THE MODIFICATION OF
A PLASTIC MULCH
PLANTER

by

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and

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REPORT SUBMIT TO FULFILL THE REQUIREMENTS OF:

COURSE 336-490D PROJECT

MACDONALD COLLEGE OF McGILL UNIVERSITY
DEPARTMENT OF AGRICULTURAL ENGINEERING

This final Design project was performed by Georges Szaraz and Normand Zemanchik. The amount of work and effort that was required from both of us, was equally distributed from the commencement of this project to its completion.

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Acknowledgement

The authors of this final design project would like to take this opportunity to give special thanks to Professor Eric Norris, Chairperson of the Macdonald College Agricultural Engineering Department for initiating this project, his guidance and assistance during all phases of this project. Special thanks are also due to Ray Cassidy for his technical assistance, and to Gabriel Van Mil for allowing us to borrow his plastic mulch machine and permitting us to modify it. Thanks are also due to Mr. Wendell Joyce and Mr. Marc Boileau for allowing us to use farm machinesand farm land for our experiments. Appreciation is expressed to Mr. John Argoll, Mr. Mercadl, Christian Gosselin, Jim Leonidas, Harold Brevoort for their assistance and advice to the successful completion of this design project. Lastly the encouragement, confidence and assistance given by our comrades was greatly appreciated.

Contents

Introduction

In November of 1987, Professor Eric Norris discussed in one of our classes a problem a farmer was experiencing with a piece of agricultural machinery. The farmer was Mr. Van Mil who lived in Verchères about 100 Km east of Montréal. The machine is a plastic mulch machine built by Polyasem, Agri Polyane a company located in Paris, France. A report published by Agriculture Canada discussed about a problem Mr. Van Mil was facing with his mulch machine. The problem, was, that he was experiencing too much lifting with the plastic. As a result he was not obtaining maximum efficiency with this machine agriculturally and economically. This as a result stimulated our interest in trying to rectify the problem Mr. Van Mil was experiencing. This led us to a series of design modifications. In this design project we discuss some of our designs and in the end we hope to finally obtain an implement which will rectify Mr. Van Mil's problem.

CHAPTER 1

REVIEW OF LITERATURE

Review & Literature

PLASTIC MULCH

Historical Perspective

Mulching the soil is a very ancient horticultural technique which was highly developed by skilled gardeners such as the Arabs and Chinese (Larkom, 1978). Early Roman writers were aware of the role that stones lying on the soil might play in conserving moisture (Jacks, Brind & Smith, 1955).

The use of paper as a mulching material in Hawaii (1914) was for the first time used, where asphalt paper was used to control weeds in a sugar cane plantation (Flint, 1928). In the 1920's and 1930's both asphalt and kraft papers were tested extensively into the United States for their use on vegetables, but unfortunately, asphalt paper contained toxic materials the kraft papers deteriorated before the end of the season, and both types tore easily (Magruder, 1930). The practice of mulching in commercial operations almost completely disappeared during the depressions years, this was mainly due to economic conditions. In the mid 1950's, black polyethylene was developed and mulching regained importance as an agriculture practice. The advantages of black polyethylene over paper include:

- non-toxicity to plant growth
- resistance to decomposition by either - moisture
- light
- soil organisms

- better elasticity
- stretching rather than tearing
- a relatively low cost.

In the 1980's, farmers are using photodegradable, transparent plastic mulch that lasts for the growing season, around 90 days. The major advantage of this plastic over the common polyethylene mulch is that the farmer doesn't have to pick up the sheets in the fall.

Effects on soil temperatures

A plastic mulch can affect soil temperatures in four basic ways. It will reduce convective heat loss, outgoing radiation and evaporation thus creating conditions for increased soil temperatures. However, it will also reflect, absorb and transmit incoming radiation, thereby potentially reducing soil temperatures (Rickard, 1979).

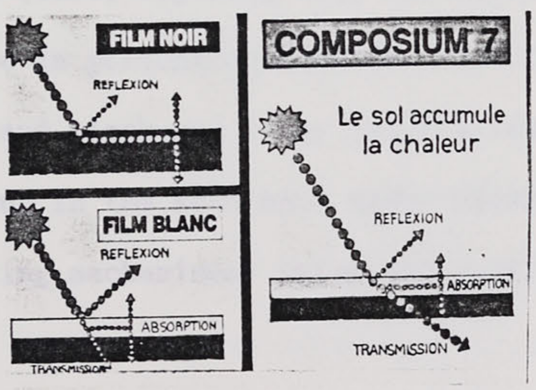


Fig. 1 Effects on Soil Temperature

It is generally accepted that clear plastic mulch will raise the temperature of the soil beneath it while a highly reflective mulch will lower the soil temperature. Studies in 1960's on the effects of black plastic mulch on soil temperature are quite contradictory; some studies state that it increases the soil temperature while others state that it doesn't. Evidently a more in depth investigation into the effects of black plastic mulch on soil temperature is required.

Usually a plastic film does not touch the soil surface evenly, unless the soil surface is absolutely smooth air pockets will always be present between the mulch and the soil surface. The air layer prevents large energy storage in the soil, due to it's low conductivity. At night, however, the film conserves a little heat by preventing evaporation and since the layer of air beneath the film acts as an insulator heat is conserved in the soil.

<u>Soil moisture</u>:

Anmy and Muspeth (1960) reported that all mulching materials they tested were equally effective in preventing moisture loss from the seed zone (roofing paper, aluminum soil and black and clear polyethylene films...) they concluded that "moisture build-up in the seed zone under plastic films is the result of at least two interacting mechanisms: vapor and capillary movement".

This "closed system" should not require additional moisture provided that there was sufficient available moisture in the soil originally to provide for crop development. However, Courter & Oebker (1964) cautioned that the use of plastic mulch does not replace the need for irrigation during drought conditions. Thus, a plastic mulch simply prevents evaporation from the soil, and in conditions where this evaporation is large the moisture loss prevention saves water which will meet later demands for transpiration and therefore be beneficial to the plant.

Breaking the plastic film by planting through it will allow some air movement and evaporation thereby reducing the mulch's effectiveness. Rickard (1979) estimated that the rate of water loss in the spring under a 4% perforated mulch may be up to 1.7 times as much as that from a similar location without the uses of plastic mulch.

Fig. 2 Soil Moisture affects using plastic mulch

Nutrient and leaching

By altering soil temperature and moisture a plastic film can affect nutrient availability in the soil beneath it (Reynolds & Lang, 1979; Hankin, Hill & Stephens, 1982). The film can also affect leaching by localizing the entry of water into the soil via the planting holes (Waggoner et al., 1960).

Plastic mulch slowed soil-water percolation and restricted removed of nutrient from the top 15 cm of soil (Jones & Jones, 1978).

Effects on sweet corn and yield

Fritschen & Shaw (1960) & Hopen (1965) reported significant yield increases for corn plants in the mulched plots than the control.

Fig. 3 Effects on yeild.

Mr. Gabriel Van Mil planted 30 acres (12 hec.) of sweet corn, on Ile Bouchard, under clear plastic mulch (17th to 20th of April 1987) and the same amount on bare soil (22nd of April 1987).

Even with 3 spring frosts the sweet corn under plastic had no damage since roots were kept warm. However, plants in bare soil had unequal shoots and some seeds were rotten.

Corn with the mulch was harvested 10 to 15 days prior to the conventional harvesting, permitting Mr. Van Mil to dream in the near future that he will be able to compete with the Southern Ontario producers and sell his product at a a higher price, which will thus make his operation more profitable.

PLASTIC MULCH MACHINE

• Historical Perspective

The plastic mulch machine used in this senior project is the "PLASTISEMEUSE POLYASEM" from AGRI POLYANE newly renamed the PROSYN POLYAM a company in Paris, France.

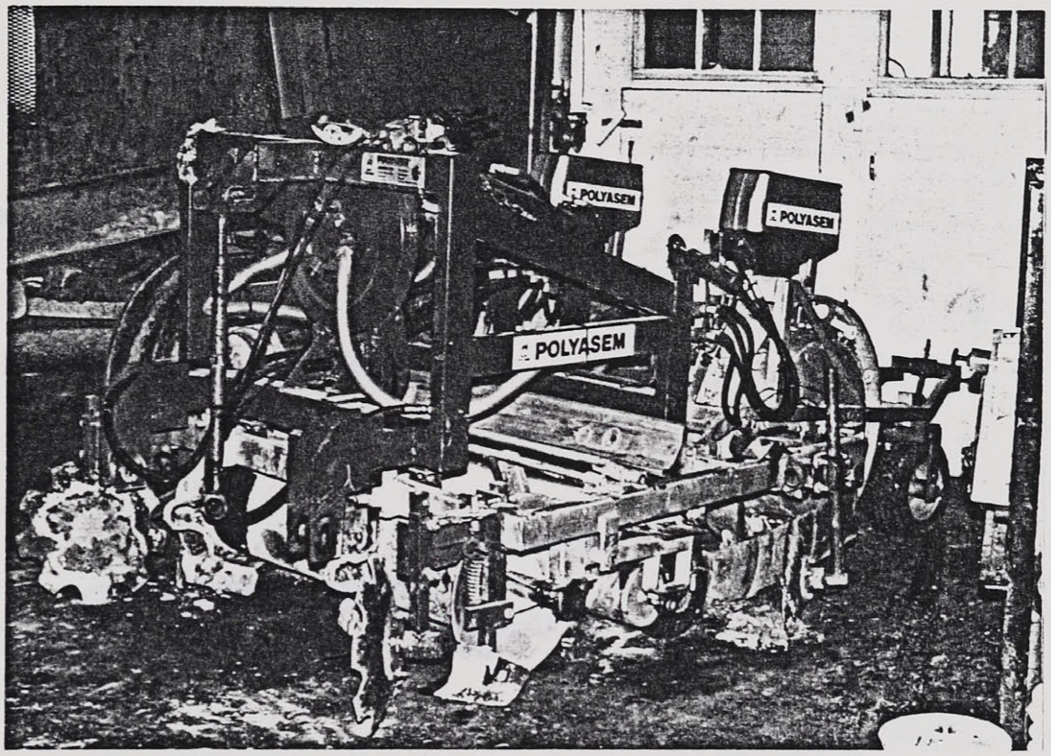


Fig. 4 Plastic Mulch Machine.

This machine is available in two, four or six row of configurations. The one used by Mr. Van Mil is equiped for 2 rows and costs approximately $16,000.00. It arequires a 60 HP tractor with a three point hitch system (category 2), to work in the field.

According to Mr. Mercadl (Prosyn Polyam Co., France), working on this new prototype was the result of research done for years, and as a result this machine was introduced into the market in 1984.

Machine Principles

This machine unrolls a plastic film, which then covers the edges and finally perforates the plastic while simultaneously depositing a sweet corn seed in a 1.2.1.1.2. fashion (see pamphlets in appendix).

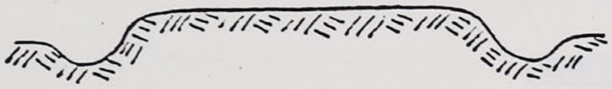


Fig. 5 Produce a berm of soil.

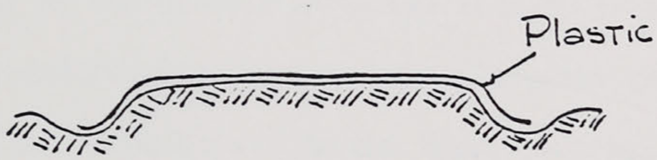


Fig. 6 Lays the plastic.

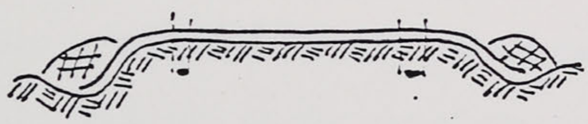


Fig. 7 Covers the edges and plants the seeds.

CHAPTER 2

PROBLEM IDENTIFICATION

Problem Identification

Gabriel Van Mil and his brother-in-law Adrien Van Vliet cultivate 600 acres of sweet corn on their land situated on Ile Bouchard, along the St-Lawrence River facing Verchères. In peak season they can harvest from 10 to 12 thousand dozens ears of corn per day which they transport by full load from the island by truck.

After 35 years of conventional cultivation of sweet corn, Mr. Van Mil asked himself if there couldn't be a way of obtaining a higher grade of sweet corn by cultivating it with the use of plastic mulch, a technique which is applied in Europe at the beginning of 1987. Mr. Van Mil decided to purchase a planter of French origin specially equipped for plastic mulch this is called "plastisemeuse". This machine unrolls a sheet of plastic, then anchors the edges of the plastic into the soil by tucking the plastic under a fine layer of soil and finally pierces holes into the plastic while simultaneously dropping a seed into the hole. In the first year Mr. Van Mil obtained financial aid from the federal government dealing with technological innovations in the agricultural field. When you consider that it cost $225.00 per acre for the plastic and more than $16,000.00 dollars for the plastic mulch machine and also the risks he takes in using this machine when no one else proved that it would work. Therefore the funds allocated to him served to reduce his financial risks, one of the aim of the program.

Experimentation with the plastic mulch was used to determine if it was possible to produce sweet corn of good quality. While improving the performance with the idea of obtaining better prices and being able to supply to the major food store in Quebec, that portion of sweet corn that is produced in Ontario, and delivered by them at the beginning of the season.

Utilization of this technique was an addition for these Verchères producers to the equipment already on hand for cultivating sweet corn such as a mechanical harvester and a high velocity cooling system aiding in the preservation of the harvest.

Within the trial period the authors of this project compared 30 acres of sweet corn grown with the plastic mulch with 30 acres of sweet corn grown on bare soil. The texture of the soil is clay/sand. The corn grown under the plastic mulch was seeded between the 17th to the 20th of April 1987, while the conventional method seeding took place on the 22nd of April. Comparing the two techniques at the beginning of the season, we could observe the advantage of using the plastic mulch. Even with 3 spring frosts there was no damage to the corn seedlings grown under the plastic, due to the fact that the plastic kept the soil warm therefore kept the plant roots warm at night. Unfortunately we could not say the same thing about the corn that was seeded without the plastic mulch. The seedling due to the low temperature grew unevenly and many seeds rotted in the soil.

<u>A few conditions to succeed</u>

During the preliminary seeding, Mr. Van Mil and Mr. Van Vliet had to modify the plastic mulch machine to the ecentricities of the terraine. The discs had to be displaced forward in order to obtain a berm of soil at the right height on each side of the plastic. They also had to install mud guards so that the soil would not interfere with the performance of the planter drums.

Ideal conditions must prevail when seeding with the plastic mulch. You must have a well prepared soil; i.e. not too dry and perfectly level. "It's not easy using plastic" commented Mr. Van Mil. "We must really learn how to work with this new technology".

The seeding operation must be done with care due to the numerous manual operations. They can only seed 8 acres per day. At the beginning and at the end of a row they must manually cut and bury the ends of the plastic sheet so that the wind will not disturb it. They must always keep a constant watch. Three to four men follow the machine by foot to verify that all the components are functioning adequately. As soon as there is a malfunction, such as the plastic mulch that is poorly buried on the sides or a rip they must stop the machine and rectify the problem immediately. Otherwise the slightest problem that may be overlooked such as the plastic not buried on slight distance on the sides may result in the plastic being blown away over the entire row.

Unfortunately they experienced many problems during the planting season of 1987. Over half of the 30 acres planted with the machine, the plastic had been blown away. Following this incident they immediately modified the machine once again. This time they modified the roller which forms the berm of soil. After having rectified this situation 70% of the plastic mulch laid remained in place. One important item must be kept in mind, and that is the plastic is cold when it is being placed and after it warms up and it expands due to the sun shining on it. The wind makes the plastic flutter and could blow away at anytime if the soil on the edges is not sufficiently heavy.

There is another reason for which the plastic mulch must remain in place, and that is if it moves the young seedling will never find their way to the outside atmosphere due to the misalignment of the holes, as a result the seedling would finish by either rotting or roasting under the plastic due to the sun's radiant energy transmitted through the plastic.

If the operation of the machine requires special attention we must give equal importance to the plastic. The plastic must be in perfect condition; i.e. be fresh and been kept in the dark. We can use leftover plastic from the previous year only if it was stored in ideal conditions or we are obliged to buy fresh rolls of plastic.

<u>Sweet corn ready for the 10th of July</u>

Gabriel Van Mil believed that there should be better results with the corn planted with the plastic mulch as compared to the corn planted the conventional way. In 1987 the corn planted with the plastic mulch was ready 10 to 15 days earlier. The corn planted with the plastic mulch was ready on the 10th of July compared to the 20th using the conventional way.

The first harvest was however sold to the local markets and shipping to the large food stores started only around the twentieth of July. The buyers from the major food chains could hardly believe that corn could be ready so soon. However for the next season an arrangement has been made for shipping the corn right after it is harvested, 10 days sooner at a rate of 5000 to 6000 dozens a day.

In comparing the performance and the prices obtained for the 30 acres of sweet corn grown with the plastic mulch and the 30 acres grown the conventional way we obtained 2016 dozens/hectare at an average price (wholesale and retail) of $1.38 per dozen for the plastic mulch. The conventional method produced 1794 dozen/hectare at $0.92 a dozen.

SATISFACTORY RESULTS

Even with the problems and the additional costs that they encountered by using the plastic mulch machine the technique remains feasible, as long as the revenues exceed the expenses. Even if this experience with this machine did not work in accordance to the scientific norms a field test on such a large piece of land along with the field conditions and the in depth economic study done by Agriculture Canada, this technique is still financially feasible.

They are many advantages in using the plastic mulch. If you remember the violent rainstorm on July 14, 1987 Mr. Van Mil told us that the corn grown using the plastic mulch did not suffer any damage and was still well anchored in the ground. However the corn that was grown without the use of the plastic mulch suffered severe damage in many places and was difficult to harvest. Weed control under the plastic is kept at a maximum.

However in between the rows the tractor moves too much soil thus resulting in the insecticide applied during the pre-planting season being pushed against the edge plastic leaving an unfavorable weed control in the rows in between the plastic mulch. The sweet corn that was grown under the plastic mulch grew more evenly and the ears were well developed as compared to the corn grown without the use of the plastic mulch.

Gabriel Van Mil and Gabriel Van Vliet are satisfied with the results obtained using this technique thus far. However because of the problem encountered with the plastic mulch on 15 out of 600 acres, 30 acres will be reserved for the plastic mulch.

We hope to successfully rectify this design problem by once again modifying the plastic mulch machine. Even though we have a restricted amount of space to work with on the machine, we will design an implement that will insert the plastic into the soil and make sure that this implement will conform to all the ecentricities that the machine has. This will permit Mr. Van Mil to be able to cultivate an area greater than 15 acres and to become more highly financially stable thus increasing the competition amongst his neighbors.

CHAPTER 3

OBJECTIVES

OBJECTIVES

The objectives of this project were:

1. To reduce or avoid plastic mulch "lifting" by improving a plastic mulch machine via modifying or adding components or implements.

2. To increase area of cultivated land using plastic mulch on Mr. Van Mil's island; thus creating a greater productivity and profit.

3. To permit Quebec producers to be more competitive with Ontario and U.S.A. producers.

4. To allow producers to obtain higher quality yields and subsequently a better product for the consumers.

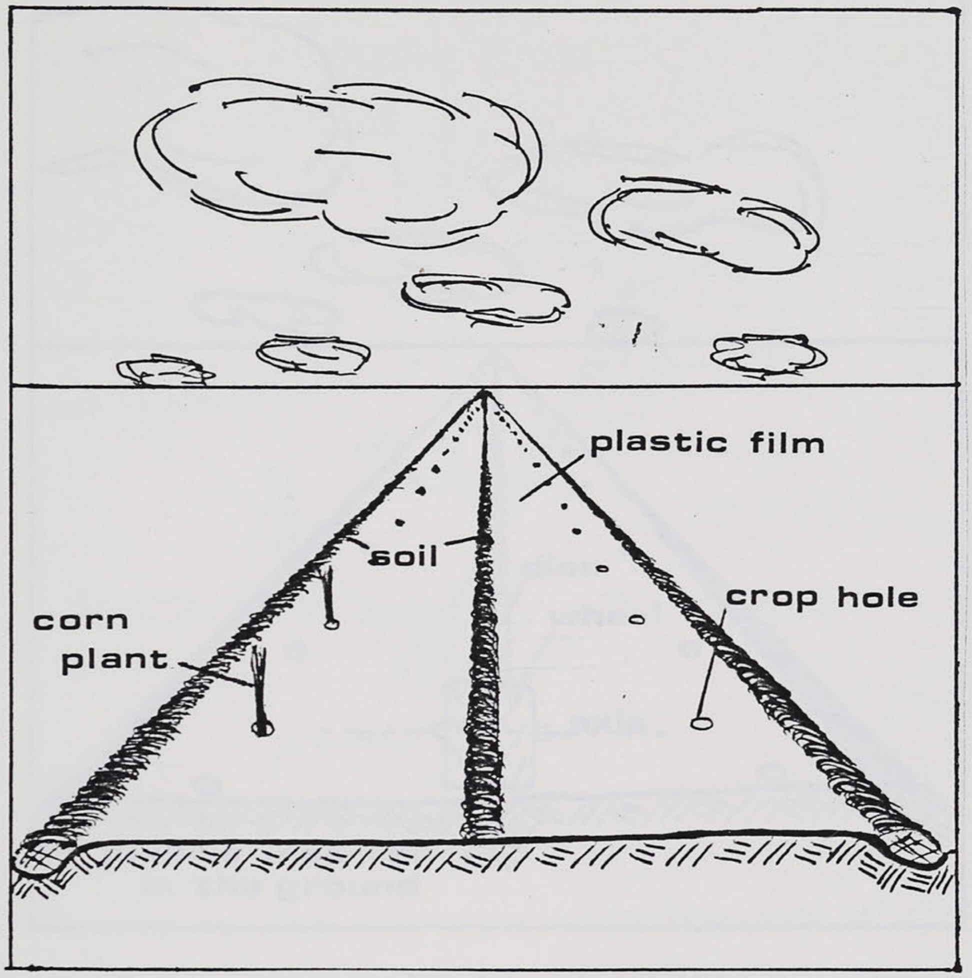
CHAPTER 4

PRELIMINARY IDEAS

Preliminary Ideas

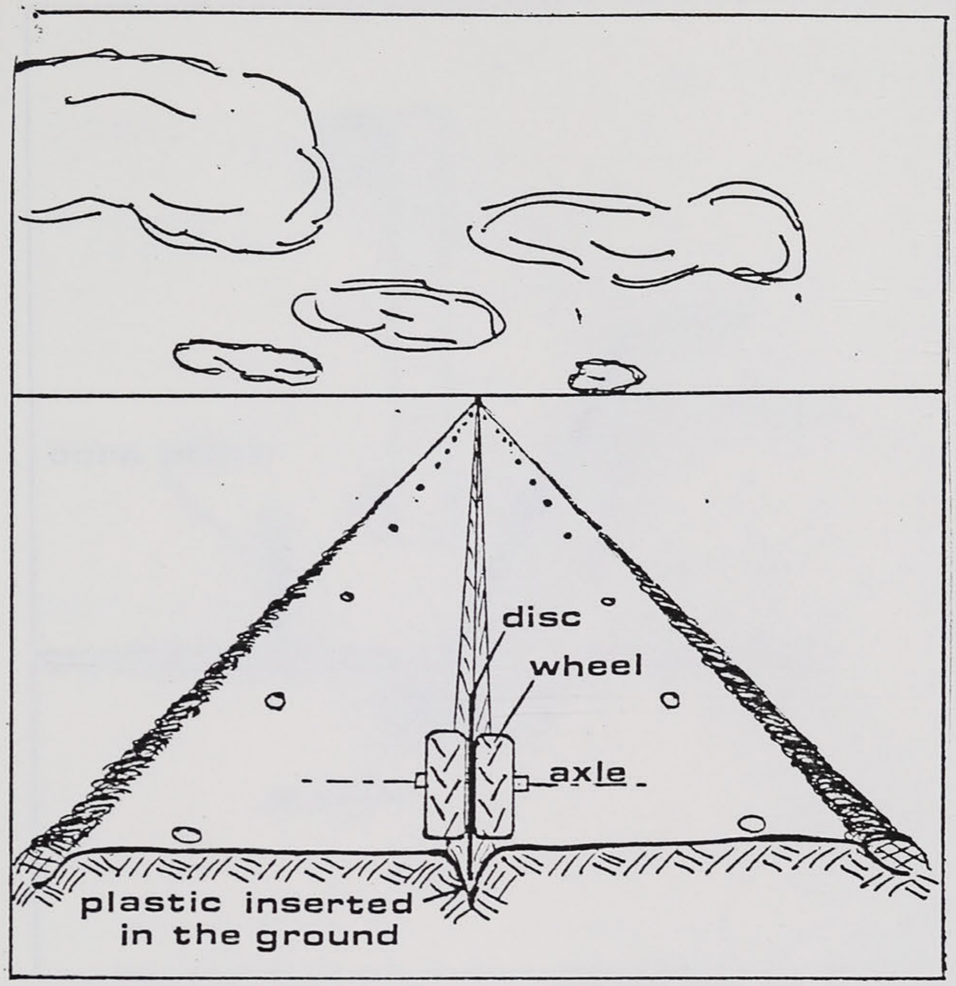
Once the problem and the objectives are identified, the next step is to accumulate as many ideas to bring about a solution to the problem. Preliminary ideas are sufficiently broad to allow for unique solutions that could revolutionize present methods. Many rough sketches of preliminary ideas have been made and retained as a means of generating original ideas and stimulating the design process. This chapter contains the ideas that we developed along with a sketch and brief description of each of them. The author wants to remind you that the primary goals of this project is to avoid plastic mulch lifting from the ground due to wind effects.

