SUMMARY REPORT

Judith Basin Nitrogen Project 2015 Farmer Survey

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Overview

In the early spring of 2015, a mail survey was implemented to capture perceptions, attitudes, and behaviors of representative farmers who operate land in Judith Basin and Fergus Counties, Montana. The survey was part of a larger participatory study -- the Judith River Watershed Nitrogen Project (JRWNP) -- that engaged local farmers and community leaders in research to better understand the sources of high nitrate levels in local groundwater, and to explore the viability and effectiveness of a range of alternative agricultural management practices designed to reduce nitrate leaching to groundwater.

Importantly, the 2015 farmer survey was designed as a follow up to an earlier survey conducted in spring 2012 with randomly sampled farmers in the same two counties. A key objective of the 2015 survey was to see if perceptions, attitudes, and behaviors of farmers have changed over the life of the JRWNP. To accomplish this, two overlapping samples of farms were included in 2015: (a) a new random sample of farms based on current lists of participants in federal farm programs, and (b) a resurvey of all farmers who had responded to the original 2012 survey.

The 2015 survey included questions about farmer cropping and nutrient management practices, perceptions about nitrate issues, and feedback on the JRWNP overall. In this report, we provide an overview of how farmers responded to questions in the 2015 survey, with particular attention to respondents who were included in the 2015 random sample. For many questions, we also compare results

Methodology

Sampling

The follow up survey was designed to provide an opportunity for us to resurvey those farmers who responded in the 2012 baseline survey, but also to include a new cross-sectional random sample of farms.

As was done in 2012, the new sampling frame for the 2015 survey was obtained from the Montana office of the USDA Farm Services Agency (FSA). Specifically, we included all persons who received farm program payments in fiscal year 2013 or 2014 under various commodity programs (e.g., Market loss assistance, direct and counter-cyclical payments, loan deficiency payments, etc.), natural disaster payments, and conservation program payments. Only persons receiving payments for farm operations located in Judith Basin and Fergus counties were included in the new random sample frame, and program payment recipients with mailing addresses outside of Montana were excluded. Because nearly all commercial farming operations in this region participate in at least one type of federal farm program, this list is viewed by local experts as very representative of the farm population.

The names and mailing addresses of all persons included in the new random sample were then compared to those included in our sample frame from 2012. For the purposes of adapting cover letter language and tracking respondents, we identified individuals in the new sample that were respondents and non-respondents from our 2012 survey.

Our final sample for the 2015 survey included 488 farms, which can be divided into several subgroups:

- **139 resurveyed farms**, including all the individuals who responded to the 2012 survey (64 of whom also appeared in the new 2015 random sample, and 75 of whom were not in the 2015 random sample).
- **413 randomly sampled farms**, including the 307 new names and addresses that were not part of the 2012 sample, 42 persons who had been included in the 2012 sample but who never responded to the survey in 2012, and the 64 people listed above who responded in 2012 and also appeared in the new 2015 random sample.

Implementation

The survey was administered through the mail using a modified Dillman Tailored Design Method.[1] This method is designed to provide potential respondents with sufficient background information to motivate them to participate, and to provide multiple opportunities for them to reply.

[1] Dillman, D.A., J.D. Smyth, and L.M Christian. 2009. *Internet, Mail and Mixed-Mode Surveys: The Tailored Design Method*. 3rd Ed. Hoboken, NJ: John Wiley and Sons.

Specifically, an advanced letter explaining the project was sent in mid-February, 2015, then several days later a full survey packet (including a cover letter, copy of the instrument, background information sheet, and prepaid return envelope) was mailed to each sampled farm household. A reminder postcard was sent to the full sample a week later. In mid-March, a second full survey packet was sent to all non-respondents, followed by a second reminder card 10 days later. A third and final survey packet was sent on April 10, 2015 to the remaining non-respondents.

Response Rates

Detailed information about response rates are listed in Table 1 below**.**

Overall, the 2015 survey experienced a 50.5% response rate.

Of the 488 sample points, 74 (or 15%) were disqualified because they were undeliverable addresses, were duplicates with other sample points, or were not current operators of a farm in the study area. Although some of these non-operators provided information on the tenant or other person who did operate their land, we did not include these 'referrals' in our sample. The resulting sample should be seen as representing the set of operating farmers who are listed on the FSA sampling lists.

We received 209 usable responses (50.5% of the adjusted sample size of 414 operating farms).

The response rate for the 345 eligible farms in the new random sample was just over 46%. The new random sample thus includes 160 useable observations in 2015. Among the farms in the 2015 random sample, response rates for the subset of 250 eligible farms who were <u>not</u> included in the 2012 survey was 47%. Not surprisingly, the response rate for farmers who had responded in 2012 and were also captured in the new random sample was higher (66%), and response rates for those who were contacted, but did not respond in 2012, and who were randomly sampled again in 2015 were lower (15%).

The right side of Table 1 shows a 69% response rates for full set of 125 eligible farmers who responded in 2012 and were resurveyed in 2015. (This includes some who overlapped with the 2015 random sample, as well as those who did not). **Overall, we have usable observations from 86 farms who responded to the survey both in 2012 and 2015.**

The combined sample (including the new random sample and the resurveyed farms) provided 209 usable observations. Given the estimated size of the farm population in these two counties (roughly 800 working commercial farms), and the number of respondents (1), statistical methods suggest that our results are accurate to within +/- 6%. Statistically significant differences between subgroups are noted where appropriate.

Table 1: Response Rates, 2015 Judith Basin Nitrogen Project Farmer Survey

		2015 RANDOM SAMPLE				RESURVEY 2012 RESPS		
Status	**OVERALL**	*NEW, no 2012 overlap*	*Overlap 2012 Resps*	*Overlap 2012 NRs*	**ALL**	*Overlap 2015 random*	*Non-Overlap 2015 random*	**ALL**
Responded -- USABLE survey	**209**	117	37	6	**160**	37	49	**86**
Returned with REFUSAL	**3**	3			**3**			**0**
Returned BLANK	**4**	2	2		**4**	2		**2**
Contacted us to REFUSE	**4**	3	1		**4**	1		**1**
UNDELIVERABLE (bad address, vacant)	***12***	*9*	*1*		***10***	*1*	*2*	***3***
Duplicate	***5***	*3*	*2*		***5***	*2*		***2***
Returned - not operating a farm	***57***	*45*	*5*	*3*	***53***	*5*	*4*	***9***
No response	194	125	16	33	174	16	20	36
Original sample frame	**488**	**307**	**64**	**42**	**413**	**64**	**75**	**139**
Disqualified (in italics)	*74*	*57*	*8*	*3*	*68*	*8*	*6*	*14*
Disqualification Rate	*15.2%*	*18.6%*	*12.5%*	*7.1%*	*16.5%*	*12.5%*	*8.0%*	*10.1%*
Adj sample size	414	250	56	39	345	56	69	125
Responded	209	117	37	6	160	37	49	86
Response Rate	**50.5%**	**46.8%**	**66.1%**	**15.4%**	**46.4%**	**66.1%**	**71.0%**	**68.8%**

Timing of Surveys

The 2012 and 2015 Farmer Surveys were implemented during times when the world market conditions and commodity prices for wheat and fertilizers were notably trending in different directions (see vertical blue lines in figures 1 and 2 below).

In early 2012, farmers had experienced historically high prices for their wheat (peaking in 2008, but again in 2011 and higher than average for the previous 10 years). They were also paying record high prices for nitrogen fertilizers.

In early 2015, the global commodity markets had weakened, and wheat prices were down from the historic highs (though still above pre-boom levels). Meanwhile, fertilizer prices had declined less quickly, so the relative cost of fertilizer to the price of the commodity.

