Using Cost of Production Analyses to Evaluate Hay Improvement, Double Cropping, Corn-Hay Field Decisions, and Cropland Acquisition

A field-level economic and agricultural water-quality decision guide

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Zachary Smith, Amber Blodgett, Jeff Sanders, and Sally Burke — UVM Extension Agricultural Business Team and Northwest Crops and Soils Team Specialists

Alternative Feed Studies Technical Report 3

University of Vermont
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Goal	Guide producers and farm advisors through repeatable field-level decisions using current cost of production, feed value, operational feasibility, risk, and agricultural water-quality effects.
Decisions examined	Improve a hay field; double crop a corn field; convert a field between corn and hay; acquire or lease new cropland.
Core question	Does the proposed field change create enough economic and operational value to justify its cost and risk while maintaining or improving agricultural water-quality outcomes?

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About This Project

This report is part of a series developed by the UVM Extension Agricultural Business Team (ABT) and Northwest Crops and Soils Team (NWCST) as an Alternative Feed Studies project for the Clean Water Improvement Program (CWIP) at the Vermont Agency of Agriculture and Food Markets (VAAFM). The work examines the cost of producing homegrown dairy forages in Vermont and connects those costs to the crop and nutrient decisions that also shape agricultural water quality. The series addresses three subjects in turn: the cost of production of haylage, the cost of production of corn silage, and how to use cost of production analyses to make management decisions.

Several farms contributed to the gathering of information for this project. Two farms, both Medium Farm Operations (MFOs), participated in in-depth interviews that provided background on crop management decisions and on their feelings and concerns about the costs and risks of managing agricultural water quality while maintaining productive homegrown forages. Those conversations inform the management perspective throughout the report. They capture practices and farmer judgment rather than measured environmental outcomes, and the report treats them accordingly.

The project rests on a straightforward idea. The decisions that govern water quality on a dairy, nitrogen rate and timing, manure placement, cover and rotation, and investment in a given field, are the same decisions that govern the cost and quality of homegrown feed. Farmers do not experience them as environmental practices added onto the business. They experience them as feed, cost, weather, labor, and land decisions. Better cost and forage information helps move the economically sound choice and the water-protective choice toward the same answer.

To keep the analysis useful and reproducible, the cost examples in this series work from a hypothetical farm rather than from any participating farm's figures. That example farm is a 200-milker dairy with youngstock, replacement heifers, dry cows, and some beef-on-dairy, running roughly 200 acres of corn and 400 acres of hay. All numbers used in the worked examples are rounded and illustrative. They are not drawn from any individual farm, and they are meant to be replaced by a reader's own figures.

Evidence Status Used in the Report

Due to the depth of the analysis that was performed after farmer interviews and meetings, information considered to be "evidence" was not all directly related to the information that was gathered on the farms. Information was gathered by the Agricultural Business Team (ABT) with the support of members from the Northwest Crops and Soils Team (NWCST) in 2025 and early 2026. We will highlight what information came from farm records, results calculated from farm records and interviews with farmers, assumptions that were made, and research-supported interpretations that we had to create from secondary data. The appendices explain our definitions and rationales.

Data Collection with the Farms

The findings that follow come primarily from on-farm interviews conducted with each case-study farm, supported by farm financial records, forage inventories, and nutrient-management documentation where available. The interviews and "follow-ups" were the central instruments. Each visit followed a long-form intake structure covering farm identity, land tenure, production goals, cropping and cutting practices, fertility and manure management, harvest and storage operations, feed quality, and water-quality context, but the conversations were allowed to move where the farmers took them. That approach traded some uniformity for depth, and it surfaced management reasoning that a fixed questionnaire would have missed.

The style of information gathered through interviews shapes how it should be read. Much of what farmers shared was practice and perception: what they do, what they have observed, and what they believe is working. Some figures, including certain acreages, shrink estimates, and allocation percentages, were worked out verbally during the visits and represent working estimates rather than measured or reconciled values. Throughout the findings, statements drawn directly from farm records are distinguished from interview observations and from working assumptions, and figures that require verification against records or laboratory results before quantitative use are marked. This distinction protects the integrity of the analysis and keeps producer perception, which is valuable in its own right, from being mistaken for measured fact.

Interviews capture management practices, not environmental outcomes. The conversations documented what each farm does with cover, nutrient timing, rotation, and storage, and they recorded the farmers' own sense of whether those practices help. They did not measure runoff, leaching, soil organic matter, or erosion. The water-quality findings should be read in that light: as a record of practice and plausible pathways, not as demonstrated water-quality results.

Evidence Label	Meaning
Farm Record	Financial, acreage, inventory, herd, or management information supplied by a participating farm.
Farm interview	Producer-reported practice, outcome, concern, or interpretation.
Advisor interview	Working rate, management recommendation, or systems observation supplied by a farm advisor.
Project observation	Result from the UVM Northwest Crops and Soils Team project information supplied for this report.
Calculated illustration	A mathematical example using transparent assumptions; not a measured farm outcome.
Research reference	Published guidance or peer-reviewed research used for interpretation.

Table 1. Description of terms used to describe the evidence included in the study

Executive Summary

Technical Reports 1 and 2 (found online at: https://www.uvm.edu/extension/agricultural-business/water-quality-business-analysis) established working cost-of-production benchmarks for haylage and corn silage. Report 3 converts those enterprise results into a practical decision process for individual fields and prospective acreage. This guide addresses four choices: **improving or renovating a hay field, harvesting a winter forage crop (double-cropping), moving a field between corn and hay, and acquiring or leasing additional cropland.**

The first step is to establish the farm's current cost per acre and cost per as-fed ton for haylage and corn silage. Schedule F is the preferred starting source for whole-farm expenses because it provides an annual control total. For future improvements in accuracy, Schedule F should be supplemented with invoices, payroll records, machinery hours, field records, forage inventories, dry-matter tests, storage records, and other documents that allow direct assignment or transparent allocation among dairy, hay, corn, and general farm operations.

Enterprise	Allocated cost	Acres	Cost/ac	As-fed tons	Cost/ as-fed ton
Haylage	$301,000	400	$752.50	4,000	$75.25
Corn silage	$235,500	200	$1,175.00	4,000	$58.75

Table 2. Sample Allocations

The case-farm figures are starting benchmarks rather than universal standards. Haylage and corn silage cannot be compared on as-fed tonnage alone because of a multitude of factors, but it is good practice to recognize and account for the main forages produced on the farm. The decision process therefore progresses from cost per acre and cost per as-fed ton toward cost per usable dry-matter ton, feed replacement value, purchased-feed avoidance, income over feed cost, and multi-year field performance.

