# FORAGE PRODUCTION
## ON POORLY DRAINED SOILS
## in the Southern Interior of British Columbia

**Province of British Columbia**
Ministry of Agriculture, Fisheries and Food

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# on Poorly Drained Soils

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prepared by

Cariboo Poorly Drained Soils Development Extension Committee

Cover photo: Forage production on an organic soil at Meldrum Creek, west of Williams Lake. Owned by Eric and Diane Reay, this site has been developed from a native stand of grass, sedge and willows to a productive hay field, with a potential yield of 6.8 tonnes/ha (3 tons/acre) of reed canarygrass.

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# INTRODUCTION

Poorly drained soils occupy a modest percentage of the total land base within the Central and Chilcotin/Cariboo regions of British Columbia. Similar poorly drained soils can be found in the Kamloops region, but occupy a smaller area. Areas of these soils range in size from a few hectares to a few hundred hectares.

Since the early development of the ranching industry in the Interior, the poorly drained soils supporting native vegetation have provided extensive grazing and a major source of winter feed. The 1986 census of agriculture indicated that 22% of the B.C. beef breed cattle, (46,500 head) were raised in the Cariboo Agriculture Reporting Region. If the poorly drained lands provide half the annual feed for these cattle then there is ample justification to give poorly drained soils special considerations. Their forage yields are generally low but the reliability of forage production on these poorly drained soils can be improved markedly by water control measures, sometimes relatively simple ones. These measures allow for draining in wet years and sub-irrigation and/or flooding in dry ones. The application of fertilizer has shown that native forage production on many sites can be markedly increased. Fertilization and seeding to domestic forage crops has increased forage yields substantially on the improved poorly drained lands (figure 1)..