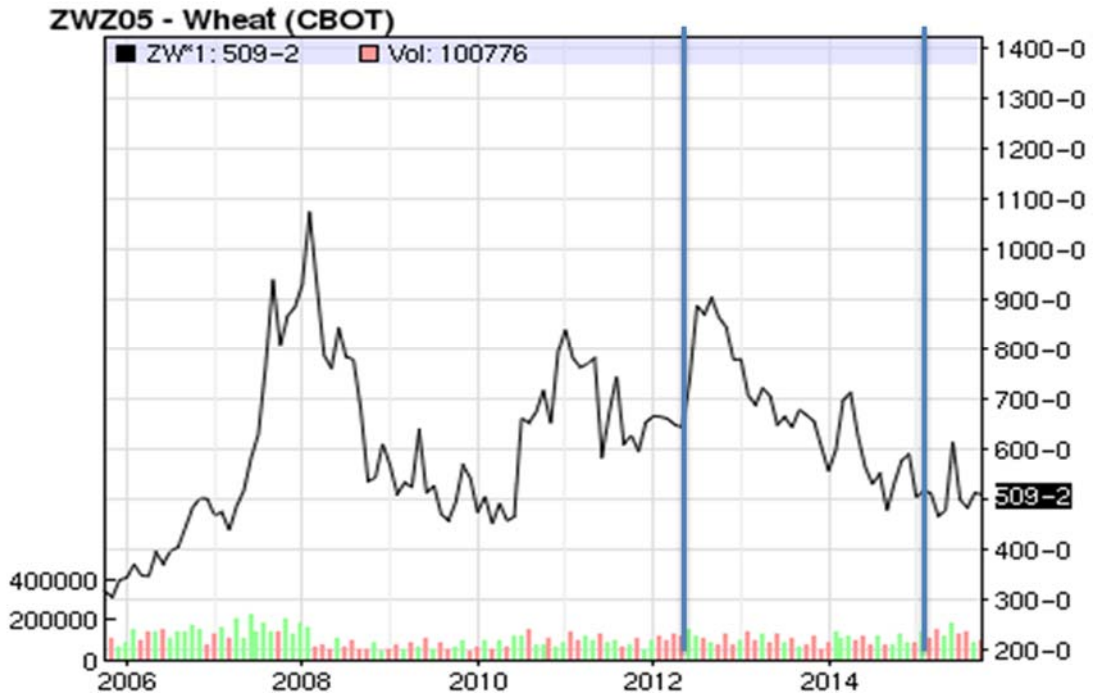

Figure 1: End of Day Commodity Futures Price for Wheat.
Source: NASDAQ: www.nasdaq.com/markets/wheat.aspx

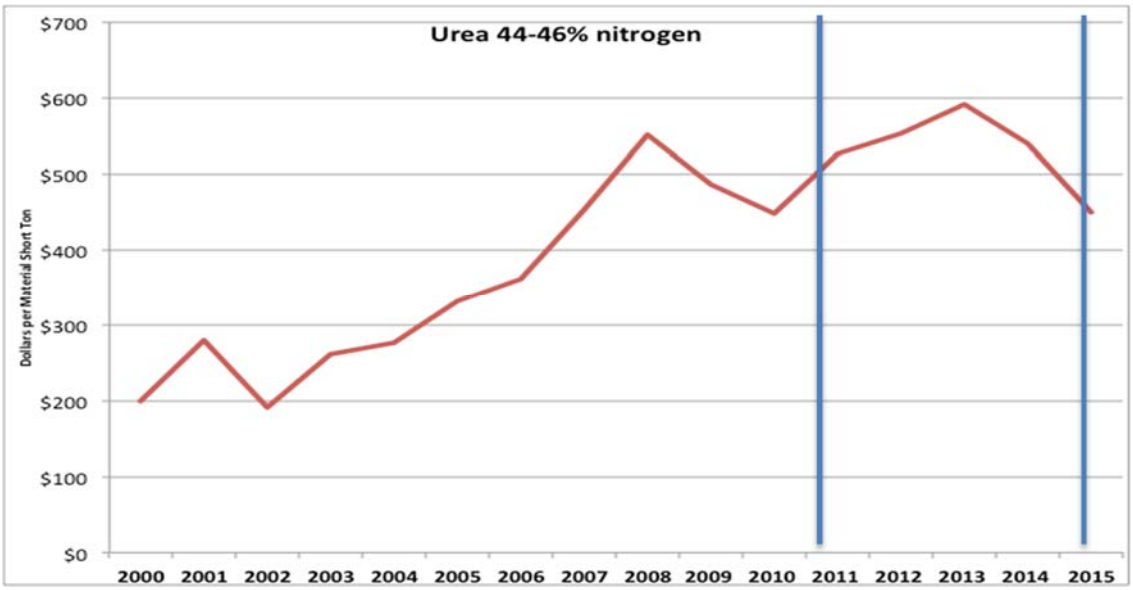

Figure 2: Price of Nitrogen Fertilizer Inputs (March/April price; per material short ton, real dollars)

Source: USDA Fertilizer Use and Price Series; updated with USDA Market News Reports from University of Illinois**.** http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx#26727

Profile of Respondents

To assess the representativeness of our survey respondents, some basic descriptive characteristics of respondents are compared to similar data reported in the 2012 US Census of Agriculture[2]. Three groups of survey respondents are profiled in Table 2:

- GROUP 1: The respondents who were selected as part of the new random sample in 2015. This group includes many farmers we had never contacted, but also some of the 2012 respondents who happened to show up in the new random sample. This sample provides the most authoritative estimate of the characteristics of the larger farm population in the two county study area in spring 2015.
- GROUP 2: Respondents who replied to both the 2012 and 2015 survey. Some of these are included in the random sample group listed above, but most are people who were included simply to get longitudinal observations from the same farms across the life of the project.
- GROUP 3: Respondents from the 2012 survey. Since roughly 30% of these did not reply in 2015 (either because they were no longer farming or chose not to respond a second time), a comparison between group 2 and group 3 permits some analysis of possible response bias among the resurveyed farmer population.

Generally speaking, the data in Table 1 suggests that all of our samples represent the larger farm community in Fergus and Judith Basin counties. There is a modest tendency to over-represent wheat producers and farmers who operate larger acreages in the survey sample than we see in the tabulations of the 2012 Census of Agriculture. Some differences (e.g., the higher reliance on livestock than crop income in 2015 than in 2012) could reflect trends in relative commodity prices as much as any sampling or response bias effects.

Most farmers in our 2015 sample raise some type of livestock, and just under half report cultivating wheat. About half of those who raise wheat rely principally on wheat for their farm net income; the other half rely more on livestock for their income.

Since the Judith River Watershed Nitrogen Project was focused on wheat production systems, many the questions in the 2015 survey were focused on wheat production practices. As such, many of the tables reported below reflect responses from the subset of respondents that raised wheat in 2014 (72 farms from our random sample; 41 of the farms that replied to both 2012 and 2015 surveys).

[2] We used characteristics of farms that reported some cropland as the census benchmark. This excludes some farms that are exclusively livestock operations (with no pasture or hay production), but closely approximates the population of farms that receives program benefits from the USDA Farm Services Agency.

Table 2: Profile of 2015 and 2012 Respondents, with 2012 Census Comparison

	2015 Random Sample	2015 Resurvey Respondents	2012 Survey Respondents (all)	2012 Census of Agriculture Benchmark[i]
Number of farms	160	86	141	835
Percent of farms raising commodity				
Livestock				
Beef	81.6	78.5	82.4	81.7
Sheep/goats	7.2	6.3	8.5	8.1
Crops				
Winter wheat	45.4	44.9	41.1	32.5
Spring wheat	26.3	21.8	26.2	19.2
Any wheat	46.1	48.7	43.0	36.4
Percent of farms with most income from:				
Beef	66.4	67.5	58.1	59.5
Wheat	20.4	20.0	25.0	22.2
Mean Acres Operated by Ownership				
Total	4,241	4,467	5,317	3,587
Owned	2,695	3,190	2,985	2,368
Rented	1,517	1,331	1,639	1,219
Mean Acres Operated by Land Use				
Harvested cereals	600	573	505	393
Harvested hay	476	490	502	298
Idled or fallowed cropland	246	219	321	277
Grazing livestock	2,945	3,152	3,630	2,551

[i] = Farms with any cropland.

Wheat Production Practices

Nearly all wheat farmers in the Judith River Watershed are utilizing no- or minimal-tillage practices on at least some of their wheat fields. Roughly 80% of wheat farmers also fallowed some of their fields in 2014, down somewhat from 2011 (the reference year in the 2012 survey). Reductions in fallowing are primarily done to allow for more continuous

production of grain crops. Only about 10% of wheat farmers planted non-cereal crops or cover crops in place of fallowing in their rotations. Later in this report we look at trends in fallowing in more detail. Wheat farmers in this area tend to grow wheat on relatively shallow soils, and constraining soil conditions (like cement gravels, hardpans, and saline seeps) are quite common.

