



Using Cover Crop Mixtures to Reduce Nitrate Leaching and Fertilization in Potato Production

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Introduction

- Potato consumption has been a major part of the North American diet since early in the 17th century.
- The need for more food and economic pressures have led to more intensive potato production systems and extensive use of fertilizers.
- Nitrogen (N) is one of the most limiting factors in potato production and farmers often over apply N to ensure against yield loss (Waddell et al., 1999).
- Up to 50% of the applied N can be lost through nitrate leaching, volatilization and de-nitrification.
- Over fertilization may increase costs of production and contamination of water resources which threatens human health and sustainability.
- Management tools such as crop rotations with cover crops and tailoring N fertilizer application could be employed to sustain production and decrease environmental concerns.
- Cover crop mixtures can decrease nitrate percolation into water resources, provide nutrients for the following cash crops, increase soil organic matter, decrease nitrogen fertilization, and suppress weeds and diseases.

Objectives

- To study the effect of cover crop mixtures with different C:N ratios and N fertilizer rates on potato tuber yield.
- To evaluate the efficiency of cover crop mixtures on nitrate leaching in soil.

Materials and Methods

• A 2-yr field experiment was conducted at the Crops and Animal Research Farm of the University of Massachusetts, South Deerfield in 2013-2015.

• The soil type was fine sandy loam (nonacid, mesic Typic Udifluent) with pH of 6.5, organic matter content of 1.2%, N, P, K, and, Ca content of 3, 12, 76, and 834 mg kg⁻¹.

• Treatments were arranged in a randomized complete block design with four replications. Main plots consisted of cover crop mixtures and sub-plots were different N fertilizer rates.

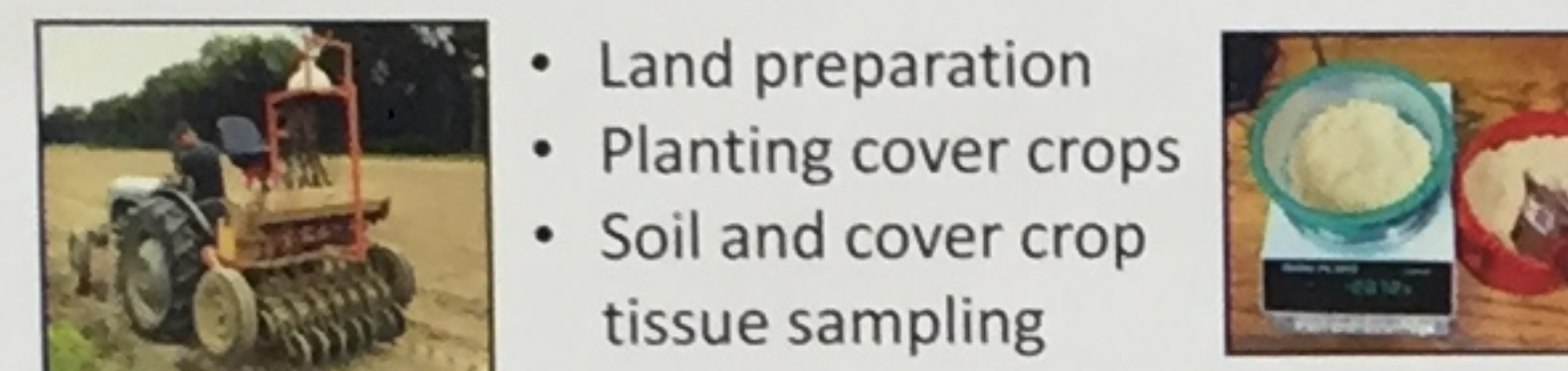
Statistical analysis

• Analysis of variance (ANOVA) was conducted by PROC GLM procedures of SAS. The effect of nitrogen fertilizer was assessed by regression analysis. Duncan's New Multiple Range Test was conducted for comparison of means of cover crops.