For hay improvement, the guide distinguishes stand problems from harvest and storage problems. A field may require soil correction, better cutting management, overseeding, full renovation, or rotation. UVM Northwest Crops and Soils Team project observations found that renovated fields averaged **0.35 more dry-matter tons per acre** across participating farms, while nutrient-yield changes differed by measure. The result is used for sensitivity analysis, not as a guaranteed response.

For double cropping, the correct baseline is a corn-only field that would otherwise have no harvested winter or spring crop. The analysis charges the double crop for seed, planting, termination, harvest, hauling, packing, storage, labor, machinery, nutrient inputs, management time, and any lost corn value. It also recognizes added feed, avoided hay purchases, risk-management value, winter soil cover, living roots, and nutrient capture. Vermont's narrow establishment and spring harvest windows are treated as major constraints.

The corn-hay conversion analysis uses a multi-year horizon because annual corn establishment and multi-year hay stands have different cost patterns. The land-acquisition analysis adds purchase or rent, financing, distance, field-development needs, delivered-feed cost, lease security, manure logistics, storage, and water-quality due diligence.

1. Introduction

1.1 Goal of the report

The goal of Report 3 is to show how a farm can use cost-of-production information to make strategic field decisions. Reports 1 and 2 answer what haylage and corn silage currently cost. Report 3 asks what the farm should do next with a particular field, management practice, or land opportunity.

1.2 Why field-level analysis is needed

Whole-farm averages can conceal differences among fields. One hay field may have an old, grass-dominant stand with low yield, while another may produce high nutrient yield under a short cutting interval. One corn field may be well drained and close to storage, while another may be distant, wet, irregularly shaped, or erosion-prone. Field-level records allow management to identify where additional investment is likely to pay and where a different crop or feed destination may be more appropriate.

1.3 What the reader should be able to do

- Calculate current haylage and corn silage cost per acre and cost per as-fed ton.
- Identify the cost boundary and data limitations behind each result.
- Use an incremental partial budget to compare a current practice with a proposed change.
- Estimate cost per usable dry-matter ton and feed replacement value when adequate data are available.
- Evaluate forage quality, nutrient yield, feed destination, purchased-feed displacement, and herd implications.
- Screen a decision for soil cover, erosion, nutrient use, compaction, runoff, and other agricultural water-quality effects.
- Test low, expected, and high scenarios before investing across a large acreage.
- Develop a field monitoring plan that compares actual results with the decision assumptions.

1.4 Scope and limitations

The hypothetical example farm from Reports 1 and 2 provides the quantitative cost benchmarks. Farm 2, additional farmer interviews, farm advisor interviews, the 2025 UVM Northwest Crops and Soils Team project information, and several soon-to-be-published manuscripts provide systems context. The report does not claim that a farm will achieve a specific yield, milk response, nutrient reduction, soil organic matter change, or purchased-feed saving without direct measurement.

2. Establishing the Current Cost-of-Production Baseline

2.1 Begin with Schedule F

The farm's Schedule F should be the preferred financial starting point for a completed production year. It supplies an annual summary of whole-farm income and expense categories and functions as a control total. Schedule F is not an enterprise budget, so each line must be reviewed to determine whether the expense belongs to dairy operations, haylage, corn silage, another enterprise, or general overhead.

Schedule F category	Enterprise assignment approach
Chemicals	Identify crop, field, product, acres, and application charge.
Custom hire	Assign mowing, merging, chopping, planting, hauling, application, and other work directly when invoices allow.
Fertilizer and lime	Use field and crop records, soil tests, manure credits, and application records.
Fuel and oil	Use machine hours, gallons, field passes, or a documented activity allocation.
Hired labor	Separate dairy, crop, maintenance, hauling, packing, and management roles.
Repairs and maintenance	Assign by machine or enterprise use when records allow.
Seed	Assign directly by crop and field.
Supplies	Separate crop, storage, shop, dairy, and general supplies.
Rent and property tax	Assign by land use, building use, acres, or another documented basis.
Depreciation	Use the depreciation schedule and machinery use records for a fuller economic cost.

After allocation, the sum assigned to all enterprises and overhead should reconcile with the Schedule F control total. A reconciliation reduces the chance that an expense is omitted or counted twice.

2.2 Supplement Schedule F with operating records

Record group	Examples
Financial	(When available) Invoices, payroll detail, loan records, depreciation schedule, property tax, rent, insurance
Field	Acres, crop, species or hybrid, planting date, stand age, soil tests, nutrients, chemicals, field passes
Harvest	Loads, scale weights, dry matter, custom invoices, labor, machinery hours, hauling distance
Storage	Storage unit, dimensions, density, tons placed, cover cost, packing hours, spoilage, feed removed
Feed and herd	Forage analysis, ration inclusion, purchased feed, milk, components, DMI, refusals, animal group

2.3 Define the cost boundary

Boundary	Included cost
Field production	Seed, lime, fertilizer, manure application, chemicals, planting, field operations
Delivered to storage	Field production plus harvest, hauling, packing, and covering
Removed for feeding	Delivered cost adjusted for storage and feedout losses
Consumed	Removed cost adjusted for refusals and other feeding losses
Full economic cost	Cash cost plus machinery ownership, unpaid labor, land opportunity cost, and operating capital

2.4 Core calculations

The table below summarizes the four cost measures used throughout the report, the formula for each measure, and the primary decision-making purpose.

Calculation	Formula	Primary use and interpretation
Cost per acre	Total annual enterprise cost ÷ harvested crop acres	Supports land-use, field-improvement, crop-rotation, double-cropping, and land-acquisition decisions.
Cost per as-fed ton	Total annual enterprise cost ÷ total crop-year as-fed tons	Measures forage cost at its recorded moisture level. The production total should reconcile feed already used, feed remaining, carryover, and all storage units.
Cost per dry-matter ton	Total annual enterprise cost ÷ total dry-matter tons	Allows forage with different moisture levels to be compared on a common basis. Measured dry matter is preferred; sensitivity assumptions should be labeled clearly.
Cost per usable dry-matter ton	Total annual enterprise cost ÷ dry matter available for feeding	Incorporates field, fermentation, storage, and feedout losses when records allow. The loss boundary must be defined to avoid double counting.