Table 3: Wheat Production Practices and Field Conditions

	WHEAT GROWERS		
	2015 RANDOM SAMPLE	**2015 RESURVEY RESPONDENTS**	**2012 RANDOM SAMPLE**
	(n=72)	*(n=41)*	*(N-65)*
Tillage Practices			
Conventional tillage	22.9	22.5	26.7
Minimal tillage	38.6	40.0	36.7
No-till	70.0	72.5	68.3
Any reduced tillage	91.4	90.0	96.0
Fallowing Practices			
Used any summer or chemical fallow in wheat rotation in 2014	77.9	76.3	88.1
			(last 10-20 yrs)
Changes in fallowing over last 5 years:			
No change	48.1	42.9	44.1
Increased	9.6	14.3	3.8
Decreased (all types)	42.3	42.9	44.2
Decreased - planted cereals/wheat more years in a row	*32.7*	*28.6*	*34.6*
Decreased - planted non-cereals for harvest when rotating out of wheat	*7.7*	*14.3*	*9.6*
Decreased - planted cover crops instead (not harvested)	*1.9*	*0.0*	*0.0*
Percent who raised a legume crop in any field prior to planting wheat in 2014	23.2	25.6	25.0
Average depth of soil on wheat fields			
Less than 2 feet	64.7	66.7	67.8
2 to 4 feet	26.5	25.6	22.0
More than 4 feet	4.4	5.1	5.1
Not sure	4.4	2.6	5.1
Presence of soil conditions on wheat fields			
Cement gravel	42.9	40.0	35.0
Hardpan layer	48.6	37.5	53.3
Poor drainage	47.1	42.5	40.0
Saline seeps	54.3	37.5	63.3

Wheat Fertilization Practices

Our summary report from the 2012 survey provides extensive detail about the fertilization practices of wheat (and non-wheat) farmers in the Judith Basin[3]. The 2015 survey asked a more limited set of questions aimed at tracking changes in fertilizer and nitrogen management over the 3-year study period (Table 4).

The 2015 survey results demonstrate that nearly all wheat farmers put some of their nitrogen fertilizer down when they plant their seed, but significant proportions (over 40%) also top-dress another round of fertilizer in the early spring (pre-tillering) and/or in the late spring/early summer (post-tillering).

Wheat farmers in 2015 were somewhat less likely to report recent changes in their nitrogen fertilizer practices than in the 2012 survey. This likely reflects the different market conditions immediately preceding each survey - the 2012 farmers had been through 5 years of dramatic fluctuations in wheat and fertilizer prices, and were more likely to be increasing application rates and shifting the timing and types of fertilizer applied to fertilizer.

By contrast, the 2015 farmers reported fewer recent changes in fertilizer practices. They were notably less likely to be increasing fertilizer rates (perhaps because commodity prices had fallen more rapidly than fertilizer costs), though relatively few reported any decreases in fertilizer rates. About a third reported some changes in the timing of fertilizer applications, and less than 20% were changing the formulation or type of fertilizer used on their wheat fields.

Overall the factors that farmers consider important when making fertilizer rate decisions remained similar across the 2012 and 2015 surveys. The most important considerations reflect production and economic goals - maximizing yield and protein levels, reducing the risk of crop failure, and minimizing costs. Reducing risks of nitrate leaching (which have both economic and environmental benefits) and adjusting for soil organic matter were less important overall, but still cited by a majority of farmers.

The most notable change in responses between 2012 and 2015 reflect the importance of minimizing cost (Figure 3). The proportion of farmers that call this a very important or important factor rose significantly between the two surveys - perhaps again a reflection of the narrowing profit margins associated with continued high cost of fertilizer relative to declining wheat prices. Farmers were also less likely to focus on maximizing wheat protein levels. The proportion of farmers reporting attention to soil organic matter and risks of leaching also rose - both among the farmers who responded in both surveys, and among the two cross-sectional random samples of farmers from the watershed.

[3] See the final survey report: Jackson-Smith, D. and A. Armstrong (2012). Summary Report: 2012 Judith River Watershed Farmer Survey.

Table 4: Nitrogen Fertilization Practices among Wheat Farmers

Question	WHEAT GROWERS 2015 RANDOM SAMPLE	2015 RESURVEY RESPONDENTS	2012 RANDOM SAMPLE
In 2014, when did you apply commercial nitrogen (N) fertilizer on your wheat crop?			
With seed at planting	82.9	87.5	n.a.
Fall top-dress application	4.4	2.5	n.a.
Winter top-dress application	14.3	15	n.a.
Early spring (pre-plant or before tillering)	41.4	42.5	55.4
Spring/early summer top dress (tillering or after)	42.9	27.5	41.1
Did not apply any commercial N fertilizer on wheat fields in 2014	4.3	2.5	3.3
Overall, how have your nitrogen fertilization practices on wheat fields changed over the last 5 years?			
No major changes	35.7	43.6	16.7
Adjusted timing of when I fertilize	31.4	33.3	45.0
Use soil tests more now	28.6	38.5	45.0
Increased nitrogen fertilization rates	27.1	20.5	48.3
Adjusted the type or form of nitrogen fertilizer I use	17.1	15.4	35.0
Decreased nitrogen fertilization rates	2.9	10.3	15.0
Factors considered important or very important in making decisions about the rate of nitrogen applied to wheat fields in 2014			
Maximizing yield	89.4	89.5	86.0
Reduce risks of low yields or crop failure	83.1	78.4	81.4
Matching rate to crop yield goal	79.4	84.2	81.1
Minimizing cost	73.0	74.3	59.7
Maximizing wheat protein levels	69.2	73.7	78.6
Reduce risks of nitrate leaching	66.1	68.4	63.0
Results of recent soil tests	59.7	61.2	63.4
Accounting for soil organic matter	54.9	62.1	43.4

n.a. = not asked or asked in a different way that precludes direct comparisons.

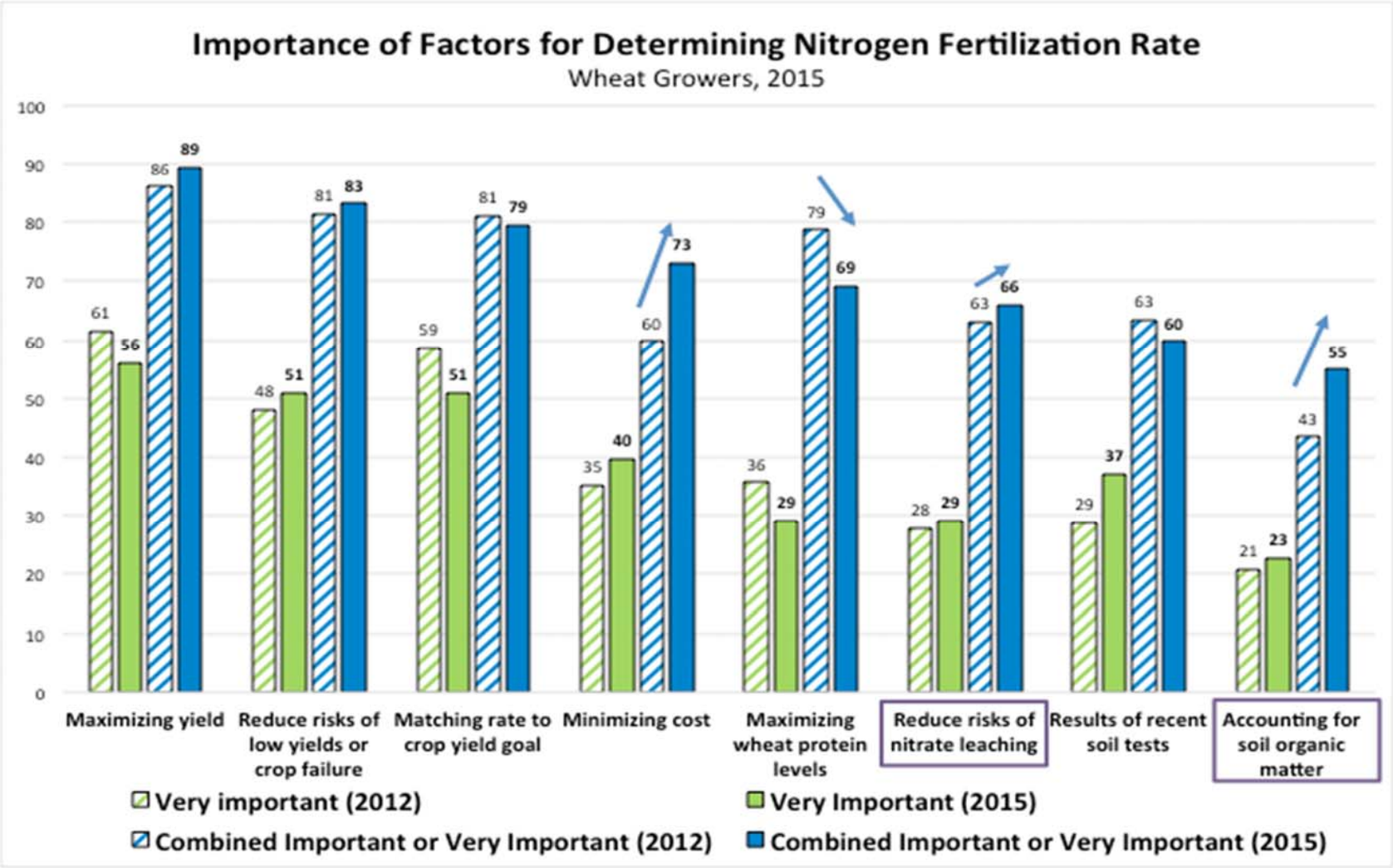

Figure 3: Percent Citing Factors as Important or Very Important to Determining Nitrogen Application Rates for Wheat.