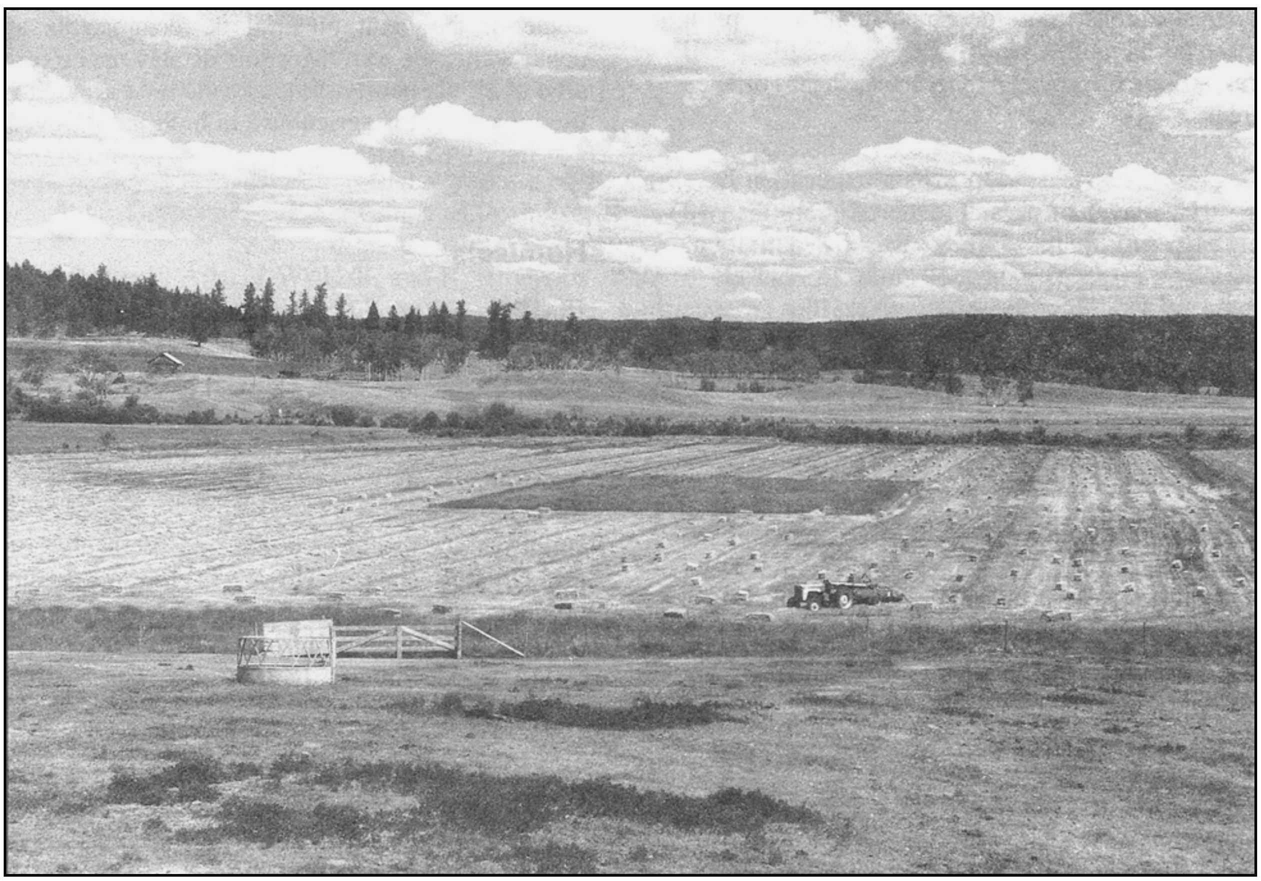


**Figure 1**. Developed hayfield on Reay Ranch, Meldrum Creek.

# SOILS

The poorly drained soils of Interior British Columbia have developed in shallow lake basins left by glaciers or sometimes old beaver ponds. These soils consist of plant material of varying degrees of decomposition. Decomposition is slow due to low temperatures and the absence of air in the water-saturated material. Water loving plants, such as lilies, rushes and subsequently sedges, invaded the shallow lakes after algae and submerged water plants had built up a base layer to act as a rooting medium. As the annual growth died, it formed a layer of organic material on top of this base layer and on the surface of the lakes. As centuries passed, the space between the bottom and surface of the lake filled with a mass of water-saturated plant material several metres thick. In some instances, the dead plant material a few metres deep extended out onto the lake surface and formed a layer thick enough to support new plants and in time this led to formation of the floating or "quaking" bog. On drier situations, more decomposition of the plant material has taken place. Here, the sedges and rushes may be replaced by grasses, shrubs or even trees.

Organic soils referred to in this publication have a surface layer of organic material more than 40 cm (16 in.) thick. They are, by definition, members of the Organic soil order in contrast to those of the Gleysolic order where the layer is less than 40 cm (16 in.) thick. These Organic soils are usually only slightly acidic, compared to the coastal ones that are highly acidic. The interior organic soils are generally well supplied with calcium.

The stage of decomposition of an Organic soil has a direct relationship to its inherent fertility. A brief description of different Organic soils, their occurrence and basic productivity and fertility in the Central Interior is presented below, together with that of the Gleysolic soils.

## ORGANIC SOILS

By definition, a depth of organic matter greater than 60 cm is required for Fibrisols and greater than 40 cm for Mesisols and Humisols.

### Fibrisols

Fibrisols are the least decomposed of all Organic soils. The term indicates that the soil is composed of fibrous plant material often found at considerable depth within the soil. These soils are generally the most infertile of organic soils. They tend to be found at higher elevations, where there is generally more precipitation and lower temperatures, and land locked areas where drainage is restricted. Their use for agriculture is quite limited, as adverse climate and low fertility conditions result in low production, even when improved by drainage, fertilizers and tame forage species.

### Mesisols

Mesisols are in an intermediate state of development between Fibrisols and Humisols. Some of the plant material is recognizable at depth within the soil. Mesisols occupy the largest area of all the poorly drained soils, and are being used the most for agriculture in both unimproved and improved states.

### Humisols

Humisols are the most decomposed of the Organic soils. They tend to be dark in colour, in many cases, black. The plant material has decomposed to the state whereby it is hard to determine its original nature. These soils are usually found at lower elevations.

Humisols are the most fertile and productive of the Organic soils. However, for maximum production of agricultural crops, even these soils require additions of nitrogen (N), phosphorous (P2O5), potassium (K20) and frequently sulphur (S).

The area extent of Humisols soil is limited, but highly regarded for its forage production capabilities.

## GLEYSOLIC SOILS

Gleysolic soils are mineral soils that occur in wet, depressional areas.

