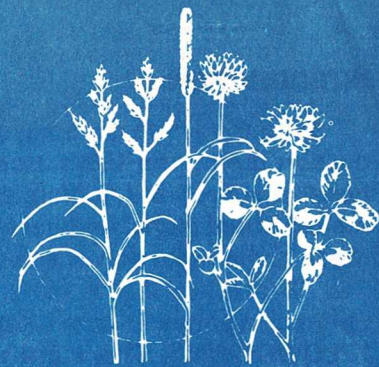


FORAGE SEED NOTES



ALBERTA FORAGE SEED COUNCIL

120 - Newsletter

PLOWDOWN

A STRATEGY FOR THE FUTURE

SOIL MANAGEMENT PRACTICES MUST NOW FOCUS ON MAINTAINING AND IMPROVING THE NUTRIENT PROFILE OF OUR AGRICULTURAL SOILS.

THE INCREASING COST OF APPLYING COMMERCIAL SOIL NUTRIENTS, THE HIGH COST OF INTENSIVE SOIL CULTIVATION PRACTICES AND THE EVIDENCE OF SOIL DEGRADATION ARE NOW OF PRIMARY CONCERN TO PRODUCERS WHEN THEY EVALUATE THEIR SOIL MANAGEMENT PRACTICES.

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INTRODUCTION

With the emphasis placed on increased crop production during the 1980s, new as well as more traditional practices are finding their place in producers' management plans. Another important decision being made is the reduction of acres in summerfallow each year. A practice that is more traditional than new is utilizing legumes in crop rotations for the purpose of "PLOWDOWN". There are many questions being asked about this practice. To clarify some of these, the following dialogue is presented:

1. THE CONCEPT

Q. You have spoken of "PLOWDOWN — A Strategy for the Eighties", could you explain this concept fully and how does it differ from the historic view of the practice?

A. "PLOWDOWN" refers to the cultural practice of allowing a legume crop such as clover or alfalfa to grow to the blossom stage and then incorporating, with a plow or other implement, the entire crop growth into the soil. The nature of this practice is identical to what "PLOWDOWN — A Strategy for the Eighties" suggests, however, the impact we feel this practice will have on today's agriculture might be different in some ways from the past. Higher available nitrogen and improved soil structure are still the main benefits. However, with optimal yield per acre being the goal of today's producer, the role of PLOWDOWN is simply only one tool of management and not a substitute for other sound field husbandry practices. The term optimal suggests all factors contributing to crop production must approach the most desirable situation, and certainly PLOWDOWN does make a contribution to that goal.

Primarily, PLOWDOWN fits today's management as part of the more intensive cropping programs practised. Summerfallow is frequently challenged today, both from an agronomic and an economic point of view. PLOWDOWN offers the opportunity for "summerfallow" to earn its keep so to speak, from the improved soil condition and nutrient levels. PLOWDOWN crops are established in a variety of ways to suit the needs and conditions in various areas. Good quality legume seed of the desired species and variety is available in abundance and at a very reasonable cost. The concept of PLOWDOWN is examined closely in this publication and we offer current ideas and practices as a guideline to your farm use of "PLOWDOWN — A Strategy for the Eighties".

Q. How can PLOWDOWN be a profitable alternative to summerfallow?

A. Summerfallow, under certain soil and climatic conditions, is a useful practice which, through weed control, moisture conservation and plant food accumulation improves production of crops.

In many instances however, the practice presents many disadvantages which the farm operator cannot afford in the light of rapidly increasing production costs:

- (1) Fallow generally decreases the organic matter content of the soil and is one of the main contributing factors to the decline of the fertility levels in the Western Canadian soils.
- (2) Fallow leaves the topsoil unprotected for relatively long periods, therefore more vulnerable to the elements and susceptible to wind and water erosion.
- (3) Summerfallow increases salinity by allowing the topsoil to dry up. This causes the moisture from the lower levels to move upwards by capillary action, bringing along the salts carried in the soil solution to the surface where further evaporation leaves these salts concentrated in the upper layers.
- (4) Good summerfallow will increase the availability of nitrogen and other plant nutrients, but a mediocre job of fallowing or one which is performed during a year of poor mineralization may actually result in a loss of total nitrogen.
- (5) Summerfallow is costly. Particularly in areas or during years of ample moisture, many tillage operations are required to achieve the weed and volunteer plant growth control desired for the success of the practice.