Idea A:



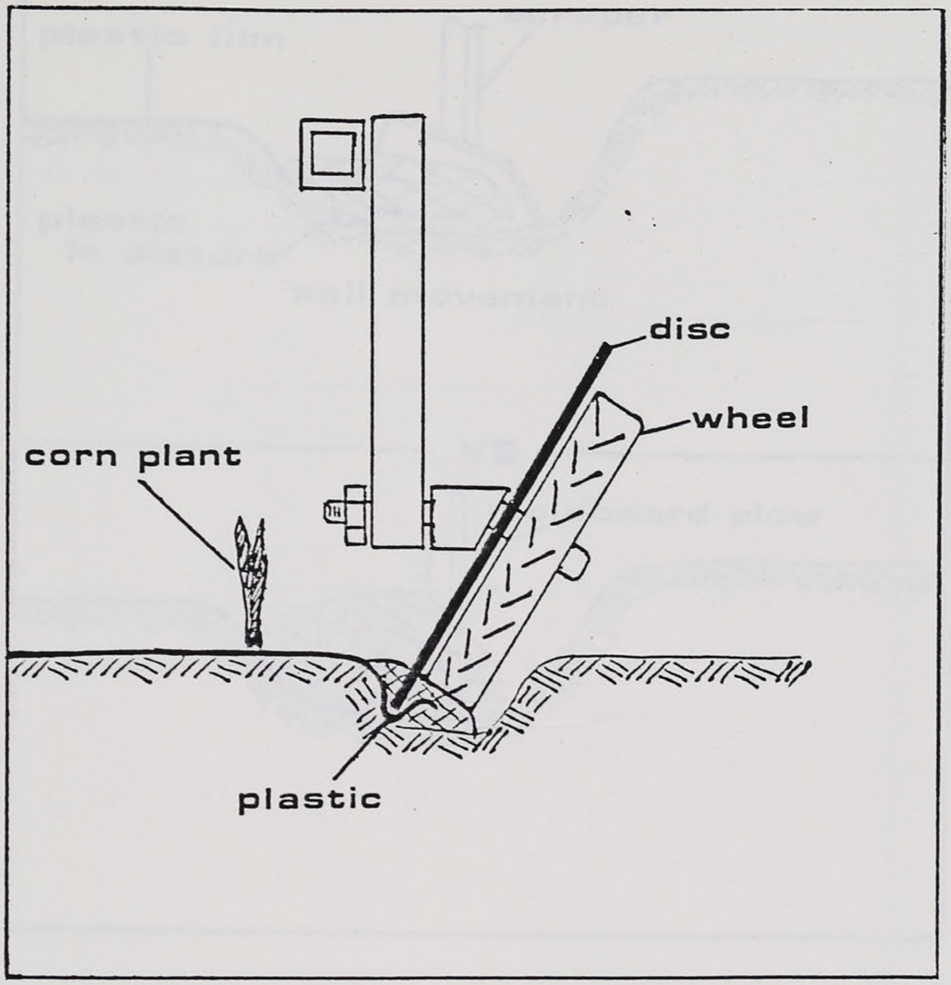
Idea A consist of continuously displacing soil from the field by means of a conveyor type mechanism. Then the soil would be placed on top of the plastic making sure that it would not interfere with the perforations. This simple option would be to apply more weight on the plastic, which would in turn keep the plastic anchored in place.

Idea B:



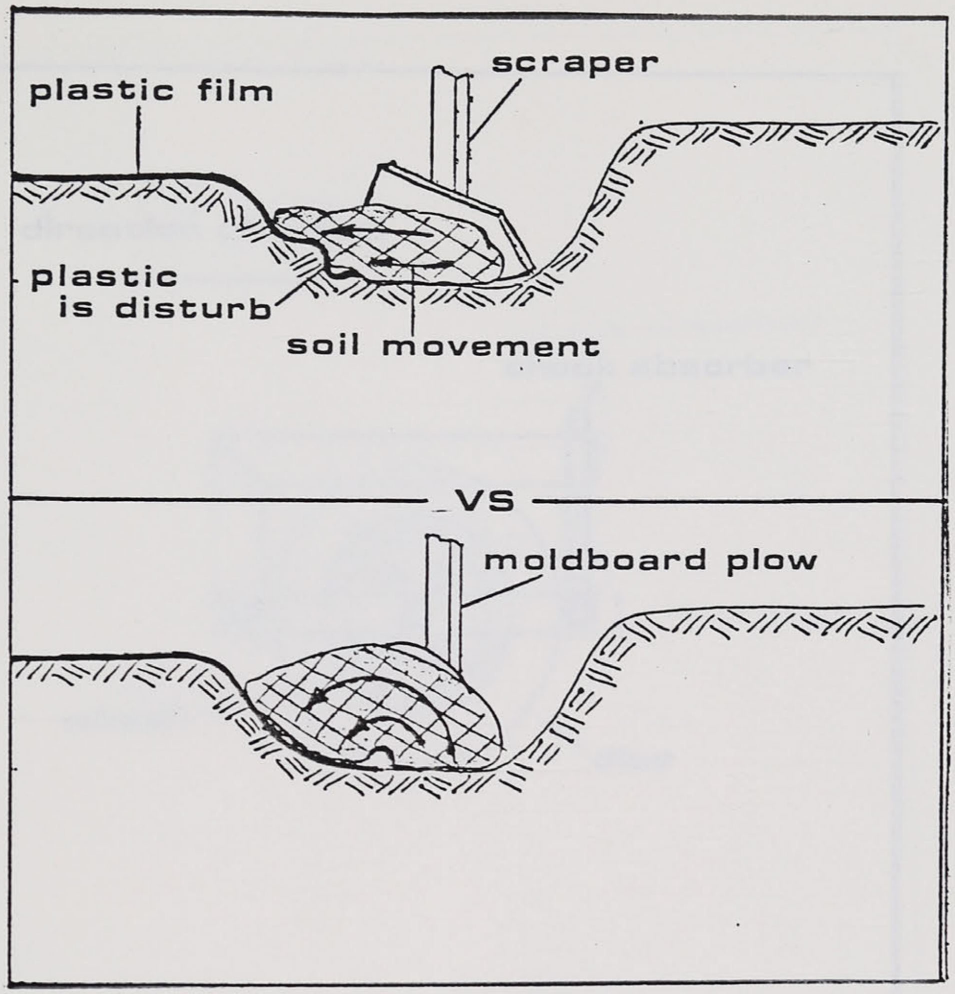
Our next idea was comprised of a large diameter disk of specific thickness which was sandwiched between two gauge wheels of a certain diameter. This implement would roll over the center of the plastic mulch while simultaneously inserting the mulch to a specific depth in the soil. The basic requirement of this system is making sure that the mulch remains anchored or tucked in the soil until the crop is fully developed and mature.

Idea C:



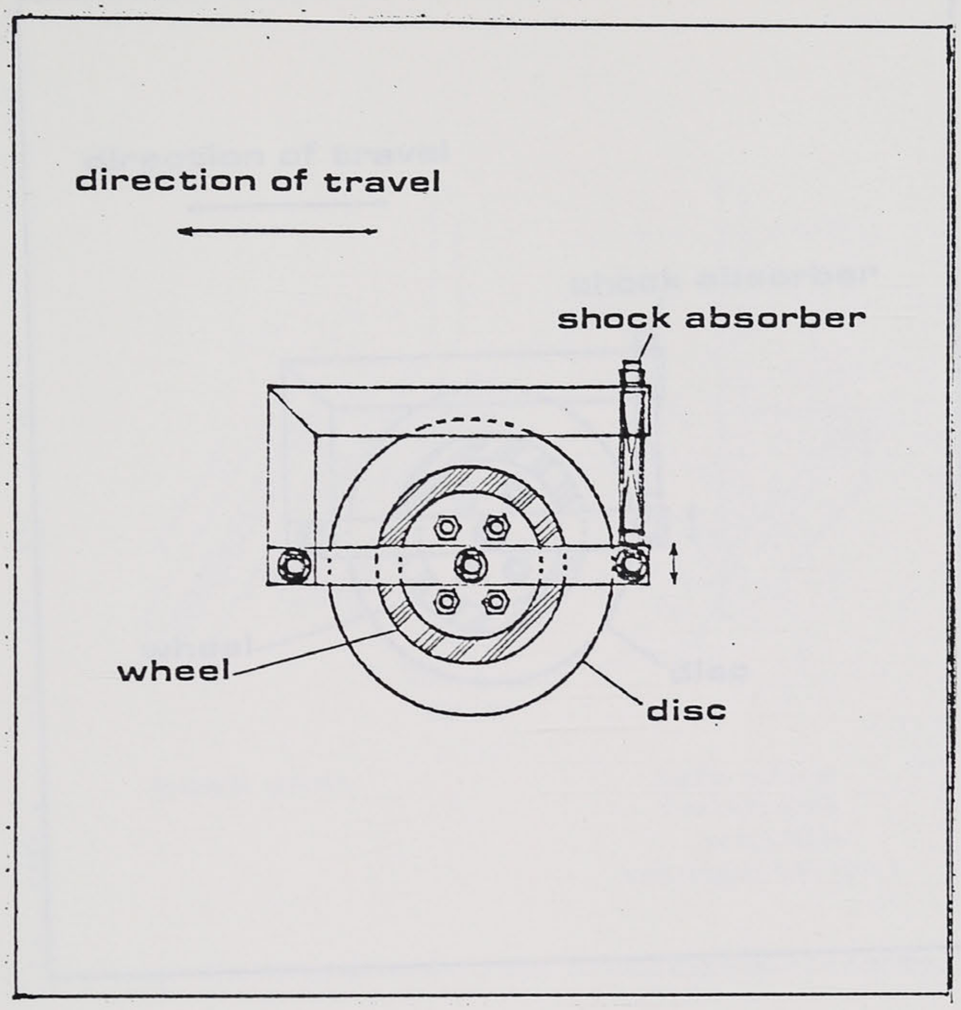
One gauge wheel and a large diameter disc rolling on both sides of the machine with a specific tilt angle, would penetrate the soil layer and than insert the plastic into the undisturbed soil. This stabilizes the plastic mulch and reduces plastic mulch lifting.

Idea D:



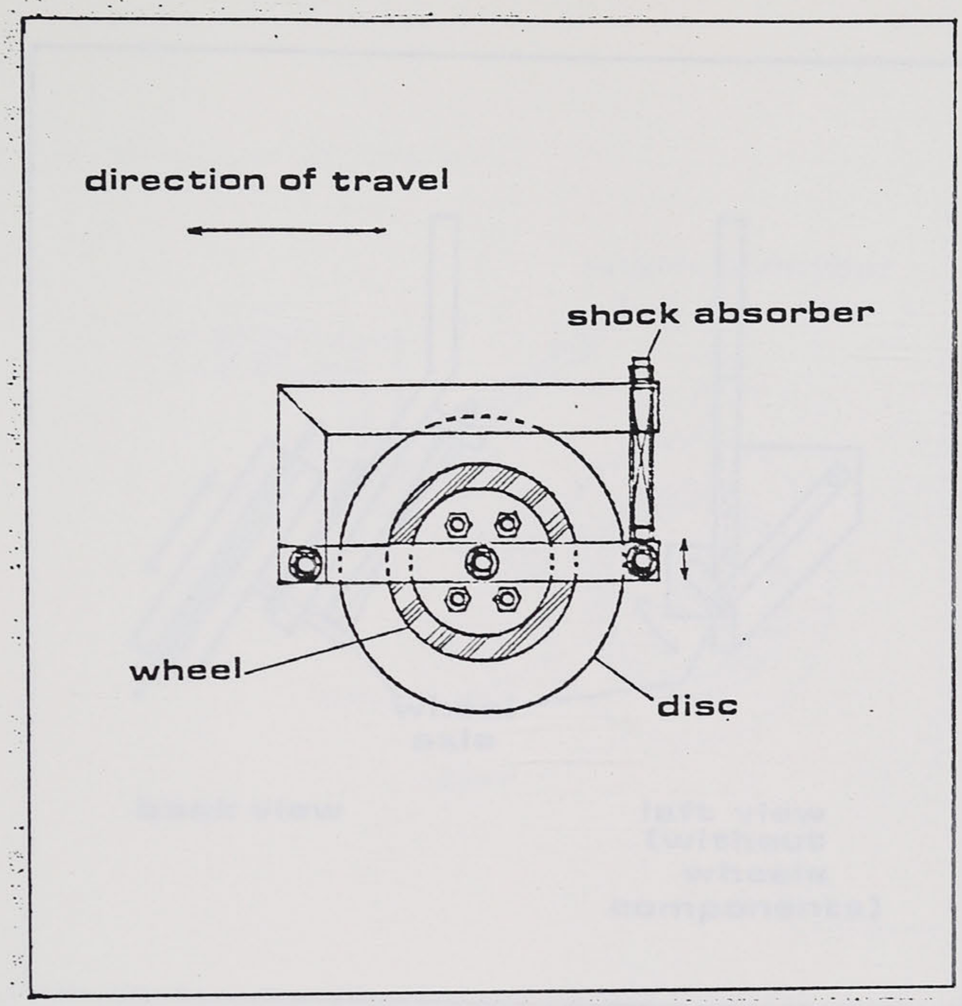
Originally the plastic mulch machine was equipped with "scrapers", used to displace soil on the edges of the plastic mulch. This in turn, disturbed the plastic mulch and decreased its efficiency. After observing the problem with the scraper we thought that maybe, it would be more feasible to use a moldboard plow. This instrument is more efficient, in that instead of pushing the soil, it lifts the soil and places it carefully on the edges of the plastic, leaving the mulch undisturbed.

Idea E:



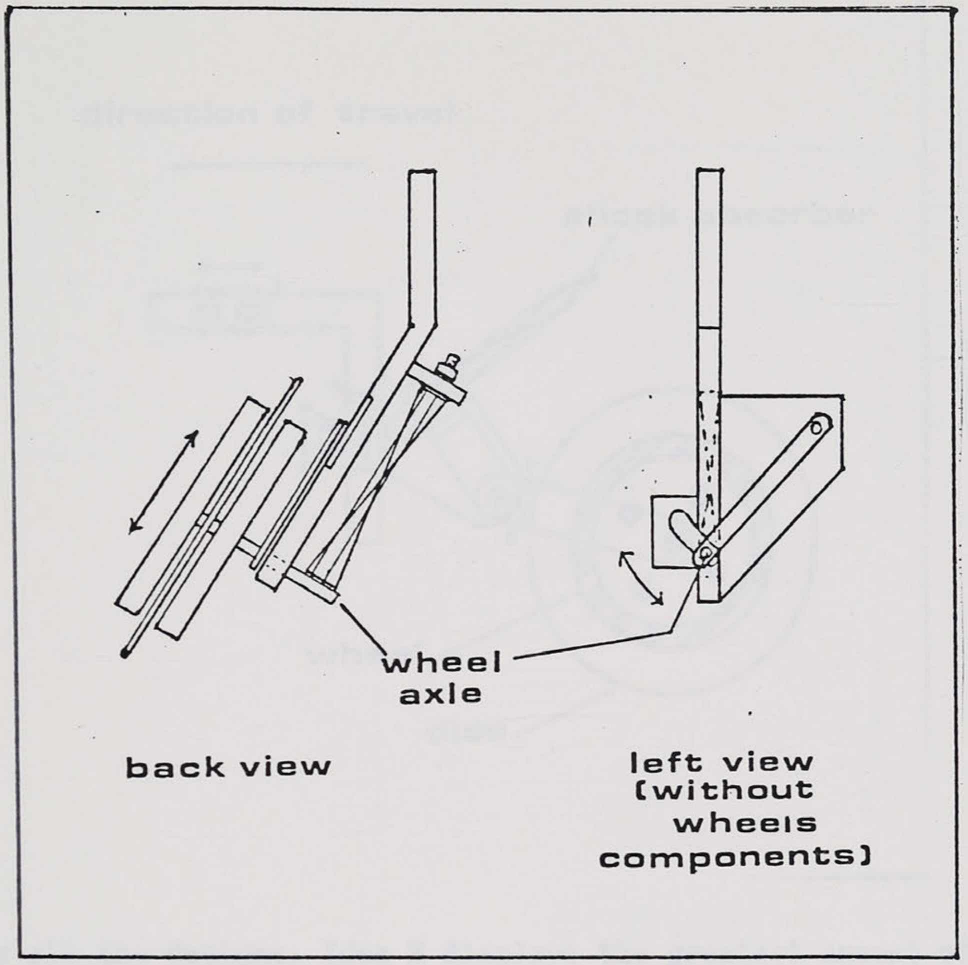
The gauge wheels and the disc of Idea B with the addition of a support structure and suspension system, which would aid in maintaining constant pressure on the plastic mulch, is used to insert the plastic vertically into the soil. The suspension system is used to sufficiently reduce the amount of shock absorbed by the implement due to stones, or other obstacles, the shock would be absorbed via the suspension system.

Idea F:



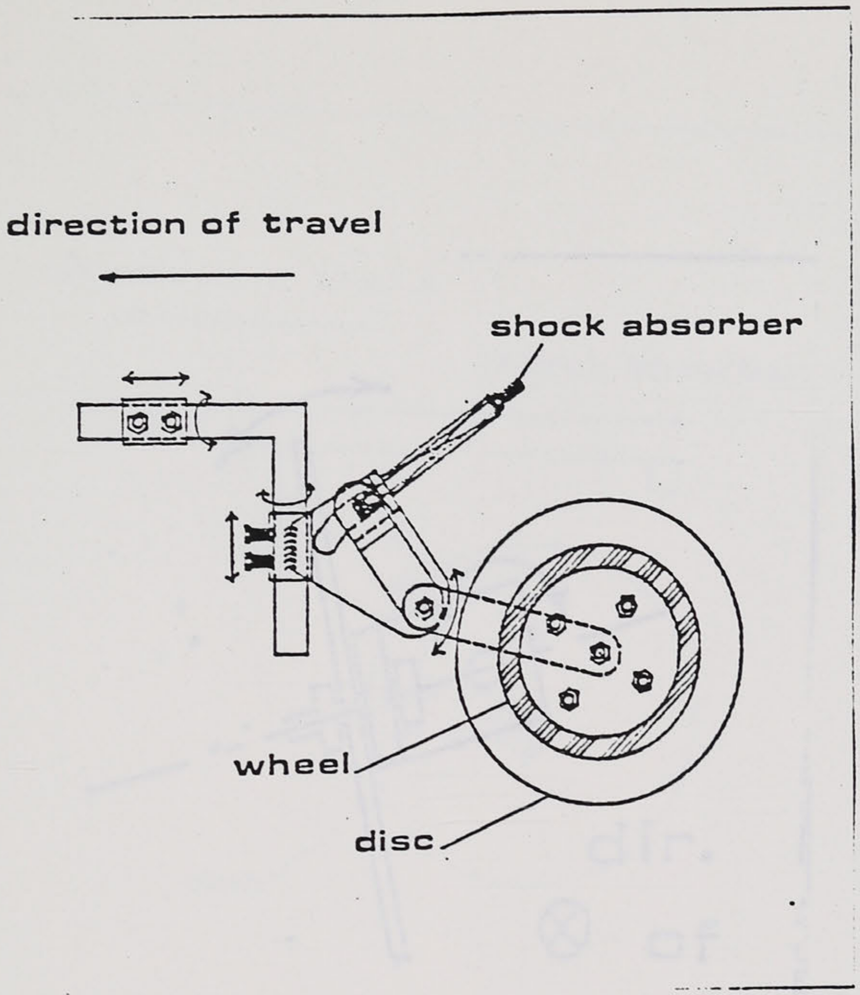
This improved version of Idea E remains almost the same except that the components of the implement are less heavy and bulky. This implement is very easy to construct, thus cuts down on the amount of labour hours required. It must be noted that Idea E and Idea F are respecting the same basic principles of inserting the plastic along the edges of the rows.

Idea G:



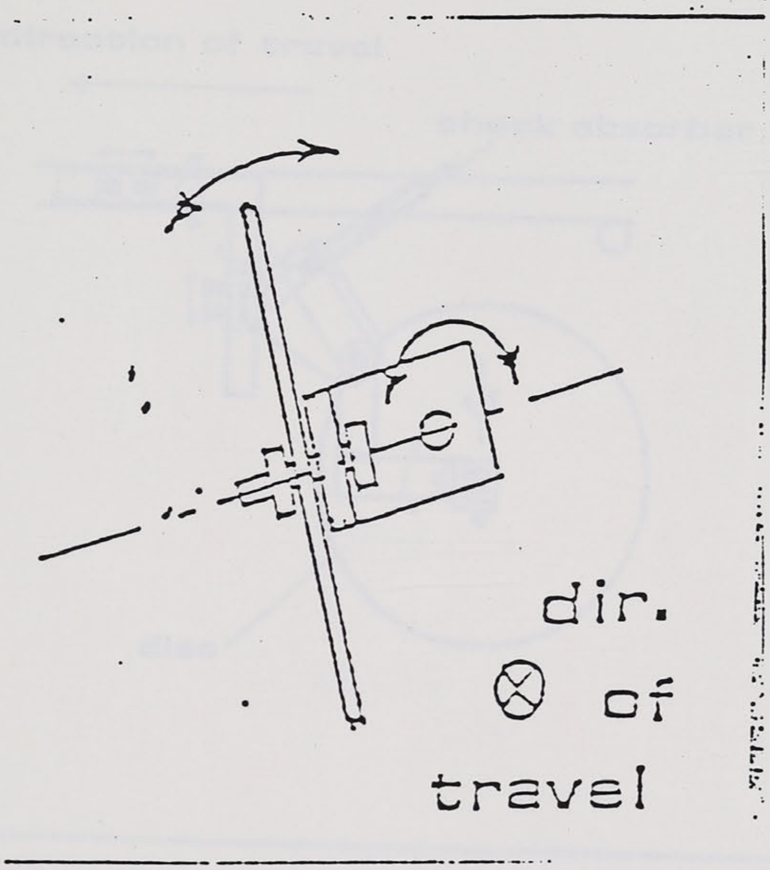
After field test on Idea F we concluded that a specific tilt angle is necessary. This implement must be adjustable for greater angle variance and also an adjustable and more sophisticated suspension system must be conceived for better efficiencies in different soil conditions.

Idea H:



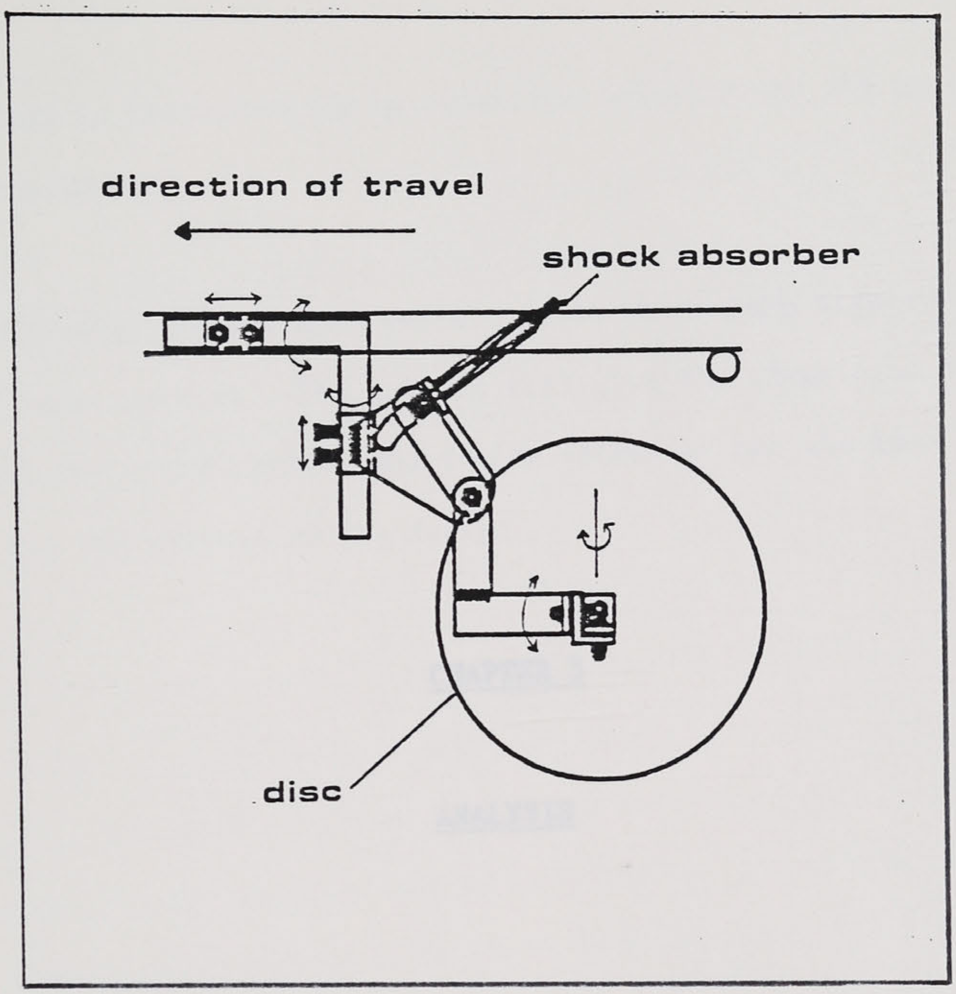
Among all the designs, Idea H displays the greatest amount of flexibility, i.e.: it can be moved along the "x" and "y" axis and rotated around the "y" and "z" axis. Therefore this ease in manoeuvrability is appreciated during field test, helping us in establishing the perfect positions in order to achieved maximum efficiency in this implement. We can observe on fig. H that only one gage wheel was utilized.

