Evaluation of a Fiber Flax Production System as a Low Input, Alternative Crop

Final Report
to
NorthEast SARE Farmer/Grower Initiated Grant Program

By

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Background

The purpose of this project was to demonstrate the production of fiber flax by testing the two latest, disease resistant varieties and harvest machinery from France.

Farmers are looking for new, low input crops to diversify our farm income. No flax is currently being grown commercially for linen production in the U.S. even though it once was a profitable crop and a staple of early settlers. A company from Connecticut has expressed an interest in establishing a mill in Aroostook County to process flax. If this idea works, then a market will be available to grow flax once again.

Today, the technology of growing the crop has been improved by the Europeans. Commercially available machinery takes the place of costly labor for the pulling, retting and baling process which use to be the limiting factor in growing and harvesting the crop. In addition, processing technology is available to remove the bark from the fiber, previously accomplished by hand.

Maine growers must reeducate themselves on the growing requirements of the crop, test this machinery, and demonstrate the feasibility of growing high quality fiber in order to make sound judgements on suitability and profitability of the crop for Maine and New England.

Project Description

Two resistant varieties of flax (Arianne and Viking) were planted on June 8th, 1993 at three different locations at Ward Farms. A total of 38 acres were planted, half to each variety at each site. In addition, a nitrogen rate trial was set up by Cooperative Extension on the home farm and a test was made of two different types of seeders at each field, a precision cultipacker/seeder from France and an Air assisted precision seeder on loan from Cooperative Extension. Nitrogen was applied at a rate of 45 lbs per acre to the home farm, with the other two farms receiving no nitrogen and a soil test for nitrogen was taken after planting.

The growing season was monitored for weed growth, plant height, apparent nutritional deficiencies, and the need for addition of pesticides.

Harvest dates were selected on the basis of French standards for days from planting (90 -102 days) and correlations were made with a growing degree day formula used in France (2500-2700 GDD above 40°F). Harvest machinery was brought in from France by Dehondt Machinery and Balers were loaned from Vermeer Company from a dealership in Wales, Maine.
Retting was done in the field, and the timing of baling was assisted by Guy DeHondt from France. The product was baled from October 7th to 10th and stored at Loring Air Force Base in concrete bunkers. Samples of the flax were sent to France in December and milled in January. Results were transmitted to the U.S. in March and a meeting was held with the Flax Company in April to summarize and receive samples of the finished product.

The final report was prepared with the assistance of the Central Aroostook Soil and Water Conservation District, USDA-SCS and the Maine Department of Agriculture.

Observations

Field Selection

Soil - It appears that well drained loams, silt loams, sand loams or gravelly loams are well suited for flax. Some what poorly drained soils seem to encourage larger stalks with resulting coarser fiber.

Slope - The equipment for harvest doesn't work well on steep slopes. Fields should be smooth and in the mid-B slope range or flatter.

Aspect/Exposure - Drying of the straw will occur faster, particularly late in the season on high, southerly or westerly sloping fields, well exposed to westerly winds.

Headlands

It is important to leave and maintain a 10-20 ft. cleanly tilled headland at the beginning and end of rows (including any unplanted areas within the field such as rock outcrops).

Previous Crop

Flax can be planted following potatoes or oats. Sufficient residual fertility produces good stands and weed control is generally good. Fields with historically low fertility or poor weed control should be avoided.

Seedbed Preparation

A well worked, but firm seedbed is needed. Rocks must be picked as they greatly interfere with harvest machinery.

