TECHNICAL NOTES

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EFFECTS OF CROP ROTATION AND NO-TILL CROP ESTABLISHMENT ON GRASS SEED PRODUCTION SYSTEMS IN THE WILLAMETTE VALLEY, OREGON

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This technical note provides a summary of the results of six (6) years of research conducted by USDA, Agricultural Research Service (ARS) to determine the short and long term effects of forage and grass seed production in the absence of open field burning.

The Non-Thermal Grass Seed Cropping Systems research project was initiated in 1992 in the Willamette Valley in response to the Oregon open-field burning phase-out plan and to USDA-ARS National Program emphasis and other federal initiatives. The goal of the project was to identify sustainable forage and turf seed production systems that were economically viable, energy efficient, and environmentally protective.

It was the intent of the research team to establish a research project that would answer long-term questions about sustainable grass seed agriculture. The project was also designed to determine the short-term effect and impact of new and developing technologies during the transition period from thermal to non-thermal residue management.

Three (3) research sites were selected that represent a range of distinct environments typical for grass seed production in the Willamette Valley. These production regions were: (1) Perennial ryegrass production in Linn County on undrained, poorly drained, and low pH soils that are intermittently flooded in winter and early spring in the south Willamette Valley. (2) Tall fescue production in Benton County on poor to moderately drained soils with moderate pH that are typical of the north Willamette Valley. (3) Fine fescue production in the Silverton Hills in Marion County on well drained soils with moderate pH on gentle to moderately steep slopes that are highly susceptible to water erosion.

There are three primary experimental factor comparisons common to each research site:

(1) Continuous grass seed monoculture compared to rotation culture systems.
(2) Conventional crop establishment with tillage compared to no-till crop establishment.
(3) Minimum (straw removal) to maximum amounts (flail) of grass seed residue management after harvest.

SUMMARY OF RESULTS

To date the project has successfully identified single-crop agronomic practices and rotations to produce grass seed with yield and returns similar to those of commercial farmers using conventional systems without open field burning. In addition, feasible methods for no-till crop establishment and management of high levels of post-harvest grass straw have been identified.

The crop rotations compared on each site to the conventional monoculture grass seed production systems included:

(1) Linn County site, perennial ryegrass rotated with meadowfoam oil seed, white clover for seed and spring wheat.
(2) Benton County site, tall fescue rotated with winter wheat, red clover for seed and meadowfoam oil seed.
(3) Marion County site, fine fescue rotated with winter wheat or spring wheat, red clover for seed and meadowfoam oil seed.

At each site grass seed production on the plots during the 6 years varied from 2 to 5 years while the rotation crops were grown from 1 to 4 years.

The results, conclusions and some assumptions from the projects integrated approach to grass seed production are summarized here in the eight (8) management areas identified in the report. These are Grass Seed and Annual Crop Rotations, Maximum Post-harvest Residue Management, Nutrient Management, No-till Crop Establishment, Volunteer Seedling Control, Slug Management, Crop Weed Dynamics, Integrated Pest Management and Agricultural Chemical Movement.

Effects or impacts in each of the management areas are displayed in a decision making format expressed as a positive or negative statement. Each statement can be directly or indirectly related to a number of soil, water, air, plant, animal and human resource concerns found in FOTG Section III, Resource Quality Criteria.

This summarized information can serve as a technical resource for NRCS conservationists while assisting grass seed growers evaluate and develop Resource Management System (RMS) alternatives.

GRASS SEED AND ANNUAL ROTATION CROPS

POSITIVE

+ Annual crops rotated with grass seed interrupt life cycles of weed, insect, disease and other pests.
+ Legume seed crops in rotation biologically fix nitrogen reducing the need for inorganic nitrogen (fertilizer) application
+ Increased diversity of crops grown in rotation provides for reduced risk.

NEGATIVE

- Rapid crop turn over in the rotation can increase amortized establishment costs.
- Increased soil erosion potential when tillage is used to establish crops in the rotation.
- Increased potential to generate airborne soil particulate during field preparation for crop establishment.
- Potential loss of annual net income due to the increased time in the rotation to establish perennial grass seed crops.