Idea I:

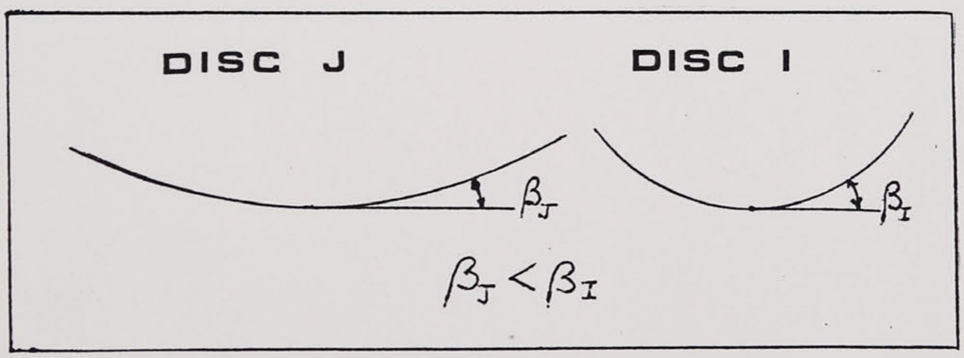


Due to a field test in October 1988, we realized that the tilt angle in Idea H was too small and, could be increased with slight changes near the disc axle, resulting in a flexibility range of -45° to 45° angle of tilt, therefore allowing a better fine adjustment in inserting the plastic. The gauge wheel was removed because it was obstructing the disc's function.

Idea J:



Using the exact replica of Idea I but implementing it with a larger disc minimizes the stress on the plastic mulch which is being inserted into the soil. We also adapted this implement to alow for more degrees of freedom in the vertical Y-Z plane as illustrated in the figure.



CHAPTER 5

ANALYSIS

ANALYSIS

This stage is characterized by objective thinking and the application of technical knowledge.

Basically this section analyzes all ideas which were displayed in the preliminary ideas section. The authors will give the advantages and disadvantages for every option, and decide wether or not the idea is applicable for the purpose of the design.

Idea A

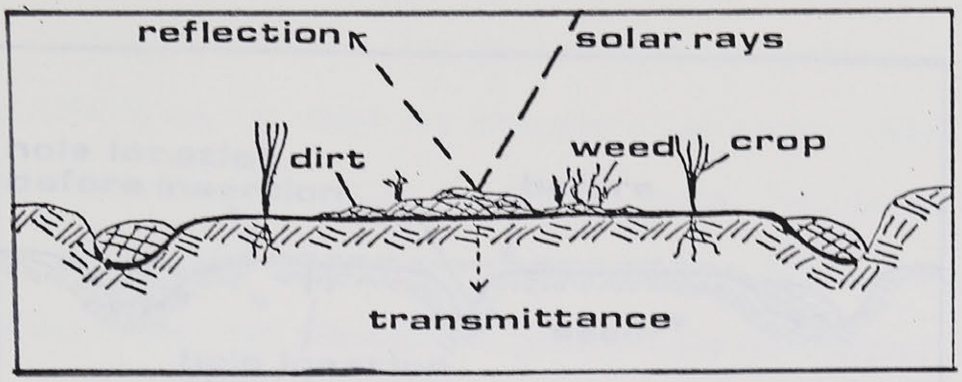


Fig. 8 Solar energy.

To move soil on the center of the plastic mulch is relatively easy and would obviously lower the risk of the lift effect caused by the wind. However covering the plastic with soil decreases the efficiency of the mulch's characteristics; i.e. elevated temperature, high moisture retention... However utilizing this method will cause the soil to spread over the plastic forming an intermediate layer, thus blocking solar rays and simultaneously inhibiting the plastic photodegration process.

A small portion of energy is transmitted to the ground, the bulk portion is absorbed or reflected by the soil.

Idea B

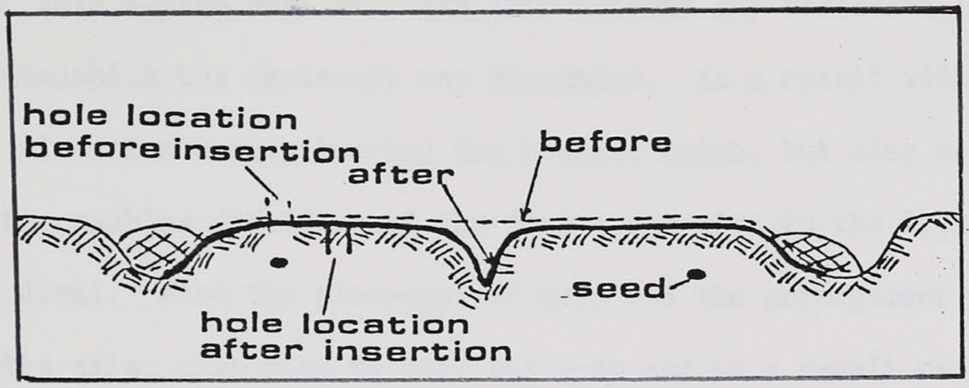


Fig. 9 Plastic insection in the center row.

Tucking the mulch in the center results in pulling the plastic on the edges and consequently making the plastic on the edge weaker. Also by using this system we run the risk of displacing the perforation in the plastic, thus creating a misalignment of the holes in the plastic with the planted corn seeds and thus run the risk of killing the plant.

Another possibility is if the bond between the soil and the plastic is strong enough we might tear the mulch when the pressure of the disk is applied. Maintaining a maximum surface of plastic mulch is of prime importance if we want the corn seedling to benefit from the plastic mulch's characteristics.

Another possibility is, if the plastic is edges are strong enough, the plastic might tear under disc pressure. Keeping the film area at its maximum is a great advantage, giving the maximum effects on the plants.

Idea C

This system does not take into account any obstacles (rock, root, ...etc)which the implement may encounter. As a result with this system, we run the risk of not only tearing the plastic mulch, but also causing serious damage to the machine (yielding of the frame) and also to the tool (bending of the disc). Also the placement of axle and the arrangement of the gauge wheel on the axle, give rise to soil build-up and as a result reduces the efficiency of the system.

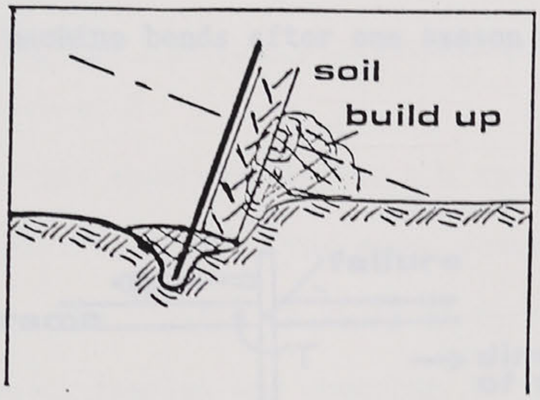


Fig. 10 Soil build up.

Idea D

A small change can make a big difference on the final result, and that's what a moldboard plow can do. As described on the preliminary ideas section the moldboard plow operates more efficiently than the scraper, it displaces more soil to the edge of the plastic mulch then the scraper. As a result reduces the risk of the plastic mulch being blow away by the wind. Another advantage is the relatively small energy needed to pull a moldboard plow as compared to pulling a scraper. It must be noted that the arm of the scraper, of the plastic mulch machine bends after one season of use.

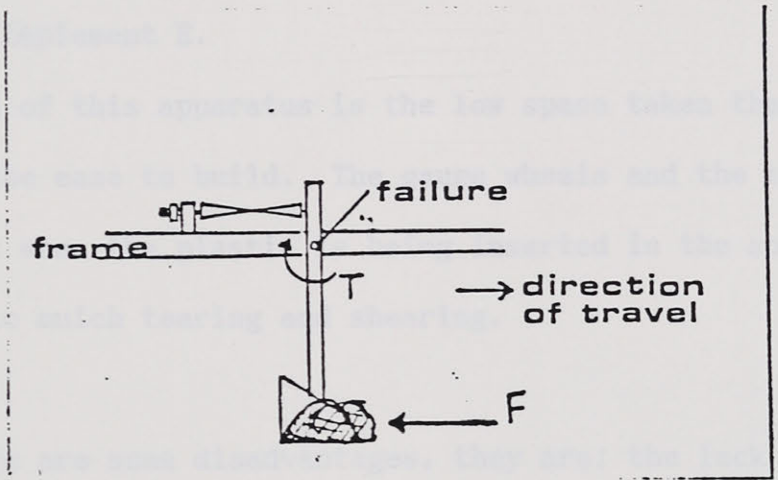


Fig. 11 Arm failure.

We can see on the figure the large amount of force applied on the scraper resulting in the arm to fail.

Idea E

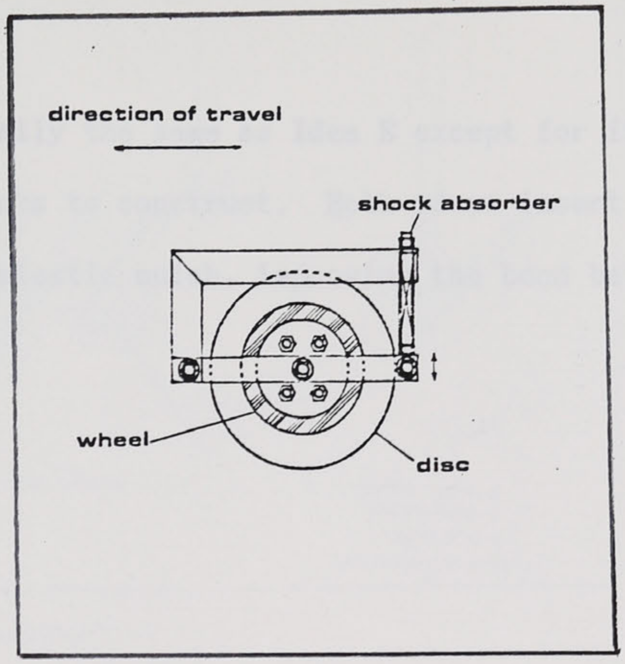


Fig. 12 Implement E.

The advantage of this apparatus is the low space taken that fits the requirements and the ease to build. The gauge wheels and the suspension system are used as guides when the plastic is being inserted in the soil. They reduce the risk of plastic mulch tearing and shearing.

However, there are some disadvantages, they are; the lack of flexibility in the "moving" parts, and the bulkiness of the design. Once installed on the machine the disc cannot be moved towards the middle or the outside unless mechanical changes are carried out.

Since plastic failure easily occurs, fine adjustments to the suspension level are performed, since we want to avoid any form of failure.

Theoretically the plastic should be inserted in the ground to provide better anchorage of the plastic in the soil, which is one of the main objectives of this project.

Idea F

Idea F is basically the same as **Idea E** except for its light structure and its labour requirements to construct. Both ideas insert the plastic vertically on the edges of the plastic mulch, improving the bond between the plastic and the soil.

Idea G

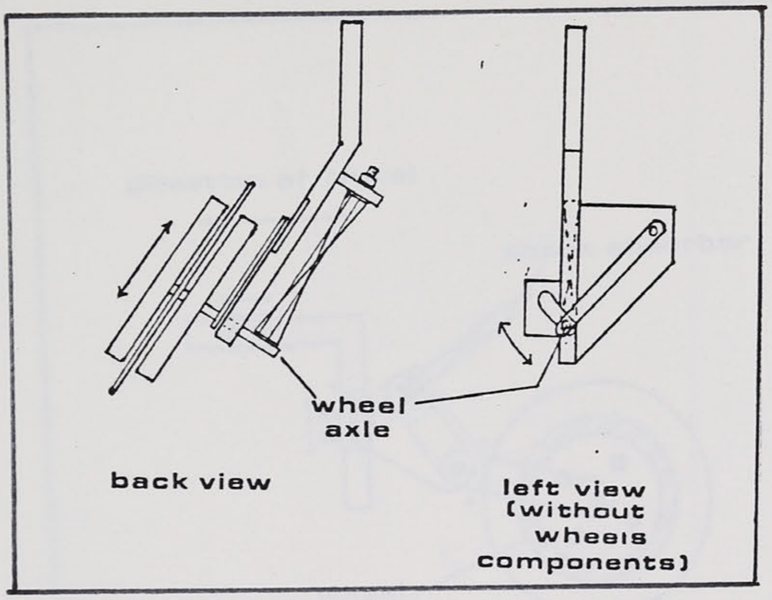


Fig. 13 Implement G.

This structure is not a sound engineering design, it has many eccentricities that will cause some components to bend or break eventually with fatigue.

Components close to the soil risk of soil a build up, thus reducing the efficiency of the implement. However, soil build up could be avoided if we were to mount a scraper onto the implement which would scrape off the excess soil.

Idea H

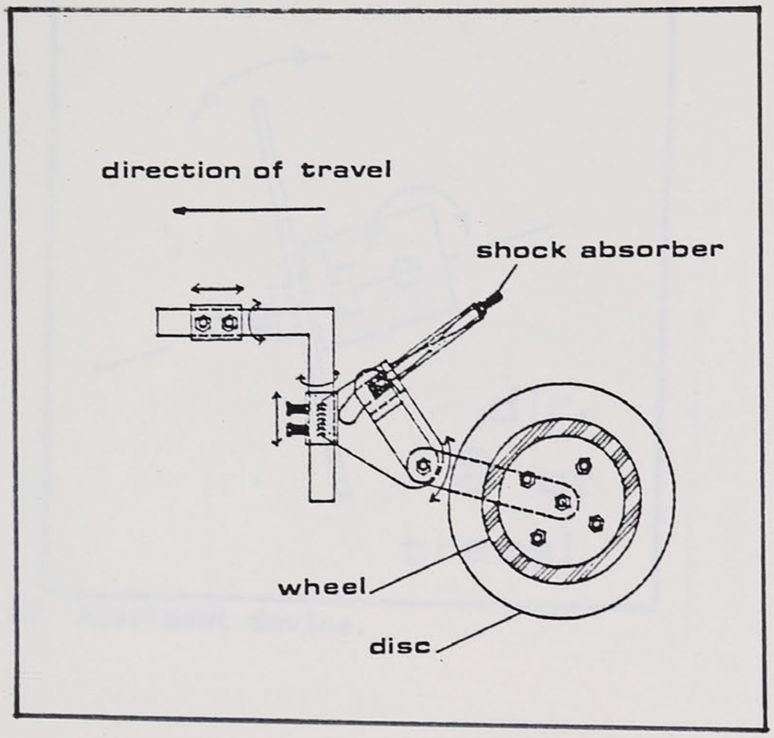


Fig. 14 Implement H.

This idea has a major advantage over others, its manoeuvrability with respect to the frame body, this as a result, facilitates the field tests.

A suspension system is provided for the same reasons.

Idea I

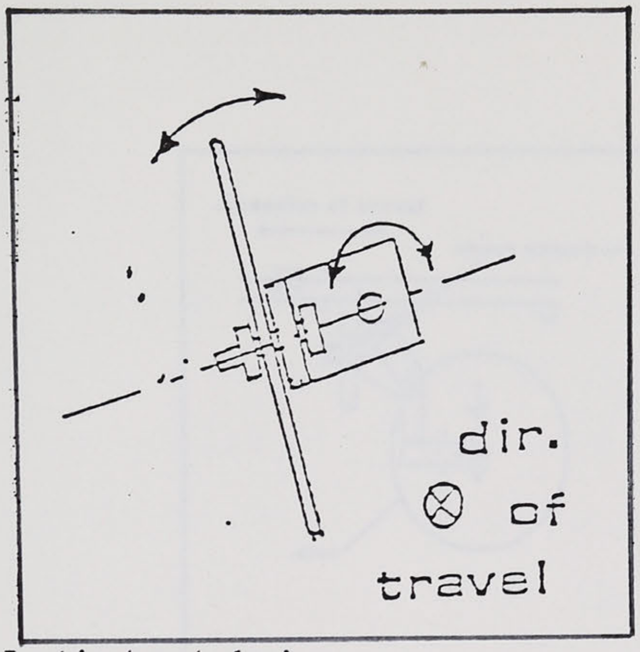


Fig. 15 Ajustment device.

This is an improved version of Idea H. This implement permits us to fine tune the tilt angle; providing for optimum plastic insertion.

Idea J

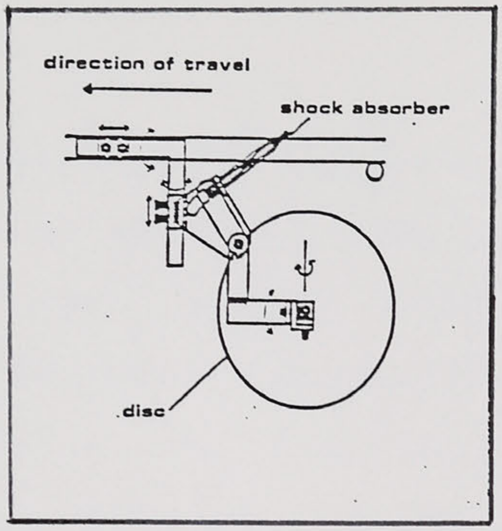


Fig. 16 Disc J vs Disc I.

With a larger diameter disc the probability of plastic failure is decreased. Since the area of contact with the plastic is larger the pressure is lower.

The second modification allows us to fine tune the specific angle in which we desire to have, for maximum efficiency.

CHAPTER 6

DISCUSSION AND RESULTS

6.1 DISCUSSIONS AND RESULTS

6.1 PLASTIC TEST #1

In March, we proceeded to perform a plastic test in the Agricultural Engineering shop of Macdonald College using a sample of plastic that Mr. Van Mil gave to us, a bin of dry sand, and a concave disc. We proceeded to try to insert the plastic. Once having performed the test it showed positive results and our concept of inserting the plastic with a disc implement would work. It showed us that we had to apply a certain pressure on the disc to insert the plastic. Also the thickness of the disc would be important because a thinner disc would shear the plastic and a thicker disc would require a great amount of pressure to be applied to the disc in order to insert the plastic to a respectable depth.

6.1.2 FIELD TEST WITH IMPLEMENT F

In implement F our primary goal was to observe if the inserting implement we designed and built would carry out its function, which was to insert the plastic at a depth of approximately 2". On the 19th of September at 08:00 a.m. we with Mr. Marc Boileau and his 60 hp John Deere tractor arrived to perform our initial test with our inserting implement. We encountered some delay due to the fact that the plastic mulch machine required a category 2 three pt hitch system.. At 08:15 a.m. we began to head out to the field where we were to commence our test. The field in which the test was going to be performed at is shown in figure # 1. We began to lay the plastic in a North-South direction and we observed that our implement was performing its required task of inserting the plastic. Unfortunately we had one mishap which was at certain distances the plastic was being sheared rather than plainly inserted. This could be due to the fact that the spring which was installed on our implement was too strong, and stiff. It must also be noted that the quality of the plastic in which we were now using was of not the same quality that we had used in the plastic test of last March. The plastic used in our present test was more fragile and had a much lower yield strength compared to our plastic of last March.

6.1.3 FIELD TEST WITH TOOL H

On the 21st of October 1988 at 8:00 o'clock we performed a test under a sunny and cool day. A John Deer tractor with a 60 hp engine was pulling the machine on a clay soil located on the Macdonald College property (See figure # 1)(Appendix).

The tool H composed of a disc and a gauge wheel was tested and the results were promising, although not perfect. The depth of insertion of the plastic was approximatively 1/4" which is too shallow to retain the plastic anchored in the ground. However the plastic was not tearing or stretching at any place and proved the feasibility of our concept of inserting the plastic.

An other problem was the mud accumulation on the gauge wheel reducing the efficiency of the implement.

Test trials were easier to do, mainly because of the new adjustable parts giving us more degrees of freedom.

Therefore the implement H was more efficient than the subsequent ones and aesthetically neater looking and not as bulky. The only further improvement, is to increase the depth of insertion of the plastic.

6.1.4 FIELD TEST WITH IDEA I

On October 24/1988 at 8:00 AM, we were commencing the field test with Idea I. It was raining and soil conditions were quite wet. We were performing this test on the field located in Figure 2 (Appendix). We were using a 60 hp John Deere tractor. In this field test we found that the depth of insertion was not adequate, meaning that the depth at which the disc was inserting the plastic was not sufficient to lock the plastic in place. However we were pleased to see that the plastic was not tearing when the disc was inserting the plastic and that all of the other components of the implement were functioning properly. The disc was only inserting the plastic at about 1/4" - 1/2" deep which was insufficient. We concluded that most probably with a larger diameter disc and retaining the same thickness of the disc we would be able to insert the plastic deeper (1" - 2") and as a result the plastic along the edges would be locked in place.

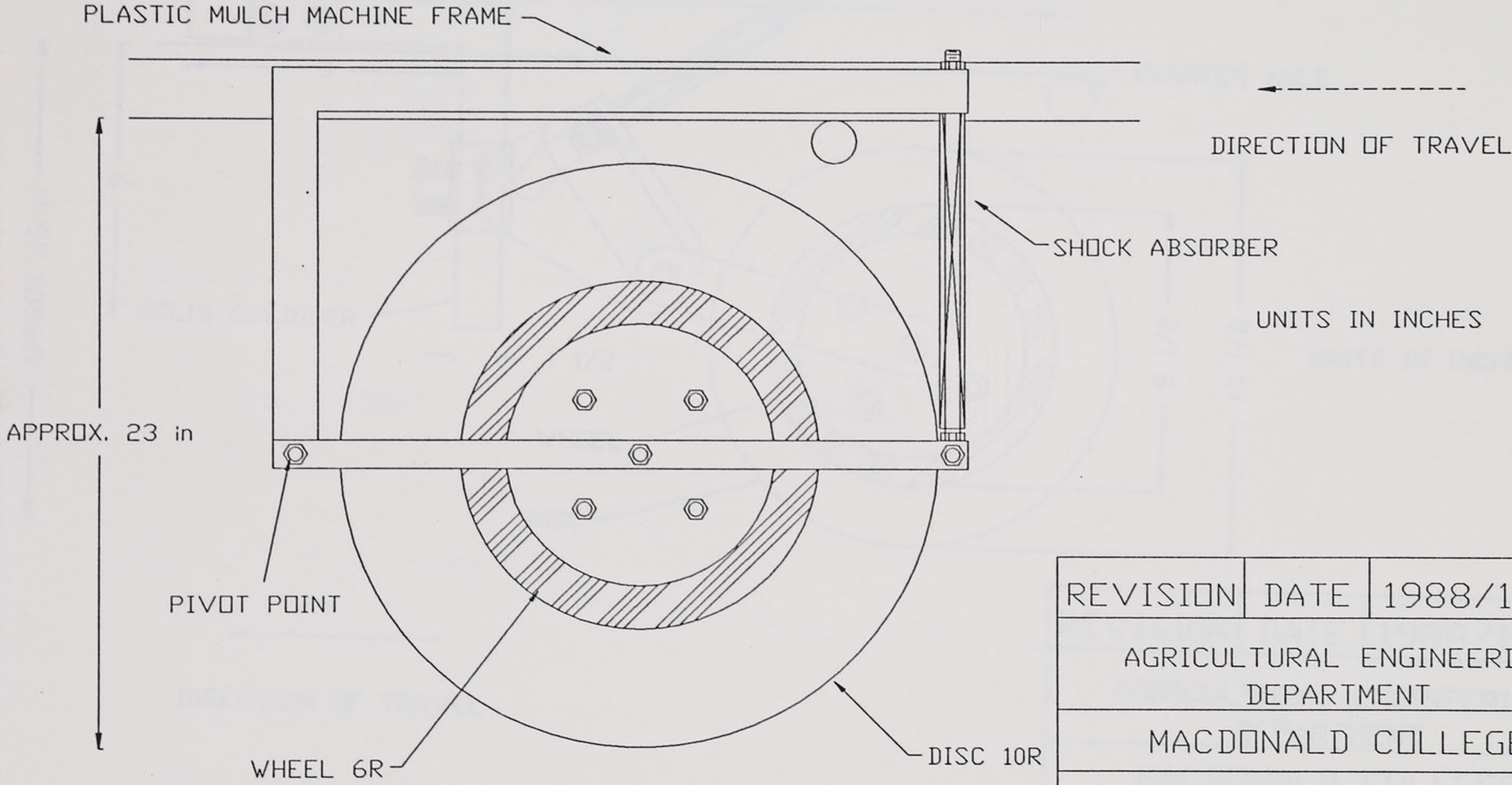
6.1.5 FIELD TEST WITH IDEA J

On November 8/1988, 4:00 PM we commenced our final test with our final design implement, Idea J. It was raining and it was cold. The soil conditions were very poor meaning that the soil was very wet, compacted, and uneven. We were performing our test on clay soil which had been previously sprayed with pig manure. This test was performed in the field located in figure # 1. This implement was modified with a larger diameter disc of 17.5". This gave us positive results in that the plastic was being inserted to a depth of 1" - 1 3/4" without shearing the plastic over most of the distance covered. The plastic was only being sheared at some places due to the unfavorable soil conditions. We also encountered problem with roll of plastic. When the plastic was unrolling, at a certain point in the roll, the plastic would get stuck and start tearing which is most probably due to a manufacturers defect. We still had problems with the gauge wheel which guides the unrolling of the plastic, it had a slow leak. Finally we were pleased to see that what we set out to achieve was accomplished. We were able to insert the plastic at a certain angle and to a specific depth and keep it locked in place.