Fertilizer

Nitrogen is the critical element in successful flax stands. Too much will delay maturity, increase the chance of lodging, and produce too large a stalk. Too little will cause short stalks. The initial soil test after planting was correlated with lodging as follows

Field	Residual ppm NO_3-N	Residual N in lbs per acre equiv.	Lodging - Rated 1 = low 2=Moderate 3= High	Yield lbs/acre
Home Farm (45 lbs N applied)	22.8	46	2	good
Home Farm (45 lbs N applied)	34	68	3	good
Ward Farm - (0) Bog Rd.	3.3	6.6	1	good
Ward Farm - (0) AMHC	2.7	5.4	1	good

* Average yield for all sites was 4200 lbs/acre

Extension Plots on Home Farm Nitrogen Treatment lbs/acre	Yield and notes on lodging
0 lbs N	4,399 lbs/acre no lodging
25 lbs N	4,399 lbs/acre no lodging
50 lbs N	5,063 lbs/acre some lodging
75 lbs N	5,893 lbs/acre lots of lodging

On the fields where we put 45 lbs of nitrogen, the stand was good, plant height excellent and very little lodging occurred early. However, as the plants matured, some lodging occurred. In the Extension plots, any rate higher than 50#/A N caused late season lodging. The other two farms had smaller stems but no visual lodging.

In early July one could see a variation in plant height and color, with greener taller plants in the row where the previous potato row had been and weaker, lighter green plants in the previous crop row middles. Arianne seemed more affected by the lack of nitrogen than Viking.

We think that flax after potatoes seems to do best without adding fertilizer. The yield and stand was still very acceptable with no additional nitrogen.

Timing of Planting

Flax should be planted as soon as the ground can be worked in the spring and no later than June 1st in Aroostook County. Plantings in late May should be of early maturing varieties like Viking. Arianne barely matured in enough time when planted on June 8th. The reason we were late in planting is because the seed did not arrive on time and the weather was bad until the first of June. However, we were able to test how late one can plant and still be able to harvest the crop, ret it in the field and bale it dry.

Planting

Flax seed should be planted at 90-100 lbs. per acre, 4" rows, and planted uniformly 3/4" deep. Planting should result in a stand of 120 stalks per square foot of row for optimum growth.

The seeds were planted at 90-100 lbs per acre, spaced 4 inches with the DeHondt machine and 5-6 inches with the Extension Precision Seeder. The Dehondt seeder was very good because the cultipacker in front smoothed the seedbed creating a uniform planting depth of 3/4 inches deep. The Extension seeder left a rough surface slightly less uniform depth due to the rough surface. In July the plant stand was measured yielding between 130 to 200 stems per square foot. The Ideal is 120 plants per square foot. The Dehondt machine spaced the plants better. In the future we should be looking to spacing at 4 inches between rows.

Weed Control

Weeds are a major problem following sod and flax does not compete well with weeds. In our plots weeds were not a serious problem. MCPA was applied only once to control mustard and a few other escape broadleaves. Application must be made before weeds have formed two true leaves and before they reach 6" high. Application must also be made prior to flax reaching 8" high. After July the Flax outgrew the weeds present. We anticipate that if Flax follows potatoes or oats then weed control will be minimal.

Pesticides

We did not observe any insect or disease problems. We may be able to minimize use of pesticides due to lack of problems right now.

Harvest

Flax needs to be pulled between 95-100 days after emergence. Properly matured flax is

between 36-45" high with leaves falling out 1/2 way up the stalk, and with the seed bolls just starting to turn brown.

When to pull is one of the most critical decisions for high quality flax. Harvesting too early will yield a finer, shorter fiber. Harvest too late will yield a coarser, lower quality fiber.

The following gives the harvest information for Ward Farm:

Planting Date	90 Day Harvest Date	Actual Harvest Date	End of Retting Date	Days To Harvest	Days To Ret
June 8, 1994	September 6, 1994 2250 GDD	September 13, 1994 2320 GDD	October 7, 1994	97	24

We were within the optimum days for good harvest, slightly low on GDD but sufficient growth had occurred. Warm temperatures were available to get the straw retted done properly. Growing degree day information, coupled with experience, will help determine optimum harvest date in the future.

Harvest Procedures

1. Fields should be divided into smaller sections and the puller operated in a counter clockwise direction (ccw) around each section.

2. Each section should be opened as shown on the attached sketch.

3. The machine should be well squared with the rows before starting a run through the field.

4. Belt speed should be maintained only slightly faster than forward speed so flax is pulled vertically and deposited to its original location. This is particularly important when starting a run.