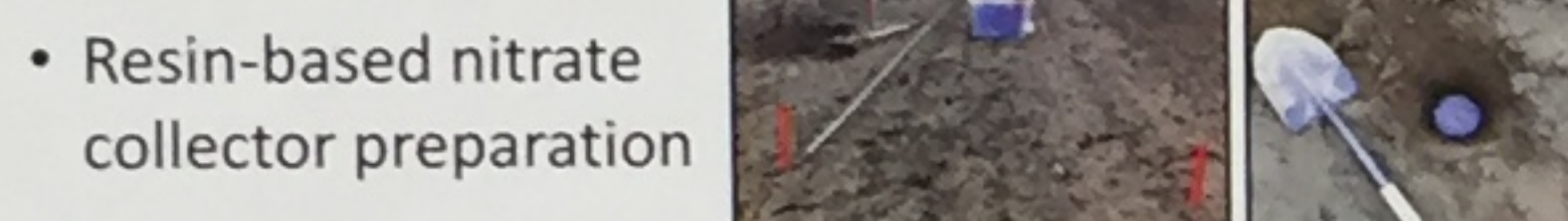
Treatments

- Cover crop mixtures: Rye /Forage radish (R+FR), Oat/Forage radish (O+FR), Peas/Forage radish (P+FR), Rye/Peas (R+P), Oat/Peas (O+P), along with no cover crop (NCC) plots.
- Nitrogen fertilizer rates: 0, 50, 150, and 200 kg ha⁻¹.
- Potato variety: Dark Red Norland.

Field operations- fall



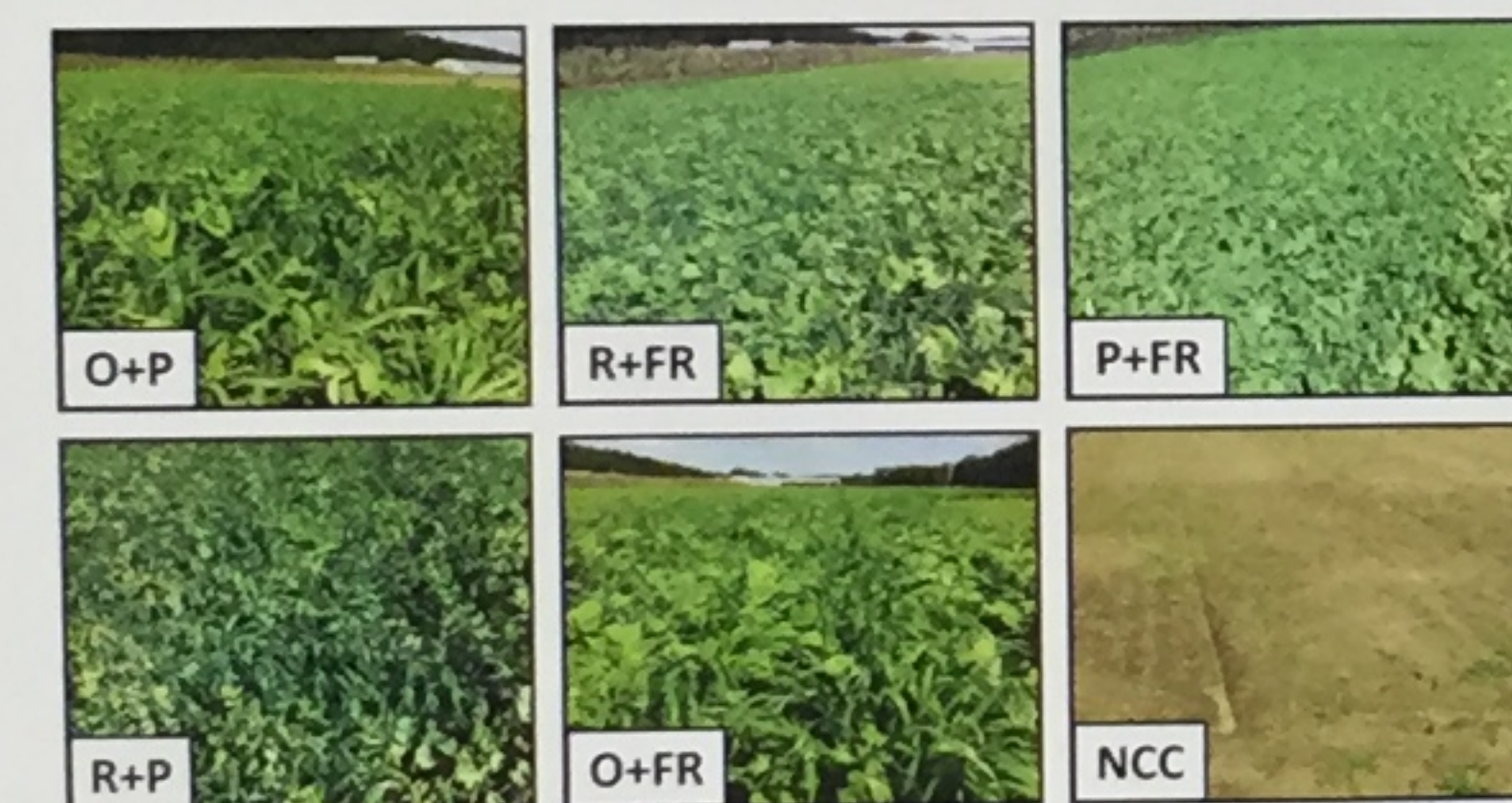
- Land preparation
- Planting cover crops
- Soil and cover crop tissue sampling