MAXIMUM POST-HARVEST RESIDUE MANAGEMENT

POSITIVE

+ High levels of post harvest residue (flail) had no effect on subsequent year grass seed yields of ‘Riviera’ perennial ryegrass, ‘Titan’ tall fescue and ‘Jasper’ creeping fine fescue at the three respective field sites.
+ At the Linn County site five (5) spring wheat and oat cultivars no-till planted after 3 years of high post harvest residue management of perennial ryegrass all yielded more grain than wheat and oats grown after minimal (rake and bale) residue management.
+ Oat grain had a higher protein content in high-level residue management.
+ No reduction in red clover seed yields and wheat grain yields under high-level residue management at the Benton County site.
+ Soil organic matter increased on 2 of the 3 sites with high levels of post harvest residue management.
+ Microbial biomass increased at all 3 sites.
+ Increased numbers of predaceous mites and worms were present with high levels of

NEGATIVE

- Potential loss of income from baled straw as feed, fiber or other products.
- Increased energy inputs and equipment costs for flailing, baling, and additional tillage to manage grass straw residue without field burning.
- High post harvest residue levels may interfere with efficacy of some herbicides.
- Increased problems planting small seeded crops such as red clover, meadowfoam or fine fescue.

residue management.

+ Decrease in the numbers of herbivorous arthropods that can be crop pests.

+ High post harvest residue levels may enhance efficacy of slug pesticides.

+ Reduced potential for soil erosion by water.

+ Increased carbon (C) sequestration in the soil reduces potential $C0_2$ loss to atmosphere.

+ Mild fall and winter temperatures promote rapid decomposition of high levels of residue after harvest.

NUTRIENT MANAGEMENT

POSITIVE

+ Chopped (flailed) grass straw on the field does not result in the need to apply additional N fertilizer to maintain grass seed yields.

+ Leaving grass straw residue on the field maintained soil K levels and may alleviate the need for future K fertilizer applications.

+ Sufficient mineralized soil N was present in fall to meet fall nitrogen needs for maximum grass seed yields. Therefore fall N application is not necessary.

+ Multiple N fertilizer applications were not needed for maximum N use efficiency and maximum grass seed yield. No fall N application was needed and one N application between late winter and mid spring (early boot stage) was sufficient. Split N application has no yield advantage, but may be necessary because of equipment

NEGATIVE

- Grass straw removal becomes non-sustainable for soil K availability requiring continuing or increased applications of K fertilizer.

- White clover for seed provided no N carryover to perennial ryegrass seed on the undrained and poorly drained soils (Dayton and Amity) at the Linn County site.

- From late spring to early fall mineralization produces more N than can be used by the grass seed crop. Leaching of soil nitrate N occurs following several rainfall events the next fall and winter. Leaching of soil nitrate N may also occur in late spring (April to June) when grass crop is flowering and setting seed if substantial precipitation events occur.

- Multiple or split fertilizer applications increase energy use, add equipment costs, and increase potential for soil compaction.

constraints due to high fertilizer volumes.

+ Spring applied N does not appear to contribute to N leaching below the root zone in poorly drained soils due to the high efficiency of N uptake by the grass seed crop, whereas late spring mineralization may.

- In some cases, without fall applied N canopy closure may be retarded and result in less weed suppression between rows.

+ Plant tissue N tests or chlorophyll meter measurements were found to be useful to manage grass seed crop N for maximum economic yields.

+ Red clover grown for seed on the Benton County site (Woodburn soil) provided 40 lb. N/ac. carryover to the succeeding tall fescue grass seed crop.

NO-TILL CROP ESTABLISHMENT

POSITIVE

+ No-till planting into cereal, clover, meadowfoam and perennial ryegrass residue was relatively easy to accomplish with slight modifications on conventional drills.

+ No-till crop establishment on undisturbed fields with poorly drained soils was accomplished successfully with conventional drills at the Linn County site.

+ Spring no-till reduces compaction caused by spring tillage and planting on poorly drained soils.

+ No-till planted spring grains provided more stable and higher yields than no-till fall planted wheat on poorly drained soils.

NEGATIVE

- Purchase no-till drill or modify conventional drill to accomplish no-till planting in rotations with tall fescue or fine fescue in rotation. The uneven planting surface in glyphosate-killed tall fescue stands required significant drill modification to obtain good soil-seed contact. A thick layer of thatch in fine fescue stands was problematic in planting small seeded crops requiring significant drill modification.