As an alternative, legumes incorporated in the soil as green manure will go a long way in helping reduce some of these problems. By the addition of large quantities of organic matter, and by virtue of the deep-rooted nature of these plants there will be improved water infiltration. The better internal and subsoil drainage resulting will in fact reverse the salinization process and permit the salts accumulated at the surface to be carried down to lower levels.

The growing crop will leave the surface soil exposed and unprotected for only a short period, and the nitrogen fixing ability of the legume will insure a positive balance in the soil nitrogen level.

Finally, the extra costs of plowdown are minimal since the added inputs of seed and seeding will be offset by the savings in the number of cultivations which are not required until mid-season of the plowdown year.

Q. What are the major legume forages and what have they contributed to agriculture?

A. Legume forages include alfalfa, alsike, red clover, sweet-clover, bird's-foot trefoil, sainfoin and cicer milk-vetch. They have always played an important role in livestock feed and soil improvement. Until chemical fertilizers became available on a commercial basis, plowdown provided the main source of added nutrients for succeeding crops in areas where livestock was not available.

Legumes can take much of the credit for the development of large tracts of land in northwestern Canada where the initial productivity of the soil was too low for economic crop production.

- Q. Why are legumes suitable for this purpose?
- A. Legume forages, when properly inoculated, have the ability to take nitrogen from the atmosphere and fix it on their roots in a form that can be utilized by subsequent crops. The atmosphere near the earth contains vast amounts of nitrogen, but with the exception of legumes, plants are unable to use it in its existing form. Growing legumes increases usable nitrogen, which is the most limiting soil nutrient for cereal and oilseed production.

2. NITROGEN FIXATION

- Q. How does the legume fix nitrogen?
- A. Soil bacteria called rhizobia infect the root hairs of the plants causing the development of nodule clusters. Both plant and bacteria benefit from this relationship. The bacteria obtain carbohydrates from the plant and the growing legume secures nitrogen in the ammonium form from the bacteria.
- Q. How much nitrogen do legumes add to the soil?
- A. This can vary from one soil type to another and is also dependent on climatic conditions. A vigorous healthy stand may fix several hundred pounds of nitrogen per acre during its lifetime. A poor stand which is ineffective in fixing its own nitrogen may deplete the soil. Agriculture Canada's Research Station at Beaverlodge provides the following estimates.

Table 1
ESTIMATES OF NITROGEN FIXATION
IN THREE YEARS
(Establishment Plus 2 Years)

Legume Crop	Lb. N Fixed/Acre ¹	
	Gray Luvisol Soil	Black Solod Soil
Red clover	298	224
Alsike clover	271	135
Alfalfa	394	153
Sweet-clover ²	191	112
Bird's-foot trefoil	170	129

¹ Nitrogen fixation estimates including nitrogen in herbage and crop.

² Establishment plus one year

It is estimated that both top and root growth of clover average 3% nitrogen. A healthy crop will produce 1.5 to 2.0 tons of top growth material per acre containing 90 to 120 lb of nitrogen. About half of this nitrogen becomes available to the crop immediately following the legume plowdown if

sufficient time is allowed for decomposition. One advantage derived from plowdown is the release of nitrogen over a continuous period without the loss of the easily leached nitrates and the volatile ammonia form of nitrogen.

3. WHERE SHOULD "PLOWDOWN" BE USED?

- Q. What areas are best adapted to legume plowdown?
- A. Plowdown will be beneficial in all areas where the annual rainfall is usually high enough to provide normal crop growth and where the practice of summerfallow will not contribute to significant moisture reserve build-up.

