The Economic Analysis of Cover Crops, Soil Health, the role of Livestock and Impact on Moisture

Final Report for FNC14-963

Project Type: Farmer/Rancher
Funds awarded in 2014: $22,378.00
Projected End Date: 12/31/2015
Region: North Central
State: Nebraska
Project Coordinator:

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farmer

Co-Coordinators:

Mike McDonald
Indigo Ridge Farm

Project Information

Summary:

The 2014-2016 project sought to measure water usage, soil health indicators and weight gain of cattle in cash crops that were drilled with cocktail cover crops (CCs) v. plots without CCs. The impact of CCs upon each of these aspects was explored. The three, participating producers from southwest IA and southeast NE were impacted by 45” of historical rains in 2015 and 37″ in 2016. The role of historical rains cannot be overstated thus their impact on proposed goals and objectives is addressed accordingly. The results are presented in a manner so that limitations are clearly evident and stated.

The project met many goals while others were partially attained or not feasible primarily because of the weather.

The project did identify weight gain in cattle, slight increase in soil health and mitigate soil loss through the stable base of cover crops during intense rains. The project was inconclusive on cash crop yield gains and water usage. These aspects will be discussed in the “outcomes and impacts” section.

Introduction:

The project was originally conceived and initially focused on three producers' farms: one in southwest, IA; two in southeast, NE. The involvement of producers from similar and comparable geographic areas was purposeful yet the historic and concentrated rains of 2015 and 2016 impacted the ability of each producer to complete their respective project. Second, it made it difficult to truly gauge the relationship and/or the cause/effect of cover crops and moisture usage.

The original grant was modified with the helpful assistance of SARE primarily

because of four reasons.

First, the late- and wet springs, (2015 and 2016) impacted crop rotation thus in turn the viability of various cover crops (i.e., radishes, turnips having time to grow and then be grazed in the fall before the early frost).

Second, the harvests were late because the weather did not allow crops to appropriately "dry down" in the fields in order to be at the appropriate moisture level (i.e., 14% in McDonald's non-GMO soybeans). Harvest generally went to the mid- to late-part of November in 2015 which prevented drilling in most cases and in turn reduced cover crop options.

Third, the lack of cover crop growth impacted whether cattle could graze on plots and the biomass. This forced different mixtures of CC uses and impacted the grazing "window" and in turn the ability to positively impact weight gain. The lack of biomass impacted the ability to create carbon and in turn soil health but the health was positively impacted, overall.

Fourth, the timing and types of water sensor moistures were changed. Because of #1-3 and the sudden onset of extreme cold in late October/November, sensors had to be augmented with informal moisture checks and satellite records. It prevented reliable and valid data.

The following article provides partial credence for the project's goals and overall purpose. Ray Archulets assisted Ackley and McDonald through informal advice and modeling. This is a part of our longterm goal--to replicate nature and the prairie.

http://johndeerefurrow.com/2016/06/03/building-soil-livestock/ [See excerpt below.]

"A place for livestock. Cover crops help soils by feeding microbes during the winter and adding organic matter, but they have yet another benefit: they bring in livestock says NRCS soil scientist Ray Archuleta. Anyone with an interest in soil health will undoubtedly have heard of Archuleta. He'll freely profess that, after many years of working with NRCS, he had a major shift in thinking a few years ago. 'I finally had the epiphany that nature was always the mentor. It was always the template, but my education got in the way,' says Archuleta. 'I came to realize I was the product of reduction science, not holistic science.'

"Attend one of his workshops and you'll hear him use the words biology and ecology and microbes. But another one is 'biomimicry.' In short: Nature already has the answers. What farmers need to do is let nature work for them. In the case of livestock, look at the buffalo and the wildebeest, he says. They move in groups, and the urine and manure distribution is closer. When farmers let livestock mob graze their pastures, they are mimicking that aspect of nature. Farmers will see huge spikes in bacteria, better nutrient cycling, and increased organic matter. In addition, the cover crops themselves change. When a plant is being grazed, says Archuleta, it reallocates some photosynthate materials back into the root system and stimulates more root growth. Plus, grazing causes the roots to release compounds that feed soil biology and stimulates the roots. 'Roots start dying and growing and dying and growing, and bacteria feeds on those roots. That becomes part of nutrient cycling.'"