6.2 PROBLEM REFINEMENT

From the analysis three designs are chosen: Idea F, H and J. In this step, it is necessary to make scale drawings with instruments to check the critical dimensions that cannot be accurately shown in sketches in the preliminary ideas section. Therefore, the three next pages are dedicated to Ideas F, H and J scale drawings.

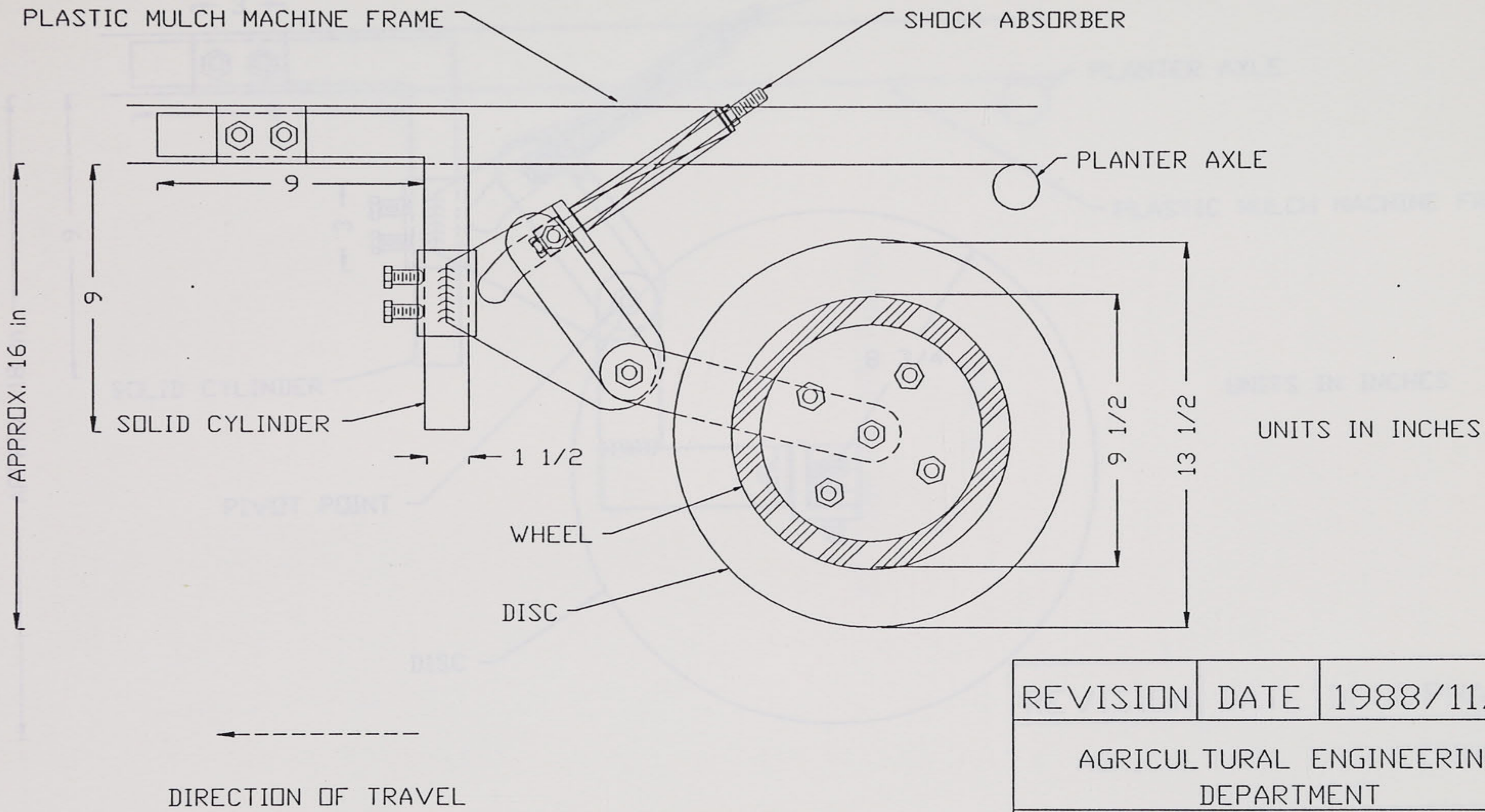
PROBLEM REFINEMENTS



UNITS IN INCHES

REVISION	DATE	1988/11/29	
AGRICULTURAL ENGINEERING DEPARTMENT			
MACDONALD COLLEGE			
IMPLEMENT FOR PLASTIC MULCH MACHINE			
SCALE	DRAWN	G. SZARAZ	DWG. #F
	DRAWN	N. ZEMANCHIK	
	REVISION		

PROBLEM REFINEMENTS



REVISION	DATE	1988/11/29

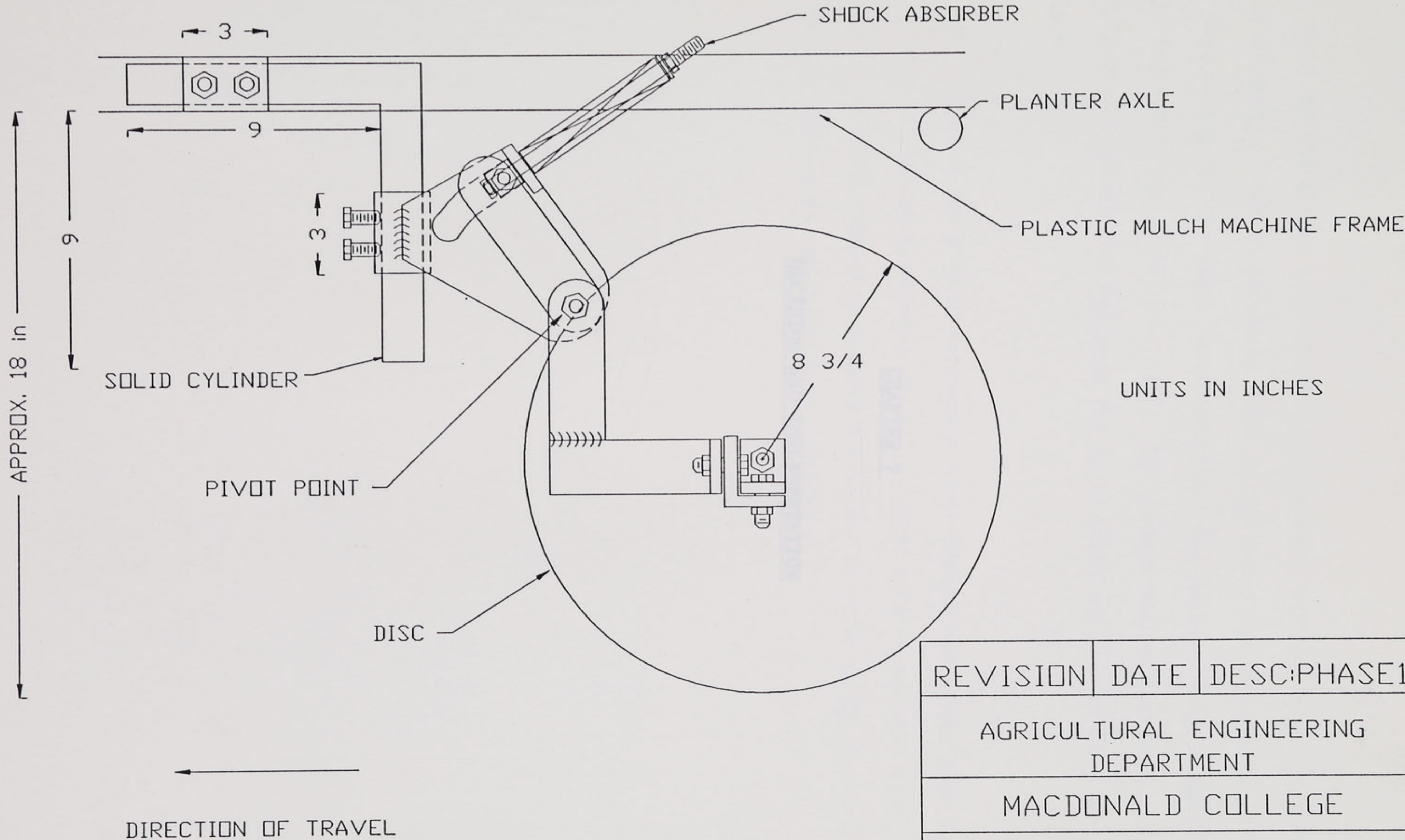
AGRICULTURAL ENGINEERING DEPARTMENT

MACDONALD COLLEGE

IMPLEMENT FOR PLASTIC MULCH MACHINE

SCALE	DRAWN	G. SZARAZ	DWG. #H
	I.D. #	8514676	
	REVISION	N. ZEMANCHIK	

PROBLEM REFINEMENTS



REVISION	DATE	DESC:PHASE1	
AGRICULTURAL ENGINEERING DEPARTMENT			
MACDONALD COLLEGE			
IMPLEMENT FOR PLASTIC MULCH MACHINE			
SCALE	DRAWN	G.SZARAZ	DWG. #J
	DRAWN	N.ZEMANCHIK	
	REVISION		

CHAPTER 7

DECISION AND IMPLEMENTATION

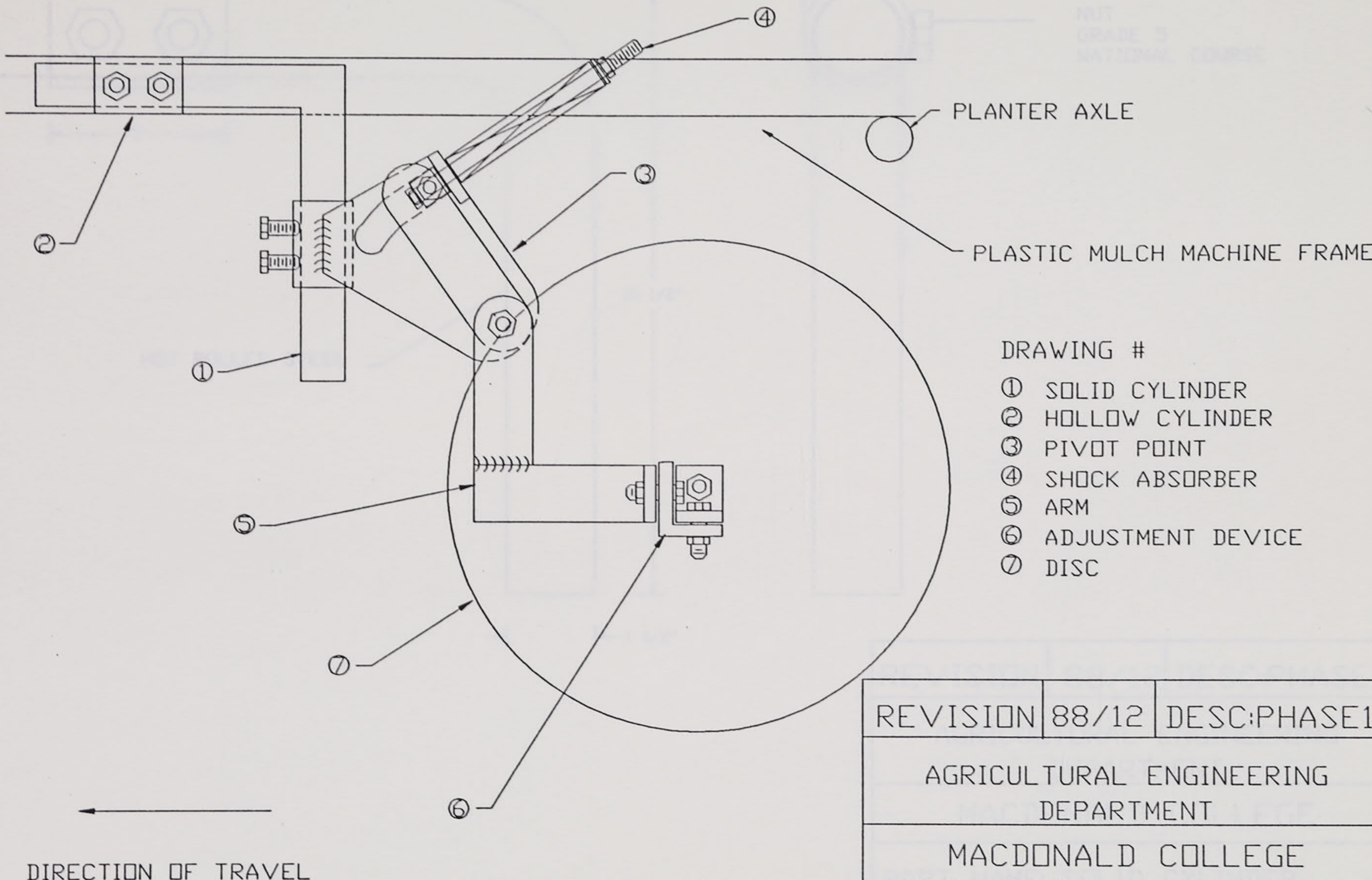
7.1 DECISION

Once the design has been conceived, developed, refined, and analyzed, a decision must be made to determine which design among the three retained, is the most worthy for the final implementation. The decision step is based on field tests done during the year 1988. The authors want to remind the reader that those implements were designed for field tests and not for long period utilization.

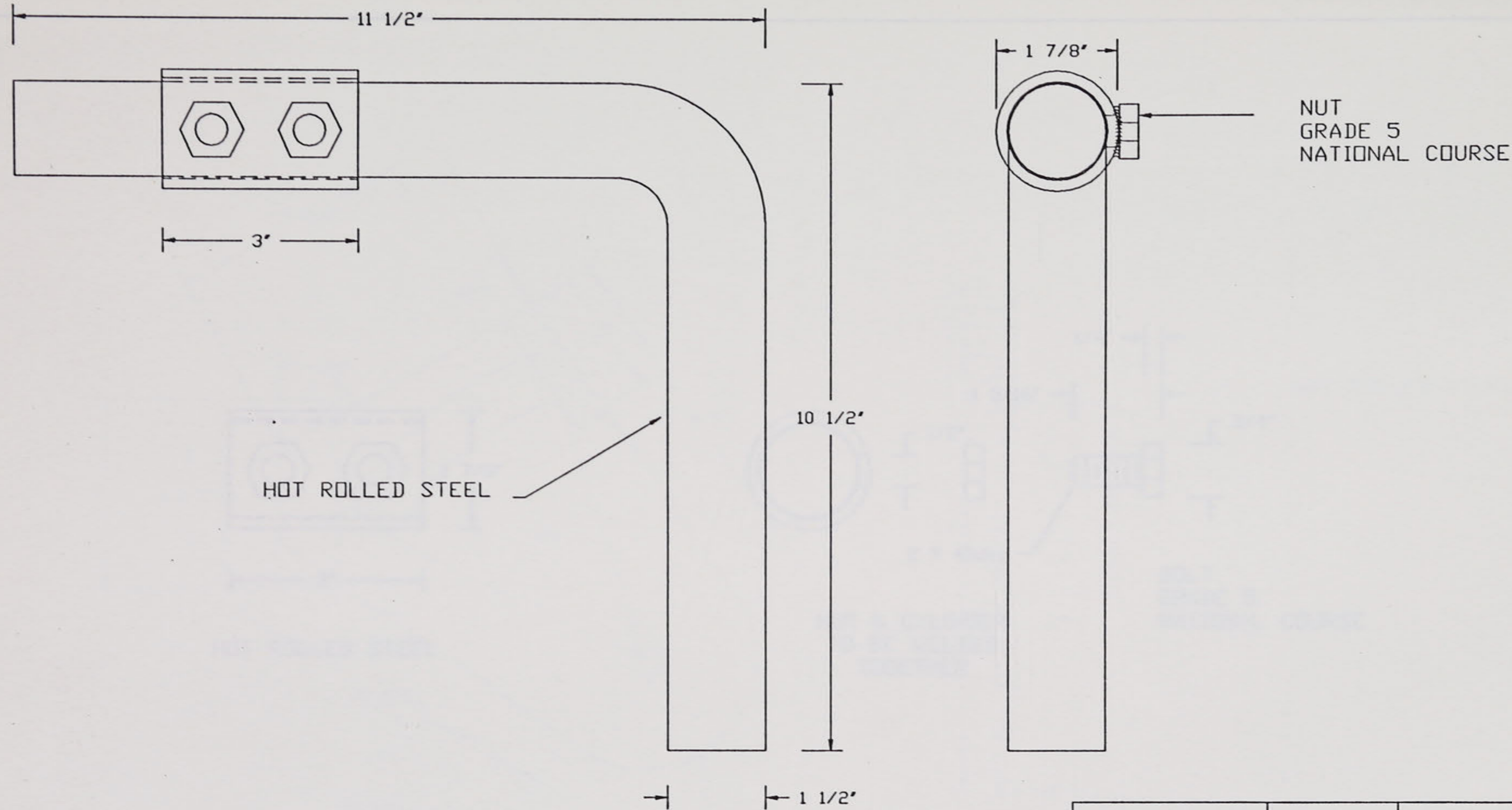
As defined in the problem refinement three designs were kept; IDEA F, H and K. One of the aforementioned, K, was accepted after successful test results. To avoid reduncy we suggest the reader to refer to the discussion and results section for the basis of our decision.

IMPLEMENTATION

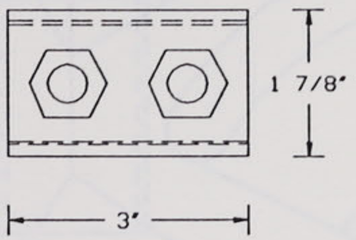
IMPLEMENTATION



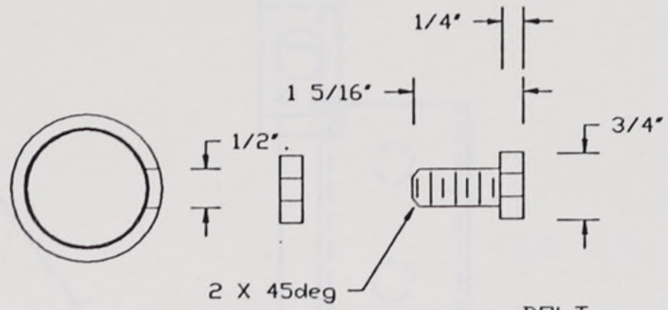
REVISION	88/12	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
FINAL IMPLEMENT		
DRAWN	G.SZARAZ	DWG. #J
DRAWN	N.ZEMANCHIK	



REVISION	88/12	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: SOLID CYLINDER		
DRAWN	G.SZARAZ	DWG #1
DRAWN	N.ZEMANCHIK	SHEET 2 OF 8



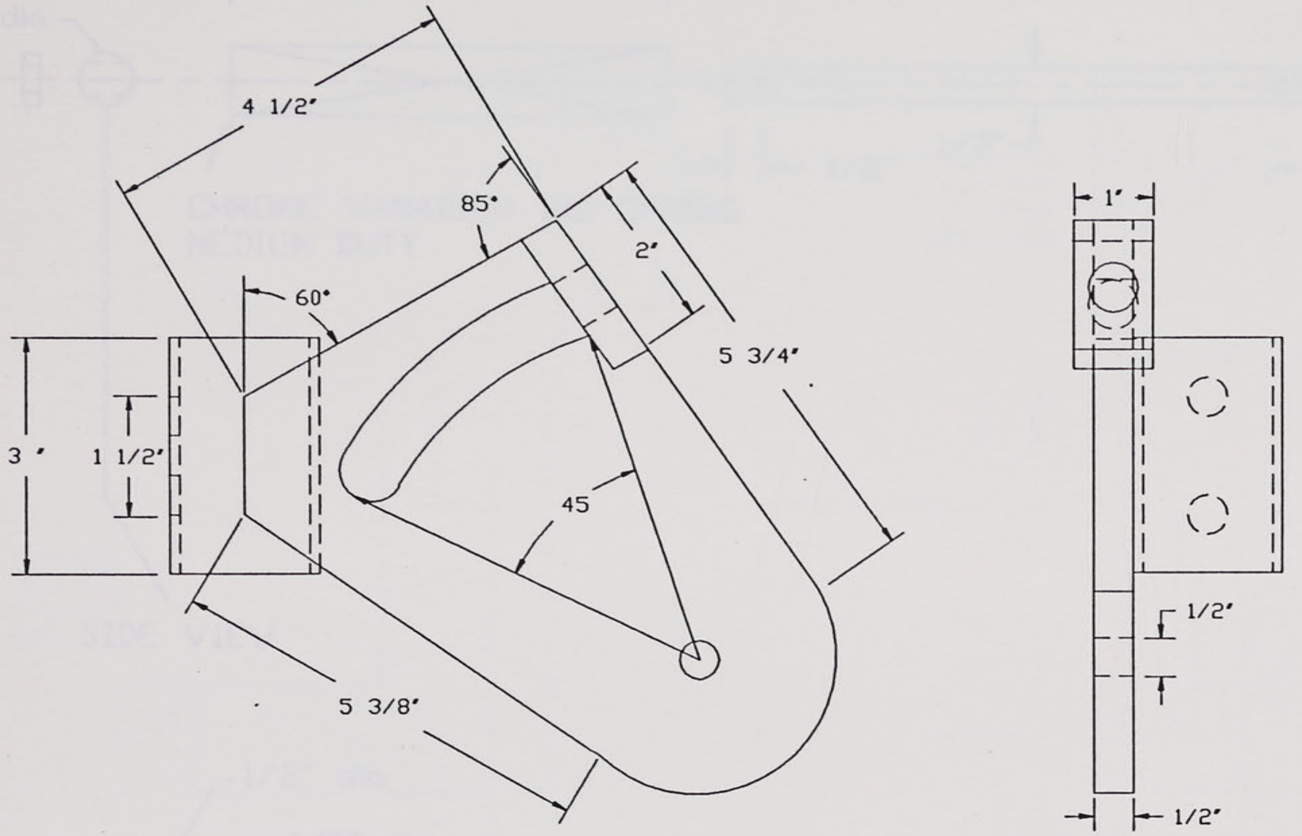
HOT ROLLED STEEL



NUT & CYLINDER
TO BE WELDED
TOGETHER

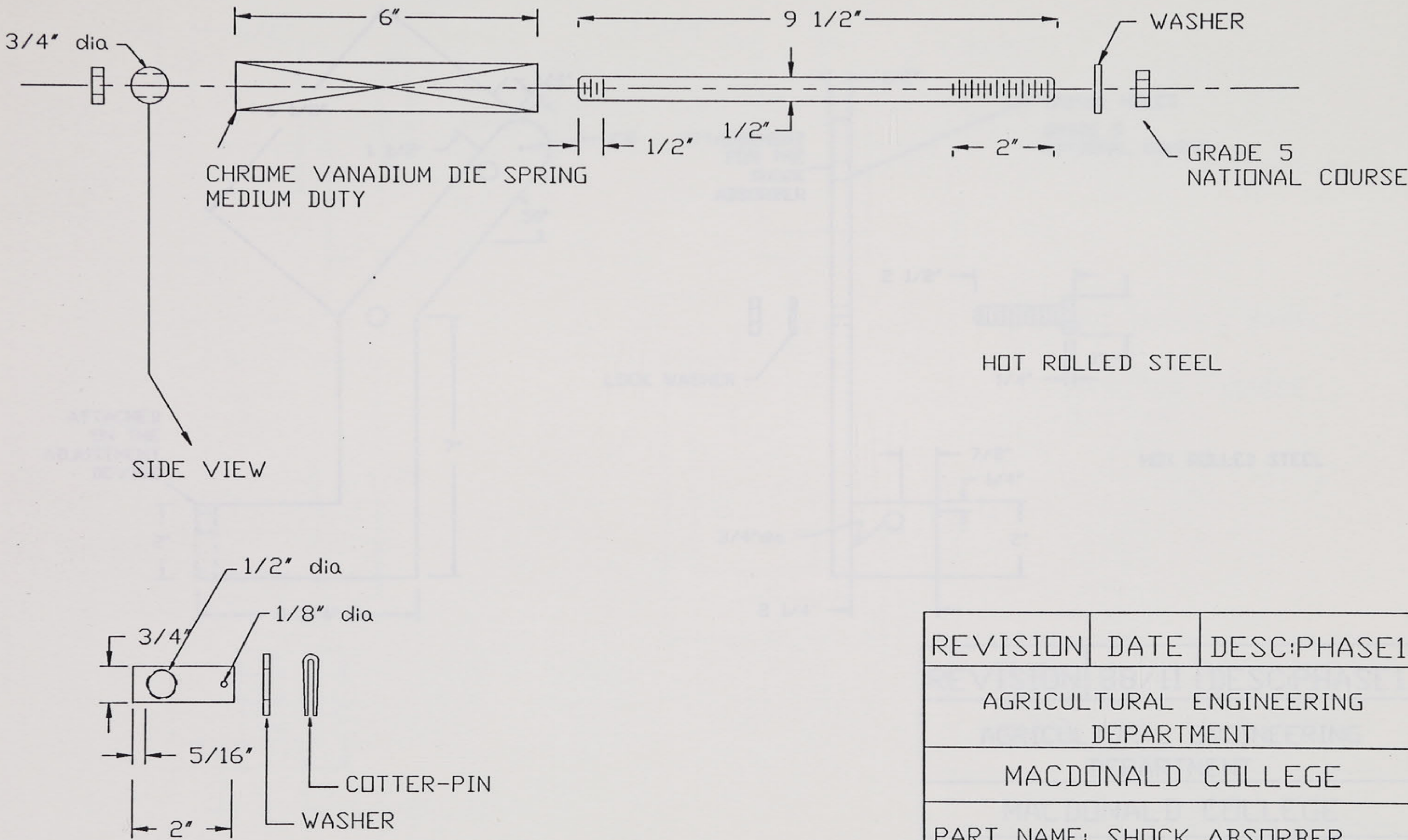
BOLT
GRADE 5
NATIONAL COURSE

REVISION	DATE	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: HOLLOW CYLINDER		
DRAWN	G.SZARAZ	DWG #2
DRAWN	N.ZEMANCHIK	SHEET 3 OF 8