Use of Various Nitrogen and Crop Rotation Management Practices

The 2015 survey collected information from a representative cross-section of Judith River Watershed wheat farmers related to their awareness and use of various management practices that might be used to reduce the rates of nitrate leaching into groundwater in the region (see Table 5 and Figure 5). The list of practices included in the 2015 survey was identical to that used in 2012.

As we saw in 2012, very few farmers in this region said they were unfamiliar with any of the listed practices. Unfamiliarity was highest for slow release forms of nitrogen fertilizer and the use of perennial crops to replace annual crops.

In spring 2015, almost two-thirds of wheat farmers report already using soil tests to determine nitrogen application rates, and a majority say they have moved away from fall toward late winter and early spring nitrogen application practices. A little less than a third split their nitrogen application (defined as "applying a second application after tillering has begun"), and just under a quarter are using slow release forms of nitrogen fertilizer.

Table 5: Awareness and Use of Various Management Practices by Wheat Farmers, 2015.

Type of Practice	Do It Now	Tried it but no longer use it	Heard of it, but never tried	Not familiar with practice
	percent of wheat growers			
Crop Rotations				
Convert from annual to perennial crops	26.9	4.5	61.2	7.5
Plant annual legumes instead of fallowing	16.4	10.4	68.7	4.5
Plant cover crop on fallowed fields	11.8	13.2	73.5	1.5
Fertilizer Rates				
Base nitrogen application rates on annual soil tests	61.8	20.6	11.8	5.9
Use variable rate fertilizer applications	19.1	5.9	69.1	5.9
Fertilizer Timing and Type				
Shift from fall to late winter/spring N application	65.7	10.4	17.9	6.0
Use split application of N fertilizer	30.4	13.0	47.8	8.7
Use slow release forms of N fertilizer	23.5	14.7	51.5	10.3

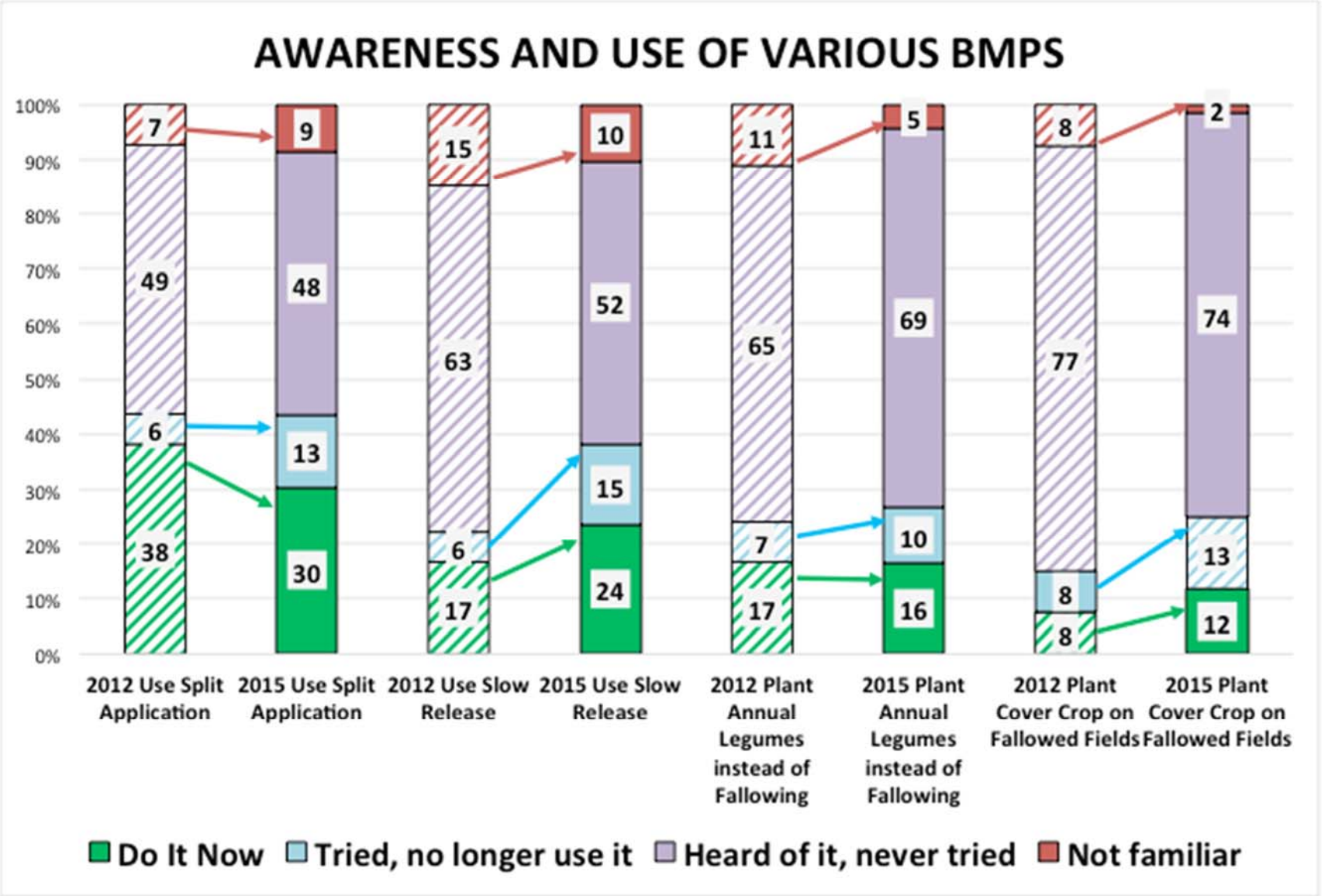

Figure 5: Awareness and Use of Various Nitrogen and Crop Rotation Management Practices by Wheat Farmers in the Judith River Watershed, 2012 and 2014 surveys.

Perceptions of Three Management Practices

The survey included a full page of questions about each of three key management practices that served as the focus for much of our project's fieldwork and research between 2012-2015. These practices included:

- **The use of "Slow-Release" forms of nitrogen fertilizer**. Slow release fertilizer consists of fertilizer pellets that are treated with a coating of material that degrades slowly – thus delaying release of fertilizer until soil conditions are warm and wet and plant growth has begun. The idea behind the practice is to avoid having nitrogen in the soil during periods of slow plant growth when excess available nitrogen cannot be used by the crop and is available to leach to groundwater during heavy rain events. Slow-release nitrogen is generally more expensive, but proponents believe it will enable more of the fertilizer to be used by the crop, with increased yields and protein levels in wheat compensating for the extra cost.
- **Split applications of spring nitrogen fertilizer** to include a 'late' application. In this case, we defined 'late application' to be fertilizer applied to the crop after the wheat plants begin tillering (or sending out new stems and shoots other than the initial parent shoot after seed germination). Conventional production practices for winter wheat are to put some fertilizer in the soil when seeds are planted in the fall, but to top-dress more fertilizer in the spring. Much of the spring application traditionally has occurred before tillering, though a growing number of producers are seeing advantages to delaying application until plants are more mature and wheat protein levels might be increased (see Table 4 above).
- **Planting peas (or other annual legumes) in place of fallow in a wheat rotation.** The dominant crop rotation in this region is a winter wheat – barley/spring wheat – fallow rotation. This suggests that grain crop fields are left fallow roughly one out of every three years. Fallowing is practiced largely to capture precipitation and retain soil moisture that can benefit the winter wheat crop the following season. Other benefits of fallowing can be opportunities to control weeds (most fallow fields are sprayed with herbicides), breaking pest cycles, and a belief that fallowing builds soil nutrients (see our 2012 farm survey report). Since no crops are grown in fallow fields, there are no plant roots to capture and utilize available soil nitrogen. If alternative crops (like an annual legume, such as peas) can be grown in place of fallow, many believe it could reduce nitrate leaching and provide many of the other benefits of fallowing. However, it is also recognized that growing a legume crop in place of fallow might reduce water and nutrients that would be available for the ensuing winter wheat crop.

The survey asks questions about a wide range of potential costs, benefits, advantages, and barriers to each of these three practices. The results are summarized in Table 6-8 below.