2.5 Example-farm baseline from Reports 1 and 2

Measure	Haylage	Corn silage
Allocated enterprise cost	$301,000	$235,000
Crop acres	400	200
Cost per acre	$752.50	$1,175.00
Represented as-fed production	4,000 tons	4,000 tons
As-fed yield per acre	10.0 tons	20.0 tons
Cost per as-fed ton	$75.25	$58.75
DM yield at 35% sensitivity	3.5 tons/ac	7.0 tons/ac
Cost per DM ton at 35% sensitivity	$215.00	$167.86

Source note: Technical Reports 1 and 2. Dry-matter figures in the final two rows are calculated illustrations because the example farm has not measured dry matter directly; the DM figures are illustrations at an assumed 35 percent.

2.6 Why both per-acre and per-ton measures matter

Cost per acre measures the annual commitment to the land. Cost per ton measures how effectively yield spreads that cost. A low-input field may look inexpensive per acre but produce costly forage when yield is low. A field with a higher cost per acre may produce lower-cost feed when usable yield and quality are strong.

2.7 Baseline decision framework

Decision status	Minimum interpretation
Proceed	Expense totals reconcile; acres and production are complete; cost boundary is stated; major assumptions are documented.
Proceed with sensitivity analysis	The farm has a reasonable estimate but dry matter, shrink, density, or shared costs remain uncertain.
Pause and improve records	Inventory does not reconcile, crop acres are unclear, or major cost categories are missing.

3. A Field-Level Decision Method

Every analysis in the report uses the same sequence. A consistent method makes alternatives easier to compare and keeps economic and water-quality questions in the same decision.

Step	Action
1. Define the field and objective	Identify acreage, ownership, soil, drainage, slope, access, current crop, feed need, and the problem management is trying to address.
2. Establish the current baseline	Record current cost, yield, dry matter, quality, feed destination, storage recovery, and water-quality conditions.
3. Define realistic alternatives	Exclude options that do not fit field conditions, herd needs, labor, machinery, storage, or land tenure.
4. Build an incremental partial budget	Record added benefits, reduced costs, added costs, and reduced benefits.
5. Evaluate feed and herd value	Estimate usable feed, purchased-feed displacement, ration fit, milk or component implications, and animal-group needs.
6. Evaluate operational feasibility	Review fieldwork windows, labor, machinery, custom capacity, hauling, packing, and storage.
7. Complete the water-quality screen	Review soil cover, erosion, nutrient timing, nutrient removal, compaction, runoff, and storage concerns.
8. Test uncertainty	Use low, expected, and high scenarios for yield, quality, cost, weather, and following-crop effects.
9. Select a decision and monitoring plan	Start at an appropriate acreage, record actual results, and compare them with assumptions.

3.1 Incremental partial-budget structure

An incremental partial budget helps a farm evaluate a proposed change by focusing only on the costs and benefits that would change if the new practice were adopted. Rather than rebuilding the entire farm budget, the analysis compares added benefits and reduced costs with added costs and reduced benefits. This approach is well suited to decisions such as renovating a hay field, adding a winter forage crop, moving acreage between corn and hay, or acquiring new cropland. It also provides a clear structure for incorporating feed value, purchased-feed savings, labor and machinery demands, transition risks, and agricultural water-quality considerations into one decision.

Budget category	Examples
Added benefits	More usable forage, improved nutrient yield, added milk revenue, cost-share, risk-management value
Reduced costs	Avoided purchased hay or grain, reduced fertilizer, lower shrink, reduced custom expense
Added costs	Seed, field passes, nutrients, harvest, storage, labor, machinery, financing, management
Reduced benefits	Lost corn or hay yield, delayed planting, lower quality, lost storage capacity, lost land flexibility

Net economic advantage of the decision
Added benefits + reduced costs – added costs – reduced benefits
A positive result is necessary but not sufficient. Operational feasibility, risk, and water-quality effects also matter.

3.2 Agricultural water-quality screen

This step helps the farm evaluate how a proposed field management change may affect soil cover, erosion risk, nutrient timing, nutrient use, compaction, runoff, and storage-related losses. The purpose is not to claim a measured environmental outcome without supporting data, but to identify likely pathways, management risks, and records that should be monitored. Used alongside the partial budget, the screen helps ensure that a financially attractive option also fits the field's soil, drainage, slope, nutrient-management, and conservation needs.

Water-quality area	Decision question
Soil cover	Will the option increase or reduce the period of protected soil?
Living roots	Will roots be present for a greater portion of the year?
Erosion	How will slope, tillage, residue, and traffic affect soil loss risk?
Nutrient timing	Will manure or fertilizer be applied closer to crop demand?
Nutrient balance	Will the option reduce excess nutrient imports or improve harvested nutrient removal?
Compaction	Will field traffic occur under wet conditions or with heavy axle loads?
Runoff and leachate	Will field runoff or storage runoff risk change?
Soil organic matter	Is a trend measured, expected, or only producer-reported?

3.3 Sensitivity analysis

A single expected value can hide risk. Each decision should test at least a low, expected, and high case. Variables can include yield, dry matter, quality, establishment success, custom rates, milk price, feed replacement value, storage loss, corn-yield effect, and payback period.

4. Situational Analysis: Improving a Hay Field (or Not)

For this situation, we will analyze the decision of attempting to improve the quality of output from a hay field.

4.1 Define higher-quality and lower-quality forage

Category	Working definition
Lower-quality forage	Undesirable species or varieties, low nutrient density, low yield, inadequate protein or digestible fiber for the intended animal group, weak persistence, or poor resilience. Quality may also be lowered by maturity, moisture, chop size, mowing height, fermentation, storage, and feedout.
Higher-quality forage	A productive and persistent stand with species and varieties suited to the field, adequate nutrient yield, digestible fiber, successful preservation, appropriate storage segregation, and a ration role that supports animal biology and production.

Interview participants linked diverse grass-legume stands with forage production, soil function, and lower fertilizer dependence under appropriate management. The report treats forage quality as the combined result of field performance, harvest timing, preservation, storage, feedout, and ration incorporation.