- Resin-based nitrate collector preparation

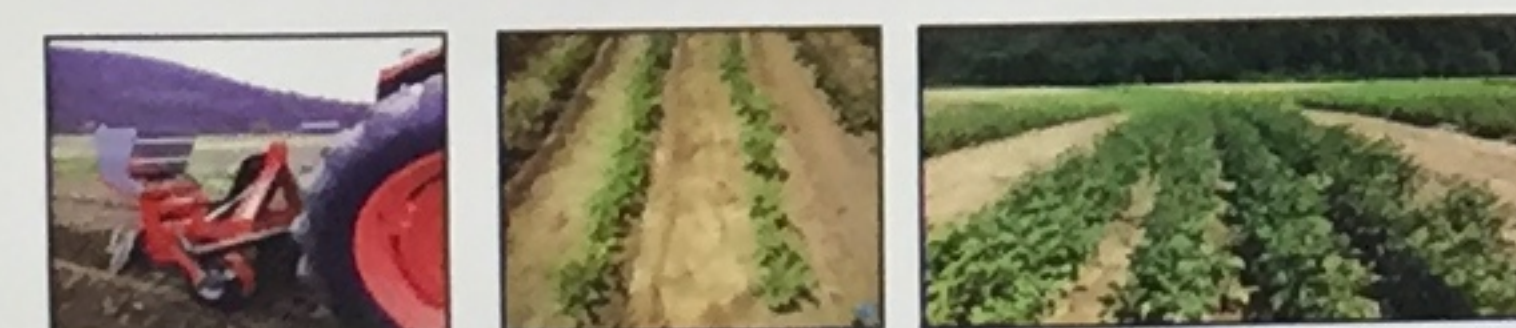
- Burying NO₃⁻ collectors prior to planting cover crops

Cover crop stands – September



Field operations – Summer

- Disking cover crop residues - Planting potatoes
- Banding N fertilizer- Plant and soil sampling-Harvest



Sample analysis



Results

- Cover crop mixtures showed a significant difference compared with no cover crop plots in terms of potato tuber yield.
- While the highest level of N increased tuber yield in no cover crop plots, mixtures produced higher tuber yield at lower N rates (Fig. 1).
- The highest tuber yield was obtained from O+FR (25.8 Mg ha⁻¹) and O+P (26.1 Mg ha⁻¹) mixtures, fertilized at 100 kg N ha⁻¹ (Fig. 1)
- Application of 150 kg N ha⁻¹ decreased yield in O+FR and O+P plots compared to 100 kg N ha⁻¹.