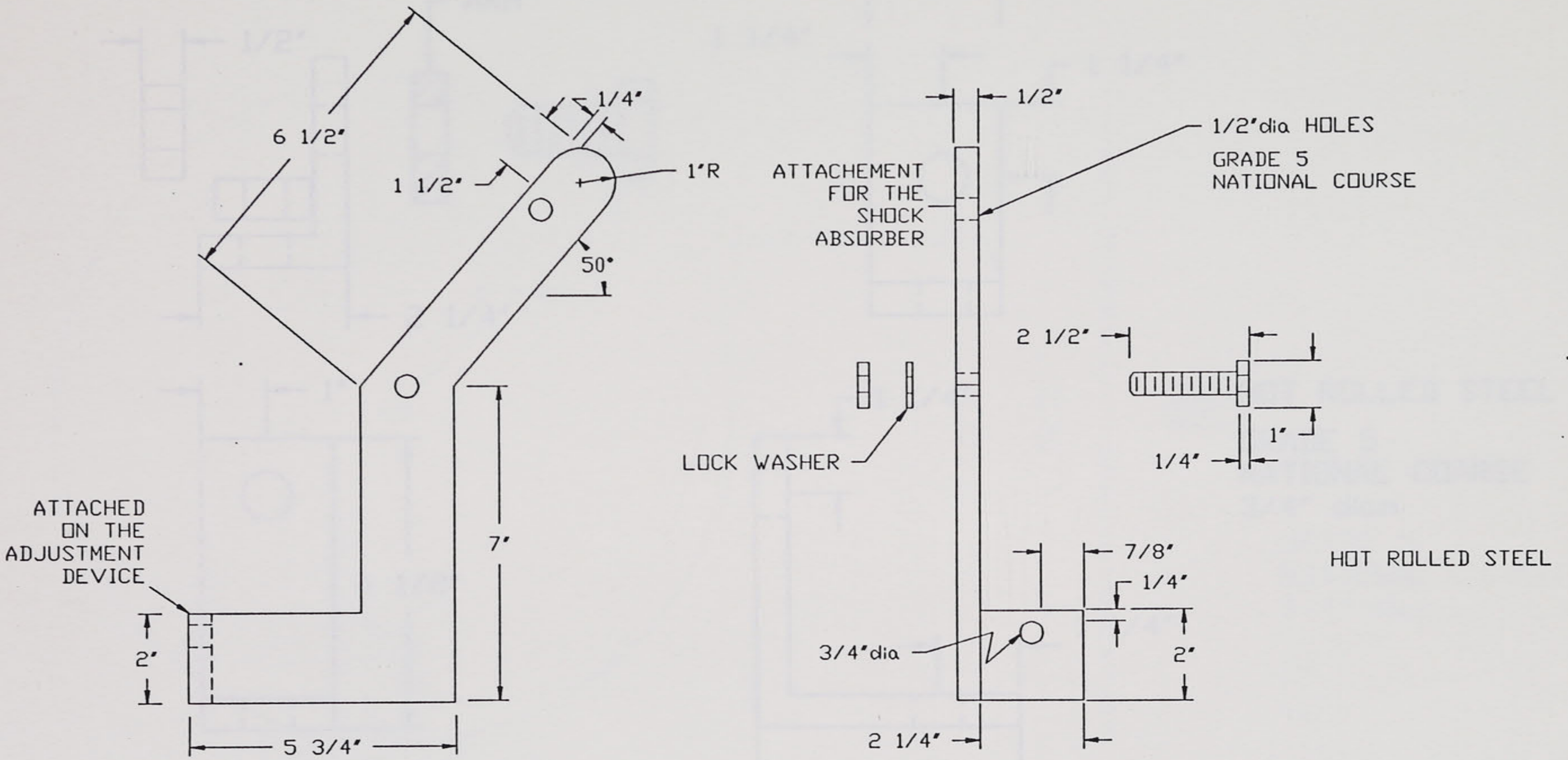


HOT ROLLED STEEL

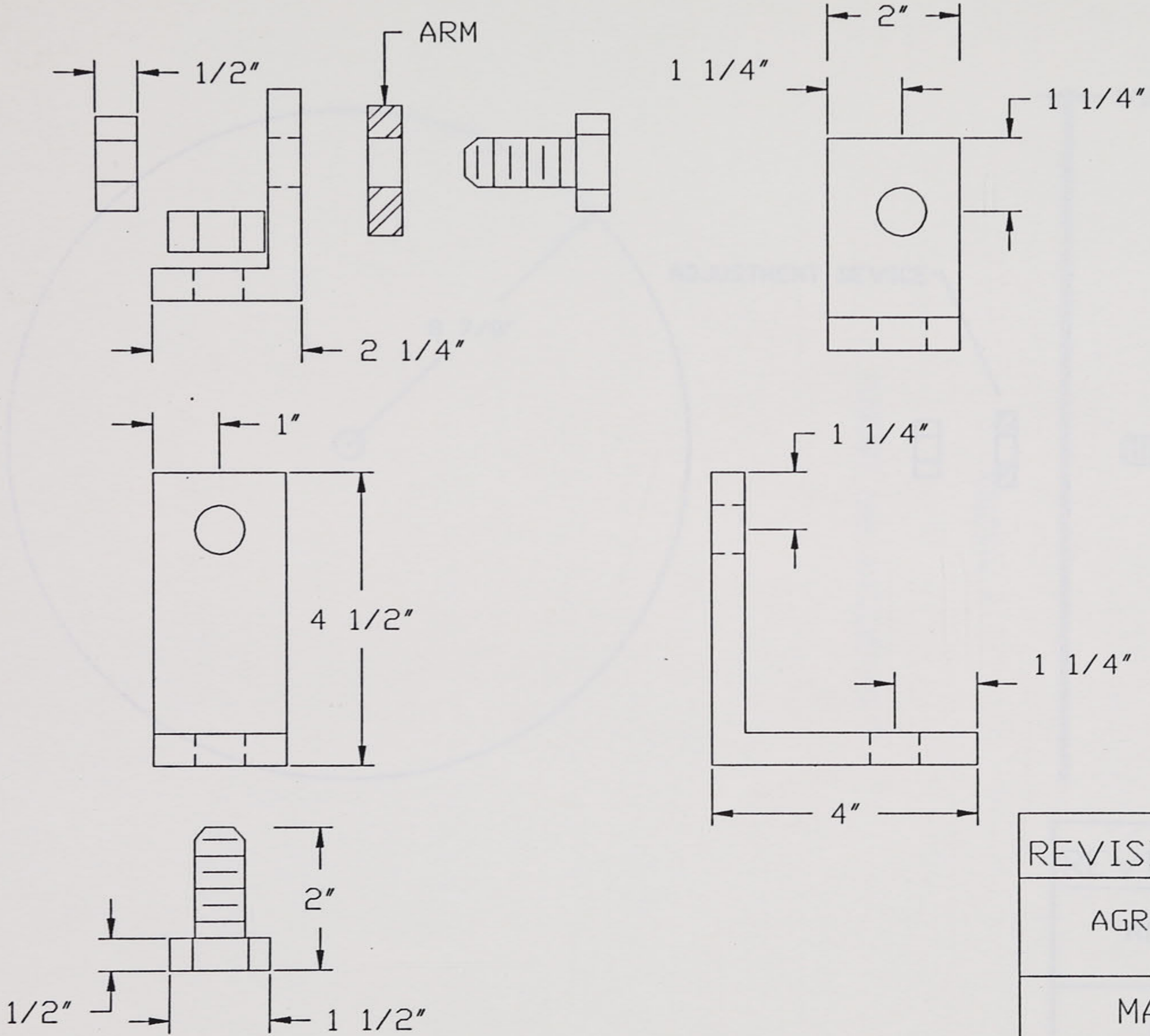
REVISION	DATE	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: PIVOT POINT		
DRAWN	G.SZARAZ	DWG #3
DRAWN	N.ZEMANCHIK	SHEET 4 OF 8



REVISION	DATE	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: SHOCK ABSORBER		
DRAWN	G.SZARAZ	DWG #4
DRAWN	N.ZEMANCHIK	SHEET 5 OF 8



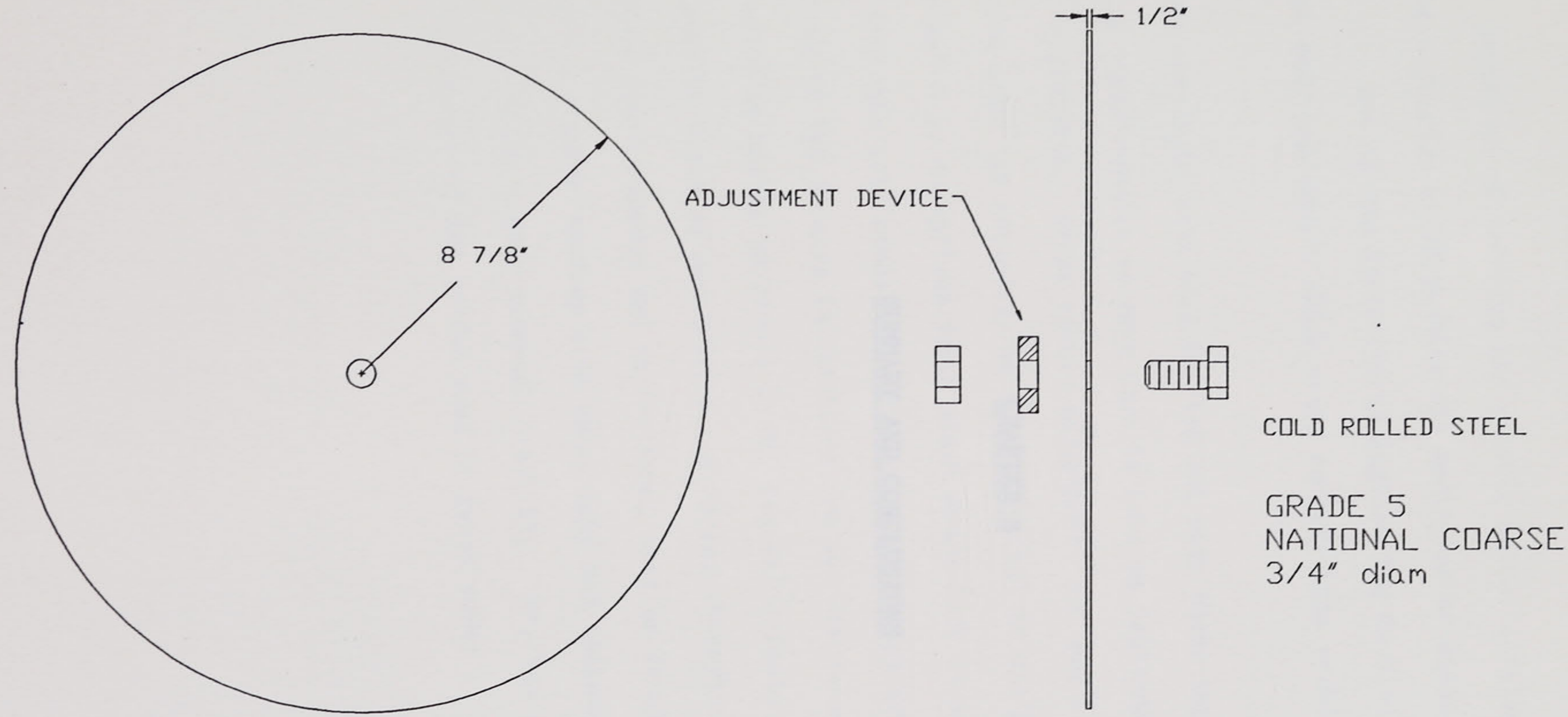
REVISION	88/11	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: ARM		
DRAWN	G.SZARAZ	DWG #5
DRAWN	N.ZEMANCHIK	SHEET 6 OF 8



HOT ROLLED STEEL

GRADE 5
NATIONAL COARSE
3/4" diam

REVISION	88/12	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: ADJUSTMENT DEVICE		
DRAWN	G.SZARAZ	DWG #6
DRAWN	N.ZEMANCHIK	SHEET 7 OF 8



REVISION	88/12	DESC:PHASE1
AGRICULTURAL ENGINEERING DEPARTMENT		
MACDONALD COLLEGE		
PART NAME: DISC		
DRAWN	G.SZARAZ	DWG #7
DRAWN	N.ZEMANCHIK	SHEET 8 OF 8

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.0 SUMMARY AND CONCLUSIONS

The objective of reducing the plastic mulch "lifting" was achieved by improving a plastic mulch machine via modifying or adding components or tools. Use of the Agricultural Engineering Machine Shop allowed us to construct many implements which would rectify this problem.

Numerous field test were carried out with these implements and after observing these results we were able to have an implement which satisfied our primary objectives. After minute adjustments our and a final field test with IDEA J (on page in appendix) we concluded that it was possible to insert the plastic mulch to an optimum depth which would lock it in place. Of course, taking that the soil conditions at Macdonald College compared to the soil conditions of the farmers in Verchères are not the same, the implement that we built would be easily adaptable to Mr. Van Mil's field conditions just by adjusting the depth of penetration and spring strength. Now that Mr. Van Mil has before him a concept and an implement that is feasible he will be able to cultivate a greater surface area using this new technology with a peace of mind and also a attain higher economic stability. Mr. Van Mil has now freed himself from the barrier of the golden road of sweet corn!

CHAPTER 9

SUGGESTIONS FOR FURTHER WORK

SUGGESTIONS FOR FURTHER WORK

The plastic mulch machine can still stand some improvements, all field tests carried out at Macdonald College were to prove the concept of a disc inserting plastic in a clay soil for less than a hundred feet with an experimental apparatus.

Those experiments are not representative of a large scale farm land and should be taken into consideration. Therefore we recommend Mr. Van Mil to perform further field tests i.e. to build two disc implements with suitable journal bearing and two pressure wheels at the rear of the machine in order to compress the soil to a firmly compacted state. After which plant approximately 30 acres with sweet corn to verify that it functions properly.

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APPENDICES

Senior Project January 28/88

Soil Survey of Mr. Gabriel Mill soils

600 Acres of cultivated land

Type of soil: St-Marcel

Symbol and characteristics: MA5 - St-Marcel

Clay-Sand

Classification I.T.C.: 2 DW

Distribution: This type of soil is distributed principally in a south-west direction, also along the banks of the St.Lawrence river in between the Verchères and Varennes counties.

Utilization: The type of cultivation, this type of soil offers is as follows:

We can cultivate: corn

cereals

ground cover plants

pasture

Topography: gently rolling (0.3%)

Drainage: poorly drained

Any stones?: few stones

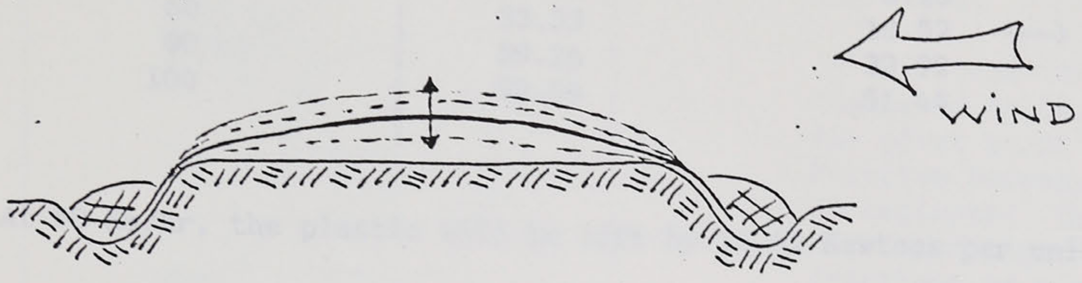
Subclassification: Glaysol

Type of soil: St-Marcel

General Description

Horizon	Depth	Description
AP	0-33 cm	Clay dark brown: fine granular structure, poor friable and firm when soil relatively moist; not porous.
BG 1	33-52 cm	Clay-loam: grayish brown mottles are very numerous small and distinct. Structure is subangular polygonic very fine; friable when moist.
BG 2	52-85 cm	Clay's olive-grey; numerous mottles that are very small and very distinct; structure polygonic subangular fine, reliable; very friable when moist and quite porous, slight alkaline.
CG	85 -	Heavy clay; olive-grey color, numerous mottles that are very small and very distinct structure is polygonic and quite angular; firm when moist and very porous and slightly alkaline.

Lift effect on the plastic due to wind



Lifting force = $C_l A \frac{U^2}{2}$

C_l = lift coefficient
A = area covered by the plastic
  = air density
U = wind velocity

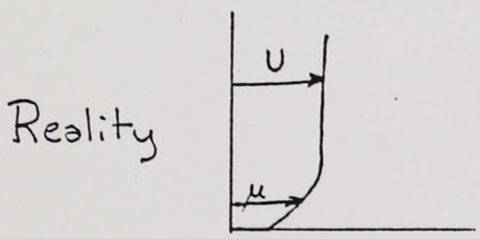
From fluid mechanics (7th edition) of McGraw-Hill Book Col., the lift coefficient with an angle of attack equal to 0°, is 0.2.

25° = 1.2 $Kg/_{m3}$

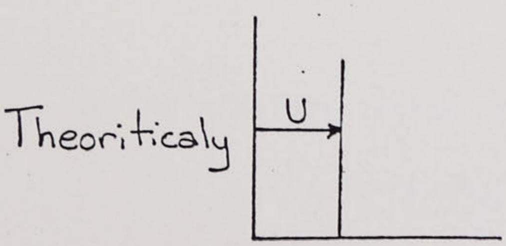
$\frac{F_L}{A}$ = (0.2(1.2 $\frac{Kg}{m^3}$ U^2

$\frac{F_L}{A} = 0.12\ U^2$

There is a loss of drag due to shear stress in the boundary layer, called skin friction.

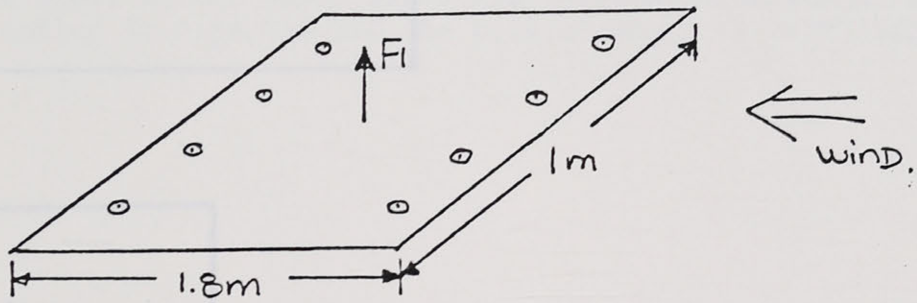


Therefore, the wind velocity will be lower at the ground level. However in this case will assume U to be constant



U ($Km/_{hr}$)	$Fl/_A$ ($N47m^2$)	$(F_L/A)/1.80m = F_L$/unit length(N/m)
20	3.70	2.06
40	14.81	8.23
60	33.33	18.52 ——> ≈ 1.27 $lb/_{ft}$
80	59.26	32.92
100	92.59	51.44

At 60 Km/hr, the plastic will be lift by 18.52 Newtons per unit length.



This lifting force is a major problem for Mr. Gabriel Van Mill in Verchères, the wind pulls the plastic out of the edges.

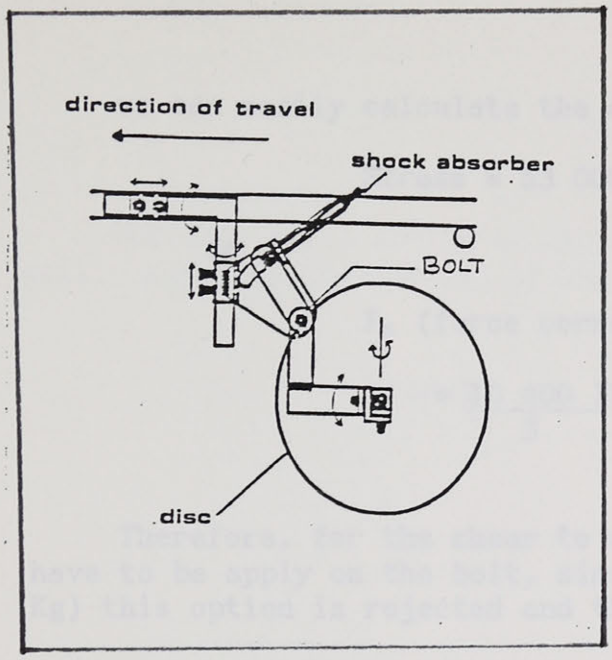


Fig. 1

Shear stress of the bolt 1/2 in - 13 unc the pivot point (see figure 1).

In this case the bolt is not tightened to its maximum allowing the pivot point to rotate. Friction between the two plates is neglected, thus, the value of the force required to overcome frictions is zero.

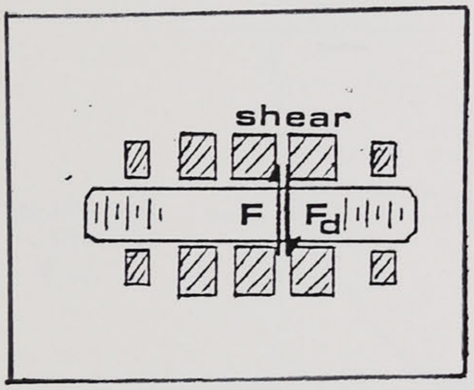


Fig. 2. Two opposite force resulting in a shear.

For the shear plane involved the force that can be transmitted to the bolt is equal to SysA, where A is the area of the bolt at the shear plane - in this case, $\pi\ (0.5)^2/4 = 0.196\ in^2$. Taking advantage of the fact that the distortion-energy theory gives a good estimate of shear yield strength for ductile metal.

$$Sys = 0.58\ Sy$$

were, Sy = 92 Ksi (Juvinall, 1983)

therefore Sys = 0.58 (92 Ksi) = 53 Ksi

thus, for yielding of the shear plane,

$$F = (.196\ in^2)(53000\ psi)$$

$$= \underline{10\ 400\ lb}$$

Using a safety factor of three N = 3, which is by definition equal to:

$$N = \frac{\text{significant strength of the material}}{\text{corresponding significant stress due to normal load. (Stress)}}$$

we can easily calculate the denminator

Stress = 53 000 psi/3 = 17.7 Ksi

or

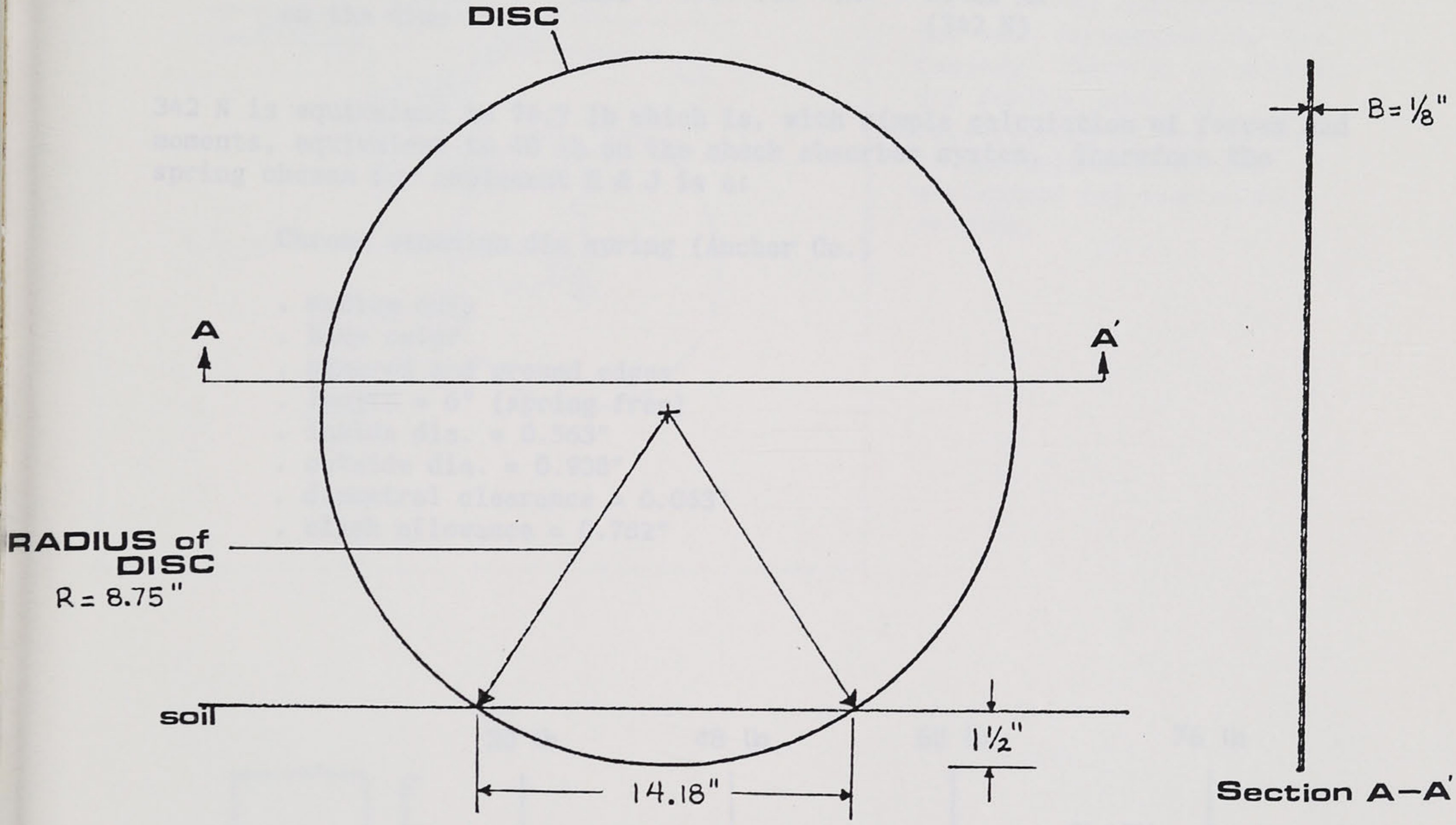
F_s (force corresponding to the stress)

$$= \frac{10\ 400\ \text{lb}}{3} = \underline{3\ 4617\ \text{lb}}$$

Therefore, for the shear to occur a force or a weight of 3467 lb would have to be apply on the bolt, since the total machine weight is 1 760 lb (800 Kg) this option is rejected and the bolt strength is sufficient.