4.2 Diagnose the source of the issue

Diagnostic area	Topics to examine
Stand	Species composition, weeds, density, age, winter injury, disease, persistence
Soil	pH, potassium, phosphorus, sulfur where relevant, drainage, compaction, organic matter, field variability
Harvest	Maturity, cutting interval, mowing height, weather, field loss, chop length
Storage	Moisture, packing, sealing, oxygen exposure, fermentation, wall loss, face management
Feeding	DM variation, segregation, ration fit, refusals, animal group, feedout rate

4.3 Four management options

Option	Description
Keep	Retain the field and direct forage to an animal group with suitable nutrient requirements.
Improve	Correct soil fertility, adjust mowing height or interval, overseed, improve harvest timing, or improve storage.
Renovate	Terminate or suppress the existing stand and establish improved species and varieties.
Rotate	Move the field into corn or another crop as part of a multi-year plan.

4.4 Interview-derived working costs

These numbers were gathered from a variety of sources. It is understood that these costs can vary from farm to farm based on contextual settings. Consistent refinement should include more sources from around the state of Vermont.

Cost item	Working rate	Interpretation
Burn-down spraying	$28/ac	Includes glyphosate, application, and fuel; interview estimate
Mowing	$20/ac	Custom rate; interview estimate
Merging	$20/ac	Custom rate; interview estimate
Chopping	$35/ac	Custom rate; interview estimate
Combined merge and chop	$48/ac	***Research not confident in this rate; verify before use***
Truck hauling	$120/ac	Custom estimate; distance and field access may change cost
Bunker packing	$120/hr	Convert to cost per acre or ton using recorded hours
Urea	$820/ton	Interview estimate

Cost item	Working rate	Interpretation
Urea example	150 lb/ac	Reported for grass-dominant or low-legume fields; ***agronomic review required***
Potash	$520/ton	Interview estimate
Potash example	400 lb/ac/year	Often split across two applications
Fertilizer application	$100/hr or $10/ac	Interview estimate
Broadcast manure	$50/ac/application	Reported at 4,000 to 4,500 gal/ac; hauling distance matters
Injected manure	$0.015/gal plus $100/hr	Reported at about 6,000 gal/ac; avoid double counting
Seed	$184 per 50-lb bag	Reported coverage of about 2.5 acres
Drill fuel	0.33 gal/ac	Reported for a 12-foot drill; apply current farm fuel price
Land rent	$70 to $100/ac	Location and land quality affect rent
Bunker plastic	$875 per 60 x 200 ft roll	Combination tarp with oxygen barrier
Inoculant	$1.00/ton	Local product estimate
Acid preservative	$1.20/ton	Local product estimate

Source note: *Most information comes from farmer and farm advisor interviews supplemented by informational calls to providers. Rates are working local estimates and require verification for vendor, date, geography, field condition, and farm scale.*

4.5 UVM NWCS renovation observations

All-farm average	Unimproved	Improved
Crude protein, % DM	21.8%	25.1%
NDF	49.0%	39.5%
NFC	16.3%	20.5%
ESC	8.4%	6.6%
NDFD30	68.0%	67.8%
CP yield	356 lb/ac	579 lb/ac
NFC yield	249 lb/ac	470 lb/ac
ESC yield	129 lb/ac	149 lb/ac
NDFD30 yield	535 lb/ac	612 lb/ac

Across participating farms, renovated fields averaged 0.35 additional dry-matter tons per acre. The improved fields did not improve every laboratory measure. NDFD30 percentages were nearly the same, while the improved group produced more crude protein, NFC, and digestible-fiber yield per acre. The result supports evaluating both forage composition and nutrients harvested per acre.

Source note: *2025 UVM Northwest Crops and Soils Team project information supplied by project team members. The 0.35 DM ton/ac response is a project average, not a guaranteed farm response.*

4.6 Illustrative renovation sensitivity

This sensitivity analysis shows how the economic value of hay-field renovation changes with three factors: the added dry-matter yield, the internal value of the forage, and the cost of renovation. The example uses the UVM Northwest Crops and Soils Team observation that renovated fields averaged 0.35 additional dry-matter tons per acre. That yield response is then valued at three possible internal feed values, $250, $350, and $450 per dry-matter ton, to estimate the added annual feed value per acre.

At those values, the added 0.35 dry-matter tons would be worth approximately $87.50, $122.50, or $157.50 per acre per year. The payback table then compares those annual benefits with renovation investments of $150, $300, and $450 per acre. A $150 renovation investment would be recovered in about 1.7 years at a feed value of $250 per dry-matter ton, 1.2 years at

$350, and approximately 1 year at $450. A $300 investment would require about 3.4, 2.4, or 1.9 years, while a $450 investment would require about 5.1, 3.7, or 2.9 years.

The table demonstrates that renovation becomes more attractive when the added forage has a higher internal value, establishment costs are lower, or the field produces a larger yield response. It should be treated as a screening tool rather than a prediction. The example does not yet include establishment failure, lost production during renovation, added fertility, harvest and storage costs, stand life, forage-quality differences, or herd response. A farm should replace the illustrative values with its own expected yield, renovation cost, feed value, and management assumptions before making a field decision.

Internal feed value	Added DM response	Annual added feed value
$250/DM ton	0.35 DM ton/ac	$87.50/ac/year
$350/DM ton	0.35 DM ton/ac	$122.50/ac/year
$450/DM ton	0.35 DM ton/ac	$157.50/ac/year

Renovation investment	$250/DM ton	$350/DM ton	$450/DM ton
$150/ac	1.7 years	1.2 years	1.0 years
$300/ac	3.4 years	2.4 years	1.9 years
$450/ac	5.1 years	3.7 years	2.9 years

The payback table isolates added feed value and renovation investment. It excludes interest, establishment loss, added fertilizer, harvest changes, storage loss, labor constraints, and herd response. A farm should replace each illustration with its own full partial budget.

4.7 Herd-level value and IOFC illustration

The herd-level value and income-over-feed-cost (IOFC) illustration shows how forage quality can affect profitability through two channels: milk revenue and daily feed expense. Income over feed cost is calculated by subtracting feed cost per cow per day from milk revenue per cow per day. The example assumes the same milk price across all three forage scenarios so that the comparison focuses on differences in milk yield and feed cost associated with higher-, medium-, and lower-quality forage.

In the illustration, the higher-quality forage scenario produces an IOFC of $10.15 per cow per day, compared with $8.33 for medium-quality forage and $6.32 for lower-quality forage. The daily advantage is therefore $1.82 per cow for higher versus medium quality, $3.83 per cow for higher versus lower quality, and $2.01 per cow for medium versus lower quality.

