent variables "adopter of conservation practices," "risk perception of long-term drought," and various hillslope categories are straight-forward for conventional and no-till practices, but more complex for conservation tillage practices. One exception is seen in the cross-tabulation of tillage practice by percent of land on greater than 15% hillslope, wherein we see that use of conservation tillage is greatest among those with less than one third of their land on greater than 15% slope and lowest among those with more than two-thirds of their land on greater than 15% slope. Overall, this observed pattern suggests that use of conservation tillage among producers in the REACCH region may be associated with a variety of variables beyond the ones included in this report. In the REACCH region, use of conservation tillage has become a prevalent practice because of fewer resource demands such as herbicide/pesticide applications, as well as time and effort needed to implement multiple passes in the fields. Furthermore, in order to understand use of conservation tillage in more detail, subsequent analysis may benefit from focusing exclusively on this category of tillage approaches.

Additionally, while the analysis in this report provides insights about associations between producers' reported tillage practices and their perceptions of risk, conservation, and farming conditions, these findings to not address the causality of those associations. As such, further statistical analyses will provide an understanding of *how* each of the independent variables may be influencing tillage practice and whether some are more influential than others. Such analysis can indicate whether producers are particularly sensitive to some factors over others when it comes to the implementation of various adaptive strategies. As such, this information could prove extremely useful in advancing climate change adaptation and mitigation among producers in the REACCH region.

References

Conservation Technology Information Center (CTIC). (2015). Conservation Tillage Systems. CTIC Information Sheet. Retrieved from http://www.ctic.org/media/pdf/Conservation%20Tillage%20Info%20Sheet.pdf

Dillman, D.A., Smyth, J.D., & Christian, L.M. (2008). *Internet, mail, and Mixed-Mode Surveys: The Tailored Design Method* (3rd ed.). Wiley.

The American Association for Public Opinion Research (AAPOR). (2011). *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. AAPOR. Retrieved from http://www.aapor.org/AAPORKentico/AAPOR_Main/media/MainSiteFiles/StandardDefinitions2011_1.pdf