ADDITION OF NEW SPECIES TO COVER CROP BMP

Addition of New Cover Crop Species with Nitrogen Reduction Efficiencies for Use in Phase 5.3.2 of the Chesapeake Bay Program Watershed Model

New Cover Crop Species Proposed:
Annual Ryegrass
Annual Legumes
Annual Legume plus Grass Mixtures
Brassica (winter hardy)
Forage Radish
Forage Radish plus Grass Mixtures
Triticale
Oats (winter hardy)
Oats (winter killed)

Recommendations for Approved by the Water Quality Goal Implementation Team's Watershed Technical and Agricultural Workgroups

Introduction

This document summarizes the recommendations of the 2012-2013 Cover Crop Expert Panel for several new cover crop species and crop mixtures, with accompanying nitrogen (N) efficiency estimates for inclusion in the Phase 5.3.2 of the Chesapeake Bay Program Watershed Model. The new cover crop species will be added within the existing Traditional Cover Crop definition; no other modifications of the existing practice definition are being recommended at this time. The report was approved and enacted for 2013 progress by the Water Quality Goal Implementation Team on October 15, 2013.

The Panel's membership was:

Panelist	Jurisdiction	Affiliation
Andy Clark	Maryland	Univ. of Maryland, Sustainable Agriculture Research & Education
Barbie Elliott	West Virginia	West Virginia Conservation Agency
Charlie White	Pennsylvania	Penn State University
Chris Lawrence	Virginia	USDA Natural Resources Conservation Service, Virginia
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Patrick Bowen	West Virginia	USDA Natural Resources Conservation Service, West Virginia
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Paul Salon	New York	USDA Natural Resources Conservation Service, New York
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Ray Weil	Maryland	University of Maryland
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Ron Hoover	Pennsylvania	Penn State University
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Wade Thomason	Virginia	Virginia Tech
Jack Meisinger	Maryland	USDA Agricultural Research Service (Panel Chair)
Mark Dubin	Maryland	University of Maryland (Panel Coordinator)
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Practice Definition

The purpose of the cover crop practice is to reduce nutrient losses to ground and surface water by sequestering excess nutrients in a short-term crop grown after the main cropping season. Important elements of the practice include selection of the cover crop species, the planting time, and the seeding method. Cover crops are one of the most valuable management practices available for protecting water quality, especially groundwater quality, which is a difficult resource to protect from non-point sources of soluble nutrients like nitrate N.

The value of cover crops in reducing N leaching for an environmental benefit has been consistently demonstrated by multiple regional scientific papers which were utilized by the panel in evaluating the relative N reduction values for the additional recommended species. Examples of relevant papers include Meisinger et al., 1991; Staver & Brinsfield, 1998; and Dabney et al., 2001. Additionally, general reference sources such as the SARE Cover Crop Handbook and the Mid-Atlantic Water Program's 2009 Cover Crop Report also supported the recommendations.

Cover crops entered the Bay Model in 1997 and have been strongly endorsed by the USDA Natural Resources Conservation Service (NRCS), state environmental and agricultural agencies, and farm-producer advocacy groups like the American Farm Bureau and the American Farmland

Trust. More importantly, they have been widely adopted by agricultural producers across the Chesapeake Bay watershed primarily for conserving valuable N, but also because they provide other benefits such as adding soil organic matter, improving soil structure, and improving soil health. There are also some habitat benefits provided by an actively growing off-season crop compared to the traditional fallow-weed cover, as well as some social benefits derived from maintaining "green" landscapes during the fall-winter seasons. However, the water quality benefits for N were the only benefits considered by the panel for new cover crop species at this time.

The current cover crop practice is recommended for revision because the existing species of rye, wheat, and barley do not adequately capture the diversity and extent of current cover crop practices being deployed in the Watershed. The new cover crop species will be added within the existing Chesapeake Bay Program's Traditional Cover Crop BMP definition, thus no modifications of the existing definition are being recommended at this time. The purpose of this revision is to allow the Bay Model to better represent current cover crop cultural practices and acreages, which have significantly expanded since 2007 when the Cover Crop BMP was last revised.

Applicable USDA-NRCS Practices

The USDA Natural Resources Conservation Service (NRCS) standard for Cover Crop (CP 340) in the National Handbook of Conservation Practices (NHCP) is partially applicable to this practice. The NRCS CP 340 standard provides a general criteria and definition which potentially may provide most if not all of the attributes as the Chesapeake Bay Program partnership's Cover Crop BMP, but the information tracked and reported by NRCS for use by the partnership does not typically include specific practice details such as species, timing, method, and nutrient application. State Offices of NRCS may elect to incorporate additional guidance with the NHCP standard, as well as implement additional tracking and reporting elements of the CP 340, which could provide increased criteria compatibility and applicability to the related Cover Crop BMP. Additional information on the CP 340 standard may be obtained under the USDA-NRCS National Handbook of Conservation Practices (NHCP) (http://directives.sc.egov.usda.gov/viewerFS.aspx?hid=22299) and the Field Office Technical Guides (http://www.nrcs.usda.gov/technical/efotg/) for each state.

Description of New Species

Annual Ryegrass, also known as Italian Ryegrass, is a cool season annual grass that does a good job of accumulating nutrients, although it does not grow as well as rye during the colder months in the Bay watershed. It has an extensive soil holding root system that establishes quickly, which is the basis for its reputation as a soil erosion fighter. It is a common component of mixtures, where it is often aerial seeded (USDA, SARE 2007).

Annual Legumes and Grass Legume Mixtures include winter annuals that are primarily used to supply N to the next crop due to their ability to fix significant quantities of atmospheric N. However, they also provide a living crop that can scavenge small amounts of residual nutrients as well as provide some erosion protection during the spring runoff season (USDA, SARE, 2007). In the Bay watershed, the most common annual legumes are Hairy Vetch and Crimson Clover. The Panel recommends combining these two legume species, and other winter annual legumes, into one category because all the existing data on legume recovery of residual N studied either hairy vetch and/or crimson clover. Another reason to include pure legume stands is to provide a way to credit grass-legume mixtures by weighting mixtures according to the common planting densities of the grass, which can absorb significant quantities of fall N, and the legume, which absorbs much less fall N. The popularity and diversity of grass-legume mixtures is increasing, so having both components of a mixture in the cover crop BMP will provide a means for estimating the N Reduction Efficiency for a wide range of grass-legume mixtures. Thus, the Panel recommends adding both the Annual Legume and Annual Legume plus Grass categories to the Phase 5.3.2 update.

Brassicas (winter-hardy) – Canola and Rape – are proposed for inclusion in the model. Both are technically rapeseed, and both can take up significant amounts of N, often comparable to rye, but only if planted early. The winter-hardy Brassicas provide full fall-winter-spring crop growth and residue cover that avoids possible residue decomposition losses while providing soil cover to manage erosion (USDA, SARE, 2007).

Forage Radish, also known as tillage radish, is a popular deep-rooted cover crop that grows fast with warm temperatures and an ample supply of N. It can recover substantial quantities of residual N, and often accumulates as much, or more, N in the fall than rye. However, it is subject to winter killing following a few days below 25 F. After winter-kill the radish residues decompose rapidly, leaving the soil bare and making it vulnerable for some nitrate-N leaching depending on weather and soil conditions, during the remaining winter and early-spring seasons (USDA, SARE, 2007).

Forage Radish and Grass is listed as a separate group because: i) it combines two distinctly different species, each contributing their own advantages to the resulting mixture, and ii) there are good data available for estimating an initial relative nitrogen reduction efficiency (RNRE) for this mixture. The general biological characteristics and uses of Forage Radish and Grass cover crops can be gleaned from their accompanying descriptions in the Forage Radish and Triticale species sections.

Oats (winter-hardy and winter-killed) is a cool season annual cereal having varieties that are winter hardy in some areas of the Bay watershed, and some varieties that are winter killed. Oats are primarily used as a short-term N scavenger with secondary benefits of reducing soil erosion.

In circumstances where herbicides are not used a winter-killed oat variety is often preferred to winter-hardy cereal covers (USDA, SARE, 2007).

Triticale is a cool season annual cereal that is a cross between wheat and rye, giving it characteristics from each parent. It serves the dual purpose roles of being a N scavenger and an erosion fighter. It grows almost as well as rye in cold months, but is easier to manage in the spring because it is less subject to the rapid spring growth that can present management difficulties with rye.

Effectiveness Estimates

The N effectiveness estimates are the only water quality parameter included for the new species because: 1) cover crops primarily function to trap or sequester N, with only minor reductions for phosphorus (P) and sediment; and 2) there are very few conservation-tillage era studies on surface runoff losses of P or sediment reductions for cover crops. The Panel recommends that a place holder, or interim, value of "0" be used for the P and sediment effectiveness estimates for all new species, to be replaced later with the Panel's recommended values derived from best available data or from estimates provided from an independent agricultural model such as APEX.

Relative Nitrogen Reduction Efficiency (RNRE) Estimates

Effectiveness estimates for N reduction by new cover crop species were initially developed as values relative to the accepted N reduction efficiency of rye, termed "Relative Nitrogen Reduction Efficiency" or RNRE by the Panel. The average RNRE values adopted by the Panel are given in Table 1. Note that the RNRE values shown are contingent on the cover crop being planted at the recommended planting time(s) only.

Table 1. Average RNRE, number of individual studies contributing to the average, and recommended planting times for the new cover crop species and species mixtures[1]

Proposed New Species or Species Mixtures	Relative Nitrogen Reduction Efficiency (relative to Rye)	Number of Individual Studies	Recommended Planting Time [2]
Annual Ryegrass	0.66	5	Early and Normal
Annual Legume	0.16	4	Early and Normal
Annual Legume + Grass	See Table 2	NA	Early and Normal
Brassica (winter hardy)	0.70	13	Early only
Forage Radish	0.58	12	Early only

Forage Radish + Grass	See Table 2	NA	Early and Normal
Triticale	0.86	10	Early, Normal, Late
Oats (winter hardy)	0.55	11	Early and Normal
Oats (winter killed)	0.40	4	Early only

[1] Seeding methods are not listed because every new species will use existing seeding methods of drilled, other, aerial/soybean, and aerial/corn according to the existing relative relations between these seeding methods in the current model.

[2] Early is more than two weeks before the average frost date, Normal is between the average frost date and two weeks before that date, Late is within three weeks after the average frost date.

An example interpretation of the RNRE values is that, on average, the total N uptake of Annual Ryegrass was 66% of the corresponding rye N uptake.

The RNRE estimates for the new species were all derived from replicated field studies reported in peer reviewed papers, current Land Grant University (LGU) cover crop or forage species trials, graduate student theses, or outside grant research projects at LGUs. Each of these trials was required to have a rye treatment with either total N or ^{15}N uptake, or dry matter, measured in the spring at a time when a traditional cover crop would be terminated, or in the fall if the cover crop was not winter hardy. The presence of the rye N uptake or dry matter data provided a watershed wide “internal standard” that allowed *a direct comparison of each new species with rye, within each individual study*. This comparison involved simply calculating the ratio of the quantity of total N or ^{15}N uptake, or dry matter, in the new species to the corresponding measurement in rye, this ratio (e.g. = (total N uptake)$_{species\ 'A'}$ / (total N uptake)$_{rye}$) defines the term “Relative Nitrogen Reduction Efficiency (RNRE)” used throughout this report, with the word “relative” in this context meaning “relative to rye”. The Panel calculated the final RNRE for each new species from the average of applicable individual studies. Further details and examples of calculating the RNREs are in Attachment A.

A major advantage of comparing all the new species to rye is that the Bay Phase 5.3.2 Model calibration already includes rye as a cover crop. Thus, the final N effectiveness estimate for each new species can be made by simply multiplying the RNRE by the existing value of the rye N effectiveness (which is already in the model with adjustments for spatial scale-up from plot to field, and adjustments for the hydrologic partitioning of N losses to ground water vs. surface runoff). Using the RNREs with the current rye N effectiveness values thus eliminates the need to recalibrate the Phase 5.3.2 models for the new species (Pers. Comm. Jeff Sweeney, 4-24-2013). Further details and examples of calculating the final N effectiveness values for the new species are given below and in Attachment A.

It can be seen in Table 1 that annual legumes are the poorest at recovering N compared to rye, but if they are grown in a grass mixture their N conservation improves substantially because all the grasses have higher RNRE than the legumes (see discussion below for Table 2). A pure stand of forage radish, over the course of the entire fall-spring (Sept. to late April) cover crop season, is credited with recovering about 58% as much N as pure rye, which includes the likely loss of some N after the forage radish is killed by frost (commonly in mid-late Dec.) followed by decomposition of the radish residues with no growing cover crop present. However, a cover crop made up of a forage radish plus grass provides a continuous growing cover crop that can trap N released by radish decomposition. Thus, a somewhat higher N recovery would be expected for radish-grass mixtures compared to pure radish (see discussion below for Table 2), because most grass species (except for oats) have higher N recoveries than radish. The grouped winter-hardy brassica species have a higher RNRE of 0.70 compared to forage radish because they are not killed by frost and maintain an actively growing crop throughout the winter and spring. The total N uptake of triticale was about 85% of the corresponding rye N uptake and the N credit of winter-hardy oats was 55% of rye, while the N credit for the winter-killed oats was 40%, which adjusts for likely loss of some N during decomposition of oat residues in the winter through spring seasons.

The recommended planting periods for each of the new species are also listed in Table 1. The Panel recommended these dates based on the agronomic optimums for establishing each species, with particular attention given to the last planting dates that would likely produce acceptable growth and avoid seeding failure.

Recommended N Effectiveness Estimates

The RNREs from Table 1 form the basis for estimating the final N Effectiveness estimates for pure stands in the Phase 5.3.2 update of the Model. Table 2 illustrates this calculation process for each new entry and also allows comparisons of two planting-date windows (early vs. normal) and two establishment methods (drill seeded vs. aerial seeding into soybeans).

Table 2. Examples of new cover crop species, and cover crop mixtures, RNREs and final N effectiveness values for selected planting and seeding methods in the Coastal Plain, Piedmont, or Karst physiographic regions of the Bay Model.

Proposed New Species, or Reference Species (i.e. Rye)	Relative Nitrogen Reduction Efficiency (relative to rye) & Mixture Estimation Method [1]	Final Nitrogen Effectiveness Phase 5.3.2

----------- Early planting by Drill seeding (high soil contact) -----------		
Annual Ryegrass (ARG)	0.66	0.30
Annual Legume	0.16	0.07
Annual Legume + Grass	Avg. N Effectiveness (Legume + Avg. Grass) [2]	0.20
Brassica (winter hardy)	0.70	0.32
Forage Radish	0.58	0.26
Forage Radish + Grass	Avg. N Effectiveness (Radish + Avg. Grass) [2]	0.29
Triticale	0.86	0.39
Oats (winter hardy)	0.55	0.25
Oats (winter killed)	0.40	0.18
Rye (Ref. Species)	1.00	0.45
------ Early planting, Aerial seeding in Soybeans (low soil contact) ------		
Annual Ryegrass (ARG)	0.66	0.20
Annual Legume	0.16	0.05
Annual Legume + Grass	Avg. N Effectiveness (Legume + Avg. Grass) [2]	0.14
Brassica (winter hardy)	0.70	0.22
Forage Radish	0.58	0.18
Forage Radish + Grass	Avg. N Effectiveness (Radish + Avg. Grass) [2]	0.20
Triticale	0.86	0.27
Oats (winter hardy)	0.55	0.17
Oats (winter killed)	0.40	0.13
Rye (Ref. Value)	1.00	0.31
---------- Normal planting by Drill seeding (high soil contact) ----------		
Annual Ryegrass (ARG)	0.66	0.27
Annual Legume	0.16	0.06
Annual Legume + Grass	Avg. N Effectiveness (Legume + Avg. Grass) [2]	0.19
Brassica (winter hardy)	NA [3]	NA
Forage Radish	NA [3]	NA
Forage Radish + Grass	Avg. N Effectiveness (Radish/2 + Avg. Grass) [2]	0.22
Triticale	0.86	0.35
Oats (winter hardy)	0.55	0.23
Oats (winter killed)	NA [3]	NA
Rye (Ref. Value)	1.00	0.41

[1] A complete listing of the N Effectiveness values is given in Table 1 of Attachment B.

[2] Average of: the N effectiveness value of the species, and the average N effectiveness values of all the grasses; which provides the estimate of the mixture's N effectiveness.
[3] Pure stands only recommended for early planting time, not for normal planting time.

Calculating the final N effectiveness values for each new species simply involved multiplying the RNRE for each new species by the corresponding rye N effectiveness value that is currently in the calibrated model for that setting. For example, in the Atlantic Coastal Plain, Piedmont, or Karst regions an early-seeded cover crop of annual ryegrass using a drill would be assigned a final N effectiveness value of 0.30 ((0.66 for ARG)*(0.45 for rye planted early by drill)). It is interesting to note in Table 2 that the triticale (which is a cross between rye and wheat) N effectiveness value of 0.39 (as estimated through the RNRE approach) agrees very well with the prior N efficiency averages already in the model for rye (0.45) and wheat (0.31), which provides a rye-wheat average of 0.38 for early-planted drilled covers.

The N effectiveness values for the two mixtures were estimated after first calculating the N effectiveness values for all pure-stand entries, as above; then calculating the mixture N effectiveness value. This involved use of a "generic grass" that is the average N effectiveness value across all the grass species in the model for a particular planting period and seeding method. To illustrate this for the early-planted drilled legume-grass mixtures: the N effectiveness value for the "generic grass" is the average N effectiveness across all grass species (rye, wheat, barley, annual ryegrass, triticale, winter-hardy oats, and winter-killed oats), which is 0.32. Next, this average grass N effectiveness is averaged with the corresponding annual legume N effectiveness of 0.07 to produce a final N effectiveness for a drilled early-planting legume-grass mixture of 0.20 (average of 0.32 and 0.07, rounded off). It is noteworthy that the legume-grass mixtures have substantially higher N effectiveness values than pure legumes, which results from the higher RNRE of grasses compared to legumes (see Table 1). The same approach was used for the early-seeded Forage Radish plus Grass mixtures that produced a final radish-grass N effectiveness value of 0.29 (average of 0.32 and 0.26).