When extended across 100 cows for a full year, the difference equals approximately $66,430 for higher versus medium quality, $139,795 for higher versus lower quality, and $73,365 for medium versus lower quality. The table demonstrates how a relatively small daily difference can accumulate into a large annual economic effect across a herd.

The example should be used as an illustration rather than as a prediction for a participating farm. The actual value of improved forage will depend on the amount of improved feed produced, the number of cows receiving it, the number of days it is fed, ration formulation, forage analysis, purchased-feed displacement, milk response, components, and animal health. The field-level decision should therefore compare the portion of added IOFC that can reasonably be attributed to the improved forage with the annualized cost of renovation, fertility, harvest, storage, and feed management.

Forage Scenario	Milk /cow/day	Milk revenue /cow/day	Feed cost /cow/day	IOFC /cow/day
Higher-quality	95 lb	$18.05	$7.90	$10.15
Medium-quality	87 lb	$16.53	$8.20	$8.33
Lower-quality	78 lb	$14.82	$8.50	$6.32

Comparison	Difference	Illustration for 100 cows
Higher versus medium	$1.82/cow/day	$66,430/year
Higher versus lower	$3.83/cow/day	$139,795/year
Medium versus lower	$2.01/cow/day	$73,365/year

The ration comparison is an attributed illustration in which milk price is $19.00 per cwt and the rations otherwise differ by forage quality. It is not a measured response from a case-study farm. The annual values assume 100 cows experience the stated daily difference for 365 days.

Source note: *This information comes from the soon-to-be-published article 'The Economic Case for High-Quality Forage,' manuscript supplied by Whitney Hull, UVM Extension Dairy Herd Management Specialist.*

4.8 When lower-quality forage remains useful

Lower-quality forage may have an appropriate role for replacement animals, dry cows, transition cows, or other livestock with lower nutrient requirements. The field should be retained only when the forage meets the biological needs of the intended group and the whole-farm value exceeds the value of renovation or rotation.

4.9 Hay improvement and agricultural water quality

Option	Potential benefit	Potential risk	Record needed
Keep current stand	Maintains perennial cover	Low nutrient uptake or sparse cover may persist	Stand density, yield, soil test, runoff observations
Improve management	May raise nutrient uptake and stand resilience	Added nutrients can be lost when timing or rate is poor	Application date, rate, rainfall, harvested nutrient yield
Renovate	May improve density, root activity, and productivity	Termination can expose soil and establishment can fail	Method, cover, erosion controls, establishment success
Rotate to corn	Can reset an old stand and create rotation benefits	Annual crop can increase soil exposure	Tillage, cover crop, nutrient plan, slope and erosion risk

4.10 Hay-field decision rule

Improve or renovate when expected added usable feed value, herd value, and risk reduction exceed annualized renovation cost and added operating cost, and when the field can support the practice without an unacceptable water-quality risk.

5. Situational Analysis: Double-Cropping a Corn Field

5.1 Define the baseline correctly

The baseline is a corn-only field that would otherwise produce no harvested crop during late fall, winter, and early spring. A fair comparison assigns every added activity to the double crop, including seed, establishment, termination, harvest, hauling, packing, storage, labor, machinery, and management time.

5.2 Common Northeast systems

Winter rye is the most common cereal used in reference materials our team reviewed, with triticale and winter wheat also used. The crop may be interseeded into standing corn in late summer or seeded after corn silage harvest. It overwinters, resumes growth in spring, and is harvested before corn planting.

Source note: *This information comes from the soon-to-be-published article 'Double-Cropping: Harvesting Cover Crops for Forage,' manuscript supplied by Whitney Hull, UVM Extension Dairy Herd Management Specialist.*

5.3 Added costs and added benefits

Partial-budget category	Double-crop items
Added costs	Seed, planting, termination, fertility, mowing, merging, chopping, hauling, packing, plastic, inoculant, storage, labor, fuel, machinery wear, management time
Added benefits	Usable winter forage, avoided hay or feed purchases, forage inventory security, possible cost-share, winter cover, living roots, nutrient capture
Reduced benefits	Lost corn yield or quality, delayed planting, reduced storage capacity, field damage, lower spring forage quality
Reduced costs	Purchased hay or grain avoided, possible reduced nutrient loss, possible lower fallow-field management cost

5.4 Yield and quality range

This section explains why winter forage production should be evaluated across several realistic scenarios rather than with a single expected yield. Reported yields may range from about one to four dry-matter tons per acre, with two to three tons per acre serving as a practical planning range. Yield is closely connected to harvest timing: an earlier harvest may provide higher-quality forage but less tonnage, while a later harvest may increase yield at the expense of digestibility and may delay corn planting. The purpose of the range is to show how yield, forage quality, harvest cost, and following-crop risk work together to determine the economic value of double cropping.

Yield case	Interpretation	Economic implication
1 DM ton/ac	Low-yield case or early harvest	Unit cost is highly sensitive to fixed field and harvest cost
2 to 3 DM tons/ac	Typical range reported by our research	Use for expected sensitivity, not a guaranteed result
4 DM tons/ac	High-yield case	May involve later maturity and lower forage quality

5.5 Cost per dry-matter ton sensitivity

The table shows how strongly double-crop economics depend on both total production cost per acre and harvested dry-matter yield. The table compares incremental costs of $250, $350, and $450 per acre across yields ranging from one to four dry-matter tons per acre.

At a cost of $250 per acre, the cost per dry-matter ton ranges from $250 at one ton per acre to $62.50 at four tons per acre. At $350 per acre, the range is $350 to $87.50 per dry-matter ton. At $450 per acre, it ranges from $450 to $112.50 per dry-matter ton.

The pattern shows that low yield can make a double crop expensive even when per-acre costs appear moderate. Higher yield spreads seed, planting, harvest, hauling, storage, and management costs across more feed. The table should be used as a screening tool rather than a final budget because it does not yet include forage quality, storage loss, purchased-feed displacement, or any reduction in the value of the following corn crop.

Incremental cost/ac	1 DM ton	2 DM tons	3 DM tons	4 DM tons
$250/ac	$250.00	$125.00	$83.33	$62.50
$350/ac	$350.00	$175.00	$116.67	$87.50
$450/ac	$450.00	$225.00	$150.00	$112.50

The table shows that yield is central. It does not include feed quality, purchased-feed avoidance, storage loss, or an effect on corn. Replace the total cost and yield with farm records.

