Double Cropping with Winter Cereals and Corn Silage or Forage Sorghum

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Department of Animal Science
Outline

• Double cropping
  • Benefits and challenges
• Winter cereal fall N uptake
• Forage winter cereal spring management
• Managing a double crop rotation
  • Forage sorghum & triticale
• Summary & conclusions
• Ongoing work
Keeping the Ground Covered

• Bare soil
  • Potential for soil + nutrient loss
  • Opportunity loss

• Cover cropping
  • “A crop grown for protection and enrichment of the soil”

• Benefits
  • Erosion control
  • Organic matter
  • Soil health/quality
  • Nutrient recycling
Can You Harvest Cover Crops?

• YES!

• **Double cropping**
  • Two crops within a growing season

• Over-wintering cereals

• **Benefits**
  • Erosion control
  • Organic matter
  • Soil health/quality
  • Nutrient recycling
  • **Yield**
Double Cropping Challenges

• **Timing and weather**

• Best time to plant is mid-September
  • Or inter-seeding into the main season crop if feasible

• Best time to harvest is (typically) mid-late May
  • May be too wet
  • May be after corn silage planting

• Shorter-season corn varieties or alternative crops
  • Forage sorghum?
Double Cropping Systems

1. Winter cereal fall N uptake
2. Forage winter cereal spring management
3. Managing a double crop rotation
Double Cropping Systems

1. Winter cereal fall N uptake
2. Forage winter cereal spring management
3. Managing a double crop rotation
Nutrient Recycling: Fall N Uptake

- **Seeded after corn silage**
- **45 fields (species not in the same field)**
- **~ 0.5 tons of biomass/acre and 20-30 lbs N/acre**

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Nutrient Recycling: Fall N Uptake

- After small grains\(^1\) or earlier seedings\(^2\)
- 6 fields
- ~ 1 tons of biomass/acre and 70-80 lbs N/acre

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Nutrient Recycling: Fall N Uptake

- Early fall planting = more fall growth and N uptake

![Graph showing fall N uptake comparison between planted by 9/20 and planted after 9/20, with potential N loss indicated.](image-url)
Fall Apparent N Recovery and Planting Date

ANR

By 9/20

After 9/20

Fall N rate (lbs N/acre)

30 60 90 120
Fall Nitrogen Uptake by Winter Cereals

• Early planting needed to increase nitrogen uptake
  • After corn silage:
    • 20-30 lbs N/acre uptake
  • After small grains:
    • 70-80 lbs N/acre uptake

• Above-ground biomass:
  • 83% of total biomass
  • 84% of total C accumulation
  • 90% of total N uptake
Fall Nitrogen Uptake

Above ground biomass (tons DM/acre)
- Rye
- Wheat
- Triticale

Total N in above+below ground biomass (lbs N/acre)
Estimating Fall Nitrogen Uptake by Winter Cereals

Introduction
Nitrogen (N) is essential for crop production, but crop N needs are difficult to predict due to uncertainty of the weather and inability to accurately predict N supply and loss. Insufficient N will impact yield and crop quality while excess N can be lost to the environment through leaching (most typical in well-drained soils) or denitrification (more likely in poorly drained soils). Cover crops after the harvest of a main crop like corn can take up and sequester end-of-season N. Actual N uptake depends on growth (total biomass accumulation) prior to the winter.

Winter cereals, including wheat, cereal rye and triticale, are increasingly used as cover crops after corn silage as they can reduce erosion risk, add organic matter to the soil, and capture end of season nitrogen. These winter cereals have a greater cold tolerance than many other cover crops. In New York, winter cereals above ground biomass accumulation in the fall typically ranges from 0.25 to 1.5 tons per acre. This fact sheet shows the relationship between total N content in winter cereal cover crop and its above ground biomass (shoots), and also presents a step-wise method of determining total N uptake in the fall. Such assessments can guide nitrogen management.

Estimating N Content of Cover Crops
There is a strong linear relationship between the above ground biomass (shoot only) and total N uptake (roots and shoots combined) of wheat, cereal rye, and triticale grown as a winter cover crop in corn rotations in New York (Figure 1). The differences in N content among the three species are very small as long as the total biomass is less than 1.2 tons of dry matter per acre. The relationships between above ground biomass and total N uptake were very consistent among different locations (farm fields), suggesting that the equations in Figure 1 can be used independent of soil type. Thus, a farmer or farm advisor can determine the above ground biomass of these winter cereals in his or her fields and then estimate total (below and above ground) N in the cover crop.