In western Canada, all the cultivated area outside the Palliser triangle would definitely find substantial advantage in substituting a large percentage of its summerfallow acreage to legume plowdown. This includes all the parkland, Black and Grey Wooded zones of Manitoba, Saskatchewan and Alberta, some of the Brown soils of these regions, the Peace River block and the interior of B.C. In these areas alone, over 10 million acres are summerfallowed each year. The practice of summerfallow can be fully justified for only a small portion of this acreage. There may be a valid reason for a complete summerfallow, such as a special soil, weed or pest problem, but in most cases summerfallow is done as a matter of convenience or as a matter of habit with little thought given to the economic losses resulting from the breakdown of organic matter, accelerated erosion, and the leaching of valuable plant nutrients.

A legume plowdown is most beneficial and results in increased productivity in areas that are low lying, land areas that are susceptible to flooding and erosion, and land areas that tend towards salinity. The greatest improvement will be noted in particular on the heavy textured or clay soils which require large quantities of organic matter for the maintenance or proper tilth. Almost all soils however will improve or at least fulfill fertility maintenance criteria, when plowdown is practiced.

- Q. What quantities of the essential nutrients are used up by our major crops?

A.

Table 2
PLANT NUTRIENT USED BY CROPS

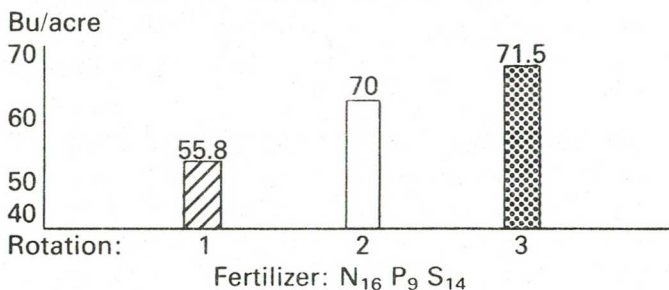
Crop	Bu/Acre	Yield Lb/Acre	Nitrogen	Pounds Removed From Soil/Acre		
				Phosphate	Potash	Sulphur
Wheat	40	2400	85	27	56	8
Barley	60	2880	90	25	55	8
Rapeseed	30	1500	119	36	72	7
Flax	20	1120	54	15	45	3
Oats	80	2720	100	20	77	13

- Q. Can legumes which are plowed under replace the need for commercial fertilizers?
- A. No, they cannot. They should be looked upon as a supplement that reduces the amount of commercial fertilizers that must be applied. Also, other nutrients such as phosphorus and sulphur must be obtained through commercial fertilizers.
- Q. Where in a rotation can I obtain the maximum benefit from using a legume as a plowdown?
- A. Legume plowdown will offer the greatest benefit in replacing summerfallow or as a break-crop. Underseeding a cereal crop prior to the plowdown year is most commonly practised. Spring seeding early without a companion crop in the year of summerfallow and working under the top growth is also possible. Demands on labor and equipment will be limited during the summer months and the reasons for fallowing in the first place will be met.

4. RESEARCH SUPPORTS PLOWDOWN

- Q. Are there any research findings to support increased crop yields following plowdown in Alberta?
- A. Long-term studies comparing rotations in western Canada have been done and some of these contain information that support the positive effects of legume plowdown. One of the longest studies which specifically looked at this subject was done by the Lacombe Research Station on a Gray Wooded soil, Caroline silt loam, at a site near Chedderville in west central Alberta. After thirteen years the highest barley yield was obtained from the two year rotation using sweet-clover as a plowdown.

Table 4
BARLEY YIELDS AT
CHEDDERVILLE IN BU/ACRE



- Rotation 1: Six year (2 barley, 4 legume hay)
- Rotation 2: Six year (barley, plowdown, barley, barley, hay, hay)
- Rotation 3: Two year (barley, plowdown)

Research was conducted at Breton to see whether it would be better to cut the hay prior to breaking or plowing down the entire legume crop. Results showed that the highest yield was

obtained from the plowdown clover. Should a market exist, however, for the hay crop it should be harvested prior to plowing.