5.6 Vermont fieldwork windows

Window	Factors to coordinate
Late-summer or fall establishment	Corn maturity, interseeding timing, harvest date, field "trafficability", seed placement, moisture, winter establishment
Spring harvest	Crop maturity, soil bearing capacity, forecast, labor, hauling, storage readiness, target corn planting date
Corn establishment after harvest	Termination, residue management, soil moisture, compaction, seedbed, planting date, hybrid maturity

The spring window is a central risk in Vermont. Harvesting too early on wet soil can damage the field; harvesting too late can reduce forage quality and delay corn.

5.7 Compaction and following-crop effects

The double-crop budget must assign any corn loss to the double-crop decision. Potential pathways include delayed planting, shortened growing season, spring compaction, soil moisture use, residue management, and a mismatch between the harvested cereal and the next corn harvest.

Net double-crop advantage
Added forage value + avoided feed purchases + cost-share – added crop costs – harvest and storage costs - lost corn value
Use feed replacement value for lost corn or purchased feed. Current CoP can serve as a reference but may not equal market replacement value.

5.8 Farmer resilience example

A farmer interviewed for the project reported that harvested winter rye was especially valuable in 2025 because the regular hay crop performed poorly that year. The rye maintained forage availability, supported herd health, and avoided purchased hay. The farmer also associated the practice with improved soil organic matter in the corn field. Avoided hay purchase and feed continuity are producer-reported outcomes.

5.9 Water-quality analysis

Area	Potential effect	Record needed
Winter soil cover	Protects soil during a period that may otherwise have limited cover	Species, planting date, establishment rating, ground cover
Living roots and nutrient capture	May retain nutrients during fall, winter, and early spring	Biomass, tissue analysis where available, manure and fertilizer timing
Erosion	Cover may reduce erosion exposure	Slope, residue, runoff observations, field risk rating
Spring traffic	Wet-soil harvest can compact soil and reduce infiltration	Soil moisture, axle load, tire setup, traffic pattern
Termination and corn planting	Timely management can preserve soil cover while establishing corn	Termination date, planting date, tillage, residue

5.10 Double-crop decision rule

Double crop when expected usable forage value, purchased-feed avoidance, risk-management value, and water-quality benefits exceed every added cost and any following-corn loss, and when the farm can manage Vermont's fall and spring windows.

6. Situational Analysis: Converting a Field to Hay or Corn

6.1 Use a multi-year horizon

Corn and hay have different cost patterns. Corn is seeded annually and has one major silage harvest. Hay establishment cost is spread across a multi-year stand, while each year may contain several harvests. The comparison should cover the expected rotation or secure lease period rather than a single year.

6.2 Field suitability screen

Field factor	Decision question
Drainage	Does the field support timely corn planting and harvest? Can desired hay species persist?
Slope and erosion	Would annual corn expose the field to unacceptable soil loss (if not double-cropped)?
Soil and fertility	What corrections are needed and which crop can use manure and nutrients efficiently?
Access and distance	Can machinery and trucks reach the field during narrow harvest windows?
Field size and shape	How does efficiency change for planting, harvesting, hauling, and manure application?
Land tenure	Is the ownership or lease term long enough to recover lime, drainage, or establishment investment?

6.3 Feed-needs screen

- Does the herd need more haylage, more corn silage, or a different forage quality?
- Will the crop reduce a purchased feed or fill an inventory gap?
- Can the storage system segregate and preserve the added forage?
- Which animal group will receive the crop?
- Does the farm have enough manure-placement acreage under either option?

6.4 Economic comparison

Alternative	Cost and benefit categories
Continued hay	Current annual hay cost, yield, forage quality, stand life, feed destination
Renovated hay	Termination, seed, fertility, establishment, annual harvest, added yield, stand life
Corn	Annual seed, crop protection, nutrients, planting, harvest, storage, yield
Corn plus double crop	Corn cost plus every added winter-crop cost and following-corn effect
Planned rotation	Transition years, residual fertility, establishment cost, multi-year feed value

6.5 Example-farm benchmarks as a starting comparison

Measure	Haylage	Corn silage
Cost per acre	$752.50	$1,175.00
As-fed yield per acre	10.0	20.0
Cost per as-fed ton	$75.25	$58.75
DM yield at 35% sensitivity	3.5	7.0
Cost per DM ton at 35% sensitivity	$215.00	$167.86

The table illustrates the scale of the example-farm enterprises but does not establish which crop is better for a field. Moisture, nutrient value, manure use, storage, animal needs, field fit, and multi-year rotation effects must be included.

6.6 Nutrient-management and water-quality comparison

System	Potential benefit	Potential risk
Perennial hay	Longer soil cover and living roots; repeated nutrient removal	Potential weak stands, compaction, or nutrient imbalance
Annual corn	High feed volume and spring manure opportunity	Greater soil exposure and annual establishment risk
Corn with cover crop	Adds winter cover and nutrient capture	Establishment and spring timing risk
Rotation	Balances perennial cover, stand renewal, manure use, and crop diversity	Transition years require careful erosion and nutrient planning

6.7 Conversion decision rule

Place the field in the crop that creates the highest multi-year whole-farm value after accounting for feed needs, field fit, transition cost, labor, machinery, storage, manure logistics, risk, and agricultural water quality.

7. Situational Analysis: Acquiring or Leasing Cropland

7.1 Compare four options

Option	Description
Do not acquire	Maintain the current land base and feed plan.
Lease	Pay annual rent and accept lease terms, renewal risk, and limits on long-term improvement.
Purchase	Commit capital and add financing, taxes, insurance, closing cost, and long-term control.
Buy or custom-produce feed	Meet the feed need without controlling the acreage.

7.2 Add parcel-specific costs to current CoP

Cost group	Items
Land control	Purchase payment or rent, closing, legal, appraisal, interest, taxes, insurance
Field development	Lime, fertility correction, drainage, clearing, access, lanes, renovation
Production	Seed, nutrients, chemicals, planting, harvest, labor, machinery
Distance	Road travel, hauling, fuel, labor, equipment transport, reduced field efficiency
Infrastructure	Storage, manure access, water, field entrance, buffer or conservation requirements
Risk	Lease renewal, weather, yield uncertainty, field restrictions, management complexity

The table below consolidates the parcel-specific calculations used to evaluate whether purchased or leased land can produce forage at an acceptable delivered cost. It is intended to follow the existing table of parcel cost groups and items.