Some Gleysols have organic layers developed on top of the mineral soil, with depths ranging from 40-60 cm (16-24 in.) or less. The mineral soil, often grey or bluish grey, is saturated with water for much of the year, and usually has medium (loam) to heavy (clay) textures. The accumulated surface organic layer is often fairly well decomposed, and its fertility would be similar to other well decomposed Organic soils, i.e., Humisols.

Gleysols are often found around the edge of poorly drained areas. Like Humisols, they are usually found at lower elevations. Salt accumulations can occur in these soils in the southern and drier areas of the Interior, to the point where salt intolerant species such as reed canarygrass will not grow.

# EXTENT OF POORLY DRAINED LANDS

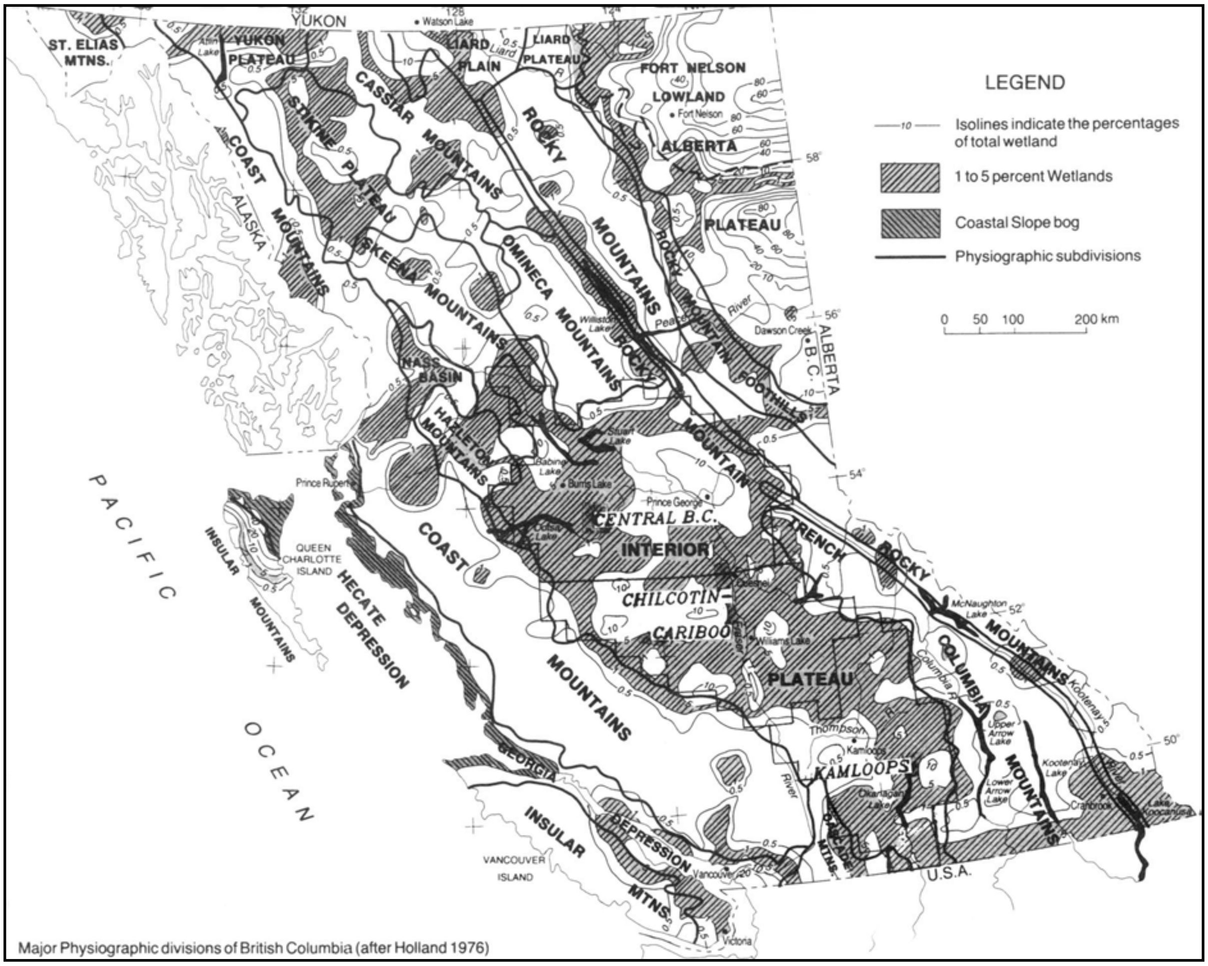
The area occupied by poorly drained soils and its elevational distribution in the southern interior of B.C. is shown in figure 2. The three defined regions were derived from Canada Land Inventory maps representing 72% of this area and indicating Organic and Gleysolic soils: and from National Topographic Series maps covering the north and northwest edges of the area, and indicating poorly drained soils as "marsh and/or swamp".