Step-wise Protocol to Determine N Uptake
1. Create a sampling frame (for example a 24 by 12 inch wooden frame) and precisely measure its length and width in inches.
2. Place the sampling frame in a representative location of the field whose biomass and N content you want to estimate. Clip all above ground biomass of the winter cereals that is within the frame, as close to the soil surface as possible, while avoiding soil contamination, and place the sample within a bag large enough for samples from 3 frames. Sample when the plants are dry (avoid sampling when there is dew, rain, or snow).
3. Repeat the sampling process at two more representative sites in the field, collecting samples from all three locations in the same bag.
4. Measure the total weight of the sample collected in pounds (lbs). Make sure to subtract the bag weight itself so that only plant weight is included in the total.
5. If your sample does not have much external moisture, you can assume it has about 18% dry matter, then skip step 6 and continue with step 7. If you want to estimate total biomass and N content more precisely, continue with step 6.

After carefully mixing the sample in the sampling bag, take a subsample of approximately 0.25 lbs from the harvested biomass, and determine the weight of the subsample in pounds (if the weight of the total sample is 0.25 lbs or less, skip the step of taking a subsample). Dry the subsample with a microwave until it has obtained a stable weight. Use short drying periods of 30-60 seconds and place an 8-oz glass of water in the corner to avoid burning of the sample. More detailed instructions of drying with a microwave can be accessed at http://extension.psu.edu/publications/-106.

Once the weight has stabilized, measure the final dry weight. The dry weight divided by the initial weight is the percent dry matter. Once you have all data collected, access the Cornell University “Fall Nitrogen and Carbon Pools of Winter Cereals” calculator (http://nmsp.cals.cornell.edu/software/calculators.html). Select the species and enter your information for frame length, frame width, number of samples taken, total wet weight, subsample wet and dry weight. The calculator (Figure 2) will report the percent carbon (C) and N, the C to N ratio, estimated biomass (tons/acre dry matter), and total C and N pools (lbs/acre). Table 1 shows the N content of different winter cereals.

Additional Resources
- Penn State University “Determining Forage Moisture Content With a Microwave Oven”: http://extension.psu.edu/publications/-106.

Disclaimer This fact sheet reflects the current (and past) authors’ best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information
Cornell University Cooperative Extension
Nutrient Management Speak Program
http://nmsp.cals.cornell.edu
Zhaneh Tang, Quinette Kettner, Carl Cayemuth, Sherry Swink and Paul Cosselaiti
2015
Estimates total N pool for total above ground biomass of 1.2 tons/acre or less.
Double Cropping Systems

1. Winter cereal fall N uptake
2. Forage winter cereal spring management
3. Managing a double crop rotation
**Forage Winter Cereal N-Rate Study**

- 62 on-farm trials across New York
- Triticale, rye, and winter wheat
- 5 N rates applied at green-up
- Variety of soil types and management practices

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On-farm Research Partnership
Statewide Project
Winter Cereal Trials

http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DoubleCrops.html
Most Economic Rate of N (MERN)

- Plot dry matter yield against N rate to produce a response curve (quadratic regression)

![Graph showing silage yield vs. Spring green-up N rate (lbs N/acre)]
Forage Winter Cereal N-Rate Study

Yield at MERN (ton DM/acre)

Trial

Rye

Triticale

Wheat

2.5 tons DM

3.0 tons DM
Forage Winter Cereal N-Rate Study

Yield at MERN (tons DM/ac)

Most economic rate of N (lb N/ac)

- Cereal Rye
- Triticale
- Wheat
Spring MERN Decision Tree

Artificial Drainage

- YES
- NO

0 lbs N/acre

Manure History

- YES
- NO

Correctly predicted 78% of trials included in analysis

Planted Before 10/1

- YES
- NO

0 lbs N/acre

60-90 lbs N/acre
Spring MERN Decision Tree

Soil drainage, manure history, and planting date are important for determining N needs of forage winter cereals.
Predicting Spring Yield

• Trends for 4 low-yielding sites (< 1 ton DM/acre)
  • No fall manure application
  • No artificial drainage
  • Most planted after 10/1
Predicting Spring Yield

Soil drainage, manure history, and planting date are important indicators of forage winter cereal yield potential.
Forages are Not Just Yield: CP

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Spring N, Yield, and Crude Protein

