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Feasibility of Using Cover Crops to Enhance Soil Organic Matter and Crop Yield in New Mexico

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Abstract

This study evaluates the potential of using cover crop to enhance yield and farm profitability using experimental data from Clovis Agricultural Research Center, New Mexico. The analysis includes seven different combinations of cover crops and one fallow treatment as a control. The Monte Carlo simulations results show that a cover crop treatment that includes a mixture of six crops (6XM) yields highest net return, while the treatment that uses only canola provides a least risky option.

Key Words: wheat-fallow system, cover crops, business risk and benefit, stochastic dominance

Introduction

Wheat-fallow is one of the widely used cropping systems in the U.S. Farm operators leave their land fallow between two crops to conserve water and soil nutrients, enhance crop yield, and improve farm profitability (Labarta et al. 2002; Griffin and Hesterman 1991; Unger et al. 2006; Adusumilli, 2016). However, in dry and semiarid regions a long period of fallow may increase soil erosion, rainwater run-off, and lead to a substantial loss of soil organic matter (SOM). Moreover, recent studies show that cover crops enhance soil quality attributes by increasing soil carbon, N content, SOM, beneficial microbial population, soil water retention, and eventually boost crop yield (Sainju et al. 2002; Nielsen et al. 2015; Calderon et al. 2016).

Cover crops are also observed to reduce greenhouse gas emissions (Coreil 2016), soil erosion (Langdale et al. 1991), leaching (Weinert et al. 2002), and chemical use (Lazarus and White 1984). Because of these multitudes of benefits, the Natural Resources Conservation Service division of the USDA promotes the use of cover crops as a conservation measure by offering various incentive programs (USDA-NRCS 2015; SARE 2015).

Moreover, precipitation trend studies in the southern High Plains regions show that more than sixty percent of the precipitation occurs during the fallow period of typical crop-fallow rotation systems, and precipitation storage efficiency during the extended fallow period is relatively low. Therefore, adopting conservation practices including reduced-tillage and the cover crop has high potential enhancing crop yield and supporting succeeding crops through improved soil health and water conservation. In this light, this study evaluates the potential of using cover crops as a means to enhance soil organic matter, rainwater absorption and retention capacity of the soil, weed suppression, crop yield, and farm profitability. We use experimental data from the Agriculture Science Center-Clovis, NM (34°35’ N, 103°12’ W, 1,348 m

elevations). The experiment includes eight treatments including seven different combinations of cover crops and one treatment with fallow (control). The preliminary results from the Monte Carlo simulation show that a cover crop treatment that includes a mixture of six crops (6XM) yields highest net return, while treatment with canola provides a least risky option. In particular, the average net return for the 6XM treatment is $433/acre, while the least risky option (canola) yields $350/acre.

Method

Consistent with the previous studies, the experiment was designed using a randomized complete block design (RCBD), with three replications and eight treatments. One of the experiments was used as control (fallow) and other seven treatments included different combinations of cover crops (see Appendix 1 for details). The study includes data from last two crop years (2016-2017). The data from the first year are used for establishing the baseline yield. The data from the second year are used for calculating the net returns by treatment. The list of cover crops with their respective treatment number and cultivated wedges are presented in Table 3.

The analysis involved preparing an enterprise crop budget for each treatment to generate net returns and identify potential stochastic variables. We used experimental yield data and market prices for outputs and production inputs to set up the budgets and used @Risk software to simulate the results. Following Hansen and Ribaudo (2008), we incorporate the indirect benefit of the cover crop by accounting for the reduced soil erosion (15 tons/acres*imputed price of $2/ton).

Result

The enterprise crop budgets for seven different cover crop treatments are reported in Table 1 below. Although identical cultivation practices used for each treatment, the crop budget differ in terms of seed cost. The crop budgets include indirect benefits of reduced soil erosion. Moreover, the cover crop can also be harvested or grazed over for a fee and generate additional revenue. However, it was terminated by using herbicide and does not yield revenue.