Force on spring

The only force acting on the spring is from the disc insertion in the soil. Assuming the portion of the disc in soil to be a small foundation,



the design pressure is,

$q_{des} = 1/2 \ BN_{\gamma} + cN_c + q\ N_q$

q_{des} = Design pressure
=
B = Disc thickness
N_{γ} = friction factor
C = cohesion (KPa)
N_c = cohesion factor
q = overberm pressure (KPa)
N_q = overberm factor

q_{des} = 1/2 (15 kn/m^3)(0.00318m)(3) + (20KPa)(15)

= 300 KPa (kn/m^2)

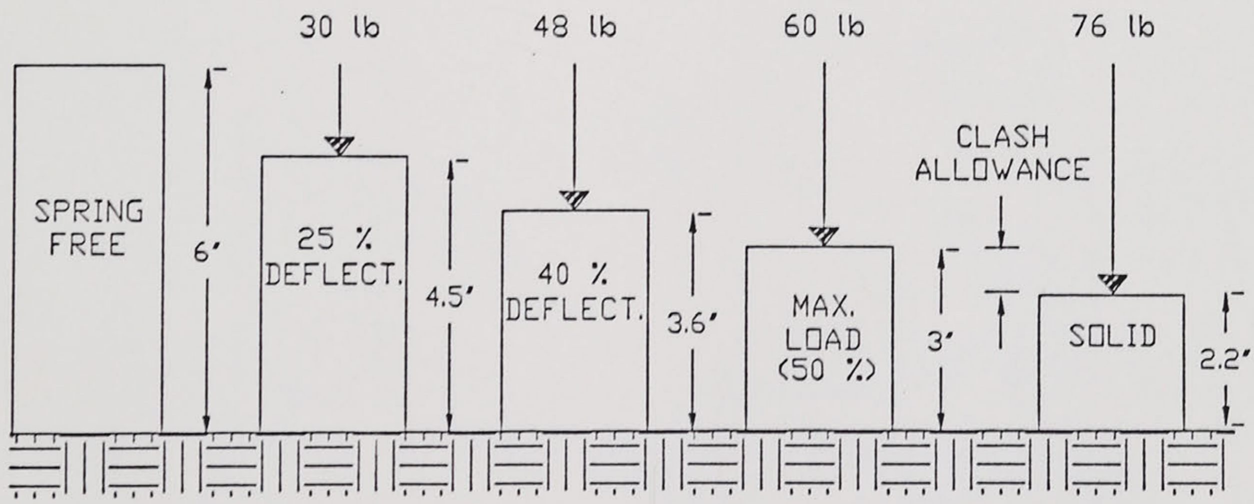
area = A = (0.00318m)(0.3601m) = 1.14 (10^{-3})m^2

Force acting on the disc = F = q_{des} X 1.14 (10^{-3})m^2 = 0.432 KN (342 N)

342 N is equivalent to 76.7 lb which is, with simple calculation of forces and moments, equivalent to 40 lb on the shock absorber system. Therefore the spring chosen for implement H & J is a:

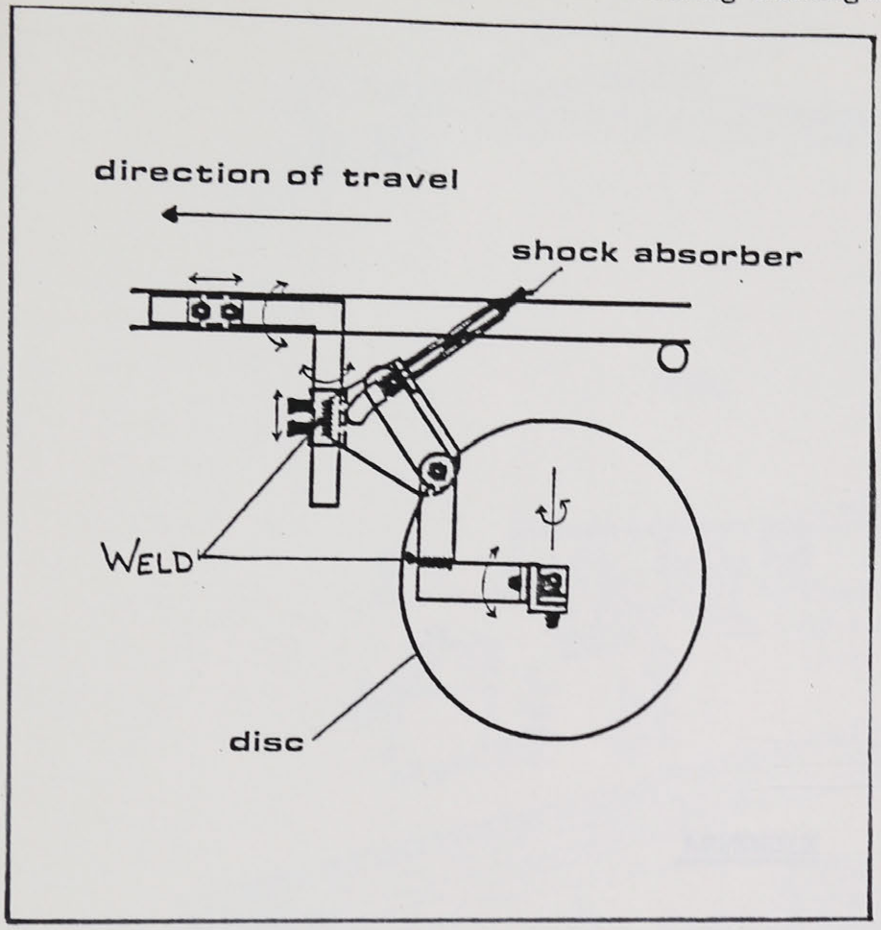
Chrome vanadium die spring (Anchor Co.)

- medium duty
- blue color
- squared and ground edges
- length = 6" (spring free)
- inside dia. = 0.563"
- outside dia. = 0.938"
- diametral clearance = 0.063"
- clash allowance = 0.782"



REPRESENTATION OF SPRING LOAD

Welding strength



The welding rods used in this project are 7018 rods that can sustains 70 000 lb in tensile strength. Those rods are commonly used for hot rolled steel welding at the Agricultural Engineering shop, and were recommended by Ray Cassidy. However we suggest for further work the calculations of the stresses at the welded areas for mechanical and economical reasons.

APPENDIX

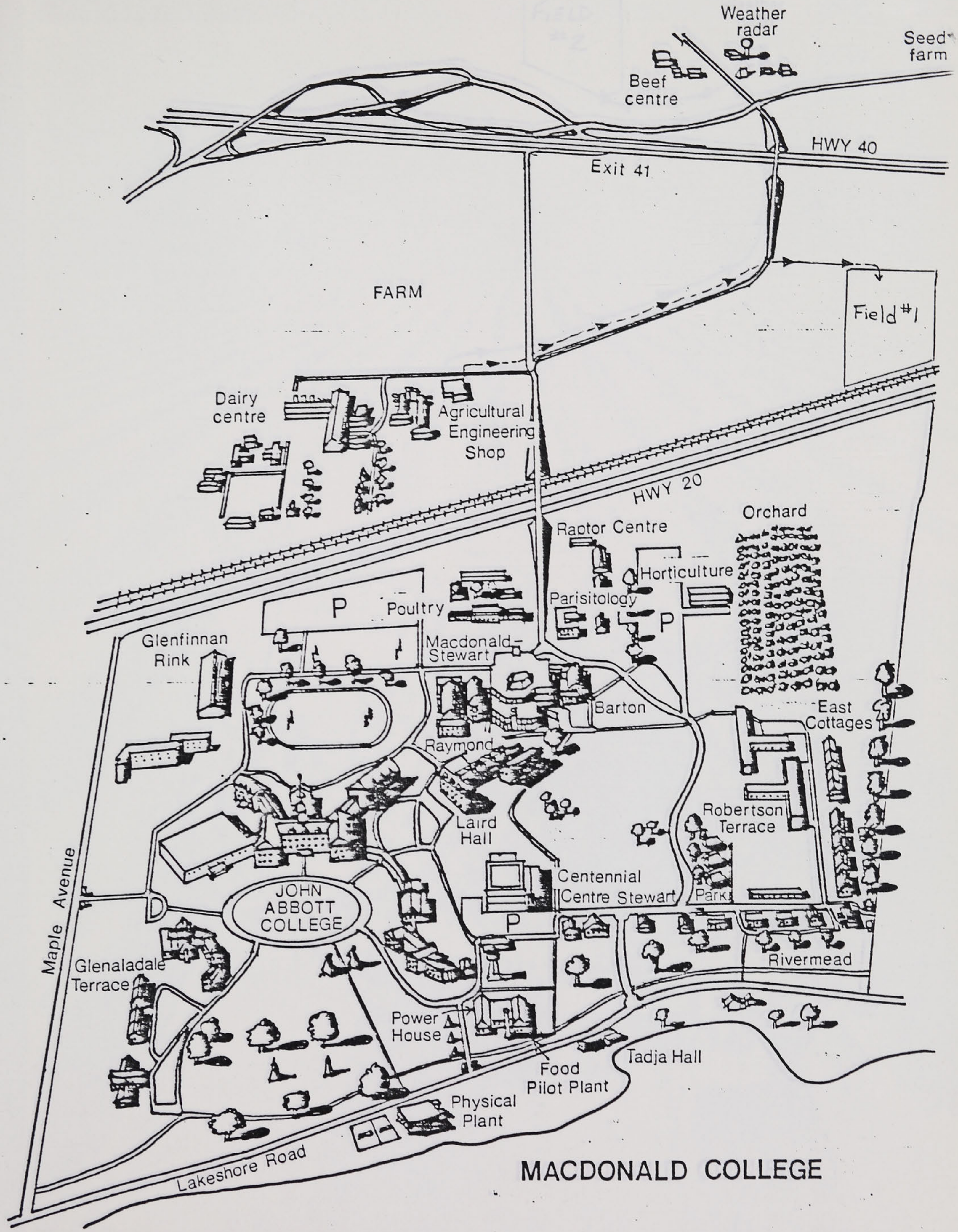

Weather radar
Seed farm
Beef centre
HWY 40
Exit 41
FARM
Field #1
Dairy centre
Agricultural Engineering Shop
HWY 20
Orchard
Raptor Centre
Horticulture
Parisitology
P
Poultry
P
Glenfinnan Rink
Macdonald-Stewart
Barton
East Cottages
Raymond
Laird Hall
Robertson Terrace
Maple Avenue
Centennial Centre Stewart
Park
JOHN ABBOTT COLLEGE
P
Glenaladale Terrace
Rivermead
Power House
Tadja Hall
Food Pilot Plant
Physical Plant
Lakeshore Road
MACDONALD COLLEGE

FIGURE #1

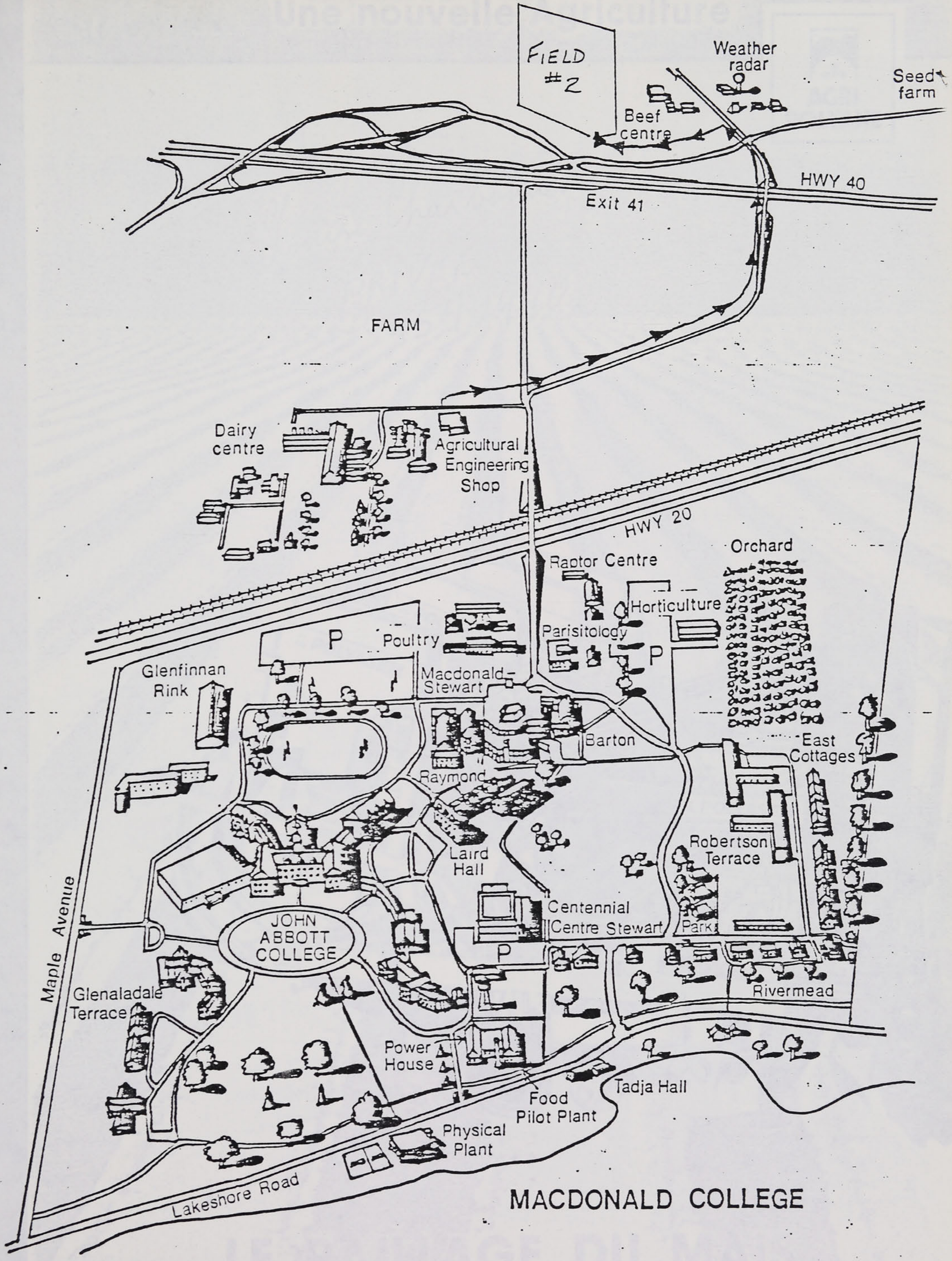
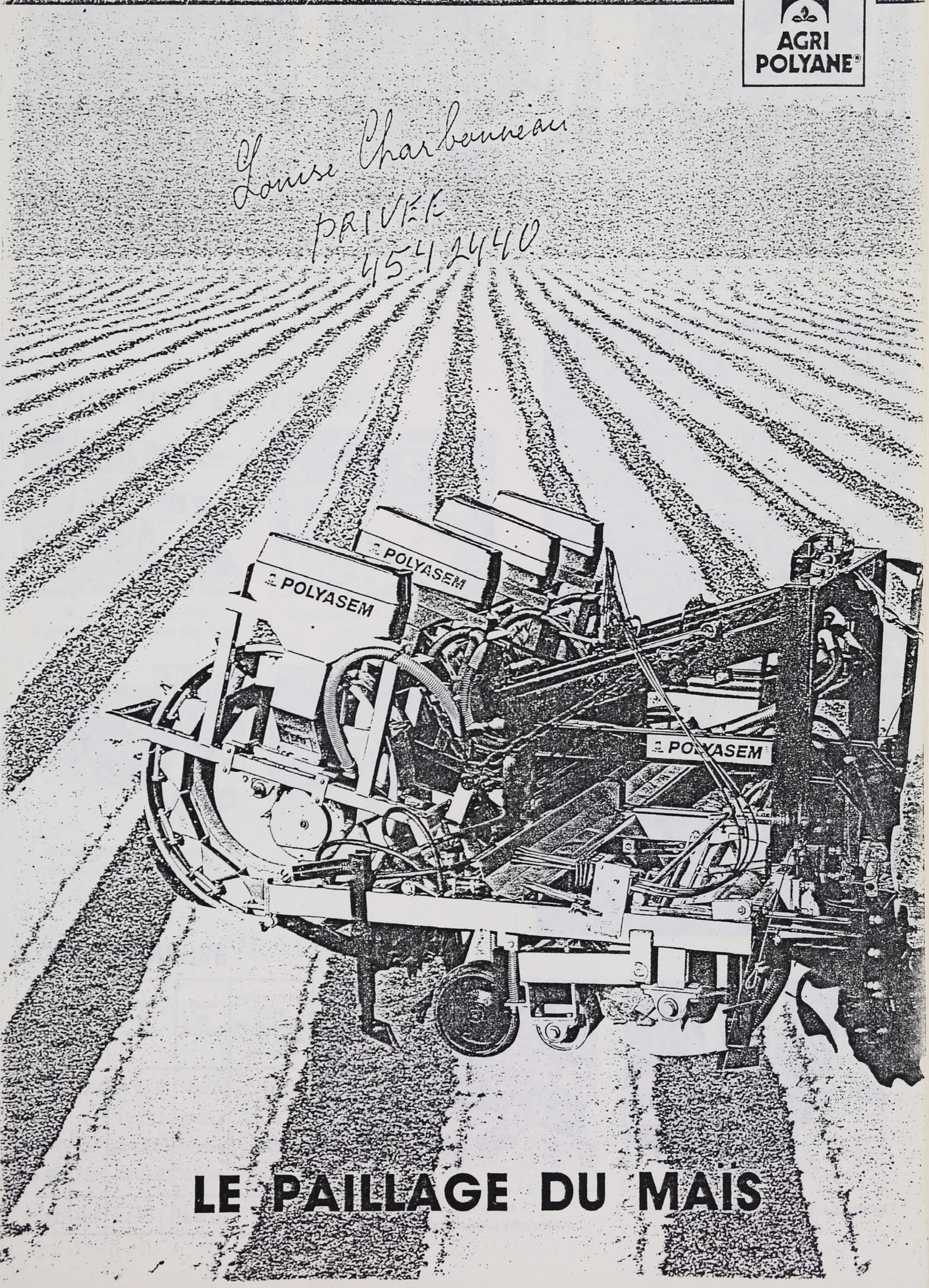

FIELD #2
Weather radar
Seed farm
Beef centre
HWY 40
Exit 41
FARM
Dairy centre
Agricultural Engineering Shop
HWY 20
Orchard
Raptor Centre
Horticulture
Parisitology
P
Poultry
Glenfinnan Rink
Macdonald-Stewart
Barton
East Cottages
Raymond
Laird Hall
Robertson Terrace
Centennial Centre Stewart
Park
JOHN ABBOTT COLLEGE
Maple Avenue
Glenaladale Terrace
Rivermead
Power House
Tadja Hall
Food Pilot Plant
Physical Plant
Lakeshore Road
MACDONALD COLLEGE

FIGURE #2

Une nouvelle Agriculture

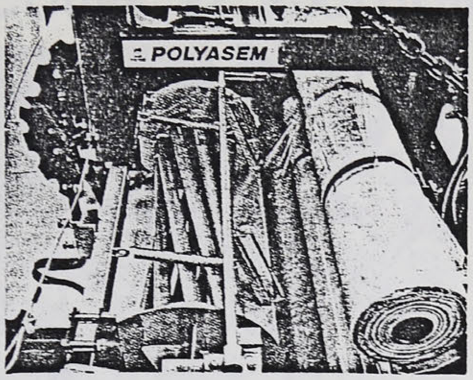
AGRI POLYANE®

Louise Charbonneau
PRIVER
454 2440

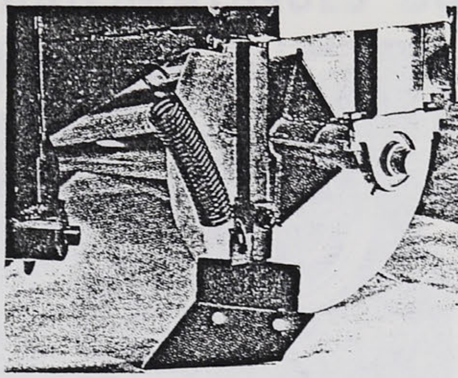


LE PAILLAGE DU MAIS

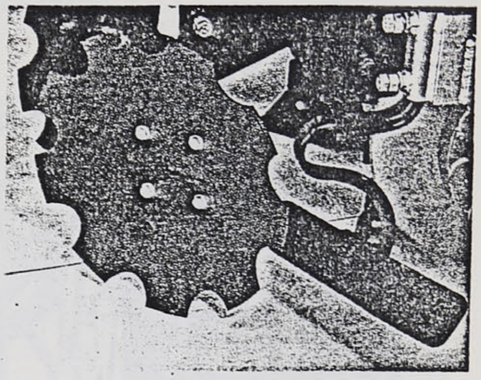
CONFORMATEUR DE PLATE-BANDE



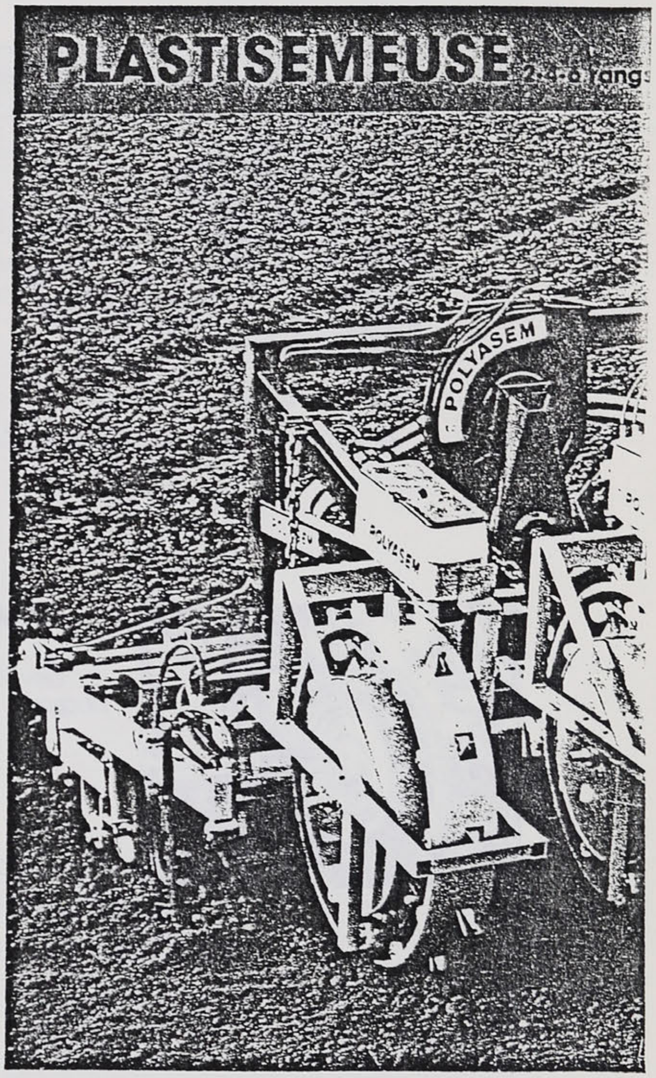
Rouleau conformateur
de plate-bande



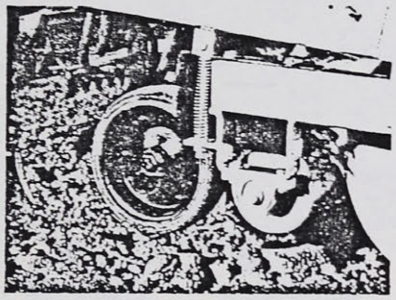
Soc rectifieur
de fond de raie



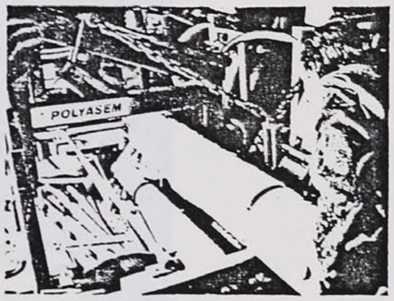
Disque cranté
avec lame niveleuse



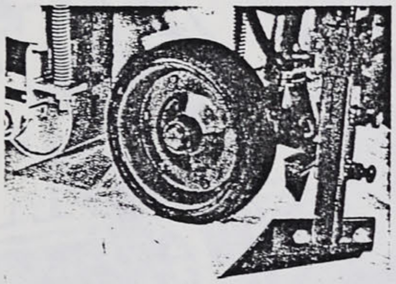
DÉVIDE-FILM ET TERRAGE



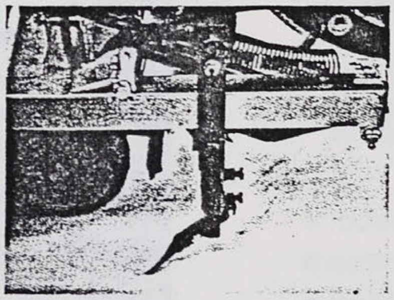
Rouleau dévide-film
à pression contrôlée sur le sol