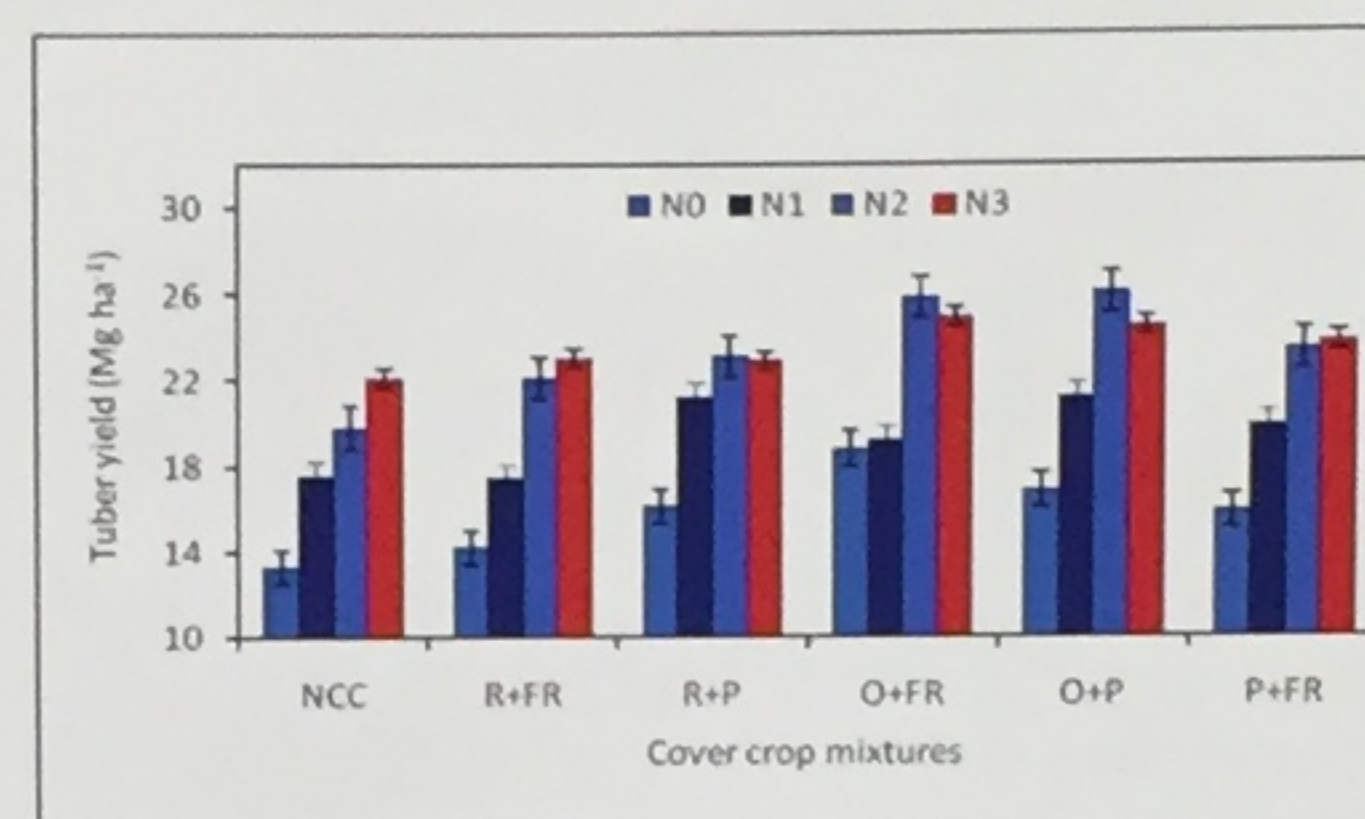


Fig. 1. Effect of nitrogen fertilization and cover crop mixtures on potato tuber yield. N₀, N₁, N₂, and N₃ represent 0, 50, 100, and 150 kg N ha⁻¹.

- Oat/Forage radish mixture showed to be more efficient in providing nutrients for the following potatoes when no N fertilizer was applied (Fig. 1).
- Our results confirm those reported earlier by Vos and Van der Putten (2004) who found increased potato tuber yield when potatoes were planted after cover crops.