Calculation	Formula	Primary use and interpretation
Delivered forage cost per ton	Annual land, production, harvest, transportation, and storage cost ÷ usable tons delivered	Measures the full cost of forage after accounting for land control, field production, harvest, hauling, and storage. A low rent or purchase price can still result in costly feed when distance, low yield, or field-development needs are unfavorable.
Breakeven rent per acre	Feed value per acre — all non-rent production and delivery costs	Estimates the highest annual rent the parcel can support before the expected economic advantage falls to zero. Use a multi-year feed value and account for risk when the lease term is short or uncertain.
Breakeven yield	Total annual cost per acre ÷ value per usable ton	Shows the minimum usable yield needed for the parcel to cover its annual cost. Compare the result with low, expected, and high yield scenarios for the field.

7.3 Purchase-versus-lease considerations

Factor	Decision implication
Investment horizon	Purchase supports long-term improvements; lease term must be long enough to recover improvements.
Capital	Purchase uses equity or debt; lease preserves capital but creates renewal risk.
Management rights	Confirm crop rotation, manure, fertilizer, drainage, cover crop, and conservation rights.
Exit and flexibility	Purchase is less flexible; a lease may be easier to exit but can be lost.
Water-quality responsibility	Clarify buffers, runoff, erosion repair, nutrient records, and compliance obligations.

7.4 Feed-security and strategic value

Additional land can create value through feed security, manure-placement flexibility, crop rotation, forage segregation, and reduced purchased-feed exposure. The analysis should quantify such value where records support it and describe remaining strategic benefits separately.

7.5 Agricultural water-quality due diligence

Due-diligence area	Focus topics
Field risk	Slope, drainage, soil type, proximity to water, erosion history
Required practices	Buffers, cover crops, setbacks, nutrient restrictions, conservation plan
Crop suitability	Whether hay, corn, or a rotation best fits the field's risk
Manure logistics	Travel distance, timing, incorporation, runoff risk, nutrient need
Baseline condition	Soil tests, compaction, organic matter, drainage, existing cover

7.6 Land-acquisition decision rule

Acquire or lease when the parcel produces feed at an acceptable delivered cost, fits the farm's capacity and feed plan, has a secure investment horizon, and can be managed without unacceptable agricultural water-quality risk.

8. Integrating Economics and Agricultural Water Quality

8.1 Why the analyses belong together

Field productivity, nutrient use, soil condition, and water movement affect both financial performance and water quality. A low-yield field receiving high nutrient and machinery inputs can produce expensive feed and create a greater pool of nutrients that are not captured in harvested forage. A well-managed crop can improve nutrient recovery, but a practice should not receive an environmental claim without measured evidence.

Decision	Primary economic question	Primary water-quality question
Improve hay	Added usable forage and herd value	Stand density, nutrient uptake, erosion protection, renovation exposure
Double crop	Added feed and avoided purchases	Winter cover, nutrient capture, spring compaction, corn delay
Corn or hay	Multi-year feed cost and crop fit	Perennial cover, annual soil exposure, manure timing, rotation
Acquire land	Delivered feed cost and feed security	Parcel risk, buffers, nutrient logistics, crop suitability

8.2 Water-quality evidence categories

Evidence level	Examples
Measured	Soil test trend, nutrient application and removal, field loss measure, water sample, yield, ground cover
Calculated	Nutrient balance, cost per harvested nutrient unit, acres under cover, application timing
Observed	Runoff, ponding, compaction, erosion, stand density, storage damage
Producer-reported	Perceived soil improvement, reduced runoff, improved trafficability
Expected pathway	A research-supported mechanism that has not been measured on the farm

The water-quality screen is a management tool, not a regulatory determination. A farm should engage qualified agronomic, nutrient-management, engineering, or conservation expertise when a decision involves regulated practices, runoff controls, drainage, or sensitive fields.

9. How to Conduct the Analyses on Your Farm

9.1 Assemble the records

- Select a completed crop year and obtain Schedule F.
- Gather invoices, payroll detail, depreciation schedule, field records, harvest records, inventories, dry matter, forage analyses, and purchased-feed records.
- Reconcile crop acres and production from all storage units.
- State the cost boundary and identify excluded costs.

9.2 Calculate current haylage and corn silage CoP

- Assign direct expenses to the appropriate enterprise.
- Allocate shared expenses using documented acres, hours, operations, fuel, or other activity records.
- Be careful not to “double-count” certain expenses.
- Reconcile enterprise allocations with Schedule F totals.
- Calculate total enterprise cost, cost per acre, and cost per as-fed ton.
- Calculate cost per DM ton only when measured DM is available or label a DM sensitivity clearly.

9.3 Define the decision

Input	Record
Field	Name, acres, location, ownership, lease term, distance from storage and machinery
Current system	Crop, stand age, yield, quality, costs, animal group, water-quality condition
Proposed system	Practice, crop, timing, expected duration, equipment, storage
Objective	Lower feed cost, improve quality, increase inventory, reduce risk, improve field condition

9.4 Build the partial budget

- List every added benefit and reduced cost.
- List every added cost and reduced benefit.
- Use the same units and production period for all alternatives.
- Include following-crop effects and transition-year losses.
- Keep producer-reported and unmeasured benefits separate from measured financial results.

9.5 Complete the water-quality screen

- Describe current soil cover, erosion, drainage, nutrient timing, compaction, runoff, and storage conditions.
- Identify how the proposed practice changes each condition.
- Record whether the effect is measured, calculated, observed, producer-reported, or expected.
- Identify mitigation practices and required technical review.