- **Yield**: (ton DM/acre)
- **Crude protein (% DM)**

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Double Cropping Systems

1. Winter cereal fall N uptake
2. Forage winter cereal spring management
3. Managing a double crop rotation
Double Crop Rotation Study

- **Forage sorghum and triticale** (2016-2018)

- Why forage sorghum?
  - Later planting date than corn silage (early June)
  - Drought tolerant, weed-competitive
  - Potentially harvested early for timely winter cereal planting

- Treatments
  - N applied to triticale at green-up (5 rates, 0-120 lbs/acre)
  - N applied to sorghum at planting (2 rates, 0 and 200 lbs/acre)
  - Timing of sorghum harvest/triticale planting (4 timings)
Double Crop Rotation Study Timeline

- **Spring**
  - Soil testing, apply fertilizer to triticale
  - Green-up
  - Harvest triticale

- **Summer**
  - Soil sample, plant, and fertilize sorghum
  - Week 1 sorghum harvest, plant triticale
  - Week 2 sorghum harvest, plant triticale
  - Week 3 sorghum harvest, plant triticale
  - Week 4 sorghum harvest, plant triticale

- **Fall**
  - Sample fall triticale biomass

- **Winter**
Double Crop Rotation Study

• Total rotation yield was **maximized** when:
  • Sorghum received 200 lbs N/acre
  • Sorghum harvested in mid-September (flower-milk stage)
  • Triticale planted mid-September
  • Triticale fertilized with 90 lbs N/acre
  • Sorghum + triticale yield: **9.8 tons DM/acre (28 tons/ac 35% DM)**

• Total rotation yield was **lowest** when:
  • Sorghum and triticale received 0 N
  • Sorghum harvested early September
  • Triticale planted early September
  • Sorghum + triticale yield: **3.9 tons DM/ac (11 tons/ac 35% DM)**
Double Crop Rotation Study

**200 lbs/acre sorghum N**

**0 lbs/acre sorghum N**

**Total yield (tons DM/acre)**

**Fall harvest/planting time**

- **200 lbs/acre sorghum N**
  - 0 Spring N
  - 30 Spring N
  - 60 Spring N
  - 90 Spring N
  - 120 Spring N

- **0 lbs/acre sorghum N**
  - 0 Spring N
  - 30 Spring N
  - 60 Spring N
  - 90 Spring N
  - 120 Spring N

**Crop Stages**

- Boot-flower
- Flower-milk
- Milk-soft dough
- Soft dough-hard dough

**N Fertilization Levels**

- 0 Spring N
- 30 Spring N
- 60 Spring N
- 90 Spring N
- 120 Spring N
Nitrogen management is important for optimum sorghum performance (like corn).

Sorghum that received N at planting did not increase in yield past the flower or milk stages.

When sorghum was harvested at the soft dough stage, overall rotation yield was decreased by 1 ton DM/acre due to lower triticale yields from late planting.
Double Crop Rotation Study

Averages by planting date across N rates

Yield (tons DM/acre)

Harvest/planting timing

Averages by planting date across N rates

Triticale

Sorghum

Milk

Boot

- flower

Flower-milk

- milk

Milk-soft dough

Soft dough-hard dough
Double Crop Rotation Study

• Carryover N?
  • Spring N for triticale did not impact sorghum yield, but in the first year increased sorghum CP by 1%.
  • Spring N for triticale was correlated with soil nitrate at sorghum planting and harvest.
Double Crop Rotation Study

Soil nitrate at sorghum planting

Soil nitrate (mg/kg) vs. Spring N rate (lbs N/acre)
Summary: Forage Winter Cereals

• If forage winter cereals are planted on-time:
  • More end-of-season N uptake
  • Potentially higher spring yields

• Spring MERNs 60-90 lbs N/acre
  • May not need additional N if field is well-drained, had recently received manure, and was planted on-time (by September 20).
  • May need extra N to manage for CP

• If double cropped with forage sorghum
  • Both crops require N management
  • Plant triticale by mid-September for best rotation yields
Ongoing Work

• Impact of double cropping on whole farm N, P, and K balances
THANKS!

- Grants
  - Northern New York Agricultural Development Program (NNYADP)
  - Federal Formula Funds
  - USDA Conservation Innovation Grants
  - New York Farm Viability Institute
  - Northeast Sustainable Agriculture Research and Education
- Farm Advisors (CCE, NRCS, and Consultants)
- Farms and Research Facilities, NMSP Staff and students