Project Objectives:

The project had several objectives and performance targets. We tried to focus on measurable steps while noting anecdotal evidence if pertinent. We wanted to be sure that the work informed future producers.

- Soil properties testing including water infiltration, soil density and soil organic

matter levels were completed for two producers.

- Determine water usage (*note this was not informative because of the excessive rain and subsequent impact on cover crop growth, cash crop water usage and weight gain in cattle).
- Complete the Haney Healthy Soil Test, Basic Soil Test, PLFA (phospholipid fatty acids) tests and assess biomass were completed on the majority of fields.
- Complete an economic analysis (partially completed because of the delays in planting and excessive rains; anecdotal findings were determined).
- Determine the weight gain of cattle in CC v. grazing in cash crop stubble (general results as based upon harvest dates and CC seeding).
- Apply statistics to analyze the interplay between water usage, CC, livestock gains and cash crop yields (this was not possible nor reliable because of the aforementioned).

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Research

Materials and methods:

The methods to measure each objective were specific and tailored to each target. The main goal was to have reliable and valid data; results are prefaced where this was not possible.

The soil properties (water infiltration, soil density and soil organic matter levels) were measured by the Natural Resources Conservation Service and with assistance by an Extension Educator from the University of Nebraska-Lincoln who also examined the CC biomass. *Water usage was not measured because of the excessive rains and the delayed plantings.

The Haney- and Basic Soil Tests, PLFA (phospholipid fatty acids) were submitted to Ward Labs at Kearney, NE for soil organic matter, basic nutrients and water soluble carbon.

The economic analysis was anecdotal; a formal analysis was not possible.

The weight gains of cattle were informally measured by producers (two) whom completed this study portion.

The interplay between water usage, CC, livestock gains and cash crop yields was not possible nor reliable. General results were presented.

Research results and discussion:

The project met several projected outcomes and possible impacts while others were partially attained or not feasible primarily because of the weather. The historically, high levels of rain, 45” of rain in 2015 and 37" in 2016 affected the outcomes. With support and guidance from SARE, it was determined to meet the limited objectives that were feasible and which could be effectively achieved. One producer, did not fully complete all aspects.

The project did identify weight gain in cattle, an increase in soil health and mitigation of soil loss through the stable base of cover crops during intense rains. The project was inconclusive on cash crop yield gains, water usage and a positive economic return when examining CCs, grazing and cash crop yield.

The soil properties [water infiltration, soil density and soil organic matter (SOM) levels] were examined. There was no measurable impact on water infiltration; the SOM increased .012 and the bulk density increased by .009. The CC biomass was inconclusive because of the late plantings and limited growing period. *Water usage was not measured because of the excessive rains and the delayed plantings.

The Haney- and Basic Soil Tests, PLFA (phospholipid fatty acids) were analyzed by Ward Labs at Kearney, NE. The Haney results demonstrated an average increase of 15 lbs. of water soluble carbon. The impact on developing soil organic matter was .012 (negligible but positive). The PLFA provided a representation of living soil microbial biomass -- it identifies the presence or absence of various functional groups known as PLFA biomarkers (bacteria, fungi, protozoa, etc.). The results indicated a positive increase--on average--of the Carbon to Nitrogen ratio from 7:1 to 12:1 (15 or higher is the preferred goal). The basic soil test indicated a positive increase of nitrogen (from soybeans and legume CCs) of approximately 30 lbs/acre (one site) or less then 30 lbs at other sites. The analysis of N-P-K, Su and Zn did not indicate measurable differences (*note, the results were not always taken at the same time or same spot thus comparisons have to be qualified).

The economic analysis was anecdotal; a formal analysis was not possible. The yields of corn, wheat and soybeans were all below historical averages. We believe the late plantings, excessive rain and late harvests, combined to provide a wide range of yields. Since our plots were small and limited, we did not achieve good results (ie., 32 bushels/acre for soybeans; 132 bushels/acre for corn; 52 bushels/acre for wheat). Note, this is on average and is widely gauged thus these figures should not be considered reliable.