Table 1. Crop Budgets for Seven Cover Crop Treatments used in the Study

	6XM	3XM	Canola	Pea	Oat	POM	PCM
Primary Yield	0	0	0	0	0	0	0
Primacy Price	0	0	0	0	0	0	0
Secondary Income (erosion)	30	30	30	30	30	30	30
Gross return	30	30	30	30	30	30	30
Operating expenses							
Seed	22.3	17.33	9	25	18	21.5	17
Fertilizer	0	0	0	0	0	0	0
Chemicals	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Crop insurance	0	0	0	0	0	0	0
Other Inputs	0	0	0	0	0	0	0
Fuel, oil and lubricants	3	2.9	2.7	2.7	2.7	2.8	2.8
Repairs	1.15	1.1	0.9	0.9	0.9	1	1
Custom Charges	4.05	4	3.8	3.8	3.8	3.9	3.9
Land Taxes	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Other expenses	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total expenses	50.94	45.77	36.84	52.84	45.84	49.64	45.14
Return over operating expenses	-20.9	-15.7	-6.84	-22.84	-15.8	-19.6	-15.1
Fixed costs	5.53	5.53	5.53	5.53	5.53	5.53	5.53
Total costs	56.47	51.3	42.37	58.37	51.37	55.17	50.67
Net farm income	-26.4	-21.3	-12.3	-28.3	-21.3	-25.1	-20.6
Labor/Management costs	1.5	1.45	1.3	1.3	1.3	1.4	1.4
Net operating profits	-27.9	-22.7	-13.6	-29.67	-22.6	-26.5	-22.0
Capital costs							
Interest on operating capital	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Interest on equipment	2.09	2.09	2.09	2.09	2.09	2.09	2.09
Total capital costs	2.29	2.29	2.29	2.29	2.29	2.29	2.29
Return to land and risk	**-30.2**	**-25.0**	**-15.9**	**-31.96**	**-24.9**	**-28.8**	**-24.3**
Flex Computation	-22.6	-17.4	-8.34	-24.34	-17.3	-21.2	-16.7

Budget format source: New Mexico State University, Extension Budget, by Hawkes et al.

The values reported in Table 1 are on per acre basis. From Table 1 we can see that the 6XM cover crop treatment has the highest cost, whereas canola is the least cost option. Cover crops also have an alternative use as livestock feed that adds revenue.

Table 2 Profitability Ranking

Treatments	Average Stochastic Net benefit*	Stochastic Range of Net Benefit*	Other Profitable Benefit	Probable Cost
6XM	422.01	6.945 -1131.42	1, 4, 5	2a
3XM	368.46	-63.94 -1026.82	1, 4, 5	2b
Pea	386.16	113.95 -700.72	1, 4, 5	2a
POM	387.73	144.82 -735.55	1, 4, 5	2a
Canola	346.56	111.23 -615.90	4, 5	2c
Oat	394.39	113.48 -732.32	4, 5	2b
PCM	389.90	114.63 -717.94	4, 5	2b
Fallow	396.17	147.31 -644.29	4, 5	

1. Probability of adding nitrogen as it is a leguminous crop
2. Cost of establishment: a) higher, b) medium, c) low
3. Takes higher amount of water
4. Added organic matter
5. Erosion Control

* These are simulated stochastic values generated from a random draw.

Economically and in agronomic traits, six cover crop mixtures come out to be the prominent alternatives for the New Mexico farmers. Highest probable mean return to risk for 6XM is 422 dollars per acre. In statically and economic terms, those data sets which have the higher variations through observations are considered risky, canola being the opposite is the safest.

Summary and Conclusion

We used Monte Carlo simulation to evaluate the potential benefits of using cover crop in Eastern New Mexico to enhance soil organic matter and farm profitability. The results from the Monte Carlo simulations show that a cover crop treatment that includes a mixture of six crops (6XM) yields highest net return, while treatment with only canola provides a least risky option. These results have significant policy and investment implication for growers in the Clovis and surrounding area. In particular, cover crop in general yield higher returns because of its potential to reduce soil erosion (i.e., it has an added value of $30/acre). Moreover, adoption of the most profitable cover crop (6XM) would further enhance farm profitability and help in reducing soil erosion. These results also indicate that further research is needed to identify other cover crop options that may yield additional benefits of adding nitrogen, weed control, enhanced water retention capacity particularly in arid regions where the incidence of wind erosion is high.

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