5. Flax which is removed from a plugged puller should be correctly oriented and spread over an adjacent row. Leaving flax in a pile will result in uneven retting and possible plugging when the flax is turned.

6. Pulling width should be the full width of the machine at all times to develop proper spacing between heads and roots of adjacent rows.

7. Thrown belts can be a problem with the puller. Thrown belts can be avoided by keeping the puller perpendicular to the row and stopping frequently to clean the machine, particularly around the top rolls.

8. Pulling Machine Improvements could be made as follows:

   a. The pulling head needs to be slightly wider to accommodate taller flax. Increasing each head with by 2" for a net increase of 8" would be beneficial.

   b. A quick release mechanism to relieve belt tension would speed up the process of re-installing thrown belts.

   c. The machine should be checked by OSHA and any necessary guards installed.

Retting and Turning

Turning the flax is critical in order to evenly 'ret' the material. Retting is the process of slowly rotting the stems in order to free the fibers from the stem. This process takes from 2-5 weeks depending on sunlight, temperature, and moisture. Typically temperatures between 60-75 with morning dew will ret the material in three weeks in Aroostook County. The flax must be turned at least once, or twice to evenly ret (rot) the straw. This is especially important when windrows are thick.

To schedule when to turn, watch the straw. Once the straw is dark brown-grey, a turning is in order:

1. Turning should proceed counter clockwise (ccw) around each section the same as pulling, except for the two rows separating each section. (see attached sketch)

2. The pickup drum (and belts) should be started in the raised position before lowering onto the flax at the beginning of a run.

3. The pickup drum should be positioned well to the root (left) end of the flax. This provides more bulk for picking up, reduces slipping while between the belts and allows depositing in close to the original position.

4. The turner seems to operate well even the flax is damp, frosted, or even frozen.

5. The turner seemed to work best by starting at low RPM, RPM can than be increased to provide more forward speed after the speed control is fully advanced if the flax is flowing well.

6. Turning machine improvements could be made as follows:....a). The machine should be outfitted with good lights for night operation and checked by OSHA and any necessary guards installed.

When to Bale

Baling should be done as soon as the flax is properly retted one day. Determining this is very critical to high quality flax. Over-retting will cause the fibers to breakdown and be short and of poor quality. Under retting will result in the inability to separate the fibers for processing. Properly retted flax is a light-moderate grey color and when dry the fibers can be extracted from the stalk easily.

1. Baling should proceed counter clockwise around each section except for the two row separating each section (see attached sketch).

2. It is very important to proceed in a direction that keeps roots to the right and unbaled flax to the left. This prevents the baler from grasping heads of adjacent rows and pulling the flax longitudinally into the machine, which would result in plugging the pickup seed and forward starting roller.

3. Flax can quickly become entwined around the pickup reel and shaft on the sides of the machine, necessitating frequent cleaning. Bent pickup fingers on the side of the pickup reel should be promptly replaced to insure that the flax moves transversely through the machine.

4. The pickup head should be moved transversely with respect to the row as much as possible to avoid cone shaped bales and twisting of baler belts.

5. Baling Machine Improvements could be made as follows:

   a. Flax will frequently wind around the forward starting roller and bind between the roller and its scraper bar. The drive mechanism for the roller needs to include a clutch mechanism or easily replaced, mild steel shear bolts. The shear mechanism on the 504 baler was okay. The tapped shear bolts on the 604 were difficult to replace. The 604 shear bolts were grade 5 and, on one occasion did not break before bending the starter roll and scraper bar. On another occasion, the roller chain broke before the bolts sheared. Grade 2 bolts worked satisfactorily and provided better protection.

   b. The pickup reel must be operated very close to the ground in order to catch the flax. A hydraulic height adjustment, controlled from the tractor might be beneficial.

   c. The electric control for the twine arms provided little advantage over a hydraulic control.

   d. The equal-fill/autotic monitor provided some advantage. The equal-fill feature was not used. The autotic feature was convenient and resulted in more uniform bale size.

   e. Centering the balers behind the tractors resulted in a tractor wheel and a baler wheel running on unharvested flax. Off setting the baler about a foot from the tractor would

prevent a tractor tire from running on unbaled flax. It may be necessary to modify baler suspension systems to keep the baler tire off the flax. The tire (s) need to run right at the edge of the pickup reel.