It should also be noted that using the above "generic grass" approach is expected to underestimate the value of mixtures, because rye is probably the most common grass used in mixtures and rye has the highest N effectiveness of all the grasses. However, the Panel supported using the "generic grass" approach because it has a much lower burden for record keeping and reporting, while still providing an avenue for including mixtures into the Phase 5.3.2 update. If suitable data can be obtained from states for estimating the average relative proportions of grasses in their cover crop mixtures (e.g. 50% of mixtures used rye, 30% triticale, 20% annual ryegrass) then an improved estimate of the grass contribution to cover crop mixtures can be developed.

For Forage Radish plus Grass mixtures planted in the normal period (later than the recommended period for radish), the radish early-planting N effectiveness value was discounted 50% before averaging with the "generic grass" value, in order to adjust for the slower radish growth in the fall compared to the early-fall period and still allow normal credit for fall growth of the "generic grass" in the mixture. Thus, a drilled Forage Radish plus Grass mixture planted in the normal period received a N effectiveness value of 0.22 (the average of one-half of the radish drilled early-planted N effectiveness or 0.13 [0.26/2] and the average N effectiveness of all drilled grasses planted in the normal period which is 0.31).

The above approaches for cover crop mixtures produced final N effectiveness values for early-planted drilled radish-grass mixtures that are 0.09 higher than the corresponding legume-grass mixtures (see Table 2), but this radish-grass vs. legume-grass advantage decreases for normal planting to 0.03 (see Table 2). These N effectiveness differences for radish vs. legume mixtures are consistent with the fact that forage radish has higher N recoveries than annual legumes, especially for early plantings.

The results of corresponding calculations of N effectiveness in Table 2 are included to allow direct comparisons of two other common seeding methods (drilled vs. aerial seeding into soybean) and two other planting times (early vs. normal) with each scenario based on the current rye N effectiveness value that is already in the model for the corresponding seeding methods and planting periods. The complete list of N effectiveness values for all relevant planting periods and seeding methods is given in the Technical Requirements section (see below) of this report.

The Panel recommends maintaining the aerial seeding category as two separate classes, one for soybean and one for corn, for the new species and species mixtures. This recommendation resulted from a lack of data to reject the proposition that any of the new species differed from the cereal grains in their aerial establishment success, and that aerial seeding into soybeans is generally more successful than into corn, as documented in the previous Cover Crop Panel Report (MAWQP. 2007. Reduction for Aerial Seeding. p. 110-113).

Phosphorus

Due to a lack of available time, the panel was unable to evaluate a significant body of literature for Total Phosphorus reduction efficiency from the additional cover crop species. The group decided to delay a recommendation until a solid base of evidence could be built and consensus for a reduction value reached by the panel. The panel expects to benefit from new simulation modeling capacity within USDA-ARS and from further refinement of the data available in the existing literature. The panel expects a final recommendation can be developed and available for future progress runs.

Sediment

Due to a lack of available time, the panel was unable to evaluate a significant body of literature for TSS reduction efficiency from the additional cover crop species. The group decided to delay a recommendation until a solid base of evidence could be built and consensus for a reduction value reached by the panel. The panel expects to benefit from new simulation modeling capacity within USDA-ARS and from further refinement of the data available in the existing literature. The panel expects a final recommendation can be developed and available for future progress runs.

Negative Pollution Reductions

The Panel did not find dependable quantitative data documenting possible negative pollution reductions, i.e. examples where the cover crop acted as a nitrogen source. However, examples of negative pollution reductions would be possible from leaching losses during residue decomposition of a nitrogen fixing legume cover crop. Therefore, the lack of dependable data on negative pollution reductions will have to be evaluated at a later time when reliable quantitative data are available.

Additionally, the Panel did not find reliable data, nor a suitable mechanism for estimation, of the scenario where cover crops might relocate N from groundwater transport (the major transport pathway assumed in this report) to either surface water transport or to direct deposition. Examples of potential relocations of cover crop N would be deer or avian grazing of cover crops, with subsequent deposition of urine and/or feces in stream corridors or wetlands (e.g. by deer), or for direct deposition into streams or the Bay (e.g. by geese). Therefore, the lack of reliable data on N relocation from cover crops into other potential N loss pathways will have to be evaluated at a later time when reliable data are available and a suitable mechanism for estimating this N relocation have been developed.

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Attachment A contains a detailed description of the specific literature sources and the calculations of the RNRE for each new species or mixture. The following paragraphs describe how the Panel used relevant references to determine the RNRE for each of the proposed new cover crop species.

Description of RNRE Estimation Process for New Species

Annual Ryegrass

The Panel used five individual studies from within the Bay watershed to estimate the RNRE; two from PA, two from MD, and one from NY. For all studies, cover crops were planted in the early- or normal-planting period and all harvests were in mid-April to early May (MD and PA), or in mid-May (NY), which is consistent with spring crop development.

The five site-years of data were summarized by calculating a simple weighted average (each mean was weighted by the number of site-years it contained), which produced a final weighted average RNRE of 0.66 that is listed in Tables 1 and 2.

A summary of the studies and methods to estimate the Annual Ryegrass RNRE follows:

a) The PA data (Houser et al.,2012 and 2013) were from the "Short-lived cool-season forage trial" planted in 2011 and 2012 that received 30 lbs starter N/ac in the fall and 100 lbs N/ac in the spring for all entries, including the rye reference entry. The PA data consisted of the yearly average total N uptake across five annual ryegrass varieties that were all present in 2011 and 2012, which contributed two individual site-years of data having an average RNRE of 0.77.

b) The MD data were from the peer-reviewed publication of Shipley et al, (1992) that added a luxury amount of ^{15}N labeled fertilizer to corn and measured the fall residual soil ^{15}N, followed by establishment of fall cover crops of annual ryegrass and rye, and measurement of the ^{15}N in these covers the following spring. This study was conducted in the 1986-87 and

1987-88 cover crop seasons on the Eastern Shore of MD. The average RNRE from these two site-years was 0.68.

c) The NY data are from an unpublished NRCS study in 2010 that evaluated cover crop planting dates (three Sept. planting dates) and compared spring dry matter (DM) production from annual ryegrass to that of rye. The Panel chose to accept DM data as a surrogate for total N uptake since annual ryegrass and rye are both cool-season grasses, and because the NY data added information capturing the large north-south range of growing conditions within the Bay watershed. The NY data were averaged across the three planting dates which produced a RNRE of 0.40 for annual ryegrass.

Annual Legumes and Grass Legume Mixtures

There were only two peer-reviewed studies, each with two site-years of data, available for estimating the RNRE for annual legumes in the Bay watershed. This is because ^{15}N is needed to directly estimate the recovery of fall N in a legume, which also contains N derived from decomposition of soil organic matter plus large quantities of N derived from atmospheric fixation. Both of these studies used early and normal planting dates along with a mid-April harvest.

The four site-years of ^{15}N data produced a final weighted average estimate for the annual legume RNRE of 0.16. The Panel recommends that the estimate for an Annual Legume plus Grass mixture should be the average of the annual legume and the “generic grass” component.

A summary of the two Bay area annual legume studies is given below, along with a summary of two other studies that provide corroborating data for the results from the Bay area research:

a) The peer-reviewed ^{15}N publication of Shipley et al. (1992), described above in the Annual Ryegrass section, also documented the recovery of fall ^{15}N labeled fertilizer by hairy vetch, crimson clover, and rye in a silt loam soil on Maryland’s Eastern Shore. The average RNRE from the 1986-87 and 1987-88 cover crop seasons was 0.22 for hairy vetch and 0.17 for crimson clover, which gives a combined average RNRE for Annual Legumes of 0.19.

b) The second peer-reviewed ^{15}N publication was by Ranells & Wagger (1997) who added ^{15}N labeled nitrate to fall seeded crimson clover, rye, and a crimson clover plus rye mixture in a loamy sand soil on North Carolina’s Eastern Shore. The average RNRE for crimson clover over the 1993-1994 and 1994-1995 cover crop seasons was 0.09. The lower ^{15}N recovery by crimson clover in the North Carolina study is likely due to greater ^{15}N leaching in the coarse-textured loamy sand soil, compared to the finer-textured silt loam in Maryland. The average N efficiency of the crimson clover plus rye mixture converts to a N effectiveness value of 0.25, which is satisfactory support for the “generic grass” N effectiveness of 0.20 in Table 2. No other studies could be found in the literature that would provide other estimates of the N effectiveness of Annual Legume plus Grass mixtures.

c) Two other studies were identified that provided corroborative data on N recoveries by legumes vs. grasses, and on the value of legume-grass mixtures. These studies could not be used to estimate a RNRE because they did not have a direct comparison with rye. Gabreil and Quemada (2011) conducted a ^{15}N recovery study with barley and hairy vetch in Spain and reported that barley recovered 10% of the residual ^{15}N, while vetch recovered only 1%. In Oregon, Feaga et al. (2010) used multi-year field lysimeter data to document that the average nitrate concentration in drainage below grass covers that was 34% less than without a cover; while a vetch-triticale mixture averaged 19% less than without a cover. These two studies support the view that grasses are much better than legumes at recovering residual N, and that a legume-grass cover is about half as effective as a pure grass cover at reducing the nitrate concentration in soil drainage water.

Brassicas (winter-hardy)

The Panel reviewed 13 site-years of data. Studies from within the Bay watershed include three site-years from a peer-reviewed Maryland study, six site-years from an unpublished Virginia study, and one site-year from a Pennsylvania extension publication. Other studies that the Panel considered valid and which had a direct comparison to rye, were from peer-reviewed research done in Oregon (two site-years) and France (one site-year).

Rape and canola are grouped together because they have similar fall and spring growth in the Bay watershed. Both should be planted early; they survive the winter and continue to accumulate biomass and N in the spring, as well as provide soil cover for erosion control.

The 13 site-years of data were initially summarized by calculating a simple weighted average as for the other species, which produced a final weighted average RNRE of 0.80. However, due to high pre-planting available N and very early planting in some site-years, and because of the wide range of N uptakes for rape; the Panel unanimously voted to recommend a more conservative RNRE of 0.70.

The data summary for rape and canola listed in Tables 1 and 2 are:

a) The largest data set is from the Eastern and Western Virginia studies (Pers. Comm. Wade Thomason, 2013) from studies in 2010-2012 (3 site-years each). The studies include rye, pure oats and an oat plus canola mixture. Cover crops were planted in the early-planting period for each location and followed cash grain-crops. The average canola N uptake value (57 lbs N/ac) was estimated by subtracting the pure oat uptake (17 lbs N/ac) from the oat/canola mixture uptake (74 lbs N/ac), while the rye N uptake was 98 lbs N/ac. Thus, the average RNRE for canola from these six site-years was 0.62.

b) The Maryland data (Dean and Weil, 2009) are based on one site-year (2004) from the Piedmont and two site-years (2003) from the Coastal Plain. In two of these studies, rape and rye were planted following mowing of a soybean crop that added an estimated 207 lbs of readily decomposable N/ac to the soil. The average RNRE for rape from these three site-years was 1.2. However, due to the high N environment in these studies, the Panel voted unanimously to adjust the final efficiency for rape as described above.

c) The Pennsylvania data (Finney and Kaye, 2013) came from one site-year (2011). The Hagerstown soil was conventionally tilled following an oat crop; rye and rape were planted in late August and harvested in mid-May. The rape N uptake was 108 lbs N/ac compared to 67 lbs N/ac for rye, giving a RNRE of 1.6.

d) Data from France (Muller, et al., 1989) was included because it had a rye cover crop whose N uptake values were similar to a high N supplying site in the Bay watershed. These data (one site-year) followed wheat and also demonstrate the effect of slightly later planting (but still in the early-planting period) on rape N uptake, which was harvested in early March. Rye N uptake was 120 lbs N/ac, but the rape N uptake was 23 lbs N/ac due to overwinter damage that would be common in the more northern areas of the Bay watershed. The resulting RNRE for rape was 0.19, which illustrates the highly variable performance of brassicas.

e) Data from Oregon (Fernando, et al., 1996) was included because the Adkins fine sandy loam and rainfall pattern is similar to the Bay watershed. The other cover crops in this study (rye, wheat and triticale) also had N uptakes that corresponded well with data from the Bay watershed. Two site-years of data were reported (1992-1993 and 1993-1994) as part of this Ph.D. thesis. Cover crops were planted in mid-September and harvested in mid-March or early-April. The average rye N uptake was 102 lbs N/ac while rape was 68 lbs N/ac, giving a RNRE of 0.62.

Forage Radish

Twelve site-years of forage radish N uptake data, with corresponding rye data, were available from Maryland, Pennsylvania, and Virginia with all planting done during the early planting period. All harvests were in the fall before frost killing, which is consistent with crop development.

The 12 site-years of data were initially summarized by calculating a simple weighted average as for the other species, which produced a final weighted average RNRE for forage radish of 1.00. However, due to high pre-plant available N and very early planting in some site-years, and because of the wide range of N uptakes for forage radish compared to rye; the Panel chose to conduct an anonymous poll to allow each member to interpret the data and submit their estimate of the radish RNRE. The Panel then pursued detailed discussions about various interpretations of the data. The Panel concluded by voting unanimously to recommend acceptance of the average RNRE from the anonymous poll, which is 0.58.

The summary for the forage radish data is given below:

a) The largest data set is from the Eastern and Western Virginia studies (Pers. Comm. Wade Thomason, 2013) in 2010-2012, with each area contributing 3 site-years of data. These studies included fall N uptakes for pure rye and pure radish, with the details of this study given in the Brassica (winter-hardy) section above. The average N uptakes, in lbs N/ac, in Eastern Virginia were 62 and 53 for rye and radish, respectively. The corresponding N uptakes (lbs N/ac) for the Western Virginia were 134 and 96 for rye and radish, respectively. These six site-years of data produced an average RNRE for forage radish of 0.79.

b) The Maryland data are from Dean and Weil (2009) and unpublished data from C. White's Ph.D. thesis. The studies have two site-years from the Piedmont and three site-years from the Coastal Plain. In three of these studies, the radish and rye were planted following mowing of a soybean crop that added several hundred pounds of N/ac to the soil. The average fall N uptake for the rye from these five site-years was 106 lbs N/ac, while the corresponding value for forage radish was 130 lb N/ac. These data provide a RNRE of 1.23.

c) The Pennsylvania data were from an Extension demonstration study from one site-year (2011), which is described above in the Brassica section. The forage radish N uptake was 27 lbs N/ac compared to 67 lbs N/ac for rye, giving a RNRE of 0.40.

Forage Radish and Grass

The Panel used individual studies from Pennsylvania and Virginia that provided 15 site-years of data for estimating the RNRE for Forage Radish plus Grass mixtures, with virtually all of the studies using rye as the grass species. All studies were planted in the early or normal planting period and all harvests were in mid-April to early May, which is consistent with crop development in the spring.

The 15 site-years of Forage Radish plus Rye data were initially summarized using a weighted average based on the number of site-years in each mean, which produced a final RNRE of 0.86 and a N effectiveness for early-planted drill-seeding of Forage Radish plus Rye of 0.39 (0.86*0.45). However, the Agriculture Work Group requested that the Forage Radish plus Grass mixture use the same estimation approach as the legume-grass mixture. Accordingly, the final N effectiveness of early-planted drill-seeded forage radish plus "generic-grass" category in Table 2 is 0.29 (= average N effectiveness of forage radish (0.26) and the "generic grass" (0.32)), which is somewhat less than the above estimate of 0.39 if rye is the dominant component in the mixture because the other grass covers (especially oats) recover less N than rye. The Panel recommends that future updates of the Cover Crop BMP consider using individual grass species rather than a "generic grass", because that would provide incentive to use the most efficient grass species in the Bay watershed. Another alternative would be to use a weighted average of the "generic grass" species, rather than a simple average, with the weighting factor being based on estimates of the most common grass species used in cover-crop mixtures in the watershed.

A summary of data and methods used to estimate the initial Forage Radish and Grass RNRE follows:

a) The Pennsylvania Cover Crop after Corn Silage Trial was the main source of data. This is an unpublished (still in progress) data set from Dr. Sjoerd Duiker containing one year of data from 10 different on-farm field locations across Pennsylvania. Each location followed silage corn and contained a direct comparison of the total N uptake of rye vs. a forage radish plus rye mixture. The average RNRE from these 10 site-years of data was 0.89.

b) The other Pennsylvania data came from two site-years from the "Short-lived cool-season forage trial" of Houser et al. (2011 and 2012) that is described in the Annual Ryegrass section. In this trial rye was compared to a mixture Forage Radish plus Annual Ryegrass, which produced a RNRE of 0.76.

c) Data from Virginia is from three site-years of data from the Radish and Mixed Species trial (Pers. Comm. Wade Thomason, 2013) that is summarized in the Brassica section. The trial contains three years of western Virginia data comparing rye with a mixture of forage radish plus rye plus annual ryegrass (a three species mixture containing two grasses). The resulting RNRE is 0.79.

Oats (winter-hardy) and Oats (winter-killed)

Virginia provided the most complete data base for winter-hardy oats, which was 11 years of data (Smith et al., 2009) comparing total N uptake from a single winter-hardy variety with corresponding data from rye. The Panel recommended that the planting periods for winter-hardy oats be early and normal, while the planting period for winter-killed oats should only be early. The winter-hardy oat data provided the base line for estimating the winter-killed RNRE, which is described in more detail below. The Panel's recommendation for the RNRE of winter-hardy oats is 0.55, and for winter-killed oats is 0.40.

A summary of the data and the methods to estimate the RNRE of winter-hardy and winter-killed oats follows:

a) The source of data for winter-hardy oats was the Virginia small grain forage variety testing report: long-term summary (1994-2004) reported by Smith et al. (2009). In this study, cover crops received 25-30 lbs starter-N/ac in the fall and 60 lbs N/ac in the spring for all entries, including the rye reference entry. The Virginia study documented the average total N uptake for a single winter-hardy oat variety and a single rye variety that were both present in 11years of the long-term study, thus providing 11 site-years of data having an average RNRE of 0.55.

b) The winter-killed oat RNRE was estimated from the above winter-hardy oat data base that was adjusted for estimates of over-winter N loss. One adjustment was based on the assumption that all the fall nitrate-N content of oats was lost (nitrate data provided by pers. comm. with Ms. Natalie Lounsbury, Univ. MD), which amounted to an 18% loss of the oat total N. The second approach was based on the loss of total N in the oat residues during the over-winter period from another unpublished three-year Virginia trial studying Radish and Mixed Species Cover Crops (Pers. Comm. Dr. Wade Thomason, 2013), which amounted to a 36% loss in oat total N. These two loss estimates for winter-killed oats were averaged together and related to the rye N uptake, which resulted in a RNRE for winter-killed oat of 0.40.