Table 5
EFFECT OF LEGUME MANAGEMENT ON
THE YIELD OF WHEAT AT BRETON¹

Fertilizer ²	Legume Cut in July Land Plowed in Aug.	Legume Turned Under in July
	Yield Bu/Ac	Yield Bu/Ac
N ₁₆ S ₂₅	34.1	35.6
N ₁₆ P ₂₀ S ₁₄	34.4	34.2
N ₁₆ P ₂₀ K ₃₀ S ₁₄	34.3	38.6
MNPS	36.6	40.3

¹ Source: Grey Wooded Soils and Their Management, U. of A.

² Applied every second year

Another long term experiment at Indian Head, Saskatchewan, showed the effect of sweet-clover as a plowdown compared to traditional summer-fallow in a rotation. Yields in a three year rotation were higher with the clover than a comparable check rotation, and were not greatly different from a similar rotation using commercial fertilizer.

Table 6
THE EFFECT OF SWEET CLOVER PLOWDOWN
AT INDIAN HEAD, SASKATCHEWAN

Treatment	17 Year Average 1960 - 1976			
	1st Year Wheat Kg/Ac	2nd Year Wheat Bu/Ac	1st Year Wheat Kg/Ac	2nd Year Wheat Bu/Ac
Wheat, Wheat, Clover-fallow	1024	37.6	643	23.6
Wheat, Wheat, Fallow	910	33.4	474	17.4
Wheat ¹ , Wheat ² , Fallow (Fert.)	1030	37.8	673	24.7

¹ 50 lb, 11-48-0

² 80 lb, 23-23-0

- Q. In addition to nitrogen contribution, what other improvements can be obtained from legume plowdown?
- A. Soil structure and tilth are greatly improved. Humus content is the most important indicator of soil fertility in mineral soils. Humus breaks down quickly with repeated cultivation and in the absence of a crop. The only way to maintain it is to supply organic matter. Legume crops plowed under will provide organic materials which are easily decomposed and which contain sufficient nitrogen to promote decomposition without interfering with the natural carbon-nitrogen ratio of the soil and restricting the amount of nitrogen available for plant growth.
- Improved tilth or soil structure resulting from plowdown has therefore many advantages:
- Soil will be easier to handle under varying moisture conditions.
 - Water infiltration, water holding capacity and capillary action will improve.

- c. Alkali and saline soils will be improved.
- d. Clay or heavier soils will be less sticky and all soils less susceptible to pulverization.
- e. It will provide a more favorable medium for microflora development and assimilation of nutrients for growing plants.
- f. Soil erosion by wind and water will be reduced over the traditional summerfallow practices.
- g. The legume as a break crop can be effective in controlling diseases and insects that can build-up under continuous crop production. The benefits of controlling weeds by cultivation are not lost by plowdown since good development of legume crops before cultivation results in effective competition for weeds.

5. WHICH LEGUMES TO USE

Q. Which of the legumes are most suitable for plowdown?

A. Any of the legume forages can be used for plowdown but the seed of some is too expensive for this purpose. Alfalfa, trefoil and sainfoin for plowdown are relatively more costly. They are also more sensitive to soil pH and more difficult to inoculate effectively. Annual legumes, like peas and fababeans are also excellent nitrogen fixers. The clovers are economical and there are good supplies of domestically grown seed. They can be used alone or as a mixture for plowdown.

1. **Red Clover (Single Cut)** — Is a short-lived perennial with many stems arising from a crown, and has as a fairly deep branched taproot. The flowers are pink and are in compact heads at the tips of the stems. Red clover is not drought resistant but once established can survive long periods of low moisture. It is very competitive with other crops but can be weakened by diseases such as mildew and northern anthracnose. Performance is best on first year after seeding. Good performance under lower pH levels. Altaswede is the single cut variety most suited to western Canada. It is particularly adapted to well drained soils of the black and grey wooded zones of the prairies, and has a very high nitrogen fixing ability.

2. **Alsike Clover** — A perennial that tillers profusely from the crown, leaves are trifoliate and heads are pinkish white. The plant is completely hairless. Alsike is very flood resistant and competes well with weeds. It has very few disease problems. In low lying areas it will grow and tolerate low pH and poorly drained field conditions. Aurora is the Canadian licensed variety of alsike most readily available in western Canada.