Transport and Storage

Baled flax should be transported from the field and stored in a cool dry location immediately after baling. Baled flax must be kept dry at all times.

1. Forklift tines appear to be the best method of handling bales. A spike was tried but could not penetrate the bales.

2. Four foot diameter bales appear to be the most convenient size to transport with conventional equipment. Six foot diameter bales, containing twice the volume, would also be efficient but would require larger forklift tines to handle.

Harvest Quality

The flax was sent to France for milling and quality tests. Our results were as follows:

Evaluator	Observation	Quality	Grade
Dehondt	Difficult passage in scutching Average baling	Good retting Sufficiently Finished Good Color	not given
Hemelrick	Sections difficult to mill Average baling	Good retting, some sections quite fine, good color, good length,	5/10 (Good)

* Under the grading systems used by Fontaine-cany, anything under 4/10 is "poor"; 4/10 to 5/10 is "average"; 5/10to 6/10 is "good" and above 6/10 is very good.

Variety Evaluation

Arianne was a later maturing variety yielding very well. The plant was taller than Viking.

Viking was lower in height, matured about five days earlier than Arianne and had thinner stalks.

Both varieties would do well in Maine. However, Viking would be preferred if planting was delayed into late May - early June.

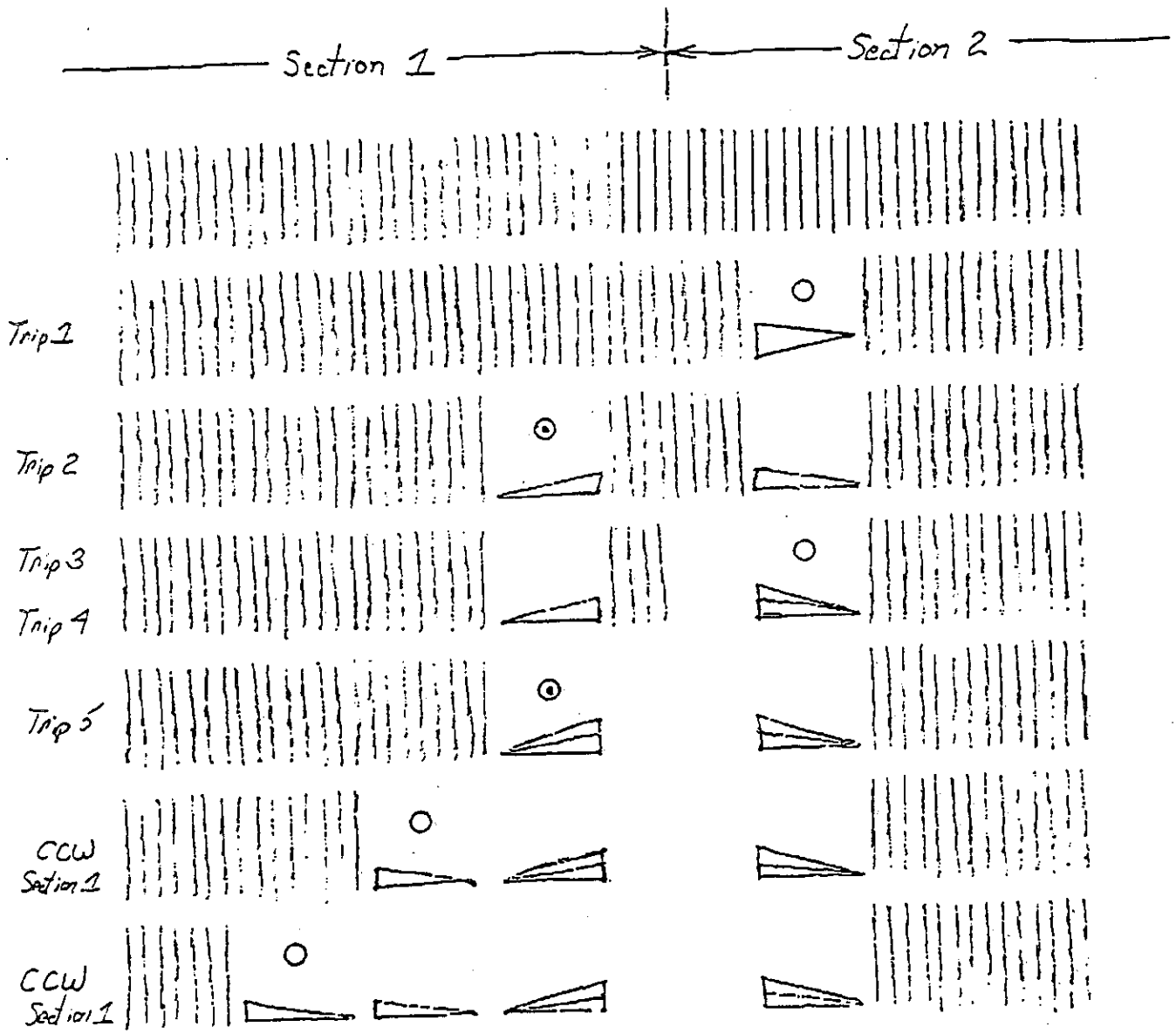
Economics

Even though this was not part of the project proposal, the University of Maine and Department of Agriculture have been reviewing our costs and have developed some preliminary cost of production summaries. At our farm, we feel that we can return between 100 and 250 dollars per acre. Another year of analysis and actual sale of product will further help us analyze this potential.

Summary

In summary, the growing of Flax on the Ward Farm proved successful. The type of plant, it's growth habit, production requirements low inputs, and costs all seem to be complimentary to our business of growing potatoes and will help us diversify. Further study is needed for growing the plant with the optimum planting date and more attention to the harvest/retting period. The lack of insect and diseases, the low nitrogen requirements should make this a good crop to grow. Future plantings may turn up problems, but so far, so good. The economics of the crop look favorable. We will need to have a mill established before the crop can really become a reality for New England. We intend to continue testing this crop in 1994.