Triticale

The Panel used individual studies from Maryland, New York, Pennsylvania, and Virginia that provided ten site-years of data for estimating the RNRE for triticale. All studies were planted in the early or normal planting period and all harvests were in mid-April to early May or in mid-May (NY), which is consistent with crop development in the spring. These studies did not include a late planting, but the Panel recommends including a late-planted category. This is the same procedure used by the 2007 Cover Crop Panel for the late planting category of rye and wheat (MAWQP, Cover Crop Report, 2007).

The ten site-years of triticale and rye data were summarized using a weighted average based on the number of site-years in each mean as before, which produced a final RNRE of 0.86 for triticale that is listed in Tables 1 and 2.

Summaries of the triticale data include:

a) The Maryland cover crop studies with triticale were the peer-reviewed paper of Coale et al. (2001) and unpublished 2004 data from Dr. Ken Staver. Each study contributed one site-year. The Staver data provided N uptake data and a RNRE of 0.84. The Coale et al. (2001) N uptake data resulted in a RNRE of 1.15, which indicates that triticale took up about 15% more N than rye – a fact that should be occasionally expected since rye was one of the parents of triticale.

b) The New York data are from the same unpublished 2010 NRCS cover crop planting date study that is described in the Annual Ryegrass section. The New York data were averaged across the three planting dates which produced a Relative DM Production Efficiency of 0.64 for triticale.

c) The Pennsylvania data from the "Short-lived cool-season forage trial" planted in 2012 (Houser et al., 2013) are the basis for the RNRE. A summarized description of this study is given in the Annual Ryegrass section. The triticale total N uptake contributed a single site-year of data having an average RNRE of 0.70.

d) The largest triticale data set came from the Virginia small grain forage variety testing report: long-term summary (1994-2004) reported by Smith et al. (2009). The crops in the Virginia study received 25-30 lbs starter-N/ac in the fall and 60 lbs N/ac in the spring for all entries, including the rye reference entry. The Virginia data consisted of the average total N uptake for a single triticale variety and a single rye variety that were both present in 6 years of the long-term study, thus providing six site-years of data having an average RNRE of 0.88.

Application of Practice Effectiveness Estimates

The units of measure and load source for the cover crop N reduction efficiencies in this report are the percentage reduction of the estimated N lost through groundwater recharge at the bottom of the root-zone. This boundary condition is analogous to the reduction efficiencies for a surface runoff BMP which is an edge of field loss. The N reduction efficiencies in Phase 5.3.2 considered hydrologic flow region by dividing the watershed into two major hydrodynamic regions: the Mesozoic Lowlands/Valley and Ridge Siliciclastic, and the Coastal Plain/Piedmont and the Crystalline/Karst Settings; with the former region having a somewhat smaller subsurface-edge-of-field factor of 0.65 compared to the latter region that has a corresponding factor of 0.85 (Cover Crop Panel Report MAWQP 2007). The subsurface-edge of field flow factors reflect the somewhat lower groundwater recharge and higher surface runoff in the upland regions of the watershed compared to piedmont and coastal regions.

This practice is applicable to agricultural cropland throughout the whole Chesapeake Bay watershed, and is most commonly applied to land growing annual crops such as grain crops, vegetable crops, fallowed land, and annual forage crops. The load reductions from cover crops apply to bottom of the root-zone and cover a broad scale because the reductions primarily impact groundwater quality that recharges both local and regional aquifers which provide base-flow water to streams and rivers. The baseline condition for these cover crop N reduction efficiencies is a winter fallow with natural weed cover. Cover crops are an annual practice with the most common pre-BMP being a recently harvested field with surface crop residues and the post-BMP being the field with residues from the terminated cover crop plus any remaining crop residues from the previous crop. This report assumes the use of a traditional cover crop that is not harvested in the spring. Cover crops are known to have varying performances across the Bay watershed, and these performance differences are indirectly accounted for by adjusting the "normal" planting season to the average frost date of the county or sub-watershed. Using the average frost date indirectly accounts for differences in latitude and altitude across the watershed, which are two important factors affecting cover crop establishment and performance.

Cover crops are an annual practice with non-cumulative effects for this report, although cover crops can contribute to a modest increase in soil organic matter that could sequester both carbon and nitrogen. The potential cumulative effects will have to be addressed in future reports. The lag-time for cover crops would be the fall establishment season, which would be only one or two weeks for covers planted within the early, normal, or late planting categories or for covers established by aerial seeding vs. drilling. The somewhat longer establishment times for later plantings and aerial seeding have been included in the estimated nitrogen reduction efficiencies carried forward from the previous Cover Crop Report (Cover Crop Panel Report MAWQP 2007). This practice could interact with conservation tillage BMPs because cover crops are a common element in conservation tillage systems and can deliver some phosphorus and sediment reductions. However, this report only considers nitrogen reductions, so the phosphorus and sediment interactions with conservation tillage will be taken up at a later time. Ancillary benefits of cover crops include, over time, increased soil organic matter, increased soil cation exchange capacity, increase water-holding capacity, and improved soil quality. There are also some habitat benefits provided by an actively growing off-season crop compared to the traditional fallow-weed cover, as well as some social benefits derived from maintaining "green" landscapes during the fall-winter seasons.

This recommendation only adds additional species of cover crops onto the existing Traditional Cover Crop BMP. The previous panel defined the panel as an annual practice which will can be applied onto applicable agricultural cropland acres. Annual agricultural visual assessment practices have subsequently been categorized by the Chesapeake Bay Program's Agriculture Workgroup as Single-Year Visual Assessment BMPs. The panel recommends that the appropriate verification guidance associated with this category of BMPs be implemented by the partnership in the verification of acres reported under this BMP.

The panel recommendations for defining, tracking and reporting to the Chesapeake Bay Program partnership models for the cover crop BMP is compatible with and supports the agricultural BMP verification guidance subsequent developed by the Agriculture Workgroup.

The panel recommends that jurisdictions should always report the most specific information available to them for cover crop implementation. Data reported for CBP purposes should preferably include all elements listed in the panel recommendation report (See Question 5). If any of this information is not reported, the default conditions for the unreported category will be the lowest nitrogen reduction benefit for that category in the approved expert panel report. If relevant, the phosphorus and sediment benefit associated with this model nitrogen reduction will also apply. If the lowest reduction benefit for the missing category is "0" or "NA," then "0" is used for model credit.

Data Gaps and Research Needs

The Cover Crop Panel's future research recommendations are:

a) Include some measure of fall residual N in the version 6 Model, to allow adjustment of N effectiveness for small vs. medium vs. large levels of residual N and provide possible targeting of cover crops to high residual N locations.

b) Include some measure of soil properties (drainage class, slope, texture, etc.) in the version 6 Model so estimates of N, P, and sediment effectiveness can be more accurate.

c) Conduct research to quantify the N losses during the winter-spring decomposition period of winter killed covers, especially the fate of forage radish N.

d) Conduct research on phosphorus and sediment losses from cover crops used in modern conservation tillage systems, especially cropping systems with silage corn.

e) Provide for grass-specific mixtures in version 6 Model, i.e. allow mixtures to have their own specific grass component rather than a "generic grass", to increase the incentive for planting the most efficient N scavengers.

f) Provide for nutrient, especially phosphorus, accumulation and decline in soils as affected by cover crops.

Attachments

- Attachment A: details and examples of calculating the RNREs
- Attachment B: Technical Requirements for Entering Cover Crops BMPs into Scenario Builder and the Watershed Model
- Attachment C: Initial Expert Panel survey summary, conducted by Tetra Tech
- Attachment D: Expert Panel meeting minutes/notes/attendance

Summary of New Cover Crop Species N Reduction Efficiencies, Sept. 13, 2013.

Proposed New Species	Relative N Reduction Efficiency [1] (RNRE) (Relative to Rye)	Number Site-Years	Planting Dates
Annual Ryegrass	**0.66**	**5**	**early and normal**
Annual Legume	**0.16**	**4**	**early and normal**
Annual Legume + Grass	**NA[2]**	**NA**	**early and normal**
Brassica (winter hardy)	**0.70**	**13**	**early**
Forage Radish	**0.58**	**12**	**early only**
Forage Radish + Grass	**NA[2]**	**NA**	**early and normal**
Triticale	**0.86**	**10**	**early, normal and late**
Oats (winter hardy)	**0.55**	**11**	**early and normal**
Oats (winter killed)	**0.40**	**4**	**early only**

[1] Data for each N Reduction Efficiency are on the following tabs,
(the yellow highlighted cell in each tab is the final value used)

[2] The final N Effectiveness was the Average of: the N Effectiveness value of the species, and the average N Effectiveness values across all grasses in the same planting date and seeding method (see Cover Crop Report for details).

Pooled SS from Legumes (3 df)	0.044054
Pooled SS from Annual Ryegrass (2 df)	0.194071
Pooled SS from triticale (8 df)	0.293511
Pooled SS from Forage Radish + Grass (9 df)	0.083565
Pooled SS from Oats (winter hardy, with 10 df)	0.174791
Total Poolded SS (32 df)	0.789992
Total Poolded Var (32 df)	0.024687
Total Poolded Std Dev (32 df)	**0.157122**
Examples of Std Error of mean for N = 4 :	**0.079**
Examples of Std Error of mean for N = 9 :	**0.052**
Examples of Std Error of mean for N = 16 :	**0.039**

Note: this is the variability from across years or sites within the species tabs (not across reps within a study).

Summary of CC N Reduction Efficiency Literature for Legumes and Legume-Grass Mixtures

Literature Citation	Notes	Plt. Date	Har. Date	Percent Recovery of 15N in above-ground DM: Rye	Ann. Ryegrass	Hairy Vetch	Crimson Cl.	Weeds	Other	Percent Recovery relative to Rye: Rye	Ann. Ryegrass	Hairy Vetch	Crimson Cl.	Other	Weeds
Shipley, P.R., J.J.Meisinger, and A.M. Decker. 1992. Conserving residual corn fertilizer nitrogen with winter cover crops. Agron. J. 84(5): 869-876.	Poplar Hill, MD; Lower Eastern Shore **Mattapex silt loam**. mod. well-drained: shallow water table. 336 kg N/ha 15N fert corn, stalks disked 2X then NT plt, No fall fert N, four covers and a control, Abruzzi rye, Marshall ryegrass, Dixie Crimson Clover, Hairy Vetch, and a weed control (chickweed). Used Above-grd 15N in covers as % of fall soil 15N, data from Table 3, Harvest II, 336 kg N/ha, 1987 & 1988 divided by (1- (% of TN in roots) fr. p.875)	Sept. 22. 1986	April 20. 1987	51%	See An. Ryegr. Tab	18%	11%	4%	NA	1.000	See An. Ryegr. Tab	0.351	0.222		0.083
		Oct. 5, 1987	April 14, 1988	69%	See An. Ryegr. Tab	6%	8%	14%	NA	1.000	See An. Ryegr. Tab	0.080	0.108		0.197
			Avg.	60%	See An. Ryegr. Tab	12%	9%	9%		1.000	See An. Ryegr. Tab	**0.216**	**0.165**		**0.140**
				Rye			**Crimson Cl.**		**Rye-Crim Cl. Mix**	**Rye**			**Crimson Cl.**	**Rye-Crim Cl. Mix**	**Weeds**
Ranells, N.N. and M.G. Wagger. 1997. Nitrogen-15 recovery and release by rye and crimson clover cover crops. Soil Sci. Soc. Am. J. 61:943-948.	Kinston NC: Coastal Plain. **Norfolk loamy sand**. very well drained, sandy clay loam subsoil, no water table mentioned, Prev. corn crop fert. @ 150 kg N/ha, field micro-plots 2mX3m fert with 50 kg $^{15}NO_3$-N /ha from KNO_3 approx. 1 wk after planting. Species were (varieties not given) rye, crimson clover, and rye + crimson clover mix. All covers sampled in mid-April (samples in Dec & March not used due to v. small harvest area). Used above-grd 15N in covers as % recovery of fall applied 15N from Table 2, for 1992-93 and 1993-94 seasons.	Oct. 8. 1992	~ April 15. 1993	35%			4%	1.0%	13%	1.000			0.114	0.371	0.029
		Oct. 1, 1993	~ April 15, 1994	42%			3%	0.5%	24%	1.000			0.071	0.571	0.012
				39%			4%		19%	1.000			**0.093**	**0.471**	**0.020**

Avg. All Legumes	**0.158**
Avg. Leg.+Gr. Mix	**0.471**
Avg Weeds	**0.080**
Avg. Std Dev (3 df):	0.100756241
Avg. Var (3 df):	0.014685
Pooled SS (3 df):	0.044054

Other Literature Citations	Notes	Plt. Date	Har. Date
Gabreil. J.L. and M. Quemada. 2011. Replacing bare fallow with cover crops in a maize cropping system: Yield. N uptake and fertiliser fate. European J. Agronomy 34: 133-143.	Irrigated corn for grain with ~210 kg 15N/ha from enriched NH4NO3 followed by unfertilized covers of vetch or barley. Mediterannean climate. calcarious silt loam soil. Used micro plot, measured soil 15N after corn and before cover planting and 15N uptake of covers in spring, including roots. The 3-yr avg cover crop recovery of the fall 15N to 1.2m deep in the soil was vetch only 1.2% and barley 10.6%. **Therefore, these data support the fact that legumes are quite poor recyclers of fall N, even in a much different climate and soil than MD.**		
Feaga, J.B., J.S. Selker, P.D. Richard, and D.D. Hepmhill. 2010. Long-term nitrate leaching under vegetable production with cover crops in the Pacific Northwest. Soil Sci. Soc. Am. J. 74:186-195.	An 11-year study of deploying a cover crop vs. fallow after vegtables in OR. Vegetables were sweet corn, brocoli, or snap beans in any year with only one vegetable grown each year. Had 3 N rates: none. a normal Ext. Recc. Rate. and one rate inbeteween. Only had one cover crop treatement each year that was compared to fallow each year. Cover crops were either rye, triticale, or a vetch-triticale mix. The cover crops were thus confounded with years and provide only a crude comparison of the effect of cover crops. Leaching was well monitored w/ large (0.31m X 0.85m) passive capillary wick lysimeterplates at a depth of 1.2m. **The only useful ~comparison was that the NO3-N conc. in the drainage below the grass covers (rye or triticale) 9-yr avg. was 34% less than w/out a cover, while the mix (vetch-triticale) averaged 19% less than w/out a cover. So the mixture performed approx. half as well as the pure grasses.**		

Summary of CC N Reduction Efficiency Literature for Annual Ryegrass

				Percent Recovery of 15N in above-ground DM						Percent Recovery relative to Rye				
Literature Citation	**Notes**	**Plt. Date**	**Har. Date**	**Rye**	**Ann. Ryegrass**	**Hairy Vetch**	**Crimson Cl.**	**Weeds**	**Other**	**Rye**	**Ann. Ryegrass**	**Hairy Vetch**	**Crimson Cl.**	**Other**
	Poplar Hill, MD; Lower Eastern Shore													
Shipley, P.R., J.J.Meisinger, and A.M. Decker. 1992.	**Mattapex silt loam**, mod. well-drained; shallow water table,	Sept. 22, 1986	April 20, 1987	51%	40%	See Leg. Tab	See Leg. Tab	4%	NA	1.000	0.795	See Leg. Tab	See Leg. Tab	
Conserving residual corn fertilizer nitrogen with winter	336 kg N/ha 15N fert corn, stalks disked 2X then NT plt,	Oct. 5, 1987	April 14, 1988	69%	39%	See Leg. Tab	See Leg. Tab	14%	NA	1.000	0.560	See Leg. Tab	See Leg. Tab	
cover crops. Agron. J. 84(5): 869-876.	No fall fert N, four covers and a control,		Avg.	60%	40%	See Leg. Tab	See Leg. Tab	9%		1.000	**0.678**	See Leg. Tab	See Leg. Tab	
	Abruzzi rye, Marshall ryegrass, Dixie Crimson Clover,													
	Hairy Vetch, and a weed control (chickweed). Used													
	Above-grd 15N in covers as % of fall soil 15N, data from													
	Table 3, Harvest II, 336 kg N/ha, 1987 & 1988 divided													
	by (1- (% of TN in roots) fr. p.875)													
Salon, P. (Pers. Comm. 2013). NRCS Cover Crop demo study 2010.	One year study of various cover crop species with three planting	Sept 1 & 15 & 29, 2010	May 11, 2011							DM Production Relative to Rye				
Unpublished data from Big Flats NY NRCS Plt. Introduction Stn.	dates (Sept. 1, 15, and 29) and harvested May 11, 2011. Species			Total aboveground DM, kg DM/ ha						Rye	Ann. Ryegrass			
	were Rye (Aroostock) and an un-named Triticale plus an un-named			6258	2477					1.000	**0.396**			
	Annual Ryegrass. Only DM data available. Took average across													
	all 3 Sept planting dates to provide additional observations.													
										TN Uptake Relative to Rye				
				Total aboveground N, kg N/ ha						Rye	Ann. Ryegrass			
Houser, C., W.S. Harkcom, and M.H. Hall. 2013.	Two years of study of various short-lived forage species and varieties. All	Sept. 19, 2011	April 26, 2012	137	145					1.000	**1.058**			
Short-lived cool-season grass trial. pp.16-19. *In* 2012 Forage trials	entries received 30 lbs N/ac in the fall and 100 lbs N/ac in spring.	Sept. 24, 2012	May 2, 2013	191	92					1.000	**0.482**			
report. Coop. Ext. Serv. PA St. University, St. College, PA.	Data from "Cut 1" that is late-boot stage. Replicated PA St study for all													
	entries. Used average of 5 Ryegrass entries listed as Annual Ryegass													
	(Marshall & Rootmax) and Italian Ryegrass (Bardelta, Barherta,													
	Barmultra II); and the one Rye variety (Aroostock).													