The total poorly drained areas (Table 1) for each respective region are: Central B.C. 3486 km. (4.0%) Chilcotin-Cariboo 2589 km$^2$ (4.2% and Kamloops 1016 km$^2$ (1.9%). Poorly drained areas below 600 m elevation (not shown) is insignificant for Central B.C. (39 km$^2$, 0.04% ) and Chilcotin-Cariboo (2 km$^2$, 0.003%), but for Kamloops it is greater (317 km$^2$, 0.6%). In Central B.C. most of the poorly drained soils lie between 300 and 1200 m in elevation. In the Chilcotin-Cariboo most are above 900 and a large portion of these are above 1200 m while those of Kamloops Region are concentrated between 300 to 900 m and above 1200m.

**TABLE 1: Area Occupied by Poorly Drained Soils in the Southern Interior of British Columbia**

| Region (see Figure 2) | Elevation Category (m) Km$^2$ / % of Total Land Area | | | | |
|---|---|---|---|---|---|
| | 300-900 | 900-1200 | >1200 | Total | Total Land Area ( km$^2$ ) |
| Central B.C. | 2,305<br>2.6 | 950<br>1.1 | 231<br>0.3 | 3,486<br>4.0 | 87,839<br>100 |
| Chilcotin-Cariboo | 192<br>0.3 | 1,511<br>2.4 | 886<br>1.4 | 2,589<br>4.1 | 63,877<br>100 |
| Kamloops | 321<br>0.7 | 105<br>0.2 | 502<br>1.0 | 1,016<br>1.9 | 52,344<br>100 |

* For conversion: 1 km$^2$ = 247.1 acres 1 km$^2$ = 0.3861 miles$^2$, and 1 m = 3.28 ft.



Major Physiographic divisions of British Columbia (after Holland 1976)

**Figure 2**. Distribution of Poorly Drained Soils in British Columbia (Van Ryswyk et al. 1992).

Thus, poorly drained soils become more common in the south to north direction and tend to be concentrated in the middle elevation ranges where the landscape slopes are gentlest (figure 2). Certain map areas (1:250,000 scale) in the Chilcotin-Cariboo and Central B.C. regions have above average percentage of poorly drained areas; Anahim Lake (93C) 5.2%, Quesnel (93B) 4.7%, McLeod Lake (93J) 5.8%, Prince George (93G) 5.8%, and Smithers (93L) 4.3%.

Within the area covered by Canada Land Inventory maps, the respective areas of Gleysolic soils as a percentage of total poorly drained soils change abruptly from the Kamloops region 63% to Chilcotin-Cariboo 29% and Central Interior 39%. The Gleysols have a general tendency to be concentrated at lower elevations. Gleysolic soils have significance for soil management. They are generally more fertile than poorly to moderately decomposed Organic soils. Since there are more Organic soils in the Central B.C. and Chilcotin-Cariboo regions, the use of chemical fertilizers will be an important factor in achieving high forage production, particularly with tame species. Drainage and cultivation of Gleysolic soils, however, will likely be more difficult particularly on those underlain by heavy textured (clayey) materials.

The elevation division at 900 m, although arbitrary, does have some significance for forage production. Below 900 m., two cuts of hay, or, if haying is delayed, one cut plus substantial aftermath growth of tame species, for grazing, can be expected. Above 900 m it is more likely that only one good cut will be obtained unless a particularly good microclimate exists. Above 1200 m it is not likely that developing poorly drained soils to the point of establishing tame species would be economic.

# SITE SUITABILITY

## FACTORS TO CONSIDER

The development of poorly drained lands for forage production may involve clearing, ditching for water table control and reseeding to tame forage species, followed by sound agronomic and water management practices. Development potential is related to a number of biological and physical constraints such as climate, soil capability and outlet restrictions. Forage production potential can be reached only by knowledge of an inventory of these features and of current development techniques and costs to management practices. Some of the necessary information is available or at least accessible from existing soil survey maps and descriptions but more data would have to be gathered from the field to understand the real agricultural capability of these lands.