9.6 Run sensitivity cases

Decision	Sensitivity variables
Hay improvement	Renovation cost, added DM yield, forage value, stand life, establishment success
Double crop	Seed and harvest cost, DM yield, quality, cost-share, corn-yield effect, weather
Corn or hay	Multi-year yield, transition cost, storage, feed need, nutrient cost
Land acquisition	Rent or payment, yield, distance, improvement cost, interest, lease term

9.7 Set the implementation and monitoring plan

Timing	Record
Before	Baseline soil test, field map, crop record, cost, yield, quality, water-quality observations
During	Dates, inputs, field passes, labor, machinery, weather, harvest, storage
After harvest	As-fed tons, DM tons, forage analysis, cost per ton, storage condition
During feedout	Ration use, purchased feed, milk and components, refusals, animal-group response
End of year	Net advantage, assumptions versus actual, water-quality observations, next decision

10. Recommendations

Priority	Recommendation	Application
1	Begin every decision with current hay and corn CoP	Use Schedule F and supporting records to calculate cost per acre and cost per as-fed ton.
2	Improve denominators	Use measured acres, scale weights, dry matter, all storage units, and crop-year reconciliation.
3	Move toward field-level records	Track yield, quality, nutrients, custom cost, machinery hours, and feed destination by field.
4	Use partial budgets	Focus on costs and benefits that change rather than rebuilding the whole farm budget.
5	Separate forage problems	Distinguish stand, soil, harvest, storage, and feeding causes before renovating.
6	Double crops: include the full system	Include establishment, termination, harvest, storage, management, and following-corn effects.
7	Use a multi-year horizon for corn-hay choices	Include establishment, transition years, stand life, and rotation effects.
8	Calculate delivered feed cost for new land	Include distance, land control, development, harvest, hauling, and storage.
9	Keep water quality inside the decision	Document soil cover, nutrient use, erosion, compaction, runoff, and mitigation.
10	Test first and scale after review	Use limited acreage when uncertainty is high and compare actual results with assumptions.

Appendix A. Schedule F Enterprise Allocation Worksheet

Expense	Schedule F total	Hay	Corn	Dairy/ other	Allocation basis
Chemicals					
Custom hire					
Fertilizer and lime					
Fuel and oil					
Hired labor					
Repairs and maintenance					
Seed					
Supplies					
Rent					
Property tax					
Depreciation					
Other					
Total					

Notes:

Appendix B. Baseline CoP Worksheet

Measure	Haylage	Corn silage
Total enterprise cost		
Harvested acres		
Cost per acre		
As-fed tons used (note timing)		
As-fed tons remaining (note timing)		
Carryover adjustment		
Total crop-year as-fed tons		
Cost per as-fed ton		
Measured dry matter		
Dry-matter tons		
Cost per DM ton		
Usable DM after loss		
Cost per usable DM ton		

Notes:

Appendix C. Hay-Field Improvement Partial Budget

Category	Line item	Per acre	Whole field
Added benefits	Added usable DM		
Added benefits	Added herd or feed value		
Reduced costs	Purchased feed avoided		
Added costs	Spray or termination		
Added costs	Seed and planting		
Added costs	Lime and fertility		
Added costs	Harvest and storage changes		
Reduced benefits	Lost production during establishment		
Net	Net annual advantage		

Notes:

Appendix D. Double-Crop Partial Budget

Category	Line item	Per acre	Whole field
Added benefits	Winter forage feed value		
Reduced costs	Purchased hay or feed avoided		
Added benefits	Cost-share received		
Added costs	Seed and establishment		
Added costs	Termination		
Added costs	Nutrients		
Added costs	Harvest and hauling		
Added costs	Packing, cover, storage, preservative		
Added costs	Labor, fuel, machinery, management		
Reduced benefits	Following-corn value lost		
Net	Net annual advantage		

Notes:

Appendix E. Corn-Hay Multi-Year Comparison

Year	Crop/system	Cost/ac	Usable DM/ ac	Feed value/ ac
Year 1				
Year 2				
Year 3				
Year 4				
Year 5				
Total				
Annual average				

Notes:

Appendix F. Cropland Acquisition Worksheet

Group	Line item	Annual value
Land	Rent or annual ownership payment	
Land	Taxes, insurance, closing, legal, interest	
Development	Lime, drainage, clearing, access, renovation	
Production	Seed, nutrients, chemicals, field operations	
Harvest	Harvest, hauling, packing, storage	
Distance	Travel, fuel, labor, road time	
Total	Annual parcel cost	
Production	Usable tons delivered	
Result	Delivered cost per usable ton	
Result	Breakeven rent or payment	

Notes:

Appendix G. Agricultural Water-Quality Screen

Area	Current condition	Proposed effect	Evidence level	Mitigation/ record
Soil cover				
Living roots				
Erosion exposure				
Nutrient timing				
Nutrient balance				
Compaction				
Field runoff				
Storage runoff				
Soil organic matter				
Mitigation needed				

Notes:

Appendix H. Sensitivity Analysis Template

Scenario	Yield	Cost/ac	Feed value/ ac	Net advan- tage/ac
Low				
Expected				
High				

Notes:

Appendix I. Advisor Checklist

Review area	Advisor question
Baseline	Are Schedule F totals reconciled with enterprise allocations?
Boundary	Are field, harvest, storage, ownership, labor, and loss costs clearly included or excluded?
Acres	Are planted, harvested, owned, and rented acres reconciled?
Production	Are used and remaining inventory, carryover, scale weights, and dry matter reconciled?
Field	Are soil, drainage, slope, access, tenure, and rotation recorded?
Feed	Is forage quality linked with a defined animal group and feed replacement value?
Hay improvement	Is the problem in the stand, soil, harvest, storage, or feeding system?
Double crop	Are all added passes, storage needs, timing risks, and corn effects included?
Conversion	Is the comparison multi-year and does it include transition years?
Land	Does delivered feed cost include distance, development, financing, and lease risk?
Water quality	Are soil cover, nutrient use, erosion, compaction, runoff, and mitigation documented?
Risk	Are low, expected, and high scenarios tested?
Monitoring	Will actual cost, yield, quality, herd use, and field condition be reviewed after implementation?

Appendix J. Assumption and Source Register from Research

Item	Working assumption/result	Evidence status
Example-farm hay CoP	$301,000 total; $752.50/ac; $75.25/as-fed ton	Reports 1 and 2 source data and calculations
Example-farm corn CoP	$235,000 total; $1,175.00/ac; $58.75/as-fed ton	Reports 1 and 2 source data and calculations
Dry matter	35% sensitivity in comparison tables	Assumed; the example farm has not measured dry matter directly
Hay renovation response	0.35 added DM ton/ac	2025 UVM NWCS all-farm average
IOFC examples	$10.15, $8.33, and $6.32/cow/day	Partner manuscript; not case-farm performance
Double-crop yield	1 to 4 DM tons/ac; 2 to 3 typical	Partner manuscript
Local rates	Interview-derived figures	Require current vendor and farm verification
Farmer rye outcome	Avoided hay purchase and maintained feed continuity	Producer-reported 2025 experience
Soil organic matter	Producer-reported improvement	No soil-test trend supplied

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