Table 6: Perceptions of Slow-Release Forms of Nitrogen Fertilizer

SLOW RELEASE FORMS OF NITROGEN	Percent of Wheat Growers				
Perceptions of Performance of Practice	*Strongly Disagree*	*Disagree*	*Agree*	*Strongly Agree*	*not sure*
Would increase farm expenses in long run	3	16	36	19	26
Would require I buy fertilizer from a new person	15	43	21	3	19
Would increase my profits	4	19	28	2	47
Would be difficult to implement on my farm	19	45	16	4	16
Would increase availability of N for crops	4	12	46	10	28
Would increase risk of crop failure	5	51	10	3	31
Would reduce nitrate losses from my soil	6	4	49	4	36
Would reduce volatilization to the atmosphere	3	6	52	4	35
Levels of concern about possible impacts of practice	*Not a concern*	*Minor concern*	*Concern*	*Major concern*	*not sure*
Extra costs not justified by possible increased yield or protein	4	19	35	32	10
Not enough information showing it works here	13	17	45	17	7
May not be enough soil moisture to work well	6	36	35	17	6
Cold spring temperatures mean nitrogen may be released too late to help the crop	6	26	42	16	10
Not available from my fertilizer dealer	39	19	10	6	26
Rating of possible incentives to use practice	*Not an incentive*	*A small incentive*	*A good incentive*	*A strong incentive*	*not sure*
Research to show impacts on yield or protein	2	5	43	42	9
Research to show economic costs and benefits	3	6	44	40	7
Research that shows decreased nitrate leaching	1	12	44	36	7
Advice from extension agent or crop advisor	10	22	40	18	10
Incentive payments from the NRCS	21	22	31	13	12

Table 7: Perceptions of Applying Fertilizer After Tillering

APPLYING SPRING FERTILIZER AFTER TILLERING	Percent of Wheat Growers				
Perceptions of Performance of Practice	*Strongly Disagree*	*Disagree*	*Agree*	*Strongly Agree*	*not sure*
Increase my farm expenses in long run	9	25	37	5	25
Requires equipment I don't have	20	36	36	3	5
Be difficult to implement on my farm	21	46	23	2	9
Be easy for my fertilizer dealer to accommodate	2	15	61	9	14
Reduce volatilization of nitrogen to atmosphere	2	15	39	2	42
Increase my profits	0	15	42	5	38
Reduce nitrate losses from my soil	0	15	43	3	37
Increase availability of nitrogen for my crops	0	8	62	8	23
Levels of concern about possible impacts of practice	*Not a concern*	*Minor concern*	*Concern*	*Major concern*	*not sure*
Extra cost of liquid fertilizer	5	14	41	32	8
Leaves wheel tracks in field	8	30	44	17	2
Might be too wet to get into field	9	27	48	13	3
Don't have time to apply fertilizer after tillering	19	25	42	13	2
Risk of burning crop	14	30	42	8	6
Rating of possible incentives to use practice	*Not an incentive*	*A small incentive*	*A good incentive*	*A strong incentive*	*not sure*
Research to show impacts on yield or protein	2	11	46	37	5
Research to show economic costs and benefits	2	11	46	35	6
Research that shows decreased nitrate leaching	2	17	42	32	8
Higher protein discounts	8	14	38	19	22
Incentive payments from the NRCS	22	27	28	16	8
Advice from extension agent or crop advisor	6	31	39	15	9

Table 8: Perceptions of Replacing Fallow with Legume Crop (e.g., peas)

ANNUAL LEGUME INSTEAD OF FALLOWING IN WHEAT	Percent of Wheat Growers				
Perceptions of Performance of Practice	*Strongly Disagree*	*Disagree*	*Agree*	*Strongly Agree*	*not sure*
Increase my farm expenses in long run	5	23	45	8	20
Be difficult to implement on my farm	9	48	32	5	6
Increase risk of crop failure	5	30	29	8	29
Increase my profits	8	27	24	6	35
Requires equipment I don't have	14	53	21	8	5
Increase availability of nitrogen for my crops	0	9	70	9	12
Reduce nitrate losses from my soil	0	2	50	3	32
Levels of concern about possible impacts of practice	*Not a concern*	*Minor concern*	*Concern*	*Major concern*	*not sure*
Uses up soil moisture needed by future crops	15	15	29	35	6
Makes weed management more difficult	15	28	27	22	8
Creates poor winter wheat seeding conditions	11	27	30	21	11
Might hurt next year's grain yield	22	21	28	21	8
Difficulties with harvesting and handling	12	28	35	19	4
Uses up nutrients needed by future crops	27	28	25	13	6
I don't have time to plant/harvest legume crop	23	32	27	12	6
Rating of possible incentives to use practice	*Not an incentive*	*A small incentive*	*A good incentive*	*A strong incentive*	*not sure*
Better local marketing options for legume crop	9	9	30	44	8
Higher prices for legume crop	9	8	33	42	8
Research to show impacts on future crops	8	11	52	24	6
Research to show economic costs and benefits	9	8	55	23	6
Incentive payments from the NRCS	24	23	29	17	8

Perceptions of Water Quality and Nitrate Leaching

As in 2012, the 2015 version of the survey asked all respondents (including both wheat and non-wheat farmers) to share their perceptions of water quality on their farm and in the watershed. We also inquired about their familiarity with the 'issue' of high nitrates in local groundwater and whether or not they were concerned about high nitrates.

Table 9: Perceptions of Water Quality, by Farm Type, 2012 and 2015 Surveys

	2015 Survey			2012 Survey			Change 2012-15	
QUESTION	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Wheat growers**	**Overall**
				percent of respondents				
Perceived Water Quality as Poor/Fair on my farm								
Overall	1.2	16.2	**8.0**	8.7	26.4	**16.0**	-10.2	**-8.0**
Surface waters	10.1	18.0	**13.6**	8.9	25.0	**15.7**	-7.0	**-2.1**
Shallow groundwater	16.3	26.8	**21.1**	15.4	26.7	**25.1**	0.1	**-4.0**
Deep groundwater	6.3	16.4	**10.9**	5.3	5.4	**5.3**	11.0	**5.6**
Perceived WQ as Poor/Fair in Judith River Watershed								
Overall	7.5	12.1	**9.6**	9.0	16.3	**12.0**	-4.2	**-2.4**
Surface waters	14.0	26.1	**19.5**	14.9	16.7	**15.7**	9.4	**3.8**
Shallow groundwater	19.5	34.9	**26.6**	22.4	16.7	**20.0**	18.2	**6.6**
Deep groundwater	7.7	9.2	**8.4**	5.4	7.4	**6.2**	1.8	**2.2**
How has water quality changed in this area over last 5 years?				*("over last 20 years" in 2012)*				
Became much worse	0.0	1.4	**0.7**	0.0	3.4	**1.4**		
Became somewhat worse	9.6	17.4	**13.2**	11.1	15.5	**13.0**		
Remained the same	71.1	60.9	**66.4**	53.8	60.3	**56.5**		
Became somewhat better	3.6	10.1	**6.6**	10.0	5.2	**8.0**		
Became much better	1.2	1.4	**1.3**	6.2	1.7	**4.3**		
Not Sure	14.5	8.7	**11.8**	18.8	13.8	**16.7**		

Table 10: Awareness and Concern about Nitrate Issues in Local Groundwater, By Farm Type, 2012 and 2015 Surveys.

	2015 Survey			2012 Survey			Change 2012-15	
QUESTION	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Wheat growers**	**Overall**
				percent of respondents				
Over last 4 years, how much have you heard about the issue of elevated nitrates in local groundwater?								
None	27.4	10.1	**19.6**	30.9	18.0	**25.4**	-7.9	-5.8
A little	23.8	24.6	**24.2**	28.4	31.1	**29.6**	-6.5	-5.4
Some	39.3	46.4	**42.5**	30.9	37.7	**33.8**	**8.7**	**8.7**
A lot	9.5	18.8	**13.7**	9.9	13.1	**11.3**	**5.7**	**2.4**
Elevated nitrate levels in local shallow GW…								
Are not likely to ever be a problem	24.7	16.7	**21**	36.8	19.6	**29.5**	-2.9	-8.5
Are not yet a problem, but could get worse if nothing is done	31.2	22.7	**27.3**	28.9	35.7	**31.8**	-13.0	-4.5
Have become a problem since settlement	2.6	4.5	**3.5**	2.6	3.6	**3.0**	0.9	0.5
Were here prior to pioneer settlement	6.5	12.1	**9.1**	5.3	8.9	**6.8**	3.2	2.3
Have become a problem in the last 50 years	16.9	28.8	**22.4**	13.2	19.6	**15.9**	**9.2**	**6.5**
Have become a problem in the last decade	18.2	15.2	**16.8**	13.2	12.5	**12.9**	**2.7**	**3.9**
I believe elevated nitrate levels in local wells are…								
Not something that needs to be addressed	13.2	8.2	**10.9**	11.3	6.4	**9.3**	1.8	1.6
Something individual landowners can fix on their own	23.7	31.1	**27.0**	31.0	40.4	**34.7**	-9.3	-7.7
Something the community can address by itself	19.7	18.0	**19.0**	25.4	14.9	**21.2**	3.1	-2.2
A situation where outside help is needed to fix	43.4	42.6	**43.1**	32.4	38.3	**34.7**	**4.3**	**8.4**
Concerned or very concerned about nitrates in…								
My household drinking water	36.2	40.5	**38.1**	25.3	36.9	**30.4**	3.6	**7.7**
My livestock water source	28.4	37.6	**32.6**	21.1	35.7	**27.3**	1.9	**5.3**
Drinking water for nearby houses	35.8	44.8	**39.8**	26.3	39.6	**32.1**	5.2	**7.7**
Groundwater in JB and F counties	44.9	49.2	**46.9**	40.8	44.0	**42.2**	5.2	**4.7**
Surface water in JB & F counties	37.5	50.7	**43.5**	40.8	47.4	**43.7**	3.3	**-0.2**