The weight gains of cattle were informally measured by producers (two) whom completed this study portion. Two producers indicated gains of approximately 1.8 lbs/day over two months (late summer) in yearlings and fifth-year cows.

The interplay between water usage, CC, livestock gains and cash crop yields was not possible nor reliable. General results are presented (above) but the excessive rains created inconclusive analyses.

Background information.

The following four variables impacted the possible accomplishments/milestones from the original proposal.

First, the late- and wet spring impacted crop rotation thus in turn the viability of various cover crops (i.e., radishes, turnips having time to grow and then be grazed in fall before the early frost). The excessive rains in 2015, impacted late to even prevented planting. For example, barley was drilled in the fall but the severe winter killed the majority of the stand and the late spring prevented a planting to spring barley, oats, etc. Consequently, the options including grazing were very limited.

Second, the harvest was late because the weather did not allow crops to appropriately "dry down" in the fields similar to 2014. Even with high-moisture corn, it was difficult to interseed cover crops.

Third, in addition, the excessive rains eliminated herbicide residuals. On one hand this enhanced the ability to use different types of cover crops but the excessive weeds (i.e., water hemp) made it really difficult to interseed and successfully initiate cover crops and fall drilling.

Fourth, harvest generally went to the mid- to late-part of November which prevented drilling in most cases and in turn reduced cover crop options and grazing options.

Impact of Results/Outcomes

Two field days were held in 2015, respectively, in August and October. The first was attended by over 45 producers and agricultural professionals. The rotations, grazing and cover crop sites were presented, analyzed and discussed. The first site in IA focused on rotational grazing, soil health, prevented planting options, drilling cover crops into post-wheat and discussed collaborative opportunities with the Practical Farmers of Iowa who also presented at the field day.

The second field day was held at Palmyra and Douglas, NE on Oct. 6. It was attended by over 67 producers and agricultural professionals. This day focused on: viewing cover crops and discussing advantages and disadvantages of species; viewing annual/perennial grasses and legumes and grazing paddocks; viewing a soil pit and discussing the soil biology of 3 years of cover crops; viewing and discussing the impact of compost; and discussing the impact of cover crops on weeds and stacked crop rotations.

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The results of the study were presented by one producer, Mike McDonald, at the annual, national conference of No-Till on the Plains at Salina, KS. The presentation to over 175 persons was on January 27, 2016. He focused on the the pros/cons of certain CCs, the uses of various legumes and grasses to enhance weight gains in cattle and the Haney Healthy Soil Assessment.

An additional accomplishment is the partnership and relationship that was enhanced between IA and NE producers. Relationships and informal learning partners were fostered between and among the local, NRCS personnel, local extension educators, and producers with common interests. Our project was included in the informal sharing at field days, one grant proposal and two workshops.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

Please refer to the "Accomplishments" section for the explanation of the field days.

SARE included past awardees in the Farmers Forum presentations at the 2016 Kansas Rural Center Fall Conference in Manhattan, Kansas, November 2016. The project was presented at this conference.

http://www.youtube.com/watch?v=YvkfaGfeNH8&sns=em

http://farmprogress.com/story-sowing-seeds-sustainability-southeast-nebraska-farm-9-144596

[Exerpt from NebraskaFarmer article July 29, 2016.]

"Through the NRCS' Conservation Stewardship Program and the Sustainable Agriculture and Research Education Program, McDonald has been able to establish that pollinator habitat; and he's also been able to more fully develop his soil health management system through the use of no-till, diverse crop rotations and cover crops.

"And while many farmers measure success by bushel outputs, McDonald also includes the cost of inputs in his financial analysis. 'We are trying to reduce, to hopefully not use, herbicides. I'm not organic, but I'm trying to manage by using different cropping rotations,' he says.

"Part of his farming approach includes managing risks like weather volatility by using continuous cover crops. The cover crops help capture and retain moisture for those periods of extended dry weather that add stress to both the crop and to the farmer.