- Annual bluegrass is a greater problem in no-till systems at the Linn County site on poorly drained soils during the transition period to no-till, maximum residue management systems.

- One to two non-selective herbicide applications are needed for no-till crop establishment to replace tillage for crop establishment.

- There was only a 50% success rate in killing established fine fescue stands with glyphosate at the Marion County site to prepare for no-till rotation crop establishment.

+ Weed management problems have been reduced with no-till at the Marion County site.

- Reduced yields in fall planted perennial ryegrass and meadow foam at the Linn County site compared to conventional tillage establishment.

+ No-till crop establishment reduces soil erosion potential and potential airborne particulate from tillage operations.

VOLUNTEER SEEDLING CONTROL

POSITIVE	NEGATIVE
+ Where volunteer seedlings became established in perennial ryegrass and tall fescue the high post harvest residue treatments did not have more volunteer seedlings than low residue treatments.	- Seed yield reductions due to phytotoxicity from herbicides used to control volunteer seedlings was as high as reductions due to competition when volunteer plants were allowed to become established.

SLUG MANAGEMENT

POSITIVE	NEGATIVE
+ Avoiding fall establishment of grass after crops (wheat and clover) that increase slug populations reduced the impact of slugs on new grass seedings.	- No economic threshold levels have been established for slugs in grass seed cropping systems.
+ Monitoring slug populations and applying bait in 10’ bands 20’ apart reduced the amount of bait applied by 25% and increased bait efficacy due to application when maximum slug activity occurred.	- Additional labor and management time to scout and monitor slug populations.

CROP-WEED DYNAMICS

POSITIVE	NEGATIVE
+ Delaying nitrogen fertilizer applications appears to increase the efficacy of selective annual bluegrass herbicides.	- Herbicide-resistant annual bluegrass biotypes have become widespread in poorly drained fields that have received prolonged diuron herbicide use.

INTEGRATED PEST MANAGEMENT

POSITIVE	NEGATIVE
+ A model to predict stem rust is under development. Currently, it is adequate to indicate years when the coming spring will be conducive to early, and therefore more	- Requires collection and processing of winter/spring weather data.

damaging rust development.

POSITIVE	NEGATIVE
+ Allows delay of initial fungicide application, reducing cost and adverse environmental effects.	- When rust hazard is indicated, requires in-field scouting to determine presence of rust in individual fields.
+ Determined that first-seed-year stands of fine fescue are more susceptible to stem rust than second or third year stands. Reduced costs and environmental risks can result from fewer fungicide applications on second and third year stands.	- Integrated pest management requires increased knowledge level of crop/pest interactions and higher level of management expertise.
+ Systematic monitoring of aphids and other floral pests of red clover seed resulted in deferment of an insecticide application in 1996 at the Benton County site.	

AGRICULTURAL CHEMICAL MOVEMENT

POSITIVE	NEGATIVE
+ Companion study by ARS, US EPA, OSU and a seed grower on poorly drained sites shows if good agricultural chemical application techniques are used minimal amounts of diuron, nitrogen, and phosphorus leave the field where they are applied.	- Nitrate losses from grass seed fields to surface and ground waters may increase when the fields are tilled in the summer and fall. Disturbance is thought to increase mineralization and nitrification processes and contribute to increased levels of soil nitrate. Leaching of excess nitrate, following late fall precipitation may contribute to surface and groundwater nitrate contamination.
+ Average yearly concentrations of diuron (0.02 and 0.003 ppm) in stream waters at the Lake Creek Study site and second site next to the Calapooia River were well below concentrations (1 to 40 ppm) toxic to certain aquatic wildlife.	- Loss of crop production acres to established filter strips or riparian buffers.
+ Riparian buffer vegetation will intercept some of the soil particles that carry diuron in run-off waters.	- Establishment and maintenance costs of filter strips and riparian buffers.

+ When ammonium N fertilizers are applied to grass seed fields in the spring, nitrate losses are reduced by plant uptake and denitrification (conversion of nitrate to gaseous N_2).

+ Uncultivated grass buffers in poorly drained soils with 12 to 20 foot widths may be wide enough to significantly reduce agricultural chemical movement (N and pesticides) to surface waters.

- During high flow periods, poorly drained riparian areas are less effective in retaining soluble agricultural chemicals that may be present in surface runoff and perched water tables.