Annual Ryegrass Wtd (# Yrs) Avg:	**0.658**
Avg. Std Dev (2 df):	0.287221
Avg. Var (2 df):	0.097035
Pooled SS (2df):	0.194071

Attachment A

Summary of CC N Reduction Efficiency Literature for Triticale

Literature Citation	Notes	Plt. Date	Har. Date	Rye	Triticale	Production relative to Rye: Rye	Production relative to Rye: Triticale
				Total aboveground N, kg N/ ha			
Smith, S.R., W. Thomason, B. Benson, D.Starner, and D. Dixon. 2009. Virginia small grain forage variety testing report: long-term summary (1994-2004). Virginia Coop. Extension Pub. No. 418-019, VA Poly. Inst. and State Univ., Blacksburg, VA. Virginia Cooperative Extension. Small grain forage variety testing, annual reports 2005-2012. VA Poly. Inst. and State Univ., Blacksburg, VA.	These data are from a long-term forage production trial in VA. All species received 25-30 lbs N/ ac in the fall and 60 lb N/ ac in the spring. They were harvested by developmental stage (not calendar date), but the data were screened so all data reflect harvests done in mid- to late-April. All harvests contain DM production, and crude protein that was converted to TN by dividing by 6.25. Wade Thomason reviewed all the 1994-2012 data from this trial and selected the varieties with mid-April harvest dates for inclusion in this summary. The varieties were: "Wheeler" Rye and "Trical 102" Triticale. Note: number of years in summary value vary, rye has 11 yrs. triticale 6 years. For calculation across studies use 6 years as the weighting factor for these data.	Various dates in October	Various dates mid-late April (boot stage)	184	161	1.000	**0.875**
				Total aboveground N, kg N/ ha		TN Uptake Relative to Rye: Rye	Triticale
Coale, F.J., J.M. Costa, G.A Bollero, and S.P. Schlosnagle. 2001. Small grain winter cover crops for conservation of residual soil nitrogen in the midAtlantic Coastal Plain. Am. J. Alternative Agric. 16(2):66-72	Used one MD location at Wye, soil was a Mattapex silt loam, the Pop Hill site was dropped due to later planting of rye and goose feeding damage (pers comm F.Coale). Prior crop had 4 rates of poultry litter, that were estimated to supply approx. 0 (no addition), ~150, ~300, and ~450 kg of plant available N/ ha. Four small grains were grown as fall cover crops: rye (Wheeler), triticale (Trical 498), wheat (Madison), and barley (Nomini). Covers sampled in spring just before killing, analyzed the total above ground dry matter for total N. Averaged across all N rates.	Oct. 26, 1996	April 10, 1997	47	54	1.000	**1.149**
				Total aboveground N, kg N/ ha		TN Uptake Relative to Rye: Rye	Triticale
Staver, K. (Pers. Comm. 2013). Cover crop demo study 2004. Unpublished data from Wye Res. & Edu. Center. Queenstown, MD.	One year study of various cover crop species and varieties planted early (early Oct probably) or late following sweet corn (probable high residual N, but fall NO3 not documented). Spring harvest at four times, but only used the April 20 harvest used. Measured aboveground DM and TN uptake.	Early October	April 20, 2004	87	73	1.000	**0.843**
				Total aboveground DM, kg DM/ ha		DM Production Relative to Rye: Rye	Triticale
Salon, P. (Pers. Comm. 2013). NRCS Cover Crop demo study 2010. Unpublished data from Big Flats NY NRCS Plt. Introduction Stn.	One year study of various cover crop species with three planting dates (Sept. 1, 15, and 29) and harvested May 11, 2011. Species were Rye (Aroostock) and an un-named Triticale plus an un-named Annual Ryegrass. Only DM data available. Took average across all 3 Sept planting dates to provide additional observations.	Sept 1 & 15 & 29, 2010	May 11, 2011	6258	3979	1.000	**0.636**
				Total aboveground N, kg N/ ha		TN Uptake Relative to Rye: Rye	Triticale
Houser, C., W.S. Harkcom, and M.H. Hall. 2013. Short-lived cool-season grass trial. pp.16-19. *In* 2012 Forage trials report. Coop. Ext. Serv. PA St. University, St. College, PA.	One year of study of various short-lived forage species and varieties. All entries received 30 lbs N/ac in the fall and 100 lbs N/ac in spring. Data from "Cut 1" that is late-boot stage. Replicated PA St study for all entries. Only one Triticale variety (Fridge) was harvested when rye was harvested, (all other Triticale's were 1-2 weeks after rye). One rye variety was in the study (Aroostock).	Sept. 24, 2012	May 2, 2013	191	133	1.000	**0.696**

Triticale Wtd (# Yrs) Avg: 0.857

Std Dev (3 df):	0.229116
Var (3df):	0.052494
From above Pooled SS (3 df):	0.157482
From VA 6 yr data[1] Pooled SS (5 df):	0.136029
Total Pooled SS (8 df):	0.293511

[1] see spreadsheet: "Va Tech Sm Gr Forage Test 1994-2004, 418-019 Raw data & 2005-2010 Extracted data.xlsx" cell "AG31"

Summary of CC Literature for Other Refs for N Reductions for Triticale

Other Literature Citations	Notes	Plt. Date	Har. Date	Rye	Triticale	W. Wheat	W. Barley	Spr. Barley	Rape	Production relative to Rye: Rye	Triticale	W. Wheat	W. Barley	Spr. Barley	Rape
Ort, S.B., Q.M. Ketterings, K.J. Czymmek, G.S. Godwin, S.N. Swink, and S.K. Gami. 2012.Carbon and Nitrogen Uptake of Cereal Cover Crops Following Corn Silage. What's Cropping Up? Nutrient Management Spear Program, PRODAIRY, Dept Animal Science, Cornell Univ. News Letter vol23 no.2, Cornell Univ. Ithaca, NY.	On-farm individual field trials with one species per field, no within field replication. Reps from different fields and different farm operators. Number of fields varied depending on number of volunteered fields. Rye Plt dates (18 fields) Sept 12-Oct 12, 2011; Triticale Plt dates (9 fields) Sept 9-Sept 13, 2011; Oats Plt Dates (4 fields) Sept 9-Sept 16, 2011. Variable manure added to fields, comparisons not made within one field nor within one manure treatment. **Didn't use any data from this source, because no direct comparisions**	See Notes													
				---------- kg N/ ha in cover crop above grd DM at spring killing ----------						Relative N Uptake compared to Rye					
Fernando, S.W. 1996. Effects of Winter Cover Crops Following Potato (Solanum tuberosum L.) on Soil Nitrate and Soil Fertility in the Columbia Basin. PhD thesis. Oregon St. Univ. Dept. Crop Sci. major prof. Alvin R. Mosley.	On an Adkins fine sandy loam at the Hermiston Agric. Research and Extension Ctr of Oregon St. Univ. on a Adkins fine sandy loam following potato crop, had been cropped for > 50 yrs. Precip + Irrig. in cover crop season 92-93 was 307mm and the 93-94 season was 150mm. Covers were Rye (cv. Wheeler), winter wheat (cv. Stephens), winter barley (cv. Hesk), spring barley (cv.Steptoe), Triticale (cv. Whitman), and rape (cv. Humus). Covers not fertilized, only had residual NO3-N from potatoes, which was 160 kg n/ha in fall 1992 & 62 kg N/ha in fall 1993. Covers killed by plowing at times shown. **These data agree surprisingly well with all our cover crop data**	Sept. 18, 1992	April 5, 1993	133	95	98	116	74	100						
		Sept. 20, 1993	March 15, 1994	71	76	76	65	45	35						
			Average:	**102**	**86**	**87**	**91**	**60**	**68**	**1.00**	**0.84**	**0.85**	**0.89**	**0.58**	**0.66**
		South W VA	South W VA	Total above ground DM, lbs/ ac											
Monks, C.D., T. Basden, J.L. Hatton, M.L. McFarland, S.M. Poland, and E. Rayburn. 1997. Cover crop response to late-season planting and N application. J. Prod. Agr. 10(2): 289-293	Northern & Southern West VA. Covers all followed corn for grain and were fertilized in the fall (took an average across all fert. N rates). Northenr soils: Wharton silt loam and Clarksburg silt loam. Southern soil: Cookport fine loam. Corn soil disked twice before shallow incorporation seeding. Fall fert. N rates: 0, 20, 40, 60 lbs N/ ac , averaged across all the fert. N rates. Measured total above ground DM, not total N. Had two rye varieties Abruzzi and Pastar, averaged across these varieties. Had one Triticale variety Wittmack. **These data have v. low DMs due to ??, set aside as an outlier.**	Oct. 5, 1992	May 11,1993	943	232					1.000	0.246				
		North W VA	North W VA												
		Oct. 26, 1993	May 29,1994	1884	467					1.000	0.248				
		Oct. 7, 1994	April, 26, 1995	1793	710					1.000	0.396				
			Avg.	1540	470						0.297				

Summary of CC N Reduction Efficiency Literature for fall seeded Oats (winter hardy)

Literature Citation	Notes	Plt. Date	Har. Date	Rye	Oats	Production relative to Rye: Rye	Oats	Year	Rye	Oat
				Total aboveground N, kg N/ ha						
Smith, S.R., W. Thomason, B. Benson, D.Starner, and D. Dixon. 2009. Virginia small grain forage variety testing report: long-term summary (1994-2004). Virginia Coop. Extension Pub. No. 418-019, VA Poly. Inst. and State Univ., Blacksburg, VA. Virginia Cooperative Extension. Small grain forage variety testing, annual reports 2005-2012. VA Poly. Inst. and State Univ., Blacksburg, VA.	These data are from a long-term forage production trial in VA. All species received 25-30 lbs N/ ac in the fall and 60 lb N/ ac in the spring. They were harvested by developmental stage (not calendar date), but the data were screened so all data reflect harvests done in mid- to late-April. All harvests contain DM production, and crude protein that was converted to TN by dividing by 6.25. Wade Thomason reviewed all the 1994-2012 data from this trial and selected the varieties with mid-April harvest dates for inclusion in this summary. The varieties were: Wheeler Rye, and SS 76-30. Note: number of years in summary value vary, but rye has 11 yrs and oats 11 years. For calculation across studies use 11 years as the weighting factor for these data, if other data can be found.	Various dates in October	Various dates mid-late April (boot stage)	184	102	1.000	**0.554**			

Oats (fall) Avg. (11 yrs) : 0.554

Total Pooled SS[1] (10 df): 0.174791295

[1] see spreadsheet: "Va Tech Sm Gr Forage Test 1994-2004 418-019 Raw data & 2005-2010 Extracted data.xlsx" cell "AE32"

Attachment A

Summary of CC N Reduction Efficiency Literature for fall seeded Oats (normally winter kills)

Literature Citation	Notes	Plt. Date	Har. Date	Rye	Oats	Production relative to Rye: Rye	Production relative to Rye: Oats
				Total aboveground N, kg N/ ha			
Thomason, W. Unpublished VA Radish and Mixed Species data, from 3 yr average values (2010-2012).	Data for the Eastern & Western regions, avg of 3 years of data	Eastern	Winter (Dec?)	32	29		
		Western	Winter (Dec?)	87	79		
		Eastern	Spring (Apr?)	62	21		
		Western	Spring (Apr?)	134	13		
		Eastern	Avg Winter	60	54		
		Western	Avg Spring	98	17		
				Avg winter-spr loss	-37		
Smith, S.R., W. Thomason, B. Benson, D.Starner, and D. Dixon. 2009. Virginia small grain forage variety testing report: long-term summary (1994-2004). Virginia Coop. Extension Pub. No. 418-019, VA Poly. Inst. and State Univ., Blacksburg, VA. Virginia Cooperative Extension. Small grain forage variety testing, annual reports 2005-2012. VA Poly. Inst. and State Univ., Blacksburg, VA.	These data are from a long-term forage production trial in VA. All species received 25-30 lbs N/ ac in the fall and 60 lb N/ ac in the spring. They were harvested by developmental stage (not calendar date), but the data were screened so all data reflect harvests done in mid- to late-April. All harvests contain DM production, and crude protein that was converted to TN by dividing by 6.25. Wade Thomason reviewed all the 1994-2012 data from this trial and selected the varieties with mid-April harvest dates for inclusion in this summary. The varieties were: Wheeler Rye, and SS 76-30. Note: number of years in summary value vary, but rye has 11 yrs and oats 11 years. For calculation across studies use 11 years as the weighting factor for these data.	Various dates in October	Various dates mid-late April (boot stage)	184	102		
				Avg winter-spr loss	-37		
			Est. Spr. If killed	184	65	**1.000**	**0.353**
		Est. Spr, only NO3-N lost (18% of TN[1])		184	84	**1.000**	**0.455**
						Combined Avg. Rel to Rye	**0.404**

[1] Pers. Comm. from Ms. Natalie Lounsbury UMCP who shared her MS thesis ("Spring Seedbed Characteristics after Winter-killed Cover Crops") data on total N content and NO_3-N content of winter killed oats.

Summary of CC N Reduction Efficiency Literature for Forage Radish

Literature Citation	Notes	Site Yr	Plt. Date	Har. Date	Rye	Oats+Canola	Oats	Est. Canola	Site-years	Percent Uptake relative to Rye: Rye	Percent Uptake relative to Rye: Canola
		Eastern	various fall dates	various spring dates	62	67	21	46	3	1.000	0.742
Thomason, W. Unpublished data. Cite as Personnel Communication	Data for the Eastern & Western regions, avg of 3 years of data	Western	various fall dates	various spring dates	134	81	13	68	3	1.000	0.507
VA Radish and Mixed Species data,											
from 3 yr average values (2010-2012)					98	74	17	57			0.625
	CMREC2- Beltsville, MD. Loamy sand soil. Radish, rye, and				**Rye**	**Rape**				**Rye**	**Rape**
Dean, JE and RR Weil. 2009. Brassica cover crops for	**rape were planted on Aug. 25 following mowing of a**	CMREC2	August 25, 2004	Oct/Nov & April/May	73	84			1	1.000	1.152
nitrogen retention in the Mid-Atlantic coastal plain.	soybean crop that contributed 208 kgN/ha as an organic N source	WREC1	August 19, 2003	Oct/Nov & April/May	38	41			1	1.000	1.093
J. Environ. Qual. 38:520-528.	WREC1- Wye, MD. Silt loam soil. Radish, rye, and rape were	WREC2	September 24, 2003	Oct/Nov & April/May	84	118			1	1.000	1.410
	planted on Aug. 19 following sweet corn harvest. Residual N										
	fertilizer from sweet corn was available as an N source.					81.2					1.218
	WREC2- Wye, MD. Silt loam soil. Radish, rye, and rape were planted on Sept 24 following mowing of a soybean crop that contributed 250 kgN/ha as an organic N source.										
	At CMREC2, Rye cleaned out the profile as well as Radish in November. In April, radish profile had elevated NO3 to 75cm, totaling ~25 kgN/ha										
	At WREC 1&2 Rye cleaned out the profile as well as radish in November and January. At WREC2 in April, Radish had elevated NO3 to 75cm, totaling ~ 20 kgN/ha										
					Rye	**Rape**				**Rye**	**Rape**
Finney, DM and JP Kaye. 2013. Cover crop cocktails to enhance nitrogen management. PSU Extension Handout	Hagerstown soil, State College, PA. Cover crops planted in late August. Previous crop oats. Soil moldboard plowed prior to cover crop establishment.		Late August 2011	mid-May 2012	67	108			1	1.000	1.612
					Rye	**Rape**				**Rye**	**Rape**
Muller, J.C., D. Denys, G. Borlet, and A. Mariotti. 1989. Influence of catch crops on mineral nitrogen leaching and its subsequent plant use. Pp85-98. In J.C. Germon (ed.) Managemnt systems to reduce impact of nitrates Elsevir Sci Pub. NY, NY.	Soil and plant samples from unfertilized covers planted after wheat in France. One year of data. Covers were rye and rape.		October	early March	120	23			1	1.000	0.192
					Rye	**Rape**				**Rye**	**Rape**
Fernando, S.W. 1996. Effects of Winter Cover Crops	on an Adkins fine sandy loam at the Hermiston Agric. Research		Sept. 18, 1992	April 5, 1993	133	100			1	1.000	0.752
Following Potato (Solanum tuberosum L.) on Soil Nitrate	and Extension Ctr of Oregon St. Univ. on a Adkins fine sandy loam		Sept. 20, 1993	March 15, 1994	71	35			1	1.000	0.493
and Soil Fertility in the Columbia Basin. PhD thesis, Oregon	following potato crop, had been cropped for > 50 yrs. Precip + Irrig.			Average:	102	68					
St. Univ. Dept. Crop Sci. major prof. Alvin R. Mosley.	in cover crop season 92-93 was 307mm and the 93-94 season was 150mm. Covers were Rye (cv. Wheeler), winter wheat (cv. Stephens), winter barley (cv. Hesk), spring barley (cv.Steptoe), Triticale (cv. Whitman), and rape (cv. Humus). Covers not fertilized, only had residual NO3-N from potatoes, which was 160 kg n/ha in fall 1992 & 62 kg N/ha in fall 1993. Covers killed by plowing at times shown. (These cover species data agree v. well with our Bay Watershed data)										
								Total	13	Wtd Avg:	0.804
										Panel Vote:	**0.70**

Pooled Std Dev (6 df): 0.505533
Pooled Var (6df): 0.255564 — Note: this is 10 times the pooled variance calculated on the Species Summary tab.
Pooled SS (6 df): 1.533385

Summary of CC N Reduction Efficiency Literature for Forage Radish

Literature Citation	Notes	Site Yr	Plt. Date	Har. Date	kgN/ha uptake by cover crops (Rye and Rape in Spring, Radish in Fall)				Percent Uptake relative to Rye		
					Rye	**Rape**	**Radish Shoot**	**Radish Root**	**Rye**	**Rape**	**Radish Shoot**
	CMREC2- Beltsville, MD. Loamy sand soil. Radish, rye, and										
Dean, JE and RR Weil. 2009. Brassica cover crops for	**rape were planted on Aug. 25 following mowing of a**	CMREC2	August 25, 2004	Oct/Nov & April/May	73.2	84.3	148.0	69.7	1.000	1.152	2.022
nitrogen retention in the Mid-Atlantic coastal plain.	**soybean crop that contributed 208 kgN/ha as an organic N source**	WREC1	August 19, 2003	Oct/Nov & April/May	37.8	41.3	44.2	33.5	1.000	1.093	1.169
J. Environ. Qual. 38:520-528.	WREC1- Wye, MD. Silt loam soil. Radish, rye, and rape were planted on Aug. 19 following sweet corn harvest. Residual N fertilizer from sweet corn was available as an N source. WREC2- Wye, MD. Silt loam soil. Radish, rye, and rape were planted on Sept 24 following mowing of a soybean crop that contributed 250 kgN/ha as an organic N source. At CMREC2, Rye cleaned out the profile as well as Radish in November. In April, radish profile had elevated NO3 to 75cm, totaling ~25 kgN/ha At WREC 1&2 Rye cleaned out the profile as well as radish in November and January. At WREC2 in April, Radish had elevated NO3 to 75cm, totaling ~ 20 kgN/ha	WREC2	September 24, 2003	Oct/Nov & April/May	83.7	118.0	155.0	60.6	1.000	1.410	1.852
Personnal Communication from:					**Rye**	**Rape**	**Radish Shoot**		**Rye**	**Rape**	**Radish Shoot**
Finney, DM and JP Kaye. 2013. Cover crop cocktails to enhance nitrogen management. PSU Extension Handout	Hagerstown soil, State College, PA. Cover crops planted in late August. Previous crop oats. Soil moldboard plowed prior to cover crop establishment.		Late August 2011	mid-May 2012	67.0	108.0	27.0		1.000	1.612	0.403
White, C and RR Weil. Unpublished Nitrogen Data from study below.					**Rye**		**Radish Shoot**		**Rye**		**Radish Shoot**
White, C. and RR Weil. 2010. Forage Radish Cover Crops	CMREC- Greenbelt, MD, sandy loam soil.	BARC08			141.4		160.1		1.000		1.132
Increase Soil Test Phosphorus Surrounding Radish Taproot Holes	BARC-SF- Silt loam soil	BARC09			191.2		142.9		1.000		0.747
SSSAJ 75:121-130.	In both sites cover crops were planted after corn silage.	CMREC08			27.6		88.7		1.000		~~3.214~~
Thomason, W. Unpublished data. Cite as Personnel Communication					**Rye**		**Radish Shoot**		**Rye**		**Radish Shoot**
VA Radish and Mixed Species data,	Data for each region is an average of 3 years of data	Eastern	various fall dates	various spring dates	62		53		1.000		0.855
from 3 yr average values (2010-2012)		Western	various fall dates	various spring dates	134		96		1.000		0.716

Note:
Pers. Comm. from Ms. Natalie Lounsbury UMCP who shared her MS thesis ("Spring Seedbed Characteristics after Winter-killed Cover Crops") data on total N content and NO_3-N content of winter killed oats.