'Utilizing a mixture of cool- and warm-season cover crops, particularly legumes, helps us capture moisture when it is there — and reduce stress if it doesn't rain, or if I'm going to have a crop,' McDonald says."

Project Outcomes

Recommendations:

Potential Contributions

There are four potential contributions.

First, the mixtures, rates and planting periods of cover crops directly impact weed suppression. The mixtures need diversity that grows in cool weather but which persists through hot and dry periods. This mixture also needs to consider CCs that most impact the "below-ground" carbon and exudates. This is where SOM can really develop. We tried too much diversity.

Second, reduce the # of variables in the research plots and increase the plot sizes so there is mitigation for possible environmental conditions such as excessive rain, heat, etc. We had small plots but think more broadly to include areas that can

prevent possible hindrances.

Third, the Haney test is valuable and gauges water soluble carbon/nitrogen but the interface with basic soil tests and the PLFA are difficult. Establishing a matrix that compares the "apples to apples" areas, where feasible, of the Haney vs. the Basic Soil Test vs. the PLFA would be helpful and enhance soil health measurements.

Fourth, establish the research to go at least two -- preferably three -- years. Because of the rain, one plot beyond the student areas had 2+ years of four types of clover. This indirect result resulted because of prevented planting, grazing and the parallel introduction of bees. The sustained impact of the clover upon the soil, honey production and overall beneficial insects is beyond this project but it was obvious that something special was happening. This is a direction in biomimicry that Ray Archuleta and others are encouraging.

Future Recommendations

We have five recommendations.

First, the original proposal was too broad. Focusing on two or possibly three aspects would achieve "greater depth vs. shallow findings." The concentration on soil organic matter (SOM), specific CCs vs. a wide-array of CCs and one cash crop are three possible areas for future study. The inclusion of too many variables created confounding variables thereby resulting in interpretations vs. specific findings in all areas.

Concentrating on SOM also helped us gauge moisture but it was not totally focused on water sensor monitors which were not helpful during the extremely, high rainfall. Concentrating on specific cover crops such as legumes narrows the focus and intensifies the ability to differentiate CCs' impact. Last, the focus on one cash crop ties more directly to SOM and intentional CCs. The original proposition is more suitable for a long-term study.

McDonald focused on these three aspects in a separate 18 acres beyond the core study field. This was beyond the intent of the study but anecdotal evidence appears to indicate that legume CCs (ladino-, medium red- and balansa clover) are increasing SOM and grazing forage beyond the previous plots. Because of the high-moisture, Ackley, was able to drill legumes, brassicas and grazing grasses into his wheat stubble. This step helped prevent weeds and enhanced grazing into stubble that is typically fallowed with an herbicide pass.

A second recommendation is to repeat the same plots for at least two years. "Less is more" is a good mantra to enhance replication and the ability to interpret the findings. Planting corn in one year then going to soybeans in the second year is a normal rotation but it was not realistic for the aims of this project. By repeating the CCs, we are able to better control herbicides, residuals and the long-term impact of CCs particularly legumes and in turn SOM. This was an unforeseen happening. The excessive rains really impacted the spraying windows and herbicide half-lives. The latter is particularly relevant to brassica and legumes which can be difficult to integrate in plots.

Third, specific herbicides should be identified so that their mode of action and site of action can be studied. Because of the rain, we were not able to get ahead of many weeds as well as plant in a timely manner. This really hindered being able to meet the original goals. This focus also ties to the intentional use of certain CCs.

Fourth, the carbon of specific cover crops should be investigated in terms of "below-ground" exudates and relationship to intentional mixtures and CC diversity. The "above-ground" biomass is important but to truly impact water infiltration and build SOM, one has to replicate the prairie environment as close as possible if substantial

gains in SOM are feasible.

Last, the maturities of the cash crops (ie., 109 vs. 114 day corn or 2.9 vs. 3.6 soybean) have a direct relationship with CC choices. This was not well-thought out and it ties to the environmental conditions. In order to grow substantial, CC roots/carbon, we need to allow as much growing time as possible prior to freezing conditions. It is a balancing act with economics and soil health.

Information Products

- Cover Crops, Soil Health, and Livestock with Michael McDonald (Multimedia)