More detailed information or a copy of the report, Non-Thermal Grass Seed Production Systems Research, Final Report for Oregon Department of Agriculture, Alternatives to Field Burning Research Program can be requested from:

Jeff Steiner or Steve Griffith
USDA – ARS
National Forage Seed Production Research Center
3450 SW Campus Way
Corvallis, OR 97334

The report can also be accessed via the world wide web at:

http://pwa.ars.usda.gov/nfsprc/steiner/steinersustain.htm

NO-TILL IN WILLAMETTE VALLEY GRASS SEED ROTATION SYSTEMS

The research project has shown that no-till management can be a viable option to significantly reduce costs of establishment and negative environmental impacts in grass seed rotation systems on a wide range of soils in the Willamette Valley.

During the first 6 years of the project, no-till has been used to successfully establish fall planted perennial ryegrass, white clover, winter wheat, and meadowfoam. In addition successfully planted spring crops include spring oats and wheat, white clover, tall fescue and fine fescue.

The approach taken to no-till establishment in the study was to utilize the most appropriate site-specific technology that is the least-expensive method to plant crop seed. From this two predominate no-till methods or techniques have emerge for no-till in grass seed production systems. The first utilizes a no-till double disc drill. It is retrofitted with an inexpensive, articulating single-disc opener attachment to prepare crop residues on the seedbed for uniform planting. The second approach to no-till planting consisted of using a conventional double disc drill without any modifications.

The double disc no-till drill with single coulter openers solved some of the problems with uneven seedbeds and poor seed-soil contact that was present when planting back into glyphosate killed stands of tall fescue and fine fescue sod. By placing single-disc coulters ahead of the no-till double disc openers, it was possible to more evenly prepare the seedbed so that each set of double disc openers can operate independently of one another and place winter wheat seeds at even depths and in good contact with the soil. This same approach will solve the problem of planting small seeded crops such as red clover through the layer of thatch that covers the soil in fine fescue stands.

Fall, winter and spring no-till planting into herbicide killed cereal, clover, meadowfoam and perennial ryegrass stubble is relatively easy and was accomplished with a conventional double disc drill. The most critical factor is the timing of planting with soil-water status and weed control.

In both approaches the residue from the previous crop (grass straw, grain stubble, etc.) must be evenly distributed on the field after to harvest. Uneven distribution of residues can reduce herbicide efficacy, interfere with seed placement at planting, promote uneven residue decomposition and increase the potential for weed, disease and insect problems.

REDESIGNING GRASS SEED CROPPING SYSTEM FOR THE WILLAMETTE VALLEY

To successfully use no-till establishment in grass seed production systems and realize maximum economic returns while managing high residue levels, entire cropping systems will need to be redesigned. Instead of the traditional monoculture perennial grass seed rotations, site-specific rotations that include spring and fall no-till planted annual crops in sequence with 3 to 5 years of grass seed will need to be adopted.

From the study a typical redesigned rotation is described for each grass seed production site in Attachments 1, 2 and 3. Each includes operations, fertilizer and pesticide inputs and typical or average operations dates. These examples are intended to provide NRCS conservationists and conservation partners with guidance when assisting grass seed producers develop management alternatives to address SWAPA + H resource concerns.

Attachment 1.
Linn County Site
Undrained to Poorly Drained
Valley Floor

<u>Perennial Ryegrass 3yr. – Spring Wheat – Meadowfoam</u>
Maximum Residue Management