% NO3 in radish tissue is 16% for shoots and 29% for roots averaged over 4 site years
Oats also had 16% NO3 in shoots averaged over 4 site years

	Rye	Rape	Radish Shoot
Wtd (by # site-years) Average	1.000	1.316	**1.003**

Panel voted N Reduction Efficiency **Forage Radish Poll:** **0.575**

Literature Citation	Notes	Plt. Date	Har. Date	Rye	Radish+Grass	# Site-Years	Rye	Radish+Grass	
				Total aboveground N, kg N/ ha					
Houser, C., W.S. Harkcom, and M.H. Hall. 2013. Short-lived cool-season grass trial. pp.16-19. *In* 2012 Forage trials report. Coop. Ext. Serv. PA St. University, St. College, PA. (used spreadsheet from Sjoerd Duiker having the 2010-2011 and the 2012-2013 data for all entries, not just those on above website)	Two years of study of various short-lived forage species and varieties. All entries received 30 lbs N/ac in the fall and 100 lbs N/ac in spring. Data from "Cut 1" that is late-boot stage. Replicated PA St study for all entries. Used the Radish+Rootmax entry (Radish+Annual Ryegass) to capture the mixture performance relative to Rye (Aroostok).	Sept. 19, 2011	April 26, 2012	137	145	1	1.000	**1.058**	
		Sept. 24, 2012	May 2, 2013	191	87	1	1.000	**0.455**	0.757
Duiker, S.J. 2013. Pers. Communication of results from a Cover Crop after Corn Silage Trial done in 2011-2012 and 2-12-2013 across the state of PA.	Two years of data from an multi-location across PA study evaluating cover crop mixtures following silage corn harvest. Each locat had 4 reps and either 7 (2012) or 8 (2013) cover crop mixtures as well as a pure rye (Aroostock) cover, and a Radish+Rye mixture that was used for these calculations. There were 10 PA locations in 2012 and 9 in 2013. All cover crop treatments measured DM and TN uptake at the boot stage.	Aug-Sept 15, 2011 (?)	??	104	92	10	1.000	**0.885**	0.885
Thomason, W.D. Pers. Communication of results from VA Radish and and Mixed Species data, 3 yr average values (2010-2012).	These data are from a VA cover crop study having radish, rye, and other mixed species (2, 3, and 4 component mixtures). The entire study was repeated in two VA regions (Eastern & Western). It had ? replicates, and measured DM and TN in the winter (at the end of growing season) and in the spring (at the end of the spring season). Used only the spring season TN uptake from the Western VA region (it's the only region that had a Radish+Grass mixture, actually it was Rad+Rye+AnnRyeGr)	Various dates in October	Various dates mid-late April (boot stage)	134	106	3	1.000	**0.791**	
					Total # Site-Yrs:	15			

Rad+Grass Wtd (# site-yrs) Avg: 0.849

Note: these data for Radish + Grass mixtures were not used due to the need to use a "generic grass" to simplify reporting, see Cover Crop Report.

From 2011 CC after C Silage, Pooled Std Dev (9 df): 0.096359
Pooled Var (9df): 0.009285
Pooled SS (9 df): 0.083565

Cover Crop Total Nitrogen Efficiency Estimates, 10-03-13

Coastal Plain/Piedmont Crystalline/Karst Settings

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	**Rye**		**Rye**		**Rye**		**Rye**		**Wheat**		**Wheat**		**Wheat**		**Wheat**		**Barley**		**Barley**		**Barley**		**Barley**	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.45	0.45	0.38	0.38	0.31	0.31	0.18	0.18	0.31	0.31	0.27	0.27	0.22	0.22	0.12	0.12	0.38	0.38	0.32	0.32	0.27	0.27	0.15	0.15
Normal planting	0.41	0.41	0.35	0.35	NA	NA	NA	NA	0.29	0.29	0.24	0.24	NA	NA	NA	NA	0.29	0.29	0.24	0.24	NA	NA	NA	NA
Late planting	0.19	0.19	0.16	0.16	NA	NA	NA	NA	0.13	0.13	0.11	0.11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Coastal Plain/Piedmont Crystalline/Karst Settings

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Forage Radish		Forage Radish		Forage Radish		Forage Radish		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Annual Legume		Annual Legume		Annual Legume		Annual Legume	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.26	0.26	0.22	0.22	0.18	0.18	0.10	0.10	0.29	0.29	0.25	0.25	0.20	0.20	0.12	0.12	0.07	0.07	0.06	0.06	0.05	0.05	0.03	0.03
Normal planting	NA	NA	NA	NA	NA	NA	NA	NA	0.22	0.22	0.18	0.18	NA	NA	NA	NA	0.06	0.06	0.06	0.06	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Coastal Plain/Piedmont Crystalline/Karst Settings

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Legume plus grass mixture		Legume plus grass mixture		Legume plus grass mixture		Legume plus grass mixture		Triticale		Triticale		Triticale		Triticale		Annual Ryegrass		Annual Ryegrass		Annual Ryegrass		Annual Ryegrass	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.20	0.20	0.17	0.17	0.14	0.14	0.08	0.08	0.39	0.39	0.33	0.33	0.27	0.27	0.15	0.15	0.30	0.30	0.25	0.25	0.20	0.20	0.12	0.12
Normal planting	0.19	0.19	0.16	0.16	NA	NA	NA	NA	0.35	0.35	0.30	0.30	NA	NA	NA	NA	0.27	0.27	0.23	0.23	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	0.16	0.16	0.14	0.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Coastal Plain/Piedmont Crystalline/Karst Settings

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Killed		Oats, Winter Killed		Oats, Winter Killed		Oats, Winter Killed		Brassica (Winter Hardy)		Brassica (Winter Hardy)		Brassica (Winter Hardy)		Brassica (Winter Hardy)	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.25	0.25	0.21	0.21	0.17	0.17	0.10	0.10	0.18	0.18	0.15	0.15	0.13	0.13	0.07	0.07	0.32	0.32	0.27	0.27	0.22	0.22	0.13	0.13
Normal planting	0.23	0.23	0.19	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Mesozoic Lowlands/Valley and Ridge Siliciclastic

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	**Rye**		**Rye**		**Rye**		**Rye**		**Wheat**		**Wheat**		**Wheat**		**Wheat**		**Barley**		**Barley**		**Barley**		**Barley**	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.34	0.34	0.29	0.29	0.24	0.24	0.14	0.14	0.24	0.24	0.2	0.2	0.17	0.17	0.1	0.1	0.29	0.29	0.25	0.25	0.2	0.2	0.12	0.12
Normal planting	0.31	0.31	0.27	0.27	NA	NA	NA	NA	0.22	0.22	0.19	0.19	NA	NA	NA	NA	0.22	0.22	0.19	0.19	NA	NA	NA	NA
Late planting	0.15	0.15	0.12	0.12	NA	NA	NA	NA	0.1	0.1	0.09	0.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Mesozoic Lowlands/Valley and Ridge Siliciclastic

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Forage Radish		Forage Radish		Forage Radish		Forage Radish		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Forage Radish plus grass mixture		Annual Legume		Annual Legume		Annual Legume		Annual Legume	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.20	0.20	0.17	0.17	0.14	0.14	0.08	0.08	0.22	0.22	0.19	0.19	0.15	0.15	0.09	0.09	0.05	0.05	0.05	0.05	0.04	0.04	0.02	0.02
Normal planting	NA	NA	NA	NA	NA	NA	NA	NA	0.16	0.16	0.14	0.14	NA	NA	NA	NA	0.05	0.05	0.04	0.04	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Mesozoic Lowlands/Valley and Ridge Siliciclastic

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Legume plus grass mixture		Legume plus grass mixture		Legume plus grass mixture		Legume plus grass mixture		Triticale		Triticale		Triticale		Triticale		Annual Ryegrass		Annual Ryegrass		Annual Ryegrass		Annual Ryegrass	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.15	0.15	0.13	0.13	0.10	0.10	0.06	0.06	0.29	0.29	0.25	0.25	0.21	0.21	0.12	0.12	0.22	0.22	0.19	0.19	0.16	0.16	0.09	0.09
Normal planting	0.14	0.14	0.12	0.12	NA	NA	NA	NA	0.27	0.27	0.23	0.23	NA	NA	NA	NA	0.20	0.20	0.18	0.18	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	0.13	0.13	0.10	0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Mesozoic Lowlands/Valley and Ridge Siliciclastic

Seeding method:	Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn		Drilled		Other		Aerial/soy		Aerial/corn	
Species:	Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Hardy		Oats, Winter Killed		Oats, Winter Killed		Oats, Winter Killed		Oats, Winter Killed		Brassica (Winter Hardy)		Brassica (Winter Hardy)		Brassica (Winter Hardy)		Brassica (Winter Hardy)	
Till:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Early planting	0.19	0.19	0.16	0.16	0.13	0.13	0.08	0.08	0.14	0.14	0.12	0.12	0.10	0.10	0.06	0.06	0.24	0.24	0.20	0.20	0.17	0.17	0.10	0.10
Normal planting	0.17	0.17	0.15	0.15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Late planting	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Attachment B
Technical Requirements for Entering the Cover Crops BMPs into Scenario Builder and the Watershed Model

Background: In June, 2013 the Water Quality Goal Implementation Team (WQGIT) agreed that each BMP expert panel would work with CBPO staff and the Watershed Technical Workgroup (WTWG) to develop a technical appendix for each expert report. The purpose of the technical appendix is to describe how the expert panel's recommendations will be integrated into the modeling tools including NEIEN, Scenario Builder and the Watershed Model.

Q1: What are the nitrogen efficiency reductions a jurisdiction can claim for implementing and reporting the new cover crop species?

A1: The table below shows the reduction efficiencies for nitrogen for each of the new cover crop species.

Table 1: Nitrogen Reduction Benefits for New Cover Crop Species

Species	BMP Short Name	Mesozoic Lowlands/ Valley and Ridge Siliciclastic	Coastal Plain/ Piedmont Crystalline/ Karst Settings
Forage Radish, Early, Drilled	CoverCropEDFR	20	26
Forage Radish, Early, Other	CoverCropEOFR	17	22
Forage Radish, Early, Aerial, After Soy	CoverCropEASFR	14	18
Forage Radish, Early, Aerial	CoverCropEAFR	8	10
Forage Radish + Grass , Early, Drilled	CoverCropEDFRG	22	29
Forage Radish + Grass, Early, Other	CoverCropEOFRG	19	25
Forage Radish + Grass, Early, Aerial, After Soy	CoverCropEASFRG	15	20
Forage Radish + Grass, Early, Aerial	CoverCropEAFRG	9	12
Forage Radish + Grass, Normal, Drilled	CoverCropSDFRG	16	22
Forage Radish + Grass, Normal, Other	CoverCropSOFRG	14	18
Annual Legume, Early, Drilled	CoverCropEDL	5	7

Annual Legume, Early, Other	CoverCropEOL	5	6
Annual Legume, Early, Aerial, After Soy	CoverCropEASL	4	5
Annual Legume, Early, Aerial	CoverCropEAL	2	3
Annual Legume, Normal, Drilled	CoverCropSDL	5	6
Annual Legume, Normal, Other	CoverCropSOL	4	6
Annual Legume + Grass, Early, Drilled	CoverCropEDLG	15	20
Annual Legume + Grass, Early, Other	CoverCropEOLG	13	17
Annual Legume + Grass, Early, Aerial, After Soy	CoverCropEALSG	10	14
Annual Legume + Grass, Early, Aerial	CoverCropEALG	6	8
Annual Legume + Grass, Normal, Drilled	CoverCropSDLG	14	19
Annual Legume + Grass, Normal, Other	CoverCropSOLG	12	16
Triticale, Early, Drilled	CoverCropEDT	29	39
Triticale, Early, Other	CoverCropEOT	25	33
Triticale, Early, Aerial, After Soy	CoverCropEAST	21	27
Triticale, Early, Aerial	CoverCropEAT	12	15
Triticale, Normal, Drilled	CoverCropSDT	27	35
Triticale, Normal, Other	CoverCropSOT	23	30
Triticale, Late, Drilled	CoverCropLDT	13	16
Triticale, Late, Other	CoverCropLOT	10	14
Annual Ryegrass, Early, Drilled	CoverCropEDAR	22	30
Annual Ryegrass, Early, Other	CoverCropEOAR	19	25
Annual Ryegrass, Early, Aerial, After Soy	CoverCropEASAR	16	20
Annual Ryegrass, Early, Aerial	CoverCropEAAR	9	12
Annual Ryegrass, Normal, Drilled	CoverCropSDAR	20	27
Annual Ryegrass, Normal, Other	CoverCropSOAR	18	23
Winter Hardy Oats, Early, Drilled	CoverCropEDHO	19	25
Winter Hardy Oats, Early, Other	CoverCropEOHO	16	21

Winter Hardy Oats, Early, Aerial, After Soy	CoverCropEASHO	13	17
Winter Hardy Oats, Early, Aerial	CoverCropEAHO	8	10
Winter Hardy Oats, Normal, Drilled	CoverCropSDHO	17	23
Winter Hardy Oats, Normal, Other	CoverCropSOHO	15	19
Winter Killed Oats, Early, Drilled	CoverCropEDKO	14	18
Winter Killed Oats, Early, Other	CoverCropEOKO	12	15
Winter Killed Oats, Early, Aerial, After Soy	CoverCropEASKO	10	13
Winter Killed Oats, Early, Aerial	CoverCropEAKO	6	7
Winter Hardy Brassica, Early, Drilled	CoverCropEDHB	24	32
Winter Hardy Brassica, Early, Other	CoverCropEOHB	20	27
Winter Hardy Brassica, Early, Aerial, After Soy	CoverCropEASHB	17	22
Winter Hardy Brassica, Early, Aerial	CoverCropEAHB	10	13

Q2: Why is there no credit given for phosphorus or sediment for the new cover crops species?
A2: As of publication of this document, the panel is recommending that consideration of phosphorus and sediment reductions for the new species will take place at a later time, due to the lack of data on the effect of cover crops on phosphorus and sediment losses. The panel's final Phase 5.3.2 report will therefore address nitrogen, and will consider phosphorus and sediment reductions for all species at a later time, most likely when the expanded modeling expertise with the NRCS APEX model is available (INSERT REFERENCE TO REPORT).

Q3: How is the reduction actually calculated in Scenario Builder and the Watershed Model?
A3: The total load reduction is determined by the Watershed Model as the product of the efficiency reduction listed in Table 1, the acres of agricultural land within the model segment with cover crops reported, and the total nitrogen load simulated for the model segment for those agricultural acres.

Q4: Did the panel alter the way existing cover crop species receive credit?
A4: No. The expert panel recommended that the current cover crop species be simulated in the same way they have historically been simulated using the Phase 5.3.2 Watershed Model (INSERT REFERENCE TO REPORT).

Q5: What does a jurisdiction need to report in order to receive credit for cover crop species?

A5: Jurisdictions should report the following information:

- Cover Crop Type: Species of cover crop
- Planting Method*: Aerial, Drilled, Other
- Planting Time Period*: Early, Standard, Late
- Crop preceding Cover Crop*: Corn, Soybean
- Land Use: Approved NEIEN Row Crop Land Uses
- Acres: Number of acres with reported species within geographic reporting unit
- Location: Approved NEIEN geographies: County; County (CBWS Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4), State (CBWS Only)
- Date of Implementation: Year cover crop was planted

*These are preferred, but are not required. See Question 6 for a more detailed description of defaults if data is not provided.

Q6: Can a jurisdiction still receive credit if it cannot report the planting method, planting time, or preceding crop?

A6: Yes. Jurisdictions should always report the most specific information available to them for cover crop implementation. Data reported for CBP purposes should preferably include all elements listed in Question 5.

If any of this information is not reported, the default conditions for the unreported category will be the lowest nitrogen reduction benefit for that category in the approved expert panel report. If relevant, the phosphorus and sediment benefit associated with this model nitrogen reduction will also apply. If the lowest reduction benefit for the missing category is “0” or “NA,” then “0” is used for model credit.

For example, if a jurisdiction reports “Forage Radish” as a Cover Crop species, they will receive a 10% reduction in N which corresponds to the lowest reduction available in the “Forage Radish” category.