PULLING

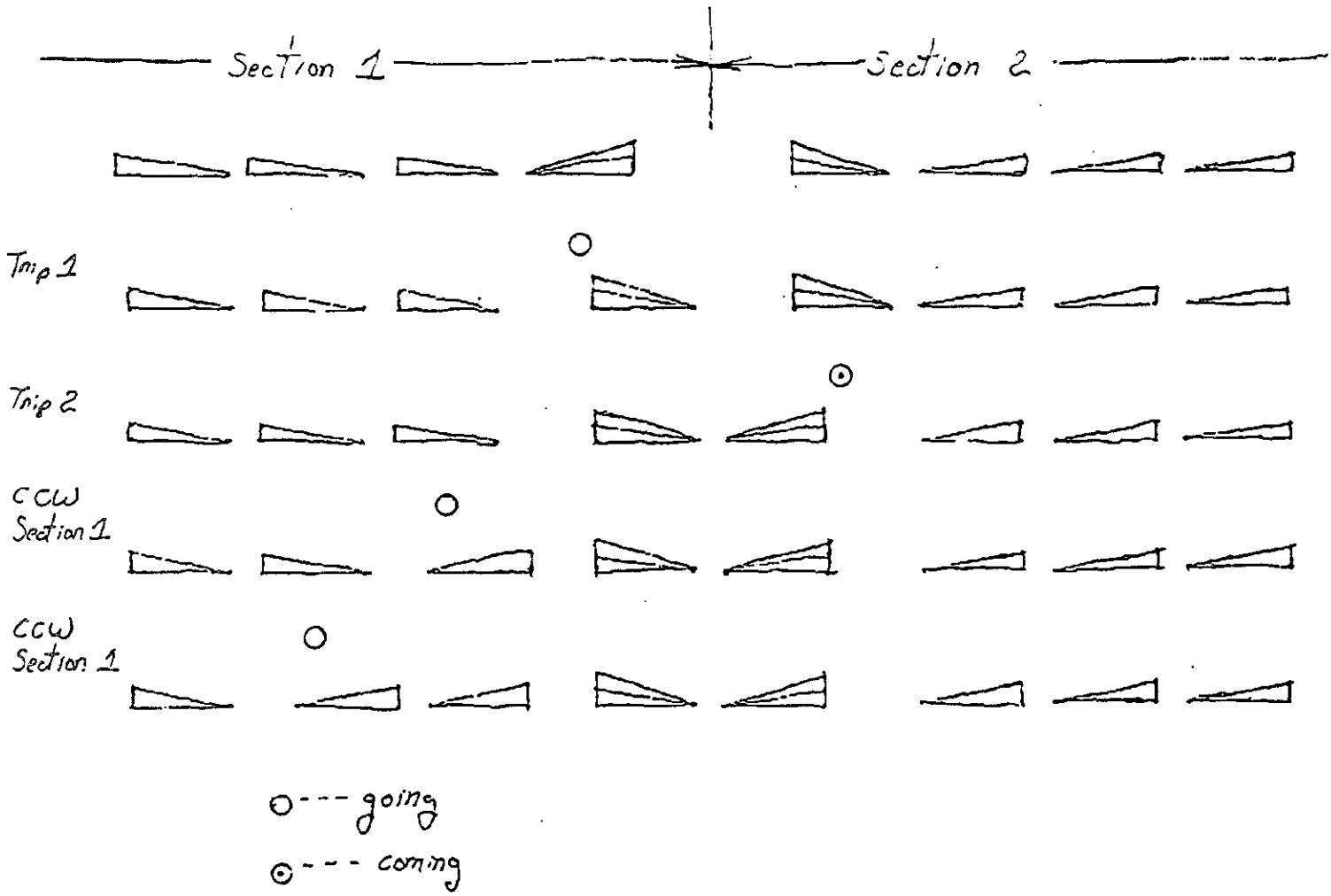


○ --- going

⊙ --- coming

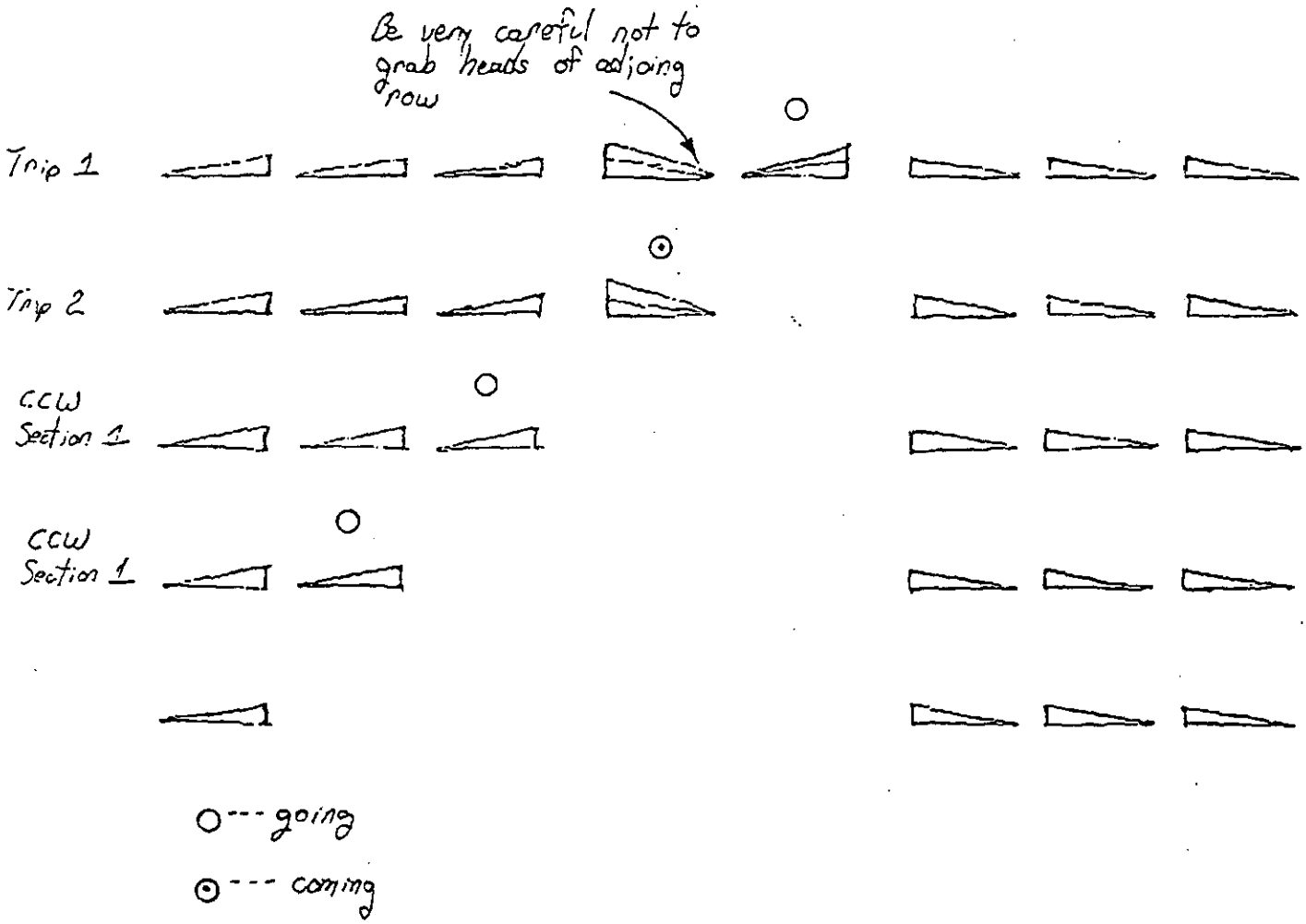
Half Strips

1. Table full night
2. Head Positioned


Section 1
Section 2
Trip 1
Trip 2
CCW Section 1
CCW Section 1
⊙--- going
⊙--- coming

TURNING

BALING


Be very careful not to grab heads of adjoing row
Trip 1
Trip 2
CCW Section 1
CCW Section 1
○--- going
⊙--- coming

From: Flax Production In Maine: An intercrop for Maine's Potato Production: A preliminary Analysis of the cost and returns of growing Flax. Phillips, Crabtree, Harker and Leiby, 1994. Unpublished

Net Return With Varying Yield, Cost Of Production and Price of Straw Flax

Production Cost $/A	500	500	500	600	600	600	700	700	700
Yield lbs/A	4690	6250	7800	4690	6250	7800	4690	6250	7800
Price $/lb				**Net Return $/A**					
$0.10	($31)	$125	$280	($131)	$25	$180	($231)	($75)	$80
$0.12	$63	$250	$436	($37)	$150	$236	($137)	$50	$236
$0.14	$157	$375	$592	$57	$275	$492	($43)	$175	$392
$0.16	$500	$500	$748	$150	$400	$648	$50	$300	$548

Net Return With Varying Yield, Cost Of Production and Price of Straw Flax

Production Cost $/A	464	565	500	600	600	600	700	700	700
Yield lbs/A	4690	6250	7800	4690	6250	7800	4690	6250	7800
Price $/lb				**Net Return $/A**					
$0.10	$5	$60	$280	($131)	$25	$180	($231)	($75)	$80
$0.12	$99	$185	$436	($37)	$150	$236	($137)	$50	$236
$0.14	$193	$310	$592	$57	$275	$492	($43)	$175	$392
$0.16	$565	$435	$748	$150	$400	$648	$50	$300	$548

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This table is considered preliminary in nature and cannot be used without the expressed written approval of the authors.