These poorly drained sites can be separated into two major soil groups, namely Gleysolic and Organic. Gleysolics are normally considered more productive than Organics but there is a wide range of productivity in both groups. Soil type can be identified by a soil specialist or other trained personnel.

### Soil pH & Fertility

A good pH range for most forages on poorly drained soils lies between 5.5 to 8.0. Extremes of acidity (pH values below 7) and alkalinity (pH values above 7) present limitations to establishment of some tame species of forage crops. Soil pH and fertility should be determined by soil analysis.

### Elevation

Elevation is critical because of its influence on the growing season climate. Areas above 1,200 m (4,000 ft.) elevation are considered less favourable for agricultural development.

### Dominant Vegetation

Analysis of the dominant vegetation species by specialists tells something of the potential productivity because it often reflects the combined effects of all the biophysical constraints. Different species of sedges, grasses or forest cover help to indicate the economic potential for forage production under improved water management and cropping. Refer to publication such as the **Wetland Managers' Manual** (Runka and Lewis, 1981) to obtain more information on this complex topic.

### Water Conditions

The water outlet conditions, periods of flooding, and duration of water inflow, such as seepage, indicate the difficulties that might be expected in developing the area. The nature of outlet conditions is important because of the relationship not only to the period of flooding but also to the feasibility of making water management improvements. Seepage and runoff from adjacent upland can be intercepted by perimeter ditching.

### Other Resource Uses

The development of meadows for forage production may impact other resources such as fish and wildlife. Farmers and ranchers are encouraged to consider any effects on other resources when planning development. Effort should be taken to minimize any negative consequences to meadows that serve important ecological functions.

Before beginning with any improvements, contact a district office of the B.C. Ministry of Agriculture, Fisheries and Food (BCMAFF) for planning assistance in the development of poorly drained sites. The staff can provide information regarding requirements of other agencies such as the Water Management Branch and Fish and Wildlife Branch of the B.C. Ministry of Environment, Lands and Parks.

# WATER CONTROL

Water control on poorly drained lands is essential for obtaining consistent forage production. Water control has traditionally been achieved in two stages. The first stage involves deepening the outlet and excavating open ditches to allow lowering of the water table. The second and equally important stage is construction of a water control structure to regulate water levels according to the flow and time of year.

Development of an effective system is essential and requires careful planning and construction. Special consideration should be given to the upstream and downstream effects on other uses and users. (e.g. recreation, wildlife and fish.)

The Water Management Branch of the Ministry of Environment should be contacted before beginning any work to determine requirements for water licensing or approvals for work in or about a stream. The B.C. Water Act states that it is necessary to have an approval or water licence prior to relocating, obstructing, diverting or cleaning a stream. These requirements are intended to assist with the management and preservation of the water and fisheries resource and to ensure that proposed developments do not have a harmful effect.

The ditching and control gates that are required differ with each sites' unique characteristics of shape, slope, outlet restrictions, surrounding uplands, existing vegetation, depth of organic layers and intended use. In many cases though, the basic requirements are a main control ditch supplemented by perimeter interception ditches and a deepened outlet channel with a water control gate.

The outlet is almost invariably the major cause of water problems encountered in development of a poorly drained site. The natural outlet might be restricted by a substratum of impermeable clay or bedrock or even debris such as fallen logs, sloughed in stream banks, beaver dams, or sedimentation. These restrictions may have caused the formation of the poorly drained land in the first place, so when they are removed, artificial means of maintaining a high water table must be installed in their place.

Water control structures serve as a method of controlling the depth to the water table in a poorly drained field. Controlling the water table in an organic meadow is desirable for many reasons. Maintaining a high water table before and during the dry season ensures an adequate supply of water necessary for good hay production and restricts decomposition of the soil. A lower water table can provide an aerobic plant root zone and allow drier conditions for easier operation of farm machinery during critical planting, fertilizing and harvesting times.