Attachment D: Expert Panel Conference Call Minutes

Cover Crop Expert Panel Conference Call Minutes
6.08.2012

Participants:
Mark Dubin, University of Maryland
Andy Clark, SARE
Barbie Elliott, WV-Agriculture
Charlie White, PSU
Chris Lawrence, USDA-NRCS-VA
Dean Hively, USDA-USGS
Jack Meisinger, USDA-ARS
Jamie Ulrich, PA-Agriculture
Ken Staver, UMD
Paul Salon, USDA-NRCS-NY
Quirine Ketterings, Cornell
Royden Powell, MD-Agriculture
Tim Sexton, VA-Environmental
Mark Sievers, Tetra Tech
Kamran Zendehdel, Tetra Tech

Introduction & Purposes
Mark D., This is the first call for this panel. We will discuss about the different group's roles in the process, objectives, and timelines. What we are working is related to agriculture under the Bay Program. The last work was done 4–5 years ago. At that time, we did not have the opportunity to focus on cover crops and did not fully complete the review. We now like to add cover crops and different management systems into the process. We would like to focus on commodity cover crops as well. We had 40 recommendations from all 6 states, which we will try to use them here. We will look to short term recommendations that we can use on current practices. In longer term, we would like to know how we should look at cover crops in current dynamic model. How we would like the model to present the cover crops. We want to calibrate the model in 2015. Tetra Tech is here to help us with the process. Short term we will look at quick fixes. Long term we will look at long term goals and potentially radical changes.
Mark S., After this call, Kamran from Tetra Tech will be in touch with the panel members. Tetra Tech is providing an overall support and documentation for review. Kamran will interview the panel through a survey. We have already done the literature search. We provided the list of potential documentation related to this panel on the SharePoint site. At the very end of this process, we will summarize the panel recommendations and develop a final report. AgWG and Mark have a leadership role and Tetra Tech is helping organize the final report.
Mark D., Basically, Tetra Tech will help the panel members with the resources they need and documentation that they can use. We want to focus on documents that have a close link to Bay. Tetra Tech provided a list of more than 1,000 documents. We want to focus on local research and recommendations first and then move geographically out, if need be.

We want to make sure that we will have discussions and communications between the members and not just to have a final document. At the same time a document without any approval from the members has no value to us.

There was a series of recommendations from the AgWG to the panel. If you have any question or suggestion you are welcome. With no great surprise, commodity cover crops need to be included into evaluation. The existing definition of commodity cover crops is rather old that we need to update that. Looking at how the model applies nitrogen to baseline condition for commodity cover crops. In addition we need to look at:

Residuals and how we are counting them
How states' regulations can eliminate fall fertilization
Using remote sensing data to track cover crops
How does commodity cover crop relate to nutrient management?
Is it possible to look at a range of values instead of a unique value for phosphorus, nitrogen, and sediments?
Improve the definition of the cover crops
Cover crop mixed species
The real values vs. research values
Multiple aspects of cover crops

Mark S., We are in the process of formulizing the interview questions with Mark D. The interview will be used to collect more information on research projects and specific information. We will interview all the expert panel members and additional experts as identified by the work group or the panel.

The survey has 10 questions plus 4 additional questions for state representatives, which mainly deal with tracking and reporting. We will find the best time based on a Doodle poll to interview you and then send an email to arrange the interview.

You will send us or suggest documents for panel review. We will look for the documents online and then post them on SharePoint where we will categorize them based on some categories, which helps you to find your subject and focus in your review.

Having SharePoint enables us to have everything in one place and it contains information for all the panels. The SharePoint site is at: https://sites.tetratech.com/projects/100-CB_BMP_Review/default.aspx. If you have a username and password already, please use it. If not, please use the generic ones for download only (Username: *ttsvcs\CBUser* and Password: *Review2012*). You can send us your documents and we will upload them for you. If you have any problem with SharePoint, please let us know.

Mark D., In each panel we have some subgroups. The reason is that we have different expertise, which we would like to use their knowledge in the best way. For this panel, I am proposing three subgroups: Academic, Programmatic, and Modeling. For those who have not indicated yet their subgroup(s), please do so.

Ken, I am thinking about the commodity cover crop issue. I do think early on that we should talk about commodity cover crop and whether they are in or out. It is very complicated for us to come up with some good recommendations here. I am not sure that it should be here or just focus on how nutrient management will apply to winter cereals.

Mark D., It was something that in the Ag workgroup came up as well, especially how commodity cover crops relate to nutrient management systems.
Royden, Given the fact that the commodity cover crop is an aspect of how states are reporting, it is valid to consider it as part of our discussion. I am not saying that it does not relate to nutrient management, but we need to know how we credit them with any efficiency.
Mark D., It is a good recommendation that we do consider it.
Tim, Maybe it will be better to have a subgroup for commodity cover crop and then come back to the rest of the group.
Mark D., It is a good recommendation. I will make a request for it. I will bring it up and look for a consensus here.
We would like to ask the panel members to nominate a chair person. I will oversee the panel. The chair person will basically be the voice of the panel. Especially when we are going to AgWG, he/she can reflect the panel views. Frank Coale is the chairperson of the nutrient management workgroup.
Jack, Maybe it will be better to select nominees and then let the panelist to vote and select one.
Mark D., I will definitely go with nomination.
I would now like to open up the call for a broader discussion. Any thought or suggestions? Starting with State of New York. Is there any questions or suggestions about the panel process:
New York
Quirine & Paul,
Not at this time, everything seems straightforward.
Pennsylvania
Jamie, We have a hard time getting cover crops where we need them. We have a lot of dairy operations in the state and grow a lot of corn silage and we have a lot of bare soil all winter. In south we are expecting cover crops every acre. But it will be good if could have our corn silage acres covered from erosion.
Charlie, I would agree with Jamie. It is very difficult to have cover crop after corn silage on a dairy farm. Because of climate it is difficult to get in cover crop after some of the fall harvestings. I am interested in applying manure to cover crop. In addition, a lot of dairy farmers are harvesting cover crops for forage, which is like the commodity cover crop issue that we need to discuss about it.
Mark D., We would like to make sure that the concept of commodity cover crop includes forage harvesting in the fall as well.
Paul (New York), Basically, everything that they just said can be echoed for state of New York.
Jamie, Regarding why people cannot easily follow cover crops after their practices is the timing issue. As you only have one week time to put your manure and to get cover crop on that the opportunity can be easily missed.
Dean, We talked about remote sensing before and the differences between cover crops areas.
Mark D., Cover crops represent the most diverse and complicated BMP in Bay modeling program system. I do not know how many combinations exist there. Maybe there are more than 100 combinations (as a comment from one of the panel members). Having a large number of combinations will be a problem to report them. However, there is a lot of interest to define and describe the diversity of cover crops, including timing, implementation method, physiological

providence, and the crop. We need to focus on the number of functions that cover crops are playing. Therefore, the question will be how we can simplify the problem for modeling.

Maryland

Royden, Our interest is to accurately capture the practice in the model and define the efficiencies. We are looking for the best modeling process to have the best data.

Andy, I am interested in forage radish, which can be a good discussion. I am interested in idea of mixture and I am working on Ray mixture cover crop work. There are some questions why you are putting legume when you are trying to scavenge at the end. The idea of going back to dairy and corn silage and the idea of small grain following your corn silage, which can cover whole winter the land. They are worth looking for some potential trade-offs.

Mark D., This is a good area to look at. I think this is a good aspect of commodity cover crop and we look to it.

Ken, Focusing on technical efficiency necessitates collecting more data to improve our understanding on cover crops and their link to load. It is important to match cover crops with load. We should link efficiency to load. Before, people thought that it is too much data to collect, but I think we can do it now.

Jack, In the panel we need to think about, how we can work it out. Are we going to focus on cropping system? We need to divide the work into subgroups.

Mark D., It is right, the complication related to cover crops is there. We need to focus on different aspects and then trying to combine them. We now have the ability based on our understanding and we need to come back together to see how we can do it.

Jack, A lot of the discussions we just had, indicates that we need a site specific evaluation for loads or for some certain cropping systems. The Bay model is very limited on what we can do. I do not know that the Bay model is open to some sub-models to be run in parallel. Now it is not possible in the current condition.

Mark D., I think we can do it. The academic community would like to have different models. But we cannot let everyone has a specific and personal model, which we need to think about. I really like the approach, but we should do it with caution.

Dean, It seems to me that the baseline was always important for the discussion. We see a lot of nitrogen leaching from cover crops in Maryland because of bad management or excessive rain. Nitrogen leaching and its relation with cover crop practices should come up. We are looking for environmental outcomes when you have a moderate system where somebody is doing a complex crop rotation. Cover crop is an important aspect of this system. Therefore, this is important to know how much value will come out of the cover crop and their role in nutrient management.

WV

Barbie, We recently adapted a statewide program in July, which cover crop is part of it. We look forward to adapting our program to go toward the Bay program. Maybe in future we might have different plans on manure and no-manure program. It is a learning process for us.

Delaware

No one was on the call from Delaware.

Virginia

Tim, We had a research about cover crops in Virginia. We have a large portion of soybeans in Virginia and 95 percent is fallow after harvest. We currently tracked both commodity and conventional cover crops. The tacking program is effective in both number of acres and where they are planted. Recent weeks, we had the discussion about vulnerability related to cover crop practices. One of the question is that how do you manage your cover crop? One of the last questions that staff always asks is how you manage your cover crops. Planting time and nutrient in fall are critical. One of the researches in Maryland indicated that most of our cereal grains do not need fall application of nutrient. We know how many acres and where those acres are located in Virginia.

Mark D., We are in the middle of reviewing verification process. The programmatic subgroup will be heading up this discussion.

Chris, I might add a little from my and NRCS perspectives. We should remember the regional differences. I really appreciate the discussing about load and importance of that. We should think about not grading early plantation with no fertilizing, without paying attention to load issue. NRCS has a national definition of cover crop and there are 8 purposes for growing cover crops in our standard. We are a partner to provide incentive to grow cover crops. Some of these purposes have nothing to do with cover crops but some can be used to promote farmers to grow cover crops. We need to focus on what we are trying to accomplish with BMPs. Is it simply managing nitrogen or is it doing other things. I am looking forward to seeing more information during the project.

Mark D., One of the aspects of AgWG is to work with NRCS and ARS as our federal partners. They are very important to us. We want to keep their inputs and their participations in our panel. We are also looking at how we can integrate NRCS and ARS information into our program.

Jack, I can see just three NRCS people in our panel. Maybe we can see who else we can invite in our panel.

Mark D., I think we have one more member from NRCS-Virginia who is not today in our call. Delaware lost their Agronomist position. I am not sure that when they can have the position back. We just need to continue the dialogue between the federal representatives and the panel.

I think based on the comments from the panel, we will move toward the subgroups meeting. We will have the larger discussion with the panel. Most of discussion will be based on conference call. Tetra Tech will be with us along the way. We have couple of actions based on the call. Based on the Jack comment, if you know anybody who can be useful or an asset for the panel, please introduce him/her to me. I will also follow the nomination for the chair person. In addition, I will work on subcommittee call and participation on that.

The timeline for this panel is end of this year or early next year.

Over at 11:58

Cover Crops Expert Panel Conference Call Minutes 12.14.2012

Participants:

Mark Dubin, AgWG, UMD
Matthew Johnston, CB Program, UMD
Jeff Sweeney, EPA
Jack Meisinger, USDA, ARS
Andy Clark, SARE
Barbie Elliott, WV-Agriculture
Charlie White, PSU
Dean Hively, USDA-USGS
Ken Staver, UMD
Mark Goodson, USDA, NRCS
Quirine Ketterings, Cornell
Ray Weil, UMD
Ron Hoover, PSU
Royden Powell, MD-Agriculture
Sjoerd Duiker, PSU
Tim Sexton, VA-Environmental
Kamran Zendehdel, Tetra Tech

Action items

Expert's questions regarding the Model: Experts should send their questions on the CC Model to Kamran. The questions and corresponding answers from Matt will be posted on the SharePoint site.

Sharing useful cover crop references/studies: Experts to share their good cover crop references/studies with Kamran. He will post them on the SharePoint site.

Contacting NRCS for an expert to run APEX Model: Jack and Mark D. will request NRCS allocate an expert to the CC and CT panels for running APEX Model. Application of APEX Model will support both panels with their aim to formulate recommendations to the AgWG.

Reviewing the CC summary report: Mark D. is in the process of reviewing the CC summary report that Kamran updated recently. It will be sent to the experts for their final approval.

Posting a Doodle poll(s) for CC sub-group conference call(s) in January: Mark and Jack will create proposal for sub-group conference call in January/February.

Ken's document on cover crop panel efficiency approach **posted to SharePoint site.**

Review of minutes

Jack Meisinger reviewed informal minutes from previous meeting.

Panel members reviewed the summary report of cover crops interviews and requested edits.

Some edits/suggestions dealt with structural and philosophical issues of the Bay Model. We provide those comments through an appendix.

Mark is reviewing Kamran's summary report. Panel members will receive the result soon.

Members discussed sub-grouping of the panel.

Hydrogeomorphic regions were determined to have too much north/south variation for our cover crops work.

Scenario Builder (SB) growth regions, which Matt will review, capture hydrogeomorphic regions, but also limit the north/south extent. They allow for the states' political boundaries to be included, which is important for tracking and reporting.

Panel sub-group's lists posted on the SharePoint.

Jeff Sweeney provided an introduction on the Chesapeake Bay (CB) Model.

Agenda items

Mark Dubin welcomed Matt Johnston, CBP Nonpoint Source Data Analyst at UMD to the CC panel.

Matt –Jack mentioned the growth regions, as we know the growth regions mimic the hydrogeomorphic regions, but more mimic the heat unit from north to south.

Mark D.- It came from USDA north region and was incorporated into the SB. It is probably a combination of degree days and frost days, but it is not a one to one correlation.

Jack - Did you use those hardiness maps?

Mark D.- Yes.

Jack - If we use growth regions, is this compatible with what SB needs as data?

Matt- Yes.

Mark clarified that current work is with the existing SB tool; however a new version is expected within a few years. Phase II of the panel will be able to look at the future model.

Matt explained that in the Watershed Model, **(view presentation)** a crop acre included precipitation, fertilizer, manure, atmospheric deposition for N and P. The runoff from that acre is driven by all sub-models. The SB takes this representative acre and provides the Watershed Model the amount of N and P that should go down on that acre per month per crop type. Then, SB (the management filter) will be applied where these current cover crops efficiencies are located. Once the nutrient in the representative acre is put down and a run off of N and P are shown, a cover crop efficiency can be simply placed, which reduces that run off by that efficiency.

Dean - In previous CCC efficiencies we applied a 0.75 coefficient for farmer efficiency.

Charlie – To determine what leaves through the sub-surface and what from the surface, are you growing the cash crop to model nutrient uptake and water evapotranspiration?

Matt - In the Watershed Model we are actually growing the crop or we are changing the uptake rate per month and the input per month and precipitation daily. The uptake per month also includes harvest. So whenever we harvest the crop we are taking out nutrients that are applied. Matt confirmed that the nutrient uptake is crop specific.

Matt - CCCs are a management filter that can only reduce runoff of N from the land use by a percent of runoff per nutrient per acre. They do not reduce P or TSS. The N efficiencies are very low for CCCs.

Although in our definition, we defined CCC as a winter crop that can receive fertilizer after March 1st, in the year of establishment we do not actually place nutrients on the land on March 1st. It is because CCC a management filter and is not in the simulation of the land use and crop.
Mark D. - The original panel developed a full set of recommendations for TCCs, but not for CCCs due to limited simulation availability. As a result the current efficiencies are very conservative.
Dean asked how winter wheat was currently included in the Model.
Matt – This presentation explains a representative acre of rye, and how it is simulated. You can assume the same process or the same three options for wheat.
Matt - We use four sub-models including hydrological sub-model that takes into account surface and sub-surface runoffs. The three different types of CCCs are barley, rye, and wheat. Their sub-types are barley after corn, barley after soy, rye after soy, and wheat after soy. The planting methods are aerial, drilled and other.
Ken – Have the acres of all these crops already been simulated?
Matt - Not necessarily. We take crop numbers from the agricultural census, but we do not know if for example rye for grain is actually a cover crop in the way that we define the cover crop in the Bay Model with no nutrient application until after March 1st. Some of the acres that we have from the agricultural census may be a TCC acres or CCCs that were collected for grain or harvested for hay.
Mark D. - Harvested data could include the regular commodity crop and CCC as both are harvested. Of course the difference could be crops that were not harvested because they failed.
Matt –The data received from NRCS and states might not always match up.
Sjoerd asked if a cover crop after corn silage was included in the model.
Matt - The barley after corn is in the Model.
Dean - Does the Model distinguish between corn for silage and corn for grain and crop modeling part?
Matt - Yes, we track both categories.
Mark D. - We generalize that corn could be either grain or silage.
Dean - Based on previous discussions, dairy farm and corn for silage can be considered different types of cover crops.
Matt noted that the types of CCC reported by states were placed into the best category available.
Tim– Does the Model give credit for split applications of nutrients of any crops?
Matt - The N application can be met by manure or fertilizer. If farmers met that N application need with manure and there is enough P to meet the P need later on, they might not need to apply P. But there are multiple applications.
Mark D. - Yes, the model does give the credit value for that in the simulation.
Matt - The simulation covers a single year from January to December. Nutrient application for crop simulation is calculated for each crop by county. The maximum nutrient application rate is taken from the maximum yield provided in the agricultural census and multiplied by the maximum uptake for crop that is reported in our literature. That is the maximum nutrient application rate that can be put down on the ground for N and P. For the non-nutrient management land uses, the actual application rate is calculated as the incremental increase from the nutrient management application rate. The maximum yield is provided by the agricultural census.