Chargement de la bobine
(en réserve)



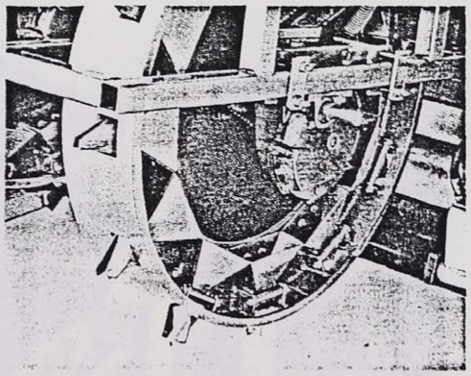
Roue de fond de raie
(support télescopique)



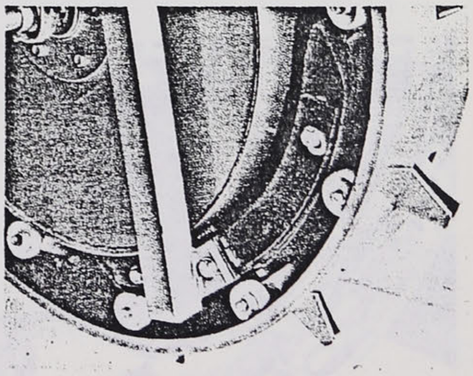
Soc recouvreur
avec support articulé

ROUE SEMEUSE

Densité hectare	Type de roue	Type de semis	Type de disques	Espacement entre perforations sur la ligne de semis
51.200	12 P	1.1.1.1	9 trous	0,25
68.240	12 P	1.2.1.1.2	12 trous	0,25
85.300	12 P	2.2.1.2.2.1	15 trous	0,25
102.400	12 P	2.2.2.2.2	18 trous	0,25
75.300	18 P	1.1.1.1.1	18 trous	0,17

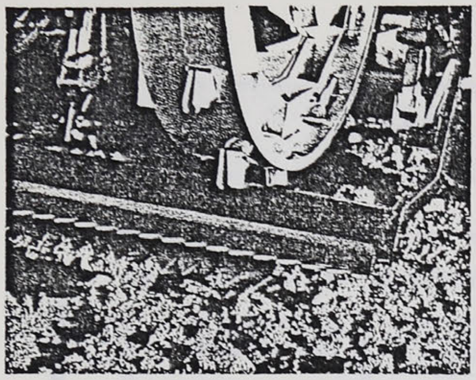


Roue semeuse
avec son distributeur Monosem

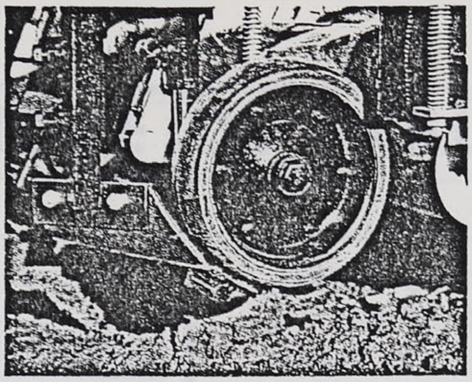


Came réglable assurant l'ouverture
des becs semeurs

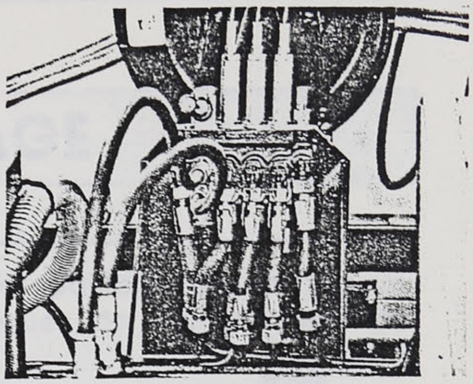
COUPE ET FIXATION AUTOMATIQUES DU FILM



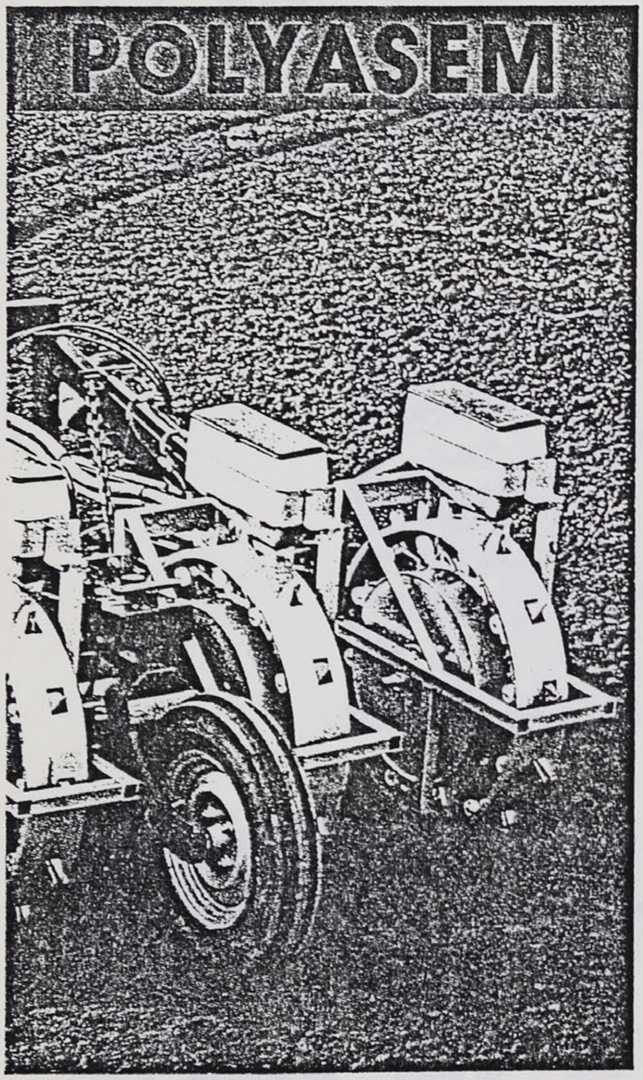
Le film est coupé par le tranchant en dent de scie de la pelle actionnée par 2 vérins hydrauliques. Cette même pelle, terre le film d'AV en AR et de l'AR vers l'AV.

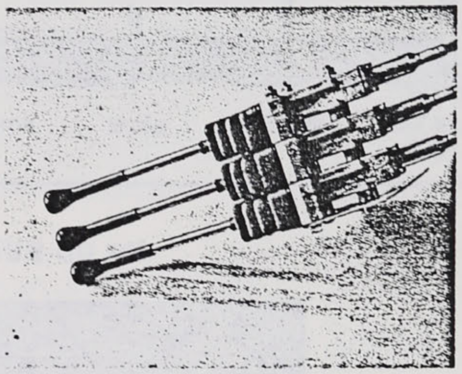


Simultanément le film est pincé sur les 2 côtés par les sabots actionnés par 2 vérins hydrauliques.



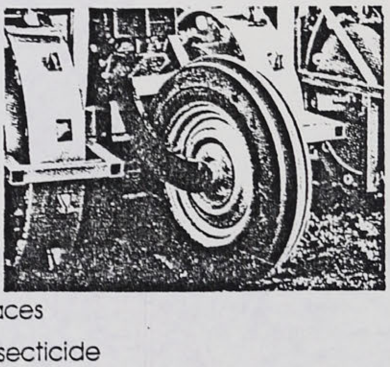
Distributeur hydraulique :
- traceur - roues semeuses
- coupes-films - sabots



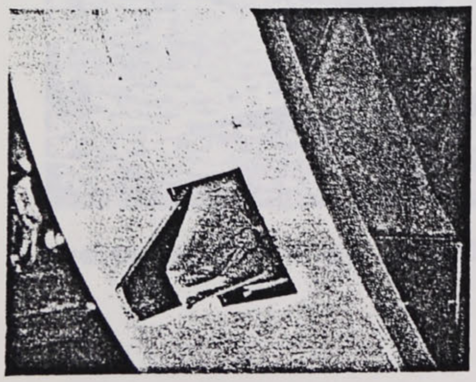


Manette de commande à câbles

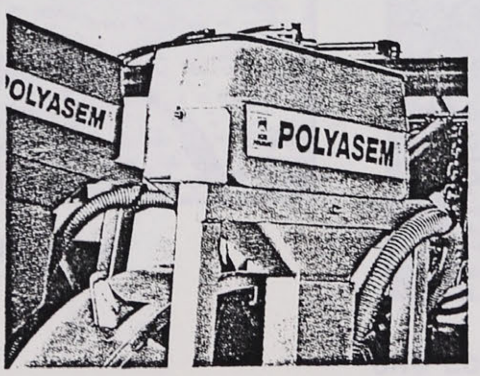
OPTIONS



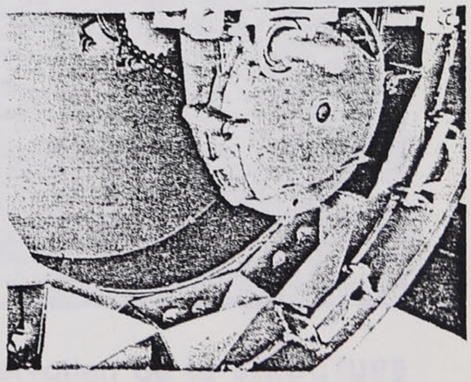
- roue anti-dévers et roue de transport sur route
- rouleaux à barres
- compteur d'hectares
- localisateur d'anti-limaces
- micro localisateur d'insecticide



Bec semeur avec entonnoir d'alimentation



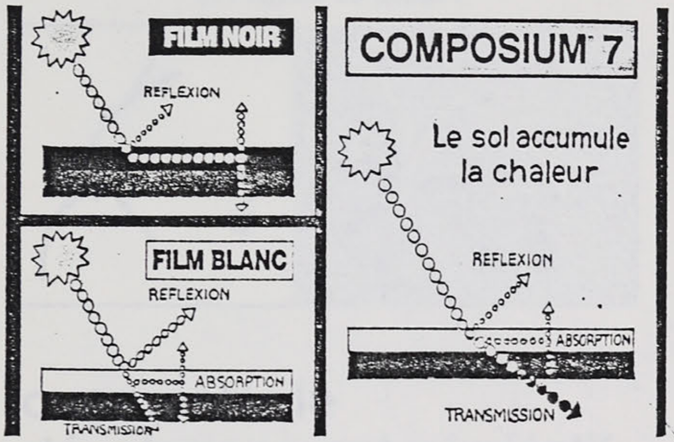
Trémie d'alimentation



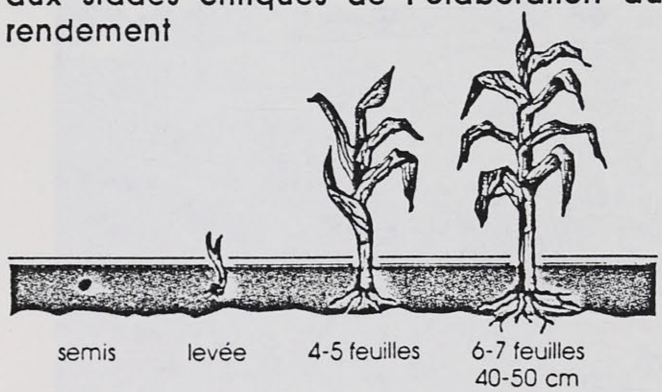
Le distributeur est entraîné par pignons et chaine. Possibilité de réglage de la synchronisation roue semeuse / distributeur

PRINCIPE DU PAILLAGE

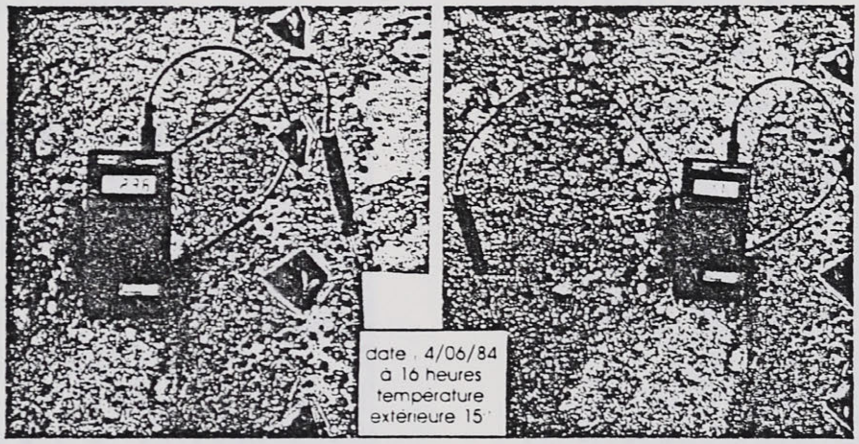
une fourniture de chaleur au sol

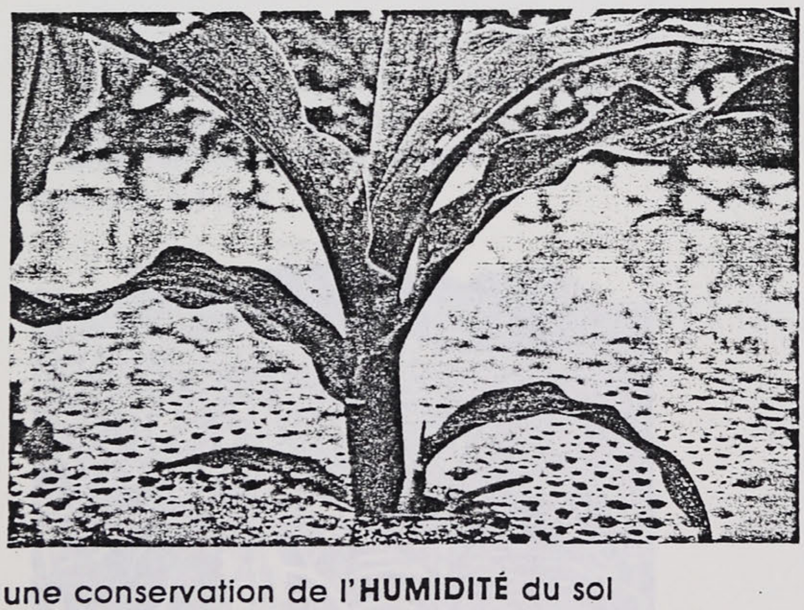


période où l'effet paillage est maximum aux stades critiques de l'élaboration du rendement

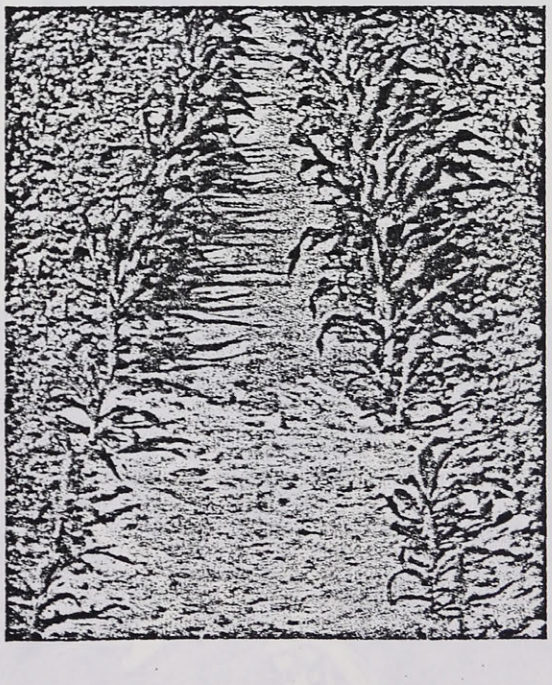


une fourniture de **CHALEUR** au sol





une conservation de l'**HUMIDITÉ** du sol

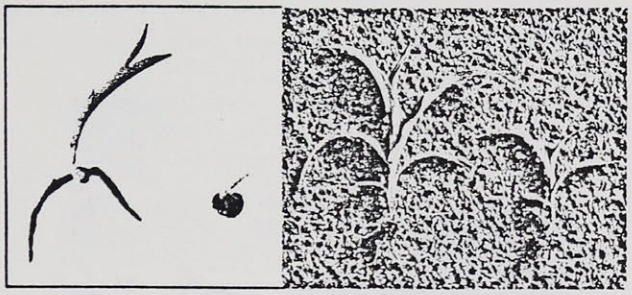


une conservation de la **STRUCTURE DU SOL** : la non battance

améliorer la levée

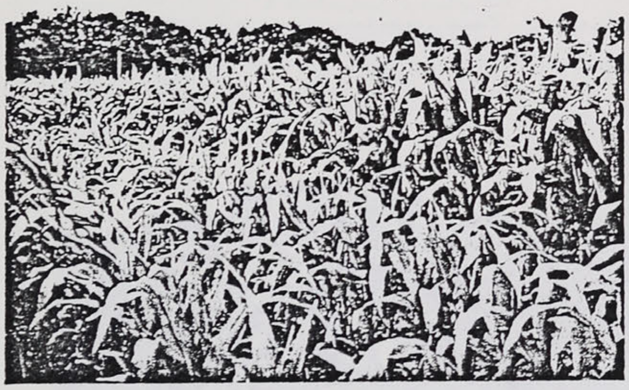
- Rapidité : 5 à 10 jours
- Meilleure germination : 3 à 5 %

La « vigueur de départ »



augmenter le développement végétatif

Diamètre des tiges (+ 5 à 12 mm)
Système racinaire plus développé.



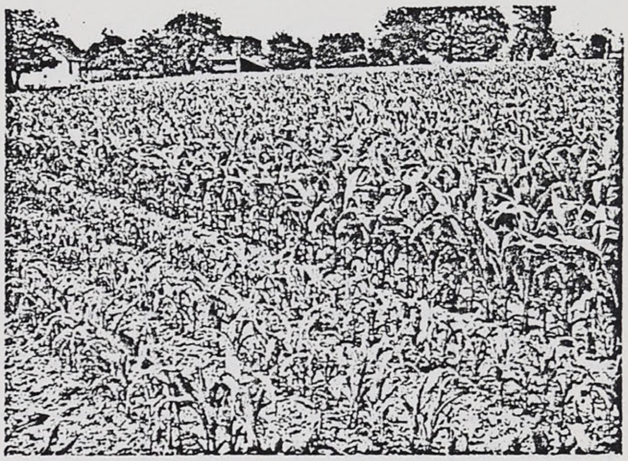
obtenir

- une floraison précoce
- une meilleure fécondation

Gain de 5 à 8 jours

stimuler la croissance

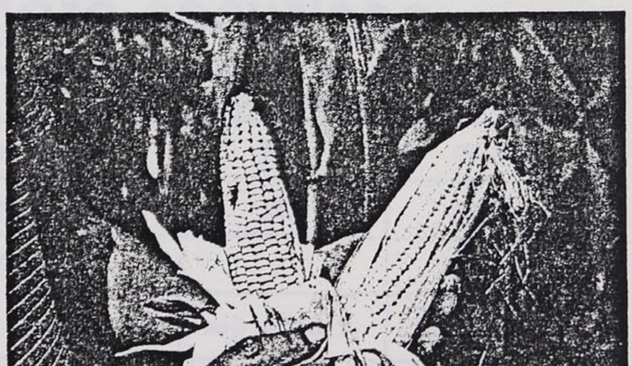
Vers le 80e jour après le semis, on observe des écarts de végétation de 60 à 80 cm de hauteur, par rapport au témoin.



améliorer la résistance à la verse

avancer la maturité

Gain de 13 à 21 jours en moyenne.



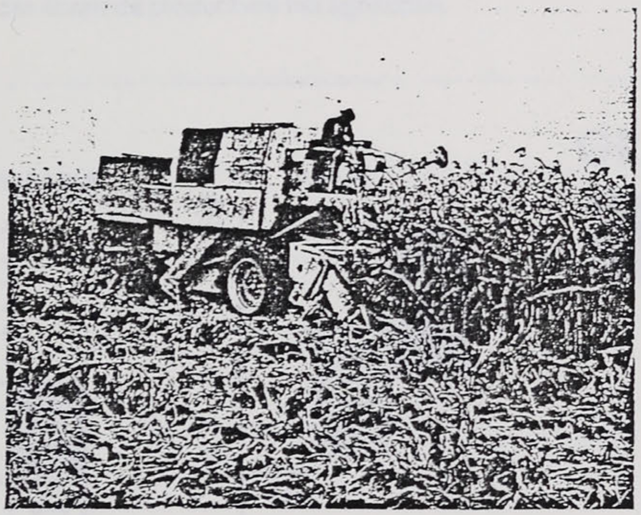
résultats agronomiques

sécurité... quantité... qualité... sécurité... quantité... qualité... sécurité... quantit

Moyenne de rendement sur plusieurs années (1981 à 1983)

MAÏS ENSILAGE

	Densité	% matière sèche	Matière sèche par ha
Paillé*	75.000	31,37	15,70
Non paillé	110.000	28,39	11,55
Écarts		+ 2,98 %	+ 4,5 t.
			soit 36 %



MAÏS GRAIN

	Tonnage humide	% humidité	Tonnage grain sec
Paillé*	117,5	33,47	91,8
Non paillé	82,6	40	58,5
Écarts	+ 34,9	−6,6 %	+ 33,3 q.
	soit 42 %		**soit 57 %**

* La plastisemeuse POLYASEM® peut semer de 51.000 à 102.000 pieds/hectare et vous permet de choisir la densité optimum.

une production fourragère sécurisée

En année défavorable, des écarts spectaculaires

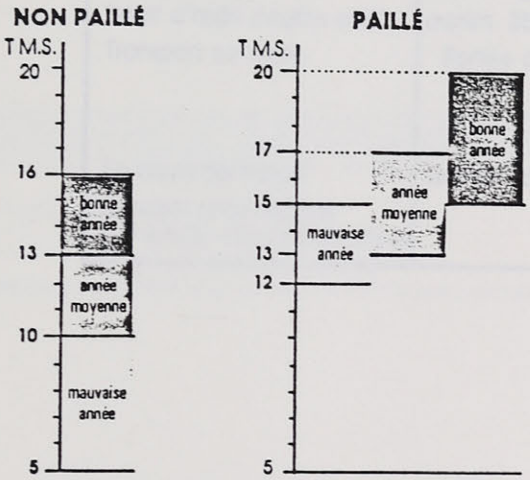
	Maïs ensilage	Maïs grain
Paillé	20 T	95,6 q
Non paillé	13 T	59,8 q
Écarts	7 T	35,8 q
	soit + 53 %	**soit + 59 %**

Exemple : Bretagne en 1984

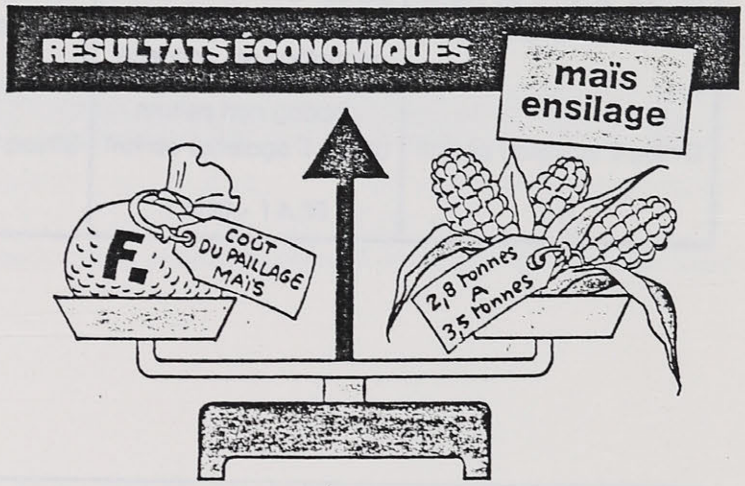
résultats économiques

qualité... sécurité... quantité... qualité... sécurité... quantité... qualité... sécurité...