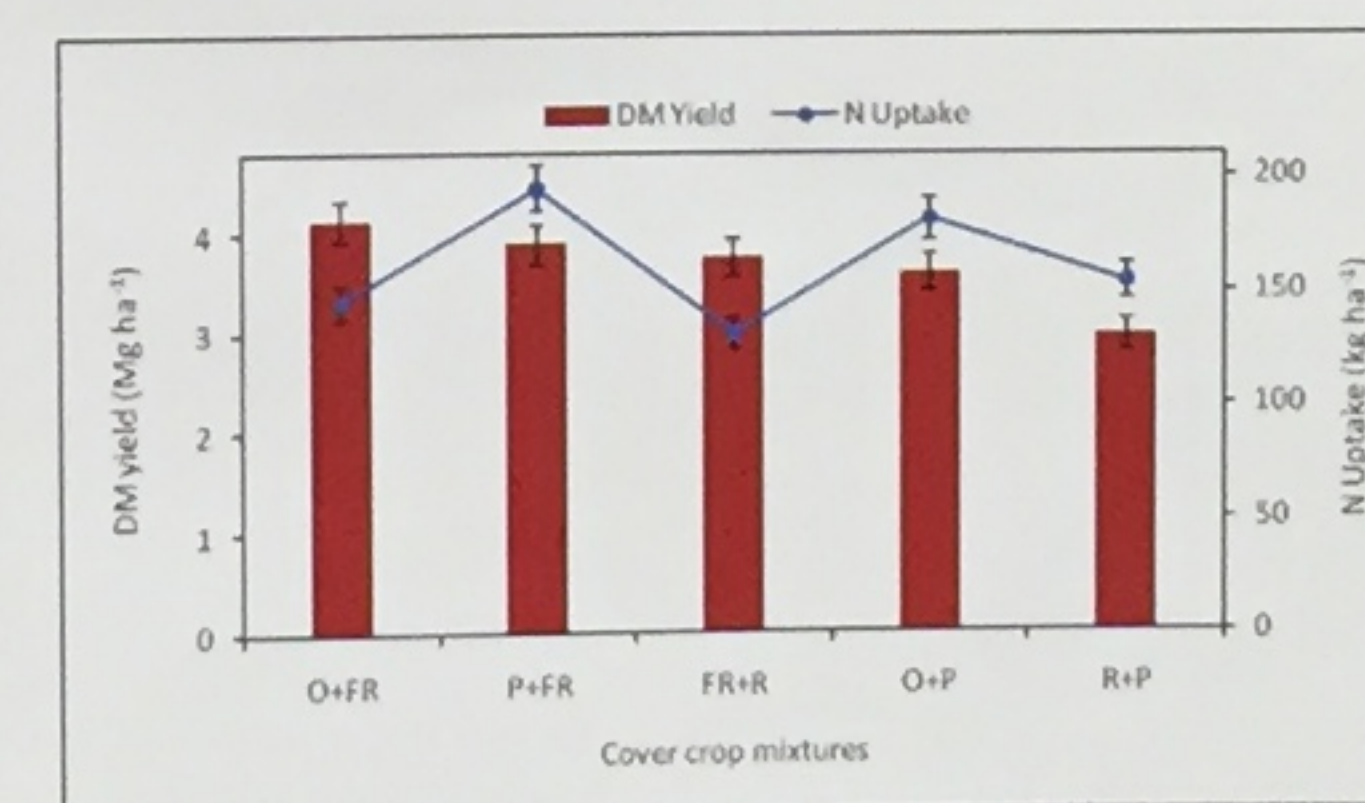


Fig. 2. Dry matter yield and nitrogen uptake at different cover crop mixtures.

- Peas/Forage radish mixture produced the highest biomass and dry matter (4.13 Mg ha⁻¹) among mixtures and the lowest DM yield was obtained from O+FR (Fig. 2).
- Nitrogen uptake followed the same trend as the DM yield and P+FR mixture had the highest N yield (195 kg ha⁻¹) followed by O+P (181 kg N ha⁻¹) (Fig.2).

- Our results showed that cover crop mixtures reduced the amount of nitrate leached into the lower levels of the soil compared with no cover crop plots (Fig. 3).
- The highest amount of nitrate leachate was observed from no cover crop plots followed by P+FR mixture (Fig. 3).
- Nitrate leaching was minimum in R+FR mixture compared with other mixtures and there was not a significant difference between R+P and O+P mixtures.
- Meisinger and Delgado (2002) have also reported reduced nitrate leaching in soil by adding cover crops into a rotation.