Mark D. **-** The model looks at six agricultural census reports or within last 30 years. It uses the maximum yield that the county reported during last six agricultural reports.
Ron- What happens in counties with diverse soil types and with different yielding potential?
Mark D. - The Model is based on county level data, which provide the county average.
Matt – The SB provides manure, chemical fertilizer lbs per acre per month, land uses per land river segment, BMP reduction, plant uptake lbs per month, N fixation by legumes, bare soil percentage, detached sediment, and sediment erosion in tons per acre. There is no plant date, harvest date, nutrient application date, plant uptake, etc.
Ken - The efficiency was based on annual load reduction independent from which month of year it happened. Having temporal differences during a year may not be as important as accurate annual load reduction.
Dean – If N availability and leaching vary by month, why not vary efficiency by month at the same time?
Ken - I do not think that we have a chance of working at that level of detail.
Jack - We might suggest this as something to be evaluated by the panel, but we might start with yearly data. Our data is coming from the field, especially when you are doing hydrological losses into water table set.
Matt - Both should work theoretically.
Jack - We can also address any further questions to Matt, Jeff, and Mark. It is important to get our efficiencies in tune with the Model use.
Matt - The Bay Program assumes that the cover crop efficiencies can be looked up in the table and it is possible to tell any stakeholders their load reduction efficiencies. Other efficiencies in the Model are not as simple. The efficiencies for CCCs are considered low, but removing CCC BMP would not be very supportive for the stakeholders and partnerships. Maybe this panel could consider how we should correctly develop efficiencies that show addition of fertilizer to CCC fields but not necessarily remove them entirely.
Ken - If you give credit for something like splitting N application on corn, it does not handle that as a filter. It changes how you apply N to the crop.
Matt - The states submit a lot of these cover crops to us and receive credit for them through the Model. If we want to remove CCC as an efficiency, I suppose that we can give them very low efficiency such as 5% N reduction. If we want to remove that and put it into a simulation, it would not be clear. It is a political point rather than a scientific point
Mark D. - This is a discussion that Nutrient Management Panel has to address.
Ken - The Nutrient Management Panel is dealing with the CCC as a practice.
Mark D. – Yes, they are currently doing that, but this is up to this panel to recommend.
Royden asked about establishing a baseline.
Matt - With SB, possible to formulate an efficiency for CCC to establish a baseline using the parameters.
Ken - Based on the Royden’s point, cover crops should be kept as a management filter rather than as a nutrient input simulation.
Royden suggested that it is too cumbersome to combine these things in nutrient management practice, and that they should be taken separately.
Jack - We will likely soon have soil test for nitrate, we may end up with no N going out of wheat just because you got plenty in the soil, which is just like CCC, however it is not.

Mark D. - Nutrient Management regulation in MD requires a nitrate test. There has been an exception for anyone who applies N in the fall for these grains.
Royden - Is the discussion of using SB for dealing with nutrient management or is that for dealing with these nuances in cover crop context?
Matt - If one wants to develop these two simulations for grain and rye for grain, then by changing the parameters, he would come up with estimated efficiency reductions.
Royden – With the ability to fine tune management, we can articulate the programmatic or regulatory deliveries that states have and develop these efficiencies and plug them in as cover crop efficiency based on those efficiencies that SB gives us. Then states can report variables based on how they are running their own programs. If they meet that level of detail, they can get the benefit of that refined efficiency.
Matt - We can run this experiment and give you a result, but we cannot use the results and then say this is what should be with the next version of the Model.
Royden - If the best professional judgment is available as well as literatures, we can validate what the SB says.
Matt - It could be that.
Mark D. **-** In our recommendations to AgWG, we need to have documentation and we cannot just use the Model as a source of documentation.
Sjoerd - It seems that the Model is really emphasizing crops that are grown by chemical fertilizer, without any attention to manure. People do not put fertilizer on the bare ground; however they do that with manure as they have a manure storage capacity limit.
Matt - In the Model, available manure in counties is applied in a sequence to the most profitable and most important crops to meet N need. In the current model, if the N or P need is met, no inorganic fertilizer is placed to meet further need. In the next version of the Model; we might have a better understanding of the fertilizer usage across the watershed.

Discussion of action items

Panelists should address their questions to Matt including those discussed today. We need to have a common knowledge about the Model, to share the answers with others. Kamran will post questions and answers to SharePoint.
Send cover crop studies to Kamran to post on SharePoint.
Exploring an option within NRCS, for a representative to run APEX Model for P and sediment losses in particular as well as for N. This provides another model to shape our recommendations and can be useful for other panels such as Conservation Tillage.
Mark will send out another Doodle poll for new sub-groups, possible conference call(s) in January.

Adjourn

Meeting Notes
Cover Crops Expert Panel
Conference Call
February 27, 2013

Jack Meisinger and Mark Dubin welcomed everyone and confirmed call participants.

Jack Meisinger announced a USDA Post-doc position to be filled soon, the position will in part support the Cover Crops panel.

Mark Dubin discussed the formation of an Agricultural Modeling Subcommittee to support the panels as well as the Phase 6 modeling development decisions. Reports from expert panels will be on the agenda for the March AgWG meeting. Current Phase 5 model recommendations must be submitted by Fall 2013 for partnership review and approval to allow implementation by December 1st for use in annual progress reporting by the jurisdictions.
Andy Clark asked about differences between phase 5 and 6 in terms of panel responsibility.
Dubin: Phase 5.3.2. is the current model, options for change are more limited due to model calibration restrictions. Large scale recommendations are more available for the new Phase 6.0 model in 2017. Panel can begin work on this new model now as well as the modifications of the Phase 5 model. For example; small adjustments can be made to cover crops currently calibrated in the Phase 5 model (wheat, barley, rye), but much more flexibility with introducing a new species, such as triticale.
Meisinger: Are the efficiencies being developed here due this fall? Or just efficiencies for the three existing cover crops?
Dubin: Both. Panel can make adjustments to wheat, rye and barley; define new cover crops and efficiencies to be reported into the model at the end of this year.
Meisinger: Suggest October 1st as deadline for the panel to report values to the AgWG.

Kamran Zendehdel provided an update on the Cover Crops interview summary.

Jack reviewed poll results and took additional volunteers:
Ken Staver: DE_1, MD_1, MD_2, VA_1
Robert Baldwin DE_1
Chris Lawrence VA_1, 2, 3
Andy Clark VA_1,2,3

ACTION: Emma will send out compiled results of this discussion, panelists can volunteer for additional regions.

Meisinger: Goal of this project is to add new species to the existing rye, barley and wheat in each of these regions such as forage radish, triticale, cover crop mixtures etc. and efficiencies for each new species. Panel should focus efforts on traditional cover crops, and include rye in every region (for consistency between regions). The first assignment to the panel is to review species for regions, next week will be reviewing by email everyone's list of species (1st rough draft, easy to revise later). Next step will be to review literature.

Meisinger: Data from Ken Staver on how efficiencies could be derived.
Staver presented his data for Rye; total N uptake as a function of fall planting dates.
Meisinger: 2-3 data sets are enough to get the efficiencies.
Dubin: Consider using heat units vs. calendar frost dates.
Meisinger: Dry matter is a good proxy for total N uptake
Andy Clark: Massachusetts model of Rye uptake based on heat units might be adaptable to the Chesapeake Bay region.
Meisinger: Efficiencies can be derived from water table data. Face to face panel meeting this summer to share data.

Panel discussed options for using heat units, which could be used within the panel to get comparable values across the regions.

Comments by state
NY's rye data currently showing about twice as much N uptake as triticale and wheat
WV Noted more commodity cover crops than traditional
Jack clarified that traditional cover crops are the basics, and with those defined the panel will have a good foundation to compare commodity etc.
DE concerned that there is not much current research, might have older data.
MD recently focused on programmatic level. Not expecting to find many new species beyond radishes.
VA baseline data for all small grains; radishes, barley, crimson clover. May need more info on planting dates, seeding rates etc.
PA rye grass as a cover crop?
Italian rye grass is the weed, but rye grass should be included
Meisinger: In a direct comparison with rye grass was not quite as good as rye, but good enough.
Dubin: Can be used if enough data.

Meisinger reviewed that the panel's next steps will be to write a species list for each region to report back to AgWG, and to begin the literature search (report the zeros as well).
Meisinger will send basic spreadsheet for members to fill in
Species list complete early in the week of March 11th

Staver presented slides with planting dates converted to heat units throughout the watershed.
Meisinger: Heat units offer more flexibility with interpreting and translating data. Heat unit information can be obtained online by entering location information.

Dubin: Should planting method be considered at this point?
Meisinger: Take note of planting methods to revisit later

NY: Looking for particulate runoff Phosphorus data?
Yes; soluble and total data optional

ACTION: Members will compile species list and begin data search in their assigned Growth Regions.

ACTION: Fill out doodle poll for next meeting between March 22-27th.

Meeting adjourned.

Participants
Paul Salon – NY
Robert Baldwin – DE
Andy Clark – UMD
Kamran Zendehdel -TetraTech
Jeff Sweeney- CBPO
Jack Meisinger - ARS
Mark Dubin-UMD
Emma Giese-CBPO
Pat Bowen -WV
Wade Thomason -VT
Ken Staver -UMD
Chris Lawrence -VA
Barbie Elliot -WV
Louise Lawrence-MD
Jamie Ulrich –PA

Cover Crops Expert Panel

Conference Call Meeting Notes

March 27, 2013

Jack Meisinger, panel chair, welcomed everyone to the call.
Members reviewed meeting notes from previous call.

DECISION: Members approved February meeting notes.

Kamran briefly updated the panel on the status of the Interview summary and procedure for approval.
Mark will distribute this report to panelists
Recommend a 10 day review period (April 10th)
Following the review period will be a vote to finalize the report

ACTION: Report will be distributed to members for review. Panelists will submit comments by 4/10/13.

Jack Meisinger provided an update on the status of a USDA post-doc position, feedback received from the Ag Workgroup, and follow up from past meeting on the Rye Model.
Rye Model from Massachusetts, discussed at last meeting, is more detailed than needed and set up for a northern climate.
Charlie White cited two crop growth models that could be used in the Chesapeake Bay Watershed.
Sequestration difficulties with post-doc hiring, but still may be able to fill the position.

Jack Meisinger led a discussion of the panel's next steps and efforts toward identifying potential species/mixtures by growth region, and determining planting dates by species and by region.
Cover Crops species spreadsheet will be distributed to members to fill in.
Ken Staver presented Rye growth heat unit slides [30:00-40:00]
Meisinger: Panelists will look at the 400, 700, 1000 (heat units) and decide if the dates match up with Rye planting dates for their regions +/- 3 days.

ACTION: Panelists will fill in cover crop species spreadsheet by region.

ACTION: Subgroup will continue work on growth models.

Mark Dubin, Nutrient Management Panel coordinator, provided an update following the newly re-formed panel's recent meeting.
The Cover Crops and Nutrient Management panels will be able to work together
Dubin: AgWG approved formation of a modeling subgroup, will provide support to the panels to address modeling questions
More information on the May 2013 modeling workshop will be available soon

ACTION: Fill out doodle poll to schedule next call

Adjourned

Participants
Jack Meisinger-USDA
Mark Dubin-UMD
Kamran Zendehdel, TetraTech
Quirine Kettering-NY
Sjoerd Duiker -PSU
Barbie Elliott-WV
Andy Clark-MD
Dean Hively-MD
Robert Baldwin-DE
Wade Thomason-VT
Charlie White-PSU
Emma Giese-CRC
Ken Staver-UMD
Royden Powell-MD
Ron Hoover-PSU
Chris Lawrence-NRCS
Ray Weil-UMD

Cover Crops Expert Panel

Conference Call Meeting Notes

April 24, 2013

Welcome and Introductions

DECISION: Members approved March 27th meeting notes

Interview Summary Report

Kamran briefly updated the panel on the status of the Cover Crop Interview Summary Report review. It is expected to be finalized this week, based on comments received from panel members.

Mark Dubin noted that the report structure may be modified slightly for the information to be presented by state

Jack Meisinger asked how the report would be used to represent panel consensus

Dubin suggested adding an executive summary session, as well as a chart of additional species written by the panel

Dubin clarified that the summary report would be the background information for the more complete recommendations report

Meisinger: The consensus points will be run through the panel to make sure everyone is in full agreement

Suggestion to add crop systems into Phase 6.0 panel recommendations

Suggestion that the panel Phase 6.0 recommendations allow cover crops with manure

Panel Updates

Sequestration cuts have decreased the possibility of hiring a USDA post-doc. Instead, there is an option for NRCS panel members to conduct RUSLE 2 model runs on sediment loss

Various RUSLE 2 training options are available

Chris Lawrence noted the need for good scenario inputs for model runs to be effective

Dubin: Agricultural Modeling Subcommittee (AMS) approved by AgWG

Building a Better Bay Model workshop will be held May 22-23, 2013, registration will available this week.

ACTION: Chris Lawrence will provide the panel with parameters needed to run RUSLE 2 scenarios

Discussion of P5.3.2 Options

Chair provided an overview of the timeline for providing panel recommendations to the AgWG and the partnership for implementation in the P5.3.2 for annual progress.
Jeff Sweeney (EPA) discussed the CBPO modeling team's perspective on the opportunities for modification or additions to the P5.3.2 for cover crops. One current option is to add the additional species that were not previously defined. Rye, Wheat and Barley are currently included.
Chair clarified that this smaller project does not change future Phase 6.0 cover crop panel projects, it functions as a short term improvement to Phase 5.3.2
Chair noted that this version is broken down by hydro geomorphic regions (not Scenario Builder Growth regions) which are divided into coastal plain and upland settings.

Nutrient Efficiencies for P5.3.2 **Meisinger**
Chair asked for volunteers to assist with the short term task development of N and P reduction efficiencies for P5.3.2.
Intention is to have a small group make some estimates, then run them by the panel for approval
Ray Weil: Data for forage radish
After panel members submit their proposed additions, will condense the list to keep it minimal
Dubin suggested using the panel's list of nominated cover crop species for Phase 6.0, and providing the panel with a collapsed version for approval and addition of values for Phase 5.3.2

ACTION: Panel subgroup will combine the proposed cover crop species into a smaller list, distribute to the panel. Panelists will then have 2 weeks to add one or two additional species to the short list. Next step will be to determine efficiencies associated with each species

Phase 6.0
Next call will focus on Phase 6.0 recommendations

Participants:
Barbie Elliott, WV
Dean Hively
Kamran Zendehdel, TetraTech
Mark Dubin, UMD
Jack Meisinger, USDA
Jeff Sweeney, EPA
Chris Lawrence, NRCS
Paul Salon, NY
Ronald Hoover, PA
Sjoerd Duiker, PSU

Ray Weil, UMD
Robert Palmer, DE
Ken Staver, MD

Cover Crops Expert Panel
Conference Call Meeting Notes
June 3, 2013

Welcome and Introductions

Meeting notes from previous call will be distributed following today's call.

ACTION: Members will review April 24 meeting notes and send any corrections to Emma by Friday, June 7th.

Status of WM Phase 5.3.2 Updates

Jack Meisinger reviewed the final additional species list developed by the subcommittee, and asked for any last minute additions.
Efficiency numbers will be needed (relative to rye) for each additional species.
Request for edge of field efficiency (or bottom of root zone) documentation of additional species.
Clarification: The existing values are delivered efficiencies.
MD: Noted that aerial planted cover crops in soybeans should not have a higher efficiency than aerial planted cover crops in corn (early planting, all species).
Jack noted that an average value will be used for mixtures.
Mark and Jack outlined the time-line for completion and next steps towards Partnership approval of Phase 5.3.2 updates.
The first draft of reduction efficiencies will be distributed to the panel by the middle of next week (June 10-14, 2013).
Jack noted that when seeking AgWG and other workgroup approval, panel will need justification for the values presented.
Clarification: previous values (those already in the model for Rye, Wheat and Barley) will not need to be defended as they are not being modified for Phase 5.3.2.
WV: Noted a concern regarding lack of values for late planting date.
MD/VA: If jurisdiction doesn't have the ability to track and report individual species, how would it be entered into the model?
Mark clarified that default values (lowest for the category) will be used when data is not available.
Jack: A better method could be used if it was justifiable.
MD: Are commodity cover crops a responsibility of this panel?
Jack: Traditional cover crops are the current focus as they are achievable in the short term. The commodity cover crop table will be distributed in the near future for the panel to review.

ACTION: The first draft of reduction efficiencies will be distributed to the panel by the middle of next week for comments.

Status of WM Phase 6.0 recommendations

Jack announced that USDA will be hiring post-doc position to support the work of this panel (funded by NRCS and ARS) particularly the Phase 6.0 recommendations and including APEX/RUSLE 2 model runs.
NY: Noted an additional task (possibly for the post-doc) in adapting Michigan State's cover crop decision tool to the Chesapeake Bay region.
Mark summarized outcomes from the Agriculture Workgroup's *Building a Better Bay Model* workshop held May 22-23. Report will be available through the Mid-Atlantic Water Program. Recommendations from the workshop will be used as the scope of work for the new Ag Modeling Subcommittee.
Mark gave an update on the status of the Cover Crop Interview Summary Report review, which is in final review incorporating comments from the panel.

Schedule Next Call

ACTION: Complete the Doodle Poll by COB Wednesday, June 5th for a conference call to be scheduled July 15-18th

Adjourn

Participants:
Tim Sexton, VA
Wade Thomason, VT
Jack Meisinger, USDA
Sjoerd Duiker, PSU
Robert Baldwin, DE
Chris Lawrence, VA
Royden Powell, MDA
Ken Staver, UMD
Mark Dubin, UMD
Quirine Kettering, NY
Emma Giese, CRC
Barbie Elliott, WV
Andy Clark, UMD
Jamie Ulrich, PA
Kamran Zendehdel, TetraTech

Paul Salon, NY

Cover Crops Expert Panel

Conference Call Minutes
July 19, 2013
10:00-12:00PM

Welcome and Introductions

ACTION: Emma will distribute June 3 minutes for member review

Panel Updates

Jack Meisinger: Funding for USDA post-doc position slowly coming into place.
TetraTech awaiting technical directives before beginning work.

Reduction Efficiency Estimates for Phase 5.3.2 Recommendation

Panel members reviewed draft reduction efficiencies for proposed additional species, and discussed options for finalizing the Phase 5.3.2 recommendations by September 2013. Additional literature values are needed for some species.
Dean Hively: Is N 15 necessary?
Meisinger: No, it allows interpretation of the plant uptake data for legumes; but is not needed for other non-N fixing species.
Meisinger: Triticale data is needed, particularly from PA/NY.
The proposed addition species of Grouped Winter cereals was briefly discussed and a proposal to use the Wheat Reduction Efficiencies for this group, which is currently being done, was tabled until the next call. In the meantime VA and PA will confer with their colleagues and report back since this category is primarily used by those states.
Dean Hively asked if the timing of the final 5.3.2 update approval, scheduled for the end of December, would be too late for the states to adjust their cover crop reporting. Matt responded that the states are now reporting some cover crop species on the Panels 5.3.2 update list, that are currently not receiving credit. So the Panels update would allow these previously unrecognized cover crops to be credited.
Ray and Ken will collect forage radish information.
Jack will finish legume data.
Staver: Triticale contains wide variation, may require a more general definition.
Meisinger noted that literature and data collected at this point should also provide data for final Phase 6.0 Recommendations following this 5.3.2 update.
Dean Hively will contribute remote sensing data.

ACTION: Members will review reduction efficiencies and submit additional literature.