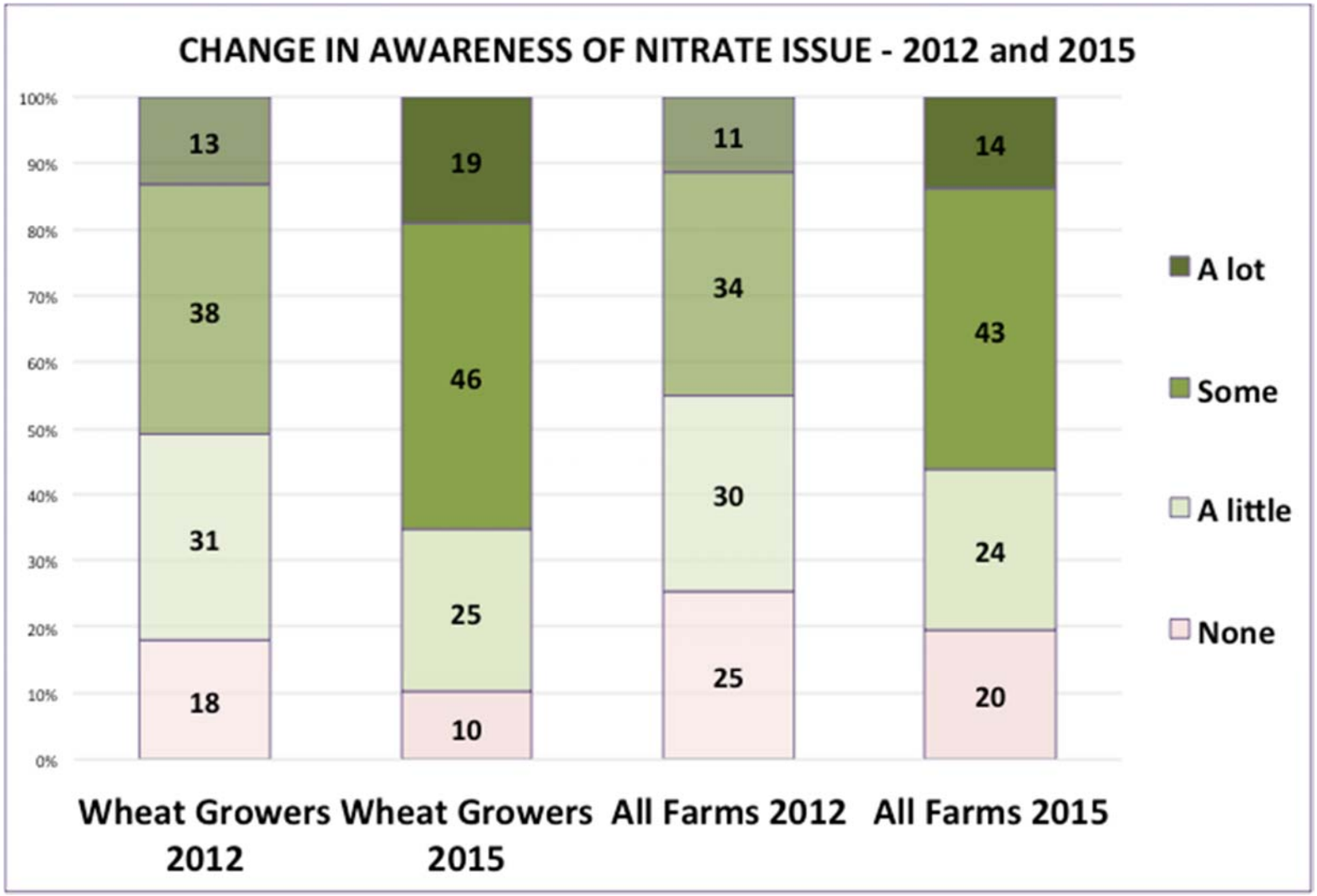

Figure 6: Change in Awareness of Nitrate Issue in Judith River Watershed, 2012 to 2015.

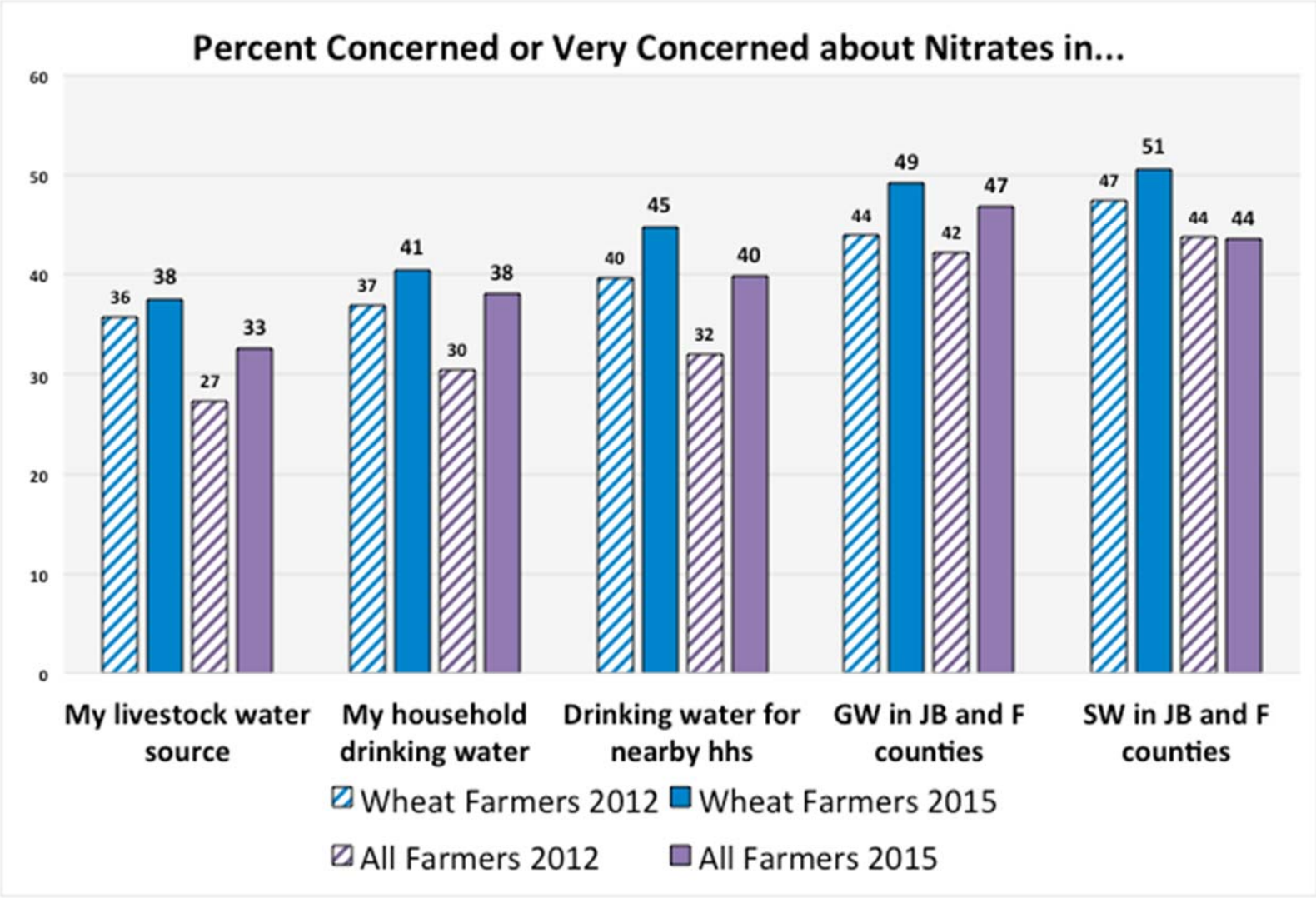

Figure 7: Change in Concern about Nitrates in Different Types of Water, By Farm Type, 2012-2015.

Table 11: Perceived Sources of Nitrates in Groundwater ("Based on what you've learned or observed, how important are each of the following possible sources of elevated nitrates in local groundwater?")