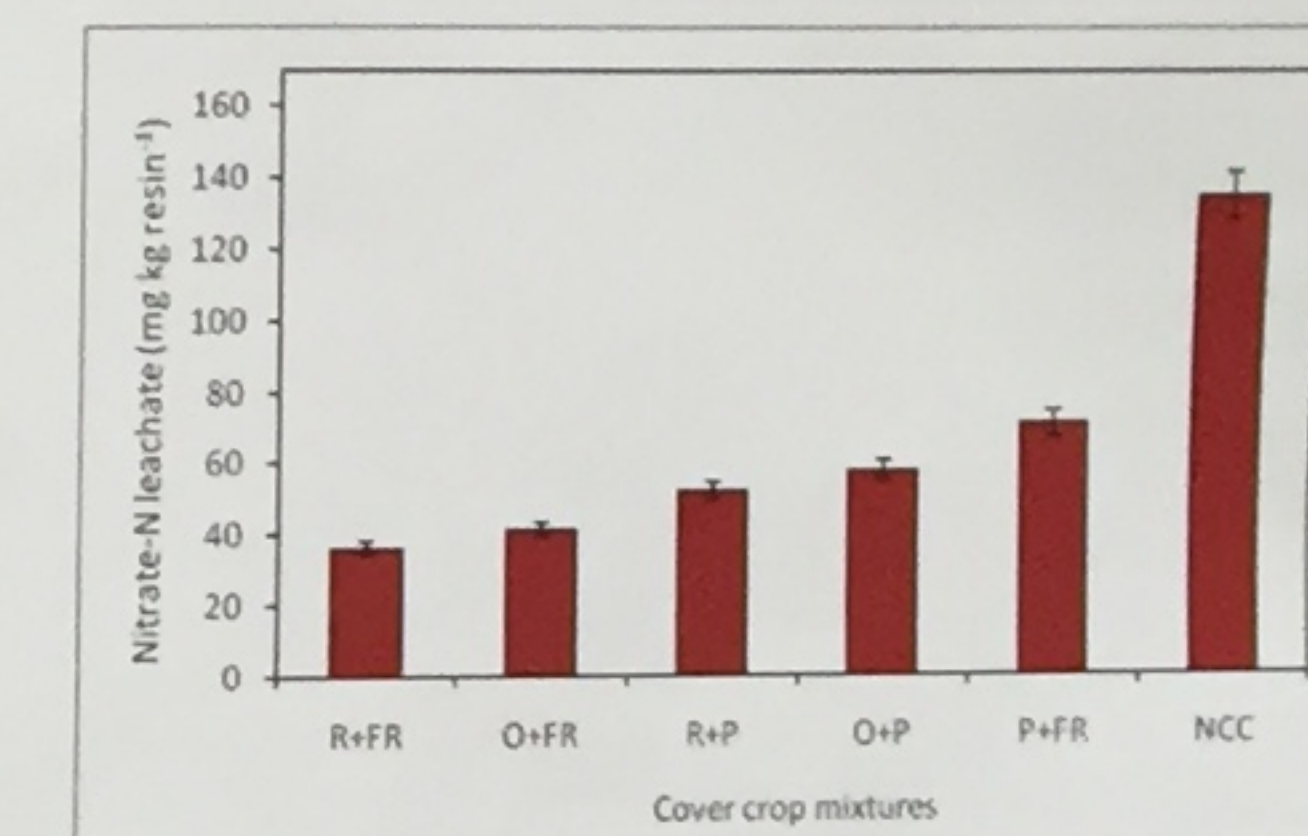


Fig. 3. Nitrate leaching as affected by cover crop mixtures.

Conclusions

- Cover crop mixtures may improve potato tuber yield and reduce nitrogen fertilizer application.
- Potatoes planted after O+FR or O+P produced higher yield at lower N rates compared with other mixtures.
- Less nitrate was leached into the soil if oat or rye were included in the mixtures compared to those were legume made a greater proportion of the mixture.

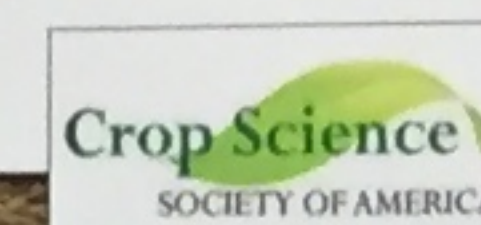
Acknowledgement

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References

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STUDY OBJECTIVES

- SUSTAINABLE FARM SYSTEMS
- SUSTAIN SOIL HEALTH AND CARBON SEQUESTRATION
- MINIMIZE RISK FOR NITROGEN POLLUTION TO AIR AND WATER

Potato (*Solanum tuberosum*)...
excesses of nitrogen...
nitrogen source...
decreased environmental...
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