Adjourned

Participants

Jack Meisinger, USDA-NRCS
Don Meals, TetraTech
Andy Clark, UMD
Dean Hively, USGS
Ken Staver, UMD
Jamie Ulrich, PA
Steve Dressing, TetraTech
Jennifer Ferrando, TetraTech
Mark Dubin, UMD
Matt Johnston, UMD
Emma Giese, CRC
Ray Weil, UMD
Sjoerd Duiker, PSU
Tim Sexton, VA

Cover Crops Expert Panel

Conference Call Minutes
August 5, 2013
1:00-3:00 PM

Welcome, Introductions and Updates

Panel members approved meeting notes from the previous call.

Forage Radish and Forage Radish with Grass

Ray Weil: introduced findings on estimates of N Reduction Efficiencies for Forage Radish and Forage Radish with Grass. Recommend that the efficiency for radish be equal to rye.
Meisinger: Note the need for the panel to define and determine efficiency for these species within the week.
Weil: Recommend that brassicas be considered in the 'early planting' category.
Meisinger: Request that Ray, Ken, Charlie and Sjoerd determine some reduction efficiency values for both coastal plain and piedmont; present to the panel at the next call.
Charlie White will be the lead person for panel's radish subgroup.
Andy Clark: Panel recommendation can include requirements for what it would be planted with if planted late.

ACTION: Ray, Ken, Charlie and Sjoerd will present their recommended N reduction efficiency values for radish to the panel at next call.

Grouped Grass

Jack requested additional information from jurisdictions on the unspecified cover crop species reported. The information obtained was of limited value to the panel. Panel will need to make a recommendation on how to credit this category. The default value, when not specified, is 0.1.
Ken Staver: Recommend an unspecified for each category that is unknown (planting date, species, or method) so that marginal credit can be given.
Sweeney: Clarified that model uses the information that is available with the unspecified submissions, i.e. not all unspecified submissions are credited 0.1.
Meisinger: Panel can better define the default method and include with the written panel recommendations.

ACTION: Jack, Mark and Jeff will clarify the method used to give credit when some aspects of reported cover crops are unspecified, to be included in the panel report.

Other new Cover Crop Species

Jack updated the panel on the other species updates anticipated for the Phase 5.3.2 update, i.e. Annual Ryegrass and Triticale as well as additions and revisions to draft reduction efficiencies for proposed additional species, and discussed options for finalizing the Phase 5.3.2 recommendations by September 2013.
Meisinger: Forage small grain trials available from PSU and VT comparing triticale relative to rye, however study involved fertilizer.
White/Duiker: The fertilizer used in the PA study is comparable to the fertility on a typical PA dairy farm.
Meisinger: Seeking input from VA and PA regarding these data sets.
Meisinger: This data will be used to obtain triticale, ryegrass, brassica efficiencies relative to rye.
Weil: There may be comparable historic data in MD.
Dubin: Recommended contacting Tom Basden for WV cover crop trials data.

ACTION: Sjoerd Duiker will provide additional information on the PSU study.
ACTION: Jack will ask Wade Thomason/Tim Sexton for more VT information.

Schedule Next Call

Adjourned

Participants
Charlie White, PSU
Jack Meisinger, USDA
Mark Dubin, UMD
Jeff Sweeney, EPA
Jamie Ulrich, PA
Jennifer Ferrando, TetraTech
Andy Clark, UMD
Dean Hively, USGS
Robert Baldwin, DE
Chris Lawrence, VA
Royden Powell, MD
Don Meals, TetraTech
Steve Dressing, TetraTech
Ken Staver, UMD
Ray Weil, UMD

Sjoerd Duiker, PSU
Emma Giese, CRC

Cover Crops Expert Panel

Conference Call Minutes
August 19, 2013
1:30-3:30 PM

Welcome, Introductions and Updates

Panel members reviewed meeting notes from previous calls.

DECISION: Members approved June 3rd and August 5th meeting notes.

Efficiency Values for Forage Radish

Charlie White led the Panel discussion of the Radish subgroup's findings on estimates of N Reduction Efficiencies for Forage Radish and Forage Radish with Grass for both the piedmont and coastal plain regions.

Andy Clark: Suggest a penalty to account for winter kill.

Ray Weil: Suggest an efficiency for radish equal to rye.

Dubin: Noted that crops are represented as a composite in the current model. Panel will therefore need to represent the average reduction over time, accounting for decay and leaching loss.

Meisinger: Noted the lack of leaching data.

Dubin: Panel working within a tight deadline in order to complete the Phase 5.3.2 recommendations. Even if this specific recommendation is not included this year, can be taken up next year or for Phase 6.0.

Meisinger: Recommend that the panel consider the options for radish, and make a decision soon about whether to include it with the other panel nominees. Panel requested to continue collecting data for future use.

NY: Request time to consult with states on this issue.

Dubin: Recommend sending a poll to panel members to collect responses.

VT: Recommend the quick survey, which will be discussed at the next panel call.

Meisinger: Another option is to take a conservative approach on the efficiencies based on the data available.

USGS: Panel can recommend future research based on identified gaps.

ACTION: Emma will send a survey mid week, which will outline the options for radish, panelists requested to provide feedback by the end of the week.

Cover Crop Species Specifically Following Silage Corn

Sjoerd Duiker led a discussion of cover crop species and mixture data from across PA that are specifically aimed to follow corn silage.
VT: VA data would look very similar to what was presented here.

Other new Cover Crop Species

Jack updated panel members on the other species updates anticipated for the Phase 5.3.2 update, i.e. Annual Ryegrass and Triticale as well as additions and revisions to draft reduction efficiencies for proposed additional species.

Review Timeline for Finalizing Recommendations
Panel discussed the next steps for finalizing the Phase 5.3.2 recommendations by September 2013.
Panel reports will be presented to the Agriculture Workgroup on September 26th.
Panel conference call will be scheduled for early next week.

Adjourned

Participants
Mark Dubin, UMD
Jeff Sweeney, EPA
Emma Giese, CRC
Jack Meisinger, USDA
Andy Clark, UMD
Wade Thomason, VT
Dean Hively, USGS
Sjoerd Duiker, PSU
Royden Powell, MDA
Charlie White, PSU
Jamie Ulrich, PA
Barbie Elliot, WV
Don Meals, TetraTech
Jennifer Ferrando, TetraTech
Tim Sexton, VA
Ken Staver, UMD
Neely Law, CWP
Ray Weil, UMD

Cover Crops Expert Panel

Conference Call Minutes
August 27, 2013
2:30-4:30 PM

Welcome, Introductions and Minutes

Panel members approved meeting minutes from the previous call.

Results of Radish Poll and Panel Discussion

Jack gave an overview of comments received through last week's radish poll, which were generally in favor of incorporating a Forage Radish recommendation in the current model recommendations. The next step for the panel is to determine the N Reduction Efficiency that will be used to represent radish.

Review of Modeling Requirements

Jack reminded the panel that all N reduction efficiencies are being calculated relative to rye, that the traditional cover crop category assumes no fall N application, and that the N Reduction Efficiency covers the entire Fall-Spring winter cover crop season with corn being the expected spring crop, i.e. Sept/Oct to ~ mid-April.

Matt Johnston: The model works on a yearly basis, which means that the efficiency selected by the panel should represent the net benefit over the entire year, and that benefit is credited each month.

Jack: We intend to have a few options for an N reduction efficiency for radish, which the panel can vote on anonymously.

Ray Weil discussed the recently distributed spring soil nitrate data for radish.

Discussion of options for Radish N Reduction Efficiencies

Jack described procedures for deciding Forage Radish N Reduction Efficiencies. One option for the panel is to divide the radish efficiency by the two regions in the current model, i.e. Coastal Plain and Upland.

Weil: The relative advantage of radish against rye is greater in the south, this method would make sense.

Dean Hively: If more sandy soils in the southeast might offset the benefit.

Sjoerd: Recommend assigning radish a latest allowable planting date by region, rather than efficiency by region.

Staver: Note that all the radish studies fall into the category of "early planting", recommend a specific planting date category representing this data.

Dubin: Recommend an "earlier" planting date to accommodate forage radish following crops like silage corn and vegetables.
Weil: Two weeks before first frost, which is the current "early" planting date category is sufficient for radish.
Meisinger: Summarized by stating that the panel recommends leaving the planting date as is, and requiring early planting for radish.
Staver: Efficiency of 1.0 relative to rye is probably too high due to the missing surface runoff data, and the very early planting dates in many of the radish studies.
Dubin: Due to limited support and the upcoming deadline, recommend that the panel determine a conservative value for radish for now. Additional recommendations can be made in the future when more data is available.
Thomason: Support a conservative value.
Staver: Without data to support a higher efficiency, recommend conservative value for radish.
Meisinger: When taking into account the winter kill, and using a weed efficiency from Jan to mid-April, the yearly composite efficiency for radish relative to rye comes out to about 0.5.
Meisinger: If the panel prefers, another anonymous poll can be used to collect feedback on the radish efficiency.
White: Recommend an open answer poll where each panel expert would estimate the N reduction efficiency, rather than multiple choice poll with fixed N reduction efficiency values. Note that the optimal window might not exist in all states given the climate, however having an optimal planting date would take care of regional differences.
Meisinger: Summarized the discussion by stating that each panel expert will suggest what the pure radish stand be assigned as a N reduction efficiency, given the current available data. Each panel member will provide the efficiency relative to rye based on optimal planting date. The N reduction efficiency results from the poll will be summarized by a simple average across all respondents. The resulting value would be applied to the entire watershed.
Dubin: Recommend that the panelists receive the data and background information with the poll announcement, especially for those not on the call today.
Hively: Recommend an option for abstention.
Meisinger: Mark will update the panelists not available for the call today.
Staver: Volunteered to put together a table of heat units to help everyone determine optimum planting date.

ACTION: Panel members will fill out anonymous poll set up by Emma to determine a radish N reduction efficiency.

Steps Toward Writing the Report

Andy Clark and Jack will begin writing the report, which is due September 19. Other volunteers welcomed.

Next conference call to discuss the results of the radish efficiency poll will be late next week after Labor Day.

Adjourned

Participants

Dean Hively, USGS
Charlie White, PSU
Jennifer Ferrando, TetraTech
Jack Meisinger, USDA
Matt Johnston, UMD
Jeff Sweeney, EPA
Emma Giese, CRC
Mark Dubin, UMD
Ken Staver, UMD
Sjoerd Duiker, PSU
Wade Thomason, VT
Quirine Kettering, Cornell
Ray Weil, UMD

Cover Crops Expert Panel

Conference Call Agenda
September 6, 2013
9:30-11:30 AM

Welcome, Introductions and Minutes

Panel members reviewed meeting minutes from previous call.

ACTION: Emma will distribute 8/27/13 minutes for panel review.

Results of Radish N Reduction Efficiency Poll

Jack presented responses received through last week's radish poll for N reduction efficiency recommendations, which averaged 0.575 relative to rye with approximately an equal number of votes clustered around each of three ratings: low (0.1-0.3), med (0.4-0.6), and high (0.9-1.0).

Charlie White: Recommend noting the distribution of panel votes in the panel report, including a statement and rationale from each of the groups.

Wade Thomason: Recommend hearing from each of the distinct groups during this call, with an explanation for why they voted the way they did.

White: Recommend the higher efficiency for radish, because the total N uptake of radish in the fall appeared to be similar to N uptake of rye in the spring in the literature reviewed by the panel.

Ken Staver: Recommend the mid range efficiency, because more information is needed before recommending a higher efficiency.

Meisinger: The low vote group may have been reflecting the disregarding of studies planted in early August, studies with large fall N applications (50-200 kg N/ha) which are not consistent with the definition of a Traditional cover crop (which is unfertilized), the lack of winter cover and bare soil surface from mid-Dec through mid-April during the main water recharge season, and the lack of directly measured leaching data during mid-Dec through mid-April, which led panelists in this category to prefer a significantly more conservative efficiency.

Meisinger: Later in this call will entertain a motion to except 0.58 for radish. If significant nays, will take an online vote to get the actual count.

Andy Clark: Does the 0.58 apply to early planting or the "super early" planting date?

Sweeney: An earlier planting date for radish can be defined, as long as it is in relation to the other planting dates.

Meisinger: Panel report will define the planting date required for radish.

Dean Hively: Recommend that the super early be defined as two weeks before early planting.

Clark: How best to deal with the northern regions, which have less chance of efficient uptake by radish?
Meisinger: There likely will just be fewer acres reported in those regions.
Meisinger: Reminded the panel that currently there is no efficiency for radish in the model at all, so even a low efficiency is an improvement.
Clark: Agree that many farmers are seeing good results from radish, support including radish in some way.
Ray Weil: Agree with getting radish in the model, support the average efficiency.
Sexton: Motion to approve the 0.58 efficiency for pure radish in the early planting category.
Weil: Second the motion.
Sjoerd Duiker: Recommend no need to specify extra early planting date, because it is currently covered by stating planting "not later than" two weeks before the average frost date.
Dubin: The current definition of early cover crops only defines the cut-off date for planting, not the early date for planting. The panel could consider just using the current early planting definition.
Sweeney: Confirmed statement.
Meisinger: called for a voice vote of those opposed to accepting the 0.58 N reduction efficiency for pure stands of forage radish, none were opposed, the motion was unanimously accepted.
Meisinger: The full sheet of cover crop efficiencies (version 10) will be distributed to the panel for review, with discussion and vote on approval to occur next week

DECISION: Panel members approved the N Reduction Efficiency of 0.58 for early planted Forage Radish.
ACTION: Emma will distribute version 10 of the N reduction efficiencies for panel approval at the next call on September 13th.

Report Writing and Next Steps

Jack and Andy will begin writing the report, in order to get a near final draft of the report for the panel to review. The current draft efficiencies will be used as placeholders, if the panel votes to change them at the next call, can adjust them as needed.
Meisinger asked assistance from Mark, Emma, and the CBPO modeling team to develop recommendation sections on the default process, and the specifics in how the new cover crop species will be implemented in the current models.
Votes will be requested at the next call, on September 13th to approve N reduction efficiencies for all species. Votes can be sent over email for anyone unable to attend the call.

ACTION: Jack and Andy will begin writing the report, in order to get a near final draft of the report for the panel to review before approximately Sept 21, 2013.

Adjourned

Participants
Tim Sexton, VA
Wade Thomason, VT
Charlie White, PSU
Andy Clark, UMD
Don Meals, TetraTech
Dean Hively, USGS
Steve Dressing, TetraTech
Jack Meisinger, USDA-ARS
Robert Baldwin, DE
Jamie Ulrich, PA
Ken Staver, UMD
Sjoerd Duiker, PSU
Jeff Sweeney, EPA
Mark Dubin, UMD
Emma Giese, CRC

Cover Crops Expert Panel

Conference Call Minutes
September 13, 2013
9:30-10:30AM

Welcome, Introductions and Minutes

Panel members reviewed meeting minutes from previous calls.

DECISION: Panel members approved the August 27 and September 6 meeting minutes.

Panel Updates

Jack is beginning to write the report, a draft will be sent to the panel soon.
Mark Dubin: Would the panel prefer to include the full sets of minutes as a report appendix, or just include the action items.
Tim Sexton: Recommend action items only, minutes can be available as requested.

DECISION: The report will include an appendix of the action items from meetings in the panel report rather than the full minutes. The full minutes will be available upon request.

N Reduction Efficiencies

Panelists discussed the draft N Reduction Efficiencies for all proposed new species. *See attachment: Cover Crop N Reduction Eff. Estimates (v11).*
Meisinger clarified that the table reflects early planting dates.
Staver: Recommend adding a third column to the table to indicate which planting dates apply.
Duiker: Recommend that ryegrass also not be allowed late planting dates.
Jack will fill in the table with early, medium, late planting dates, and panel will discuss.
Clark: Specify that oats are fall planted winter hardy oats.
Charlie White: Recommend opening up the category to winter killed oats, and using a conservative efficiency.
Staver: If winter killed, restrict to early dates.
Clark: Request Charlie and Sjoerd's data for the winter killed oats to help make this decision.
Thomason: Motion to accept N reduction efficiencies for all new species except winter killed oats,
Weil: Second.
No objections.
Meisinger: Panel will make a final decision on the planting date recommendations at the next call. The seeding method will also be discussed, for new species will only specify aerial or direct contact.

ACTION: Jack will fill in the N Reduction Efficiencies table with early, medium and late planting dates for the added species.
ACTION: Charlie will provide the panel with leaching data for winter killed oats.
DECISION: Panel members finalized the panel N Reduction Efficiency recommendations for all new species except winter killed oats.
ACTION: Panel will finalize recommendations for winter killed oats at next call.
ACTION: Panel will finalize planting date and seeding method recommendations at next call.

Canola

Chris Lawrence: Recommend canola be included in the report similarly to radish, with early only planting. Data to support the efficiency would be similar to radish. NRCS in favor of providing as many options as possible.
Weil: Agree that canola would perform similarly to radish.
White: Similar results in PA, efficient uptake.
Hively: What was the planting method?
White: Drilled in mid to late August. Recommend the early planting date.
Meisinger: Noted that this cover crop requires fertilization, which raises the question of how to categorize it.
Meisinger: To include winter hardy brassicas, need data to determine N reduction efficiency. Data must be relevant to a large part of the watershed.

ACTION: Jack will add winter hardy brassicas to the N reductions spreadsheet.

Adjourned

Summary of New Cover Crop Species N Reduction Efficiencies

Proposed New Species	N Reduction Efficiency [1] (Relative to Rye)	Number Site-Years
Annual Ryegrass	0.66	5
Annual Legume	0.16	4
Annual Legume + Grass	Avg (0.16 & Grass)	2
Forage Radish	0.58	12
Forage Radish + Grass	0.90	24
Triticale	0.86	10
Oats (fall)	0.55	11

[1] Data for each N Reduction Efficiency are on the following tabs, (the yellow highlighted cell in each tab is the final value used)

Participants

Tim Sexton, VA
Chris Lawrence, VA
Wade Thomason, VT
Andy Clark, UMD
Dean Hively, USGS
Royden Powell, MDA
Mark Dubin, UMD
Jamie Ulrich, PA
Sjoerd Duiker, PSU
Jack Meisinger, USDA
Don Meals, TetraTech
Steve Dressing, TetraTech
Charlie White, PSU
Neely Law, CWP
Jeff Sweeney, EPA
Emma Giese, CRC
Ken Staver, UMD
Quirine Ketterings, Cornell
Ray Weil, UMD