DATE	OPERATION	INPUTS/ACRE
9/15/1	Spray; seedbed preparation	Glyphosate 2 pt.
10/1/1	Drill; double disk	Grass seed 8 lb. Activated carbon 25 lb. 10-34-0 8 lb. 32-0-0 8 lb.
10/5/1	Spray; weeds	Diuron 3 lb. Glyphosate 1 pt.
10/25/1	Spray; weeds	Ethofumesate 2 pt.
3/15/1	Fertilize	46-0-0 135 lb.
4/1/1	Spray; weeds	Dicamba 0.5 pt. 2,4-D amine 2 pt.
4/15/1	Fertilize	46-0-0 135 lb.
5/7/1	Spray: leaf and stem rust	Propiconazole 4 oz.
6/1/1	Spray; leaf and stem rust	Propiconazole 4 oz.
7/15/1	Swath	-
8/10/1	Combine	-
8/21/1	Flail; “J” knife	-
8/22/1	Flail; straight blade	-
9/15/2 (end yr. 1)	Spray; weeds	Metolachlor 1 pt.
10/15/2	Spray; weeds	Diuron 1.5 lb. Oxyfluorfen 16 oz.
3/15/2	Fertilize	46-0-0 135 lb.
4/15/2	Fertilize	46-0-0 135 lb.
4/1/2	Spray; weeds	Dicamba 0.5 pt. 2,4-D amine 2 pt.
4/15/2	Spray; leaf and stem rust	Propiconale 4 oz.
5/1/2	Spray; leaf and stem rust	Propiconale 4 oz.
5/20/2	Spray; leaf and stem rust	Propiconale 4 oz.
7/15/2	Swath	-
8/10/2	Combine	-
8/22/2	Flail; “J” knife	-
8/23/2 (end yr.2)	Flail; straight blade	-
9/15/3 to 8/10/3	Year 2 operations repeated	Year 2 inputs repeated
9/1/3 (end yr. 3)	Flail; “J” knife	-

Attachment 1. Cont.
Linn County Site
Undrained to Poorly Drained

Valley Floor

Perennial Ryegrass 3yr. – Spring Wheat – Meadowfoam
Maximum Residue Management

DATE	OPERATION	INPUTS/ACRE
10/1/4	Spray; seedbed preparation	Glyphosate 4 pt.
4/1/4	Spray; seedbed preparation	Glyphosate 2 pt.
4/16/4	Drill; double disk	Spring Wheat 100 lb. 40-0-0-6 50 lb.
5/1/4	Fertilize	40-0-0-6 200 lb.
5/2/4	Spray; weeds	Diclofop-methyl 2.5 pt.
5/15/4	Spray; weeds	Dicamba 0.5 pt. 2,4-D amine 2 pt.
5/17/4	Spray; leaf and stem rust	Propiconazole 4 oz.
6/7/4	Spray; leaf and stem rust	Propiconazole 4 oz.
8/30/4	Combine	-
9/5/4 (end yr. 4)	Flail; "J" knife	-
10/15/5	Spray; seedbed preparation	Glyphosate 2 pt.
11/1/5	Drill; double disk	Meadowfoam seed 15 lb.
11/5/5	Spray; weeds	Metolachlor 2 pt.
3/15/5	Spray; weeds	Clethodim 1 pt. Clopyralid 5 oz.
4/1/5	Fertilize	46-0-0 87 lb.
6/15/5 (end yr. 5)	Combine	-

Attachment 2
Benton County Site
Poor to Moderate Drainage
North Willamette Valley

<u>Tall Fescue 4yr. – Winter Wheat – Meadowfoam</u>
Maximum Residue Management

DATE	OPERATION	INPUTS/ACRE
10/15/1	Spray; seedbed preparation	Glyphosate 4 pt.
3/15/1	Spray; seedbed preparation	Glyphosate 2 pt.
4/10/1	Drill; no till	Grass seed 7 lb. Activated carbon 25 lb. 10-34-0 8 lb. 32-0-0 8 lb.
4/20/1	Spray; weeds	Diuron 3 lb. Glyphosate 1 pt.
4/30/1	Spray; weeds	Ethofumesate 2 pt.
10/15/2 (end yr. 1)	Spray; weeds	2,4-D amine 2 pt. Dicamba 0.5 pt.
3/10/2	Fertilize	46-0-0 110 lb.
4/1/2	Fertilize	46-0-0 110 lb.
5/5/2	Spray; leaf and stem rust	Propiconazole 4 oz.
5/25/2	Spray; leaf and stem rust	Propiconazole 4 oz.
7/15/2	Swath	-
8/10/2	Combine	-
8/20/2	Flail; “J” knife	-
8/21/2	Flail; “J” knife	-
8/22/2	Flail; “J” knife	-
10/15/2 (end yr.2)	Spray; weeds	2,4-D amine 2 pt. Dicamba 0.5 pt.
3/15/3 to 8/22/4	Year 2 operations repeated 2x	Year 2 inputs repeated 2x
10/15/4 (end yr. 4)	Spray; seedbed preparation	Glyphosate 4 pt.
12/1/5	Drill; no till	Winter Wheat 100 lb. 46-0-0-6 50 lb.
4/1/5	Fertilize	46-0-0 200 lb.
4/15/5	Spray; weeds	Diclofop-methyl 2.5 pt.
5/15/5	Spray; weeds	2,4-D amine 2 pt. Dicamba 0.5 pt.
5/17/5	Spray; leaf and stem rust	Propiconazole 4 oz.
6/7/5	Spray; leaf and stem rust	Propiconazole 4 oz.
8/30/5	Combine	-
9/5/5	Flail; “J” knife	-