It is important not to over drain these lands. When an organic soil is drained, air replaces the water in the soil pores. Subsidence also occurs due to deflation or reduction in flotation. This results from the soil collapsing as the water is removed. It is most pronounced on the most fibrous organic soils. Muck or humisol soils are not as prone to deflation reduction under drained conditions. The increase in air oxidizes the organic material and encourages it to decompose, resulting in irreversible soil shrinkage. A low water table for an extended time causes crops to experience moisture stress while the soil shrinkage results in a lowering of the land surface (subsidence). In some instances it may subside so much that the benefits of poorly drained soils would be lost, making further improvements impossible.

Excessive drying of an Organic soil can cause it to become hydrophobic (water repellant) and the soil will not rewet. This can cause problems with seed germination etc. It will also make the soil act as an insulator, preventing heat from penetrating the soil. This will result in slower warming of the soil in spring and may lead to an increased risk of frost damage. Fire hazard is greatly increased for a dry organic soil. Organic soil fires are almost impossible to put out unless complete water flooding can be affected.

## WATER CONTROL STRUCTURES

Water control is typically provided by simple stop-log type structures installed near the outlet, preferably in a non-Organic (Gleysolic) soil for more stability. The stop-logs raise and lower the water level in the main channel according to cropping and harvesting requirements. To provide uniform water coverage on large fields or those with significant slope, more than one structure may be necessary. This will prevent deep standing water on one area and no water on another area. In many cases, modifications will be required to ensure fish passage to upstream of the structure.

The most effective, inexpensive, and easy to construct control structure is an eight gauge sheet-steel weir with stop-logs to control the water level (figure 3). This type of structure is required for central ditches where the depth of water against the structure is between 0.5 and 1.2 metres. The structure should be installed with adequate depth and width to prevent seepage under or around it. For smaller channels, there are alternative structures such as the timber water control structure shown in Figure 4 and the half-round culvert with stop-logs shown in Figure 5. These structures provide excellent control in smaller channels.

For further information on selecting and designing water control structures, contact the Soils and Engineering Branch of the Ministry of Agriculture, Fisheries and Food.