	2015 Survey			2012 Survey			Change 2012-15	
POSSIBLE SOURCES	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Non-Wheat Farms**	**Wheat growers**	**Overall**	**Wheat growers**	**Overall**
	percent of respondents saying it is a "moderate" or "major" source							
Agricultural fertilizers	71.6	56.7	**64.6**	59.4	56.9	**58.4**	-0.2	**6.2**
Livestock wastes	22.7	21.2	**22.0**	25	32.1	**38.0**	-10.9	-16.0
Decomposing organic matter in soil	14.9	18.7	**16.7**	17.6	28.5	**22.3**	-9.8	-5.6
Bedrock	10.7	19.7	**14.8**	11.5	9.3	**9.4**	10.4	**5.4**
Household wastes	13.5	10.5	**12.0**	16.9	14.5	**15.9**	-4.0	-3.9
Rain and snow	8.0	13.4	**10.6**	17.6	17.9	**17.7**	-4.5	-7.1
Wildlife	2.8	7.5	**5.1**	10.7	10.7	**10.7**	-3.2	-5.6

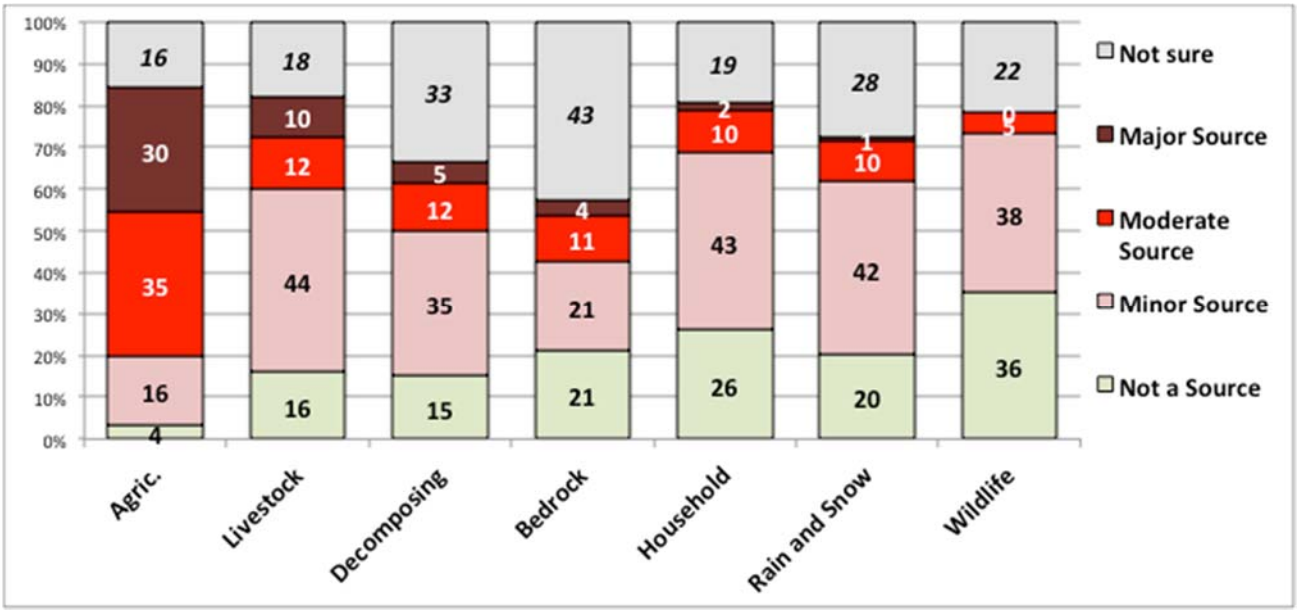

Figure 8: Perceived importance of Various Possible Sources of Nitrates in Local Groundwater, All Farms, 2015.

Table 12: Responses of Farm Households to Reports of High Nitrates in Area Groundwater (2015)

Steps taken in response to reports of elevated nitrates in this area	Non-Wheat Farms	Wheat Growers	All Farms
	percent saying they took this step		
Tested our Drinking Water	46.3	55.1	50.3
Bought bottled water	23.8	27.5	25.5
Installed a water purification or filtering system in home	15	23.2	18.8
Changed fertilizer practices on crop fields	3.8	23.2	12.8
Changed crop rotations	7.5	15.9	11.4
Drilled new well	7.5	5.8	6.7
Changed manure application or management practices	7.5	5.8	6.7
Changed fertilizer practices on pastures	2.5	7.2	4.7

Table 13: Perceptions of Quality of Scientific Research on Nitrate Issues

	2015 Survey		
	Non-Wheat Farms	Wheat growers	Overall
	percent of respondents		
I believe the current quality of scientific knowledge about nitrate issues in this area is strong			
Strongly disagree	5.3	7.4	6.3
Disagree	13.2	5.9	9.7
Neither agree nor disagree	56.6	60.3	58.3
Agree	21.1	17.6	19.4
Strongly agree	3.9	8.8	6.3
I believe that past scientific research on nitrate issues in this area has been done objectively			
Strongly disagree	1.3	4.5	2.8
Disagree	16.0	9.1	12.8
Neither agree nor disagree	52.0	56.1	53.9
Agree	29.3	27.3	28.4
Strongly agree	1.3	3.0	2.1
I believe that future scientific research on nitrate issues in this area could be done objectively			
Strongly disagree	1.3	1.5	1.4
Disagree	6.5	9.1	7.7
Neither agree nor disagree	33.8	36.4	35.0
Agree	46.8	39.4	43.4
Strongly agree	11.7	13.6	12.6

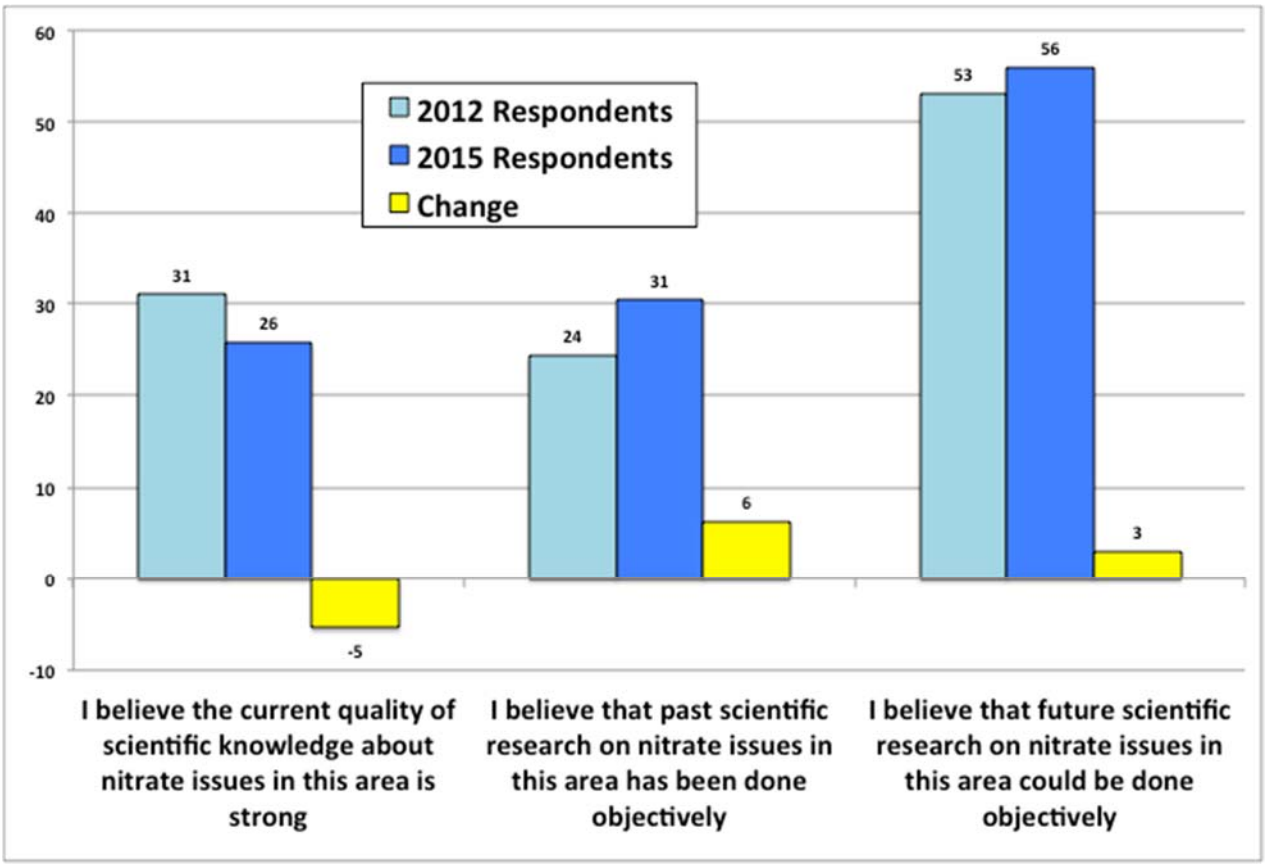

Figure 9: Changes in Perceptions about Quality of Scientific Research on Nitrate Issues, 2012-2015