Attachment 2 Cont.
Benton County Site

Poor to Moderate Drainage
North Willamette Valley

Tall Fescue 4yr. – Winter Wheat – Meadowfoam
Maximum Residue Management

9/6/5	Flail; "J" knife	-
10/15/5 (end yr. 5)	Spray; seedbed preparation	Glyphosate 2 pt.
11/1/6	Drill; no till	Meadowfoam 15 lb.
11/5/6	Spray; weeds	Metolachlor 2 pt.
3/15/6	Spray; weeds	Clethodim 1 pt. Clopyralid 5 oz.
4/1/6	Fertilize	46-0-0 87 lb.
6/15/6	Swath	-
6/20/6 (end yr. 6)	Combine	-

Attachment 3
Marion County Site
Well Drained Steep Slopes
Silverton Hills and Valley Foothills

<u>Fine Fescue Grass Seed 4 yr. - Spring Wheat – Meadowfoam</u>
Maximum Residue Management

DATE	OPERATION	INPUTS/ACRE
10/20/1	Spray; seedbed preparation	Glyphosate 6 pt.
3/20/1	Spray; seedbed preparation	Glyphosate 2 pt.
4/15/1	Drill; no till	Grass seed 10 lb. Activated carbon 25 lb. 16-20-0-12 125 lb.
4/17/1	Spray; weeds	Diuron 2.5 lb. Glyphosate 2 pt.
7/5/1	Spray; weeds	Clopyralid/2,4-D am. 3 pt. Sethoxydim 2.8 pt. Crop oil 3 pt.
11/5/2 (end yr. 1)	Spray; weeds	2,4-D amine 1 pt. Bromoxynil 1.5 pt.
12/15/2	Spray; weeds	Oxyfluorfen 80 oz. Terbacil 0.75 lb.
3/10/2	Fertilize	46-0-0 80 lb.
3/15/2	Spray: weeds	Sethoxydim 1.5 pt. R-11 1 pt.
4/15/2	Fertilize	46-0-0 80 lb.
7/15/2	Swath	-
8/10/2	Combine	-
8/20/2	Flail; "J" knife	-
8/21/2 (end yr. 2)	Flail; straight blade	-
12/15/3 to 8/21/4 (end yr.4)	Year 2 operations repeated	Year 2 inputs repeated
10/1/5	Spray; seedbed preparation	Glyphosate 4 pt.
4/1/5	Spray; seedbed preparation	Glyphosate 2 pt.
4/15/5	Drill; no till	Spring Wheat 100 lb. 46-0-0-6 50 lb.
5/1/5	Fertilize	46-0-0 200 lb.
5/2/5	Spray; weeds	Diclofop methyl 2.5 pt.
5/15/5	Spray; weeds	2,4-D amine 2 pt. Dicamba 0.5 pt.
5/17/5	Spray; leaf and stem rust	Propiconazole 4 oz.
6/7/5	Spray; leaf and stem rust	Propiconazole 4 oz.
8/30/5	Combine	-
9/5/5	Flail; "J" knife	-
9/6/5 (end yr. 5)	Flail; "J" knife	-

Attachment 3 Cont.
Marion County Site
Well Drained Steep Slopes

Silverton Hills and Valley Foothills

Fine Fescue grass Seed 4 yr. – Spring Wheat – Meadowfoam
Maximum Residue Management

DATE	OPERATION	INPUTS/ACRE
10/15/6	Spray; seedbed preparation	Glyphosate 2 pt.
11/1/6	Drill; no till	Meadowfoam 15 lb.
11/5/6	Spray; weeds	Metalchlor 2 pt.
3/15/6	Spray; weeds	Clethodim1 pt. Clopyralid 5 oz.
4/1/6	Fertilize	46-0-0 87 lb.
6/5/6	Swath	-
6/20/6 (end yr. 6)	Combine	-