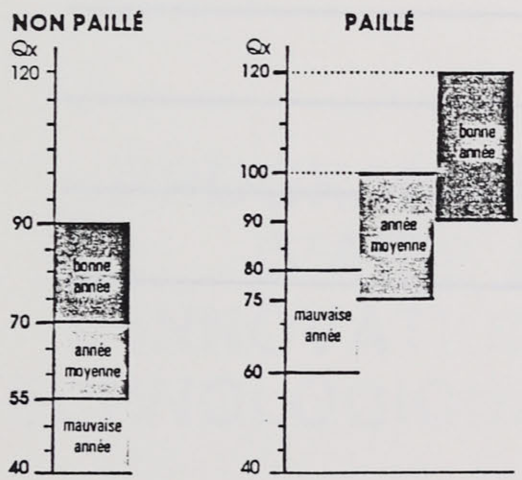
ENSILAGE



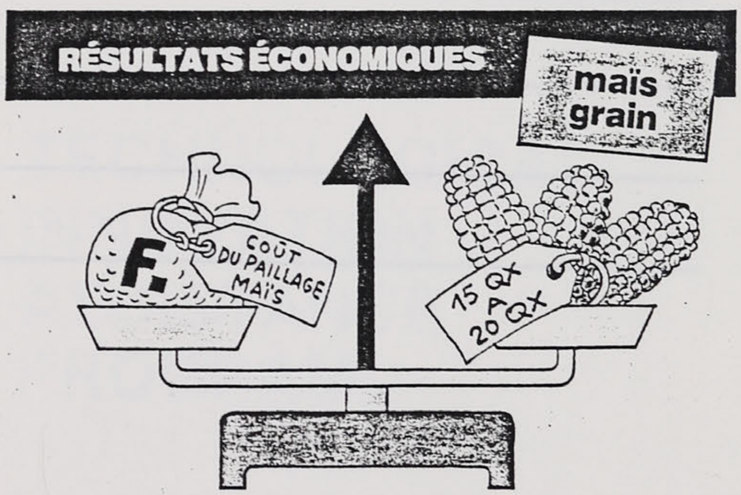
Quelle que soit l'année climatique
des écarts de productivité très significatifs.



GRAIN



Quelle que soit l'année climatique
des écarts de productivité très significatifs.



limites économiques de la plasticulture

- Implantation en zones sèches et sol peu profond.
- En terrain à très forte pente, risque d'érosion brutale.
- Maîtriser les autres facteurs de production (choix de la parcelle, préparation du sol, fertilisation, désherbage, choix de variété, etc...).

Voir itinéraire technique.

PLASTISEMEUSE POLYASEM

Fiche Technique	2 rangs	4 rangs	6 rangs
Nombre de rangs de maïs	2 (1 module)	4 (2 modules)	6 (3 modules)
Largeur de travail	1,60	3,10	4,65
Largeur hors tout	1,70	3,20	4,80
Déport AR	2,60	2,60	2,60
Écartement des lignes de semis	0,75 0,80	0,75 0,80 0,75 0,80	0,75 0,80 0,75 0,80 0,75
Poids	800 kg	1.400 kg	2.100 kg
Puissance tracteur	50 CV	90 CV - 4 roues motrices	100 CV - 4 roues motrices
Prise de force	540 T/mn	540 T/mn	540 T/mn
Débit d'huile double effet	minim. 35 L/mn à 150 bar	minim. 35 L/mn à 150 bar	minim. 35 L/mn à 150 bar
Transport sur route	Portée derrière tracteur	Portée derrière tracteur Attention, se conformer au règlement des véhicules routiers hors gabarit.	Sur chariot (option)
En cours de travail	Traînée (attelage 3 points)	Traînée (attelage 3 points)	Traînée (attelage 3 points)
Rendements/hectare à 5 km/h valeurs indicatives	2 h 30	1 h 20 - 1 h 30	1 h

NOTES ______________________________

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AGRI POLYANE®

siège social :
12, rue Christophe-Colomb - 75008 PARIS (FRANCE) - Tél. (1) ~~723.01.41~~ 47237571 - Télex 613 004

groupe ELF-AQUITAINE

Agriculture
Canada

Bernard Gravel
Program Officer
Agriculture Development (Quebec)
Guy Favreau Complex
200 Dorchester Blvd West
East Tower, Suite 1002-D
Montréal, Quebec H2Z 1Y3
514 285-8888

Canada

Agriculture Canada | Direction générale du développement agricole | Agriculture Development Branch

ESSAI D'UNE PLASTISEMEUSE POUR LA PRODUCTION DE MAÏS SUCRE DE PRIMEUR

PROGRAMME D'AIDE À L'INNOVATION TECHNOLOGIQUE

TECHNOLOGICAL INNOVATION ASSISTANCE PROGRAM

Développement agricole (Québec)

Agriculture Development (Quebec)

Canada

ESSAI D'UNE PLASTISEMEUSE
POUR LA PRODUCTION DE MAÏS
SUCRE DE PRIMEUR

Cet essai s'est déroulé en milieu commercial et les résultats n'ont pas nécessairement été vérifiés scientifiquement par Agriculture Canada.

février 1988

PROGRAMME D'AIDE A L'INNOVATION TECHNOLOGIQUE

L'objectif de ce programme est d'accroître la productivité de l'industrie agro-alimentaire québécoise dans son ensemble. Il vise particulièrement à:

- accélérer l'adoption, par l'industrie des aliments et boissons, de technologies, de systèmes de production et de produits innovateurs, en aidant à la dernière mise au point et la démonstration des procédés expérimentés dans les centres de recherche gouvernementaux ou autres;

- accélérer l'adoption, par les producteurs agricoles, de systèmes, de méthodes, d'équipements de production innovateurs, en aidant à leur évaluation, leur mise à l'essai et leur démonstration à la ferme dans des conditions commerciales;

- augmenter le taux d'utilisation de l'équipement de production et de transformation déjà établi.

Les coûts admissibles de ce projet se sont élevés à 14 530,00$ et une aide gouvernementale de 10 000,00$ a été accordée. Ce projet a débuté le 17 avril 1987 et a duré une saison.

LISTE DES INTERVENANTS

Promoteur du projet : M. Gabriel VanMil
655, Marie Victorin
Verchères, Qc
J0L 2R0
(514) 583-3235
(514) 589-4845

Agent de projet : M. Bernard Gravel
Agriculture Canada
Développement agricole
Complexe Guy Favreau
200, boul. Dorchester ouest
Tour est, suite 1002-D
Montréal, Qc
H2Z 1Y3
(514) 285-8888

Analyste scientifique : M. Pierre Martel, agr. ing.
Station de recherche de St-Jean
430, Boul. Gouin
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St-Jean-sur-Richelieu, Qc
J3B 6Z8
(514) 346-4494

Analyste économique : M. Martin Labrecque, agr.
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5, Parc Samuel Holland
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Québec, Qc
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(418) 648-4775

Collaborateurs : M. Louis-Albert Edger, agr.
MAPAQ
337.est, Chemin des 25
St-Bruno, Qc
J3V 4P6
(514) 653-8061

M. Robert Boisvert, agr.
MAPAQ
337 est, Chemin des 25
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J3V 4P6
(514) 653-8061

TABLE DES MATIERES

RESUME

Le projet consistait à mettre à l'essai une plastisemeuse deux rangs de marque Polyasem pour la culture du maïs sucré sur paillis. Cet essai visait à établir dans un environnement commercial, l'incidence de cette technique sur la qualité, le rendement et la date de récolte du maïs, combinée à une évaluation économique des coûts et bénéfices de ce système.

Les résultats de cet essai font ressortir les multiples avantages de l'utilisation du paillis. Le premier effet fut d'avancer la date de récolte de plus d'une dizaine de jours comparativement à la récolte sur sol nu. Cette situation a permis à l'entreprise de bénéficier d'un prix moyen supérieur pour l'ensemble de la période de commercialisation du produit. La qualité et la quantité de maïs vendable à l'hectare ont également été améliorées.

Dans l'ensemble, l'utilisation de cette technique s'est avérée rentable et bénéfique pour l'entreprise.

DESCRIPTION DU PROJET

Le projet consistait à faire l'essai, sur une superficie minimale de 8 hectares de la culture de maïs sucré sur paillis plastique. Le projet visait également à faire l'essai d'une plastisemeuse deux rangs de marque Polyasem et de comparer les résultats de cette méthode à une culture conventionnelle sur sol nu. Dans les faits, l'essai s'est déroulé sur une superficie de 12.5 hectares.

OBJECTIF DU PROJET

Diverses considérations économiques et techniques ont entraîné la réalisation de ce projet. L'utilisation de paillis plastique sur de grandes superficies de maïs sucré visait à:

- permettre d'avancer la date de récolte du maïs de plusieurs jours;

- bénéficier de meilleurs prix étant donné la précocité de la récolte;

- garantir une meilleure uniformité du produit à la récolte;

- évaluer avec précision les coûts et les bénéfices de la technique comparativement à une culture sur sol nu;

- permettre le remplacement, auprès de nos principales chaînes d'alimentation, du maïs en provenance de l'Ontario par de la production locale hâtive;

- évaluer la performance et l'efficacité de la plastiseuse.

IDENTIFICATION DE L'ENTREPRISE

Monsieur Gabriel VanMil est un producteur spécialisé dans la culture de maïs sucré. En 1987, il a cultivé 240 hectares de maïs sucré ce qui représente, en pleine saison de production, une récolte de 10 à 12 000 douzaines par jour. Monsieur VanMil, qui est engagé dans cette production depuis plus de 35 ans, approvisionne les principales chaînes d'alimentation du Québec. L'entreprise possède depuis quelques années un système "Hydro Cooler", ce qui lui permet d'offrir un produit de qualité en plus d'en faciliter la mise en marché. Point intéressant à souligner, les champs de M. VanMil sont situés sur une île. Cette caractéristique est importante puisque toutes les opérations de l'entreprise nécessitent le transport par barge de la machinerie, de l'équipement et de la main-d'oeuvre.

PLAN DE TRAVAIL

Afin d'évaluer avec précision les coûts et les bénéfices de la culture sur paillis, comparativement à une production sur sol nu, il faut mettre en parallèle les résultats obtenus avec cette technique versus les résultats obtenus sur une parcelle témoin de même dimension.

Pour bien réussir cet exercice, il faut s'assurer au départ que tous les facteurs de production sont les mêmes dans les deux parcelles (paillis et sol nu) et qu'ils sont à leur niveau optimum.

1- Choix de la parcelle: - bon drainage
- bonne fertilité
- faible pente
- faible pierrosité

2- Une bonne préparation du sol, soit une terre bien nivelée et humide au moment du semis.

3- Un programme de fertilisation basé sur l'analyse du sol en apportant les correctifs qui s'imposent.

4- Choix de la variété Earlyvee, bien adaptée à la région.

5- Contrôle des mauvaises herbes selon les recommandations du Conseil des productions végétales du Québec.

6- La densité de semis sera fixée en fonction des équipements disponibles et de leurs flexibilités.

7- Semis très hâtifs: dès que les conditions seront propices.

Il faut bien se rendre compte au départ que le paillis permettra théoriquement de réaliser un semis hâtif en créant un microclimat plus favorable à la croissance que celui sur sol nu. Dans le cadre de cet essai, il sera utilisé un paillis translucide photodégradable pour les 2/3 des superficies et non dégradable pour l'autre 1/3. De par cette dernière caractéristique, il faut prévoir à la fin de la récolte le ramassage du paillis non dégradable. Comme ce paillis est translucide, il faut prévoir également l'application d'un herbicide avant la pose de celui-ci.

Les données recueillies seront d'ordre technique et économique. Au niveau technique, il faut quantifier les performances de l'équipement utilisé et les données agronomiques (rendement, hâtivité, uniformité, etc.). Du point de vue économique, nous compilerons les prix obtenus sur le marché et les coûts supplémentaires générés par l'utilisation du paillis. La parcelle témoin nous servira de référence dans l'établissement de la comparaison.

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[illegible] TECHNICO-ÉCONOMIQUE

Comme nous l'avons écrit précédemment, M. VanMil est un producteur spécialisé dans la production de maïs sucré et approvisionne les grandes chaînes d'alimentation Steinberg et Provigo. Dans cette période de l'année, ces chaînes d'alimentation s'approvisionnent sur le marché ontarien. Pour pouvoir pénétrer le marché à cette époque, le producteur doit être en mesure de répondre à la demande et fournir un volume suffisant estimé à 4 à 5 000 douzaines par jour. On comprend alors l'intérêt de celui-ci pour cette technique, si celle-ci peut s'appliquer sur une grande échelle, ce qui justifie à notre avis l'ampleur du projet.

Nous ne voyons pas d'effets négatifs pour le Québec à pénétrer le marché à cette époque, car les arrivages proviennent de l'extérieur. Nous croyons que les retombées positives d'un tel projet ne pourraient qu'être bénéfiques pour améliorer ce secteur d'activité économique qu'est l'horticulture dans la région.

Les principaux avantages du paillis transparent sont:

1- La température au niveau des racines dépend essentiellement des conditions thermiques du milieu ambiant. L'utilisation de paillis transparent permet un réchauffement significatif du sol en créant un microclimat qui diminue le risque de gel et rend possible la production de primeur. Ce microclimat stimule l'activité microbienne, facilite une meilleure minéralisation des fumures organiques et améliore l'assimilation des engrais.

2- La présence du film limite aussi le lessivage de l'azote et conserve l'humidité du sol plus longtemps. Les épis de maïs sont plus uniformes et de meilleure qualité et le nombre d'épis vendables est plus élevé.

3- La précocité de la récolte permet un étalement plus grand du calendrier de production.

RESULTATS DETAILLES

Chronologie des événements

Semis

Du 17 au 20 avril 1987, 10,5 hectares (26 acres) ont été semés et paillés avec l'aide de la plastisemeuse, 2 rangs Polyasem. Plusieurs ajustements ont été nécessaires pour réussir le tout d'une façon satisfaisante.

Le 21 avril, des vents violents ont déferlé sur la région et malgré des interventions ponctuelles du producteur pour protéger le paillis avec l'aide de roches et/ou de terres, les 2/3 de celui-ci a été arraché.

On a alors débuté les semis réguliers à partir du 22 avril et laissé de côté l'utilisation de la plastisemeuse.

Reprise le 12 mai 1987 des essais avec la plastisemeuse sur une superficie de 2 hectares (5 acres), le paillis a très bien résisté dans cette parcelle. (Le terrain à cette période était plus humide et a favorisé semble-t-il un meilleur ancrage du plastique).

Récolte

Dans la partie semée du 17 au 20 avril 1987, une récolte manuelle a été nécessaire dans un premier temps, compte tenu du manque d'uniformité dans le champ, suivie quelques jours après de la récolte mécanique.

A remarquer qu'aux endroits où le paillis a été emporté, les quelques jours que celui-ci était en place ont permis un bon démarrage du maïs comparé au témoin en pleine terre qui a pourri.

Le paillis a bien résisté dans le deuxième essai et la récolte s'est faite avec l'aide de la récolteuse mécanique.

Compilation des données

Le producteur a compilé les rendements sur l'ensemble des superficies sous paillis même si dans certains rangs le paillis avait été arraché par le vent. Il aurait été impensable de récolter uniquement les rangs où le paillis a résisté puisqu'il aurait fallu procéder strictement à une récolte manuelle. Etant donné les superficies cultivées cette éventualité était inconcevable.

Données recueillies

A) Description physique de la machine

- Poids 800 kg
- Largeur 1,85 m (une fois agrandie)
- Longueur 2,60 m
- Puissance du tracteur nécessaire pour la tirer:
  On parle dans la fiche technique de 37 kw, il semble plus réaliste de parler de 45 kw
- Description des différents ajustements.
  On a modifié la plastisemeuse pour porter l'écartement de semis de 75 à 92 cm pour permettre la récolte mécanique.

B) Evaluation de la performance de la machine

- vitesse d'opération normale: 4 km/h
- superficie ensemencée: 0,24 ha/h
- profondeur de semis: 3,8 cm
- régularité du semis: uniforme
- efficacité dans la pose du paillis: non satisfaisant
  On a remplacé le soc recouvreur (couteau) par un disque pour avoir un meilleur recouvrement et la pose d'un garde de plastique pour éviter que la terre ne

pénètre dans la roue semeuse. Il reste cependant encore des ajustements à faire pour arriver à un bon ancrage du paillis, à cause du fait d'avoir modifié l'écartement du semoir qui a augmenté la surface du polythène exposé au vent.

C) Evaluation du rendement du maïs

- choix du cultivar: EARLYVEE
- date de semis : deux dates
  10,5 hectares entre le 17 et 20 avril 1987
  2,0 hectares le 12 mai 1987
- taux semis : 63 000 grains/ha (estimé)
- date de l'émergence: 3 jours après le semis dans les deux cas
- population au stade de deux feuilles: 58 000 plants
- type de semis: 2.2.1.2.2.1
- espacement entre les plants: 25 cm
- espacement entre les rangs : 91 cm
- type de paillis: transparent
  2/3 photodégradable
  1/3 non dégradable
- date de la récolte:
  - 16 au 21 juillet pour le 10,5 hectares
  - 26 juillet pour le 2,0 hectares

- Rendements obtenus:
  - rendement moyen sur les 12,5 hectares a été de 2,016 douz/ha (816 douz/acre).

- Qualité:
  - le producteur a observé un maïs plus uniforme, mieux formé et moins de petits épis qu'en plein champ.

D) Main-d'oeuvre supplémentaire

- Temps requis pour le semis:

  - deux hommes de plus, à 43 heures chacun

- Temps requis pour l'enlèvement du paillis:

  - à noter que seulement le 1/3 du paillis était non dégradable, cependant il a nécessité environ un homme pendant 45 heures pour procéder à l'opération. C'est vraiment un problème! On préfère pour l'avenir travailler avec un paillis dégradable.

TABLEAU

Date de semis	Superficie	Date de récolte	Rendement (Epis vendables)	Prix moyen
avec paillis:				
17 au 20 avril et	10,5 hectares	16 au 21 juillet 1987	(1) 2,016 douz/ha	(1) 1,375$/douz.
12 mai 1987	2,0 hectares	26 juillet 1987		
semis en pleine terre:				
22 avril 1987	12,5 hectares	27-28 juillet 1987	(2) 1,794 douz/ha	(2) 0,917$/douz.

(1) Le rendement et le prix moyen représente la compilation des résultats de l'ensemble des superficies avec paillis, soit 12,5 hectares.

(2) Nous nous sommes servis d'une superficie identique sans paillis à titre de parcelle témoin.

EVALUATION DE LA RENTABILITE

Le producteur a dû acheter du distributeur la plastisemeuse deux rangs de marque Polyasem en raison des modifications qu'on devait apporter à celle-ci pour la rendre compatible avec ses équipements de récolte. La plastisemeuse d'origine avait un écartement entre les rangs de 75 cm (30") et les besoins étaient de 92 cm (36"). Le prix après négociation avec le distributeur a été fixé à 16 000,00$, ceci incluant les frais de modification. Il semblerait après avoir consulté le fournisseur qu'il n'existe pas au Canada d'autres plastisemeuses du même type.

Pour nous donner un aperçu économique du projet, nous nous sommes attardés à établir un budget partiel à partir des données recueillies au cours de la saison.

Pour les fins de l'exercice, les coûts additionnels et les revenus supplémentaires escomptés par l'utilisation de cette nouvelle technologie ont été utilisés.

Revenus

Le rendement moyen dans les champs avec paillis a été de 2,016 doz/ha comparé à un rendement moyen en champ sans paillis de 1,794 doz/ha ce qui représente une augmentation et/ou un volume supérieur de maïs vendable de 12%.

Le prix moyen pour l'ensemble de la période de commercialisation a été pour le maïs avec paillis de 8,25$/6 doz. comparé à 5,50$/6 doz. pour le maïs semé sans paillis.

Donc nous obtenons un revenu brut pour l'ensemble des 12,5 ha. avec paillis de 34,650$ versus 20 556.00$ pour la parcelle témoin sans paillis.

Calcul:

paillis: 12,5 ha X 2016 doz X 8,25$/6 doz: 34 650,00$

témoin (sans paillis): 12,5 ha X 1794 doz X $5,50/6 doz: 20 556,00$

Coûts supplémentaires avec paillis

Plastisemeuse

Nous avons appliqué pour fin de calcul un D.I.R.T.A. de 15% sur le prix d'achat de l'équipement. Donc 16 000 X 15% : 2 400,00$

Paillis

Le coût du paillis utilisé se montait à 9 294,60$ ce qui représentait l'achat de: 40 rouleaux (photodégradable) à 169,15$/rouleau
20 rouleaux (non dégradable) à 126,43$/rouleau.

Main-d'oeuvre supplémentaire

La main-d'oeuvre supplémentaire à l'ensemble des opérations a été estimée à 131 heures par le producteur à laquelle nous appliquerons un taux horaire de 7,00$/heure,
donc 131 heures X 7,00$/heure : 917,00$.

Budget partiel

A) Revenus bruts avec paillis
12,5 ha X 2016 doz X 8,25$/6 doz : 34 650,00$

B) Coûts supplémentaires

- paillis	9 294,60$
- plastisemeuse	2 400,00$
- main-d'oeuvre supplémentaire	917,00$
- TOTAL:	12 611,60$

C) Revenus bruts avec paillis, moins coûts supplémentaires à l'utilisation de cette technologie:
34 650,00$ - 12 611,60$: 22 038,40$

D) Revenus bruts sans paillis (témoin)

12,5 ha X 1794 doz X 5,50$/6 doz : 20 556,00$

E) **On arrive à une différence de 1 482,40$ (118,60$/ha) en faveur du paillis plastique versus le témoin sans paillis dans le cas de cet essai effectué sur une surface de 12,5 hectares.**

Discussion

Malgré les problèmes rencontrés les coûts supplémentaires engendrés par l'utilisation de la plastisemeuse ont été couverts par l'obtention d'un prix moyen supérieur ainsi que d'une plus grande quantité de maïs vendable à l'hectare.

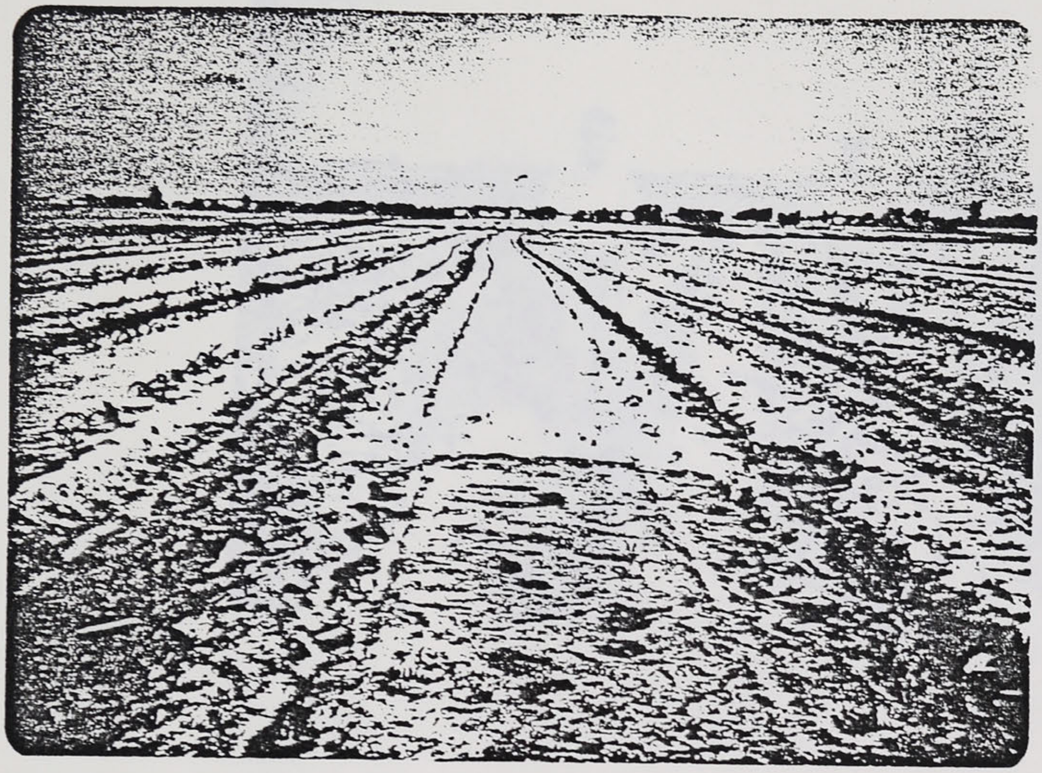
CONCLUSION

La plupart des objectifs visés par l'utilisation du paillis de plastique ont été atteints, à savoir: une quantité et une qualité de maïs vendable à hectare de 12% environ supérieur à la parcelle témoin et un prix moyen supérieur pour l'ensemble de la période de commercialisation de 0,458$ la douzaine.

Les résultats économiques favorisent cette technologie malgré les problèmes rencontrés dans la mise en oeuvre du projet. Il nous semble évident que si l'expérience s'était déroulée comme prévu, l'avantage économique du paillis aurait été encore plus marqué.

La technique demande à être raffinée et les performances de la plastisemeuse devraient être améliorées (meilleur ancrage du plastique et augmentation de la vitesse d'opération). Il serait intéressant qu'une personne qualifiée examine la plastisemeuse pour suggérer des solutions aux problèmes rencontrés. Une partie du projet pourrait être reprise l'année prochaine pour raffiner cette technologie.

Nous demeurons convaincus que l'avenir des primeurs dans la culture du maïs sucré passe par cette technologie et que nous devrions continuer nos efforts dans le développement de celle-ci.



VUE D'ENSEMBLE

STADE TROIS FEUILLES

SANS PAILLIS ←┴→ AVEC PAILLIS