3. **Sweet Clover** — An upright growing biennial with stems that are succulent in the early

stages of growth but turn woody as the plants mature. Sweet clover is drought tolerant because of its deep root system. It is also quite aggressive and very winter hardy. It does best in well drained and neutral soils, but it tolerates saline soil conditions as long as moisture is adequate. The main insect pest is the sweet-clover weevil which can eat seedlings quickly if the infestation becomes serious. A short rotation use such as plowdown, will minimize the risk of weevil damage.

Q. What consideration should be given to seed quality?

A. As a buyer of seed you should carefully select a high quality product. In the case of clovers the grade of seed should have a higher priority than the variety chosen. Canada No. 1 seed is of much higher quality and should be used before Canada No. 2 seed. There is a much greater tolerance for primary and secondary noxious weeds in Canada No. 2 seed, and its purchase for PLOWDOWN purposes should be avoided. If the seed is graded down because of sweet-clover seed content this would have little significance in a plowdown mixture of clover seed. Quality is higher in the Canada No. 1 for single crops (species) than in Canada No. 1 mixtures, thus it is preferable to buy blends of Canada No. 1 seed than to buy a Canada No. 1 forage mixture. The germination standard is also much lower and in most cases lower germination in a Canada No. 2 more than offsets the price differential between No. 1 and No. 2.

6. MANAGING PLOWDOWN

Q. What herbicides are recommended for use in crops underseeded to clovers or to control weeds seeded without a companion crop?

A. Embutox E may be used in wheat, barley and oats underseeded to alfalfa, alsike, white dutch clover or bird's-foot trefoil for the control of most broad-leaved weeds. A similar compound, Tropotox Plus is preferred when the above crops are underseeded to alsike, red, white dutch or ladino clover. Legumes should be at the 1-3 trifoliate stage when these applications are made.

Eptam, a preplant soil incorporated herbicide or Asulox F may be used in flax underseeded to alfalfa for the control of broad-leaved weeds and grasses. Hoe-Grass or Carbyne can be used in flax, rapeseed, mustard, wheat and barley underseeded to alfalfa, red or sweet-clover where annual grasses are a problem.

For the control of green foxtail in flax or rapeseed undersown to bird's-foot trefoil or alfalfa, apply Dalapon.

It should be noted that there are no herbicides for the control of broad-leaved weeds in crops underseeded to sweet-clover. When sweet-clover

is used for PLOWDOWN it may be necessary to cut the nurse crop early for silage to prevent weeds from going to seed. The sweet-clover can then be used as a hay crop or plowdown in the second year.

For details, obtain a copy of "Guide to Chemical Weed Control" from your local Alberta Agriculture office.

Q. What about seed inoculation?

A. Inoculation is the process of implanting infective and effective rhizobia into the soil where they will contact the roots of young legume plants. Rhizobia are applied prior to seeding and are specific to different types of legumes. Alfalfa and sweet-clover use one group, alsike and red clover another, and bird's-foot trefoil yet another. It is important to obtain the right rhizobia group. The most popular inoculant form is a peat-base one since it assures rhizobial survival in the package before use. The sprinkle method is the most common on farms. This method involves moistening the seed with a little water and then mixing the inoculant into the seed. This can be done in the grass seed attachment or in a container where mixing by hand is easier. The use of a sticking agent with the inoculant containing a sugar in solution increases the effectiveness of inoculation and is highly recommended. It is important that the seed be planted shortly after inoculation and to avoid, as much as possible, exposure of the inoculated seed to direct sunlight. Soils that have had clover previously may contain sufficient levels of rhizobia in the soil to provide adequate nodulation, however, the cost of inoculation is small compared to the potential benefits obtained from proper inoculation which ensures the presence of rhizobia in the soil. Soil conditions are important at time of seeding and play a large part in the survival of applied rhizobia. Warm, moist conditions that induce fast germination will help to maintain survival of rhizobia and produce successful nodulation.