Table 14: Awareness of Judith River Watershed Nitrogen Project

	2015 Random Sample Respondents		
	Non-Wheat Growers	**Wheat Growers**	**All Farms**
Before getting the survey, percent who have heard about the Judith River Watershed Nitrogen Project (JRWNP)	34.1	61.1	46.5
	Percent of those aware of the project		
Where did you hear about it?			
Local farmers hosting research on their farm	6.9	22.7	16.4
From other farmers	17.2	29.5	24.7
From county extension agent or other government	**55.2**	**54.5**	**54.8**
From crop advisors or local agribusiness	6.9	6.8	6.8
Attending field days	17.2	**43.2**	**32.9**
Reading newspaper	**48.3**	**54.5**	**52.1**
Radio program	24.1	9.1	15.1
Newsletters or brochures	**37.9**	**36.4**	**37.0**
Contacted directly by project staff	13.8	25.0	20.5
Based on what you've heard or seen, what is your general impression of the JRWNP?			
Very unfavorable	0.0	2.3	1.4
Unfavorable	0.0	2.3	1.4
Neutral	35.7	31.8	33.3
Favorable	53.6	54.5	54.2
Very favorable	10.7	9.1	9.7
Based on what you've heard or seen so far, how has the JRWNP changed your understanding of how nitrates get into groundwater in this area?			
No impact	17.9	13.6	15.3
Small change	39.3	40.9	40.3
Moderate change	42.9	43.2	43.1
Major change	0.0	2.3	1.4
Percent who told other farmers about the JRWNP	10.7	20.5	16.7

Table 15: Farm management changes made by people aware of the JWRNP at least partly because of the project.

	2015 Respondents		
	Non-Wheat Growers	Wheat Growers	All Farms
Test Drinking water for nitrates			
Already did this before JRWNP	32.0	53.7	45.5
JRWNP prompted me to do this	**24.0**	**9.8**	**15.2**
JRWNP made me more likely to do this	**36.0**	**19.5**	**25.8**
Do not plan to do this in future	8.0	17.1	13.6
Consider nitrate leaching when making farm decisions			
Already did this before JRWNP	19.2	45.5	35.7
JRWNP prompted me to do this	**15.4**	**4.5**	**8.6**
JRWNP made me more likely to do this	**53.8**	**38.6**	**44.3**
Do not plan to do this in future	11.5	11.4	11.4
Use slow release forms of N fertilizer			
Already did this before JRWNP	4.5	10.0	8.1
JRWNP prompted me to do this	**13.6**	**2.5**	**6.5**
JRWNP made me more likely to do this	**36.4**	**50.0**	**45.2**
Do not plan to do this in future	45.5	37.5	40.3
Apply spring fertilizer after tillering			
Already did this before JRWNP	5.0	38.1	27.4
JRWNP prompted me to do this	**10.0**	**2.4**	**4.8**
JRWNP made me more likely to do this	**25.0**	**35.7**	**32.3**
Do not plan to do this in future	60.0	23.8	35.5
Reduce use of fallow in wheat rotations			
Already did this before JRWNP	30.0	44.2	39.7
JRWNP prompted me to do this	**5.0**	**4.7**	**4.8**
JRWNP made me more likely to do this	**10.0**	**27.9**	**22.2**
Do not plan to do this in future	55.0	23.3	33.3
Change crop rotations			
Already did this before JRWNP	29.2	24.4	26.2
JRWNP prompted me to do this	**20.8**	**2.4**	**9.2**
JRWNP made me more likely to do this	**16.7**	**39.0**	**30.8**
Do not plan to do this in future	33.3	34.1	33.8

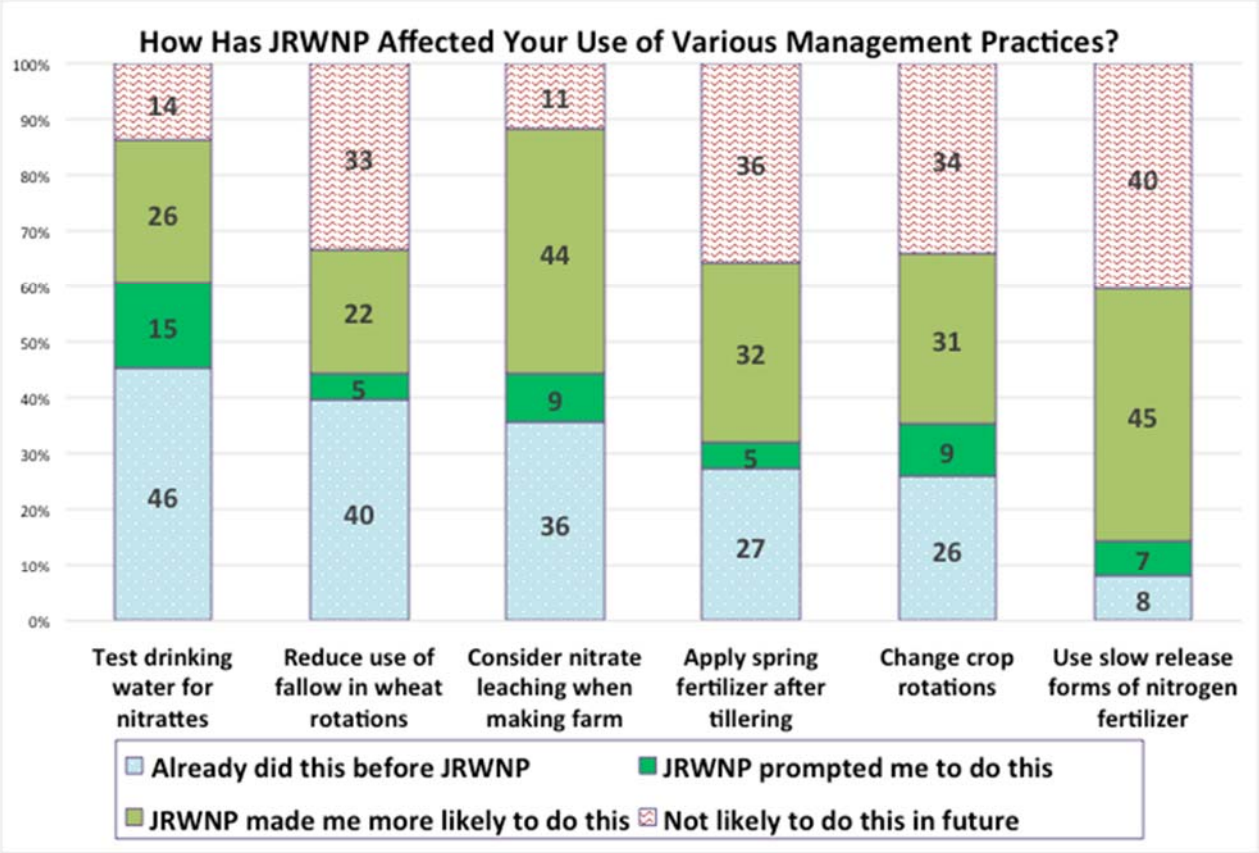

Figure 10: Proportion of farmers in 2015 survey who have heard of JWRNP that changed behaviors based on the project.

Table 16: Overall Evaluation of the JWRNP by 2015 Survey Respondents

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	*Agree & Strongly Agree*
Involving farmers in the research is a positive part of the JRWNP	0.7%	2.6%	15.1%	42.5%	**39.2%**	*81.7%*
I want to know more about the research results of the JRWNP	1.3%	2.0%	34.9%	33.6%	**28.3%**	*61.9%*
The JRWNP is likely to produce useful information in the future	1.3%	2.6%	21.8%	53.3%	**21.1%**	*74.4%*
The JRWNP is good for farmers in this area	1.3%	3.9%	36.8%	40.8%	17.1%	*57.9%*
The JRWNP will help our community	2.0%	4.0%	24.5%	53.6%	15.9%	*69.5%*
The JRWNP will improve water quality in this watershed	2.7%	2.0%	36.7%	44.0%	14.7%	*58.7%*
The JRWNP is an example of a good use of tax dollars	2.6%	5.3%	39.8%	37.7%	14.6%	*52.3%*
I want to participate in participatory projects like the JRWNP	4.7%	5.4%	57.7%	19.5%	12.8%	*32.3%*
The JRWNP has already produced useful information	1.3%	4.7%	57.7%	28.9%	7.4%	*36.3%*