Q. What seeding practices are recommended for plowdown crop?

A. The 50 years of research on the Breton plots in Alberta have shown that the best yield of grain is obtained following the heaviest crops of legumes. For an effective plowdown it is therefore essential to obtain a good stand. Every precaution should be taken to insure that the right quantity of good quality, well inoculated seed be placed at the right depth in a well prepared firm seedbed, where quick and even germination is promoted.

A clover crop grown for PLOWDOWN could be seeded with the companion cereal or oilseed crop and generally with a small seeder attachment on the drill. Since the companion crop will provide some competition to the underseeded legume,

the rate of seeding for the cereal or oilseed should be reduced slightly. Rates of 10 lb. per acre (i.e. red clover, sweet-clover, alsike or crop combination) are reasonable for PLOWDOWN when underseeded. Direct seeding of clover without a companion crop would take place in early spring after the first fallow operation to allow good growth before plowdown. The seeding rate could be reduced slightly. All other cultural recommendations are similar.

Q. When is the best time to plow down clovers?

A. The timing of turning under a clover crop is important and many factors have to be considered for optimum results. The main points to remember are: nitrogen accumulation, organic matter breakdown time, and soil moisture balance. Extensive research in both Canada and the U.S. indicates that optimum nitrogen fixation and organic matter are reached shortly after the clovers are in full bloom. Theoretically, at this stage of growth, the plowing down of a clover crop should yield the greatest benefits. The soil improvement value of the clover crop will decline very rapidly after reaching this point and there is no reason to delay plowdown beyond this stage. Once the crop starts to mature, it becomes woody, it is harder to handle with machinery, and it will take much longer to decompose and release plant nutrients for further crops. It will also use up large quantities of soil moisture.

Q. What equipment is recommended for plowdown?

A. Traditionally the moldboard plow has been the machine used for plowdown. The moldboard plow can do a good job of killing weeds and turning the crop under in a neat furrow but does not incorporate it into the soil as well as other equipment. Moldboard plowing can be slow and other machinery such as heavy duty discs can be used for the same purpose with good results for the first cultivation. When the soil is dry and the crop is heavy, plowing down with the moldboard can result in the deposition of a thick mat of loose organic material, insulating the topsoil from the subsoil, preventing water movement between the two layers and substantially slowing down the process of decomposition, humus formation and release of plant foods. Disk implements, single and double disk harrows, one-way diskers, off-set disks, Rome-type and serrated disks, followed or preceded by the heavy duty cultivators, can be as effective in providing good incorporation of materials with the soils, especially if conditions are not the most favorable. The timing of the first operation to insure that the field will be covered before the crop gets too thick for the machine selected is often more important than the choice of the machine.

Since the objective of PLOWDOWN is humus

formation, a favorable medium for this process is necessary. Good incorporation of organic matter near the surface of the soil will encourage bacterial fermentation and decomposition resulting in more efficient humus formation and conservation of plant nutrients than the deeper placement of the crop under a plow furrow.

- Q. What crop is best to grow after plowdown?
- A. On grey wooded soils of western Canada, research by the University of Alberta at Breton has shown that cereal crops were the most consistent in producing profitable increases after clover crops. Not only were the yields significantly high-

er over a long period of years, but with wheat the quality shown by higher protein content and higher baking quality proved consistently superior.

Oilseeds, like canola or pulse crops such as field peas and beans have been reported to suffer seed injury when they were planted too soon after a heavy crop of clover was plowed down and poorly incorporated in the soil, as a result of the development of fungi, or diseases such as sclerotinia. But since the damage is confined largely to the first stages of decomposition of the legumes, there is no danger of any serious setback when the clover crop is plowed down early and since a whole winter season separates the seeding from the green manuring.

Acknowledgements: In preparing this presentation The Forage Seed Council obtained valuable assistance from many individuals and institutions.

The council wishes to express its appreciation to the Department of Soil Science, University of Alberta; The Alberta Soil and Feed Testing Laboratory; Agriculture Canada Research Station, Beaverlodge; and the Alberta Agriculture Plant Industry Division.