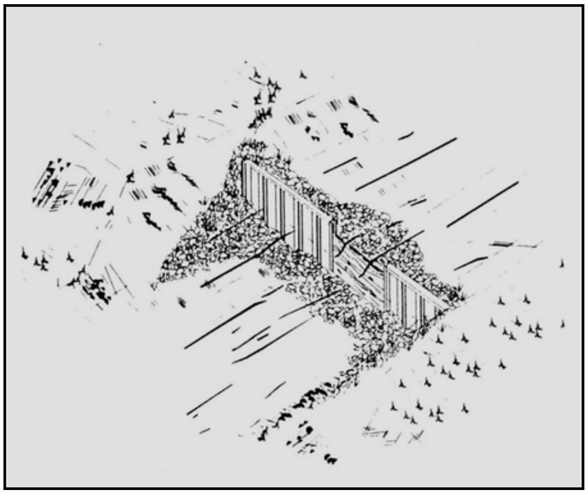


**Figure 3.** sheet steel weir with stoplogs.

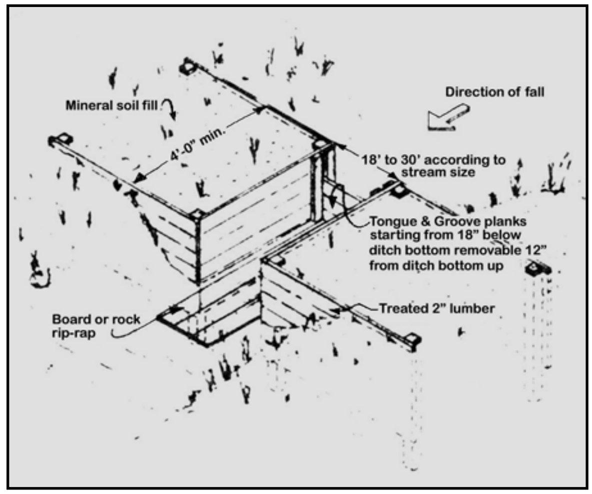



**Figure 4.** Timer control structure - for smaller flows.

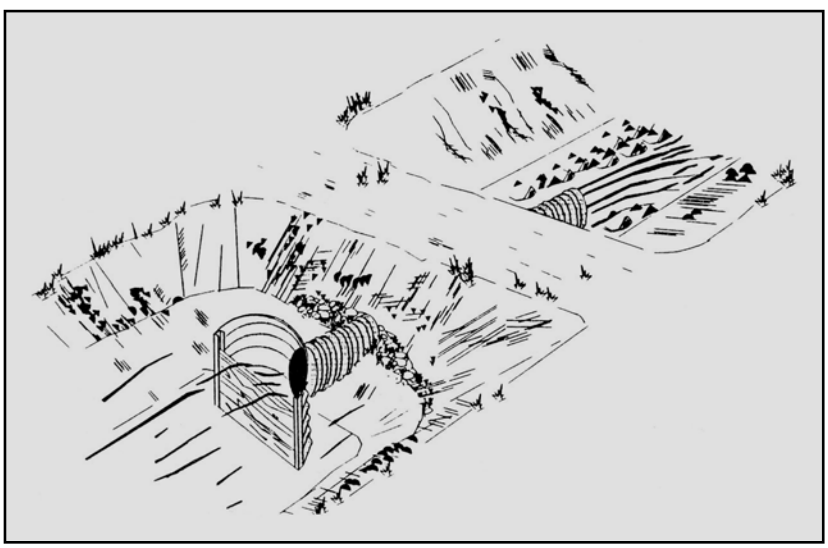


**Figure 5.** Half Round culvert with stoplogs.

# DITCHING

In many cases naturally occurring, poorly drained lands are impossible to farm or even to graze due to the high amount of surface water found throughout the year. This water is usually the result of a combination of events. Naturally poorly drained lands typically occur in a bowl or depression relative to the surrounding area and often have a stream running through the middle or along the side of it. The water from the surrounding uplands flows onto these lands that have a constrained outlet.

Clearing the land for the first time will often dramatically change the drainage patterns. Removal of the vegetative cover results in less snow pack and allows for the sun and wind to more quickly effect evaporation in the spring. Hummocks and willow clumps hold back natural surface drainage, preventing overland flow towards the outlet. As the root systems break down, there may also be better subsurface drainage.

Shallow surface ditches can assist in removing surface water but will have a limited effect in lowering the water table because Organic soils have notoriously low permeability. Most of the water within the soil is removed by evapotranspiration. Therefore, it is important to drain off surface water early enough in the growing season so new plant roots that grow early can reach deep into the soil to obtain nutrients and water. Evapotranspiration will pull the remaining water from within the soil profile. This will allow safe use of haying equipment and will reduce severe hummocking from trampling by livestock.

Main ditches may replace or supplement the main water course. The objective is not always to straighten and deepen the water course, but to provide a system that is easily managed. This can be achieved by allowing access to one side of the channel to maintain a clear water way. There should be a adequate width and depth to handle peak flows while also providing sufficient outlet depth to lower the water table for harvest. Main ditches should be constructed to meet water flow needs, but care should be taken to prevent hazards to livestock or the movement of machinery. Large, deep ditches should be fenced from the field.

Most poorly drained areas require perimeter ditches to intercept run-off from surrounding uplands. Where inflows are concentrated at a few points around these areas, connecting ditches from the edge of the field to the central ditch may be preferable to long perimeter ditches. If the area is narrow, the perimeter ditches may eliminate the need for a central ditch. Perimeter ditches do not need to be more than 60 centimetres deep.

## DITCHING METHODS

The most cost effective equipment for constructing or cleaning large main ditches are conventional mid-sized track-type hydraulic excavators (figure 6). The high flotation and maneuverability of excavators combined with the use of wide ditch cleaning buckets more than compensate for the additional cost over backhoes. Many excavator contractors have "pads" to increase the machine's flotation for jobs lacking stable ground. The best times for ditching work are in the fall when the ground is dry, or early spring when there is still 5 to 10 cm of frost in the ground. If the ditching is done in the late fall when the ground is frozen, the ditch is likely to adjust its slope when the ground thaws. In most cases, it is advisable to rely on having the excavator back to reshape the ditch a year later, after drainage conditions have stabilized and the surrounding ground is dryer with added stability.

**Figure 6.** Track-type hydraulic excavator.

# LAND CLEARING

Natural vegetative cover on most poorly drained areas is often less dense than on uplands. As a result, land clearing can usually be accomplished more quickly and with smaller equipment.

Difficulties encountered in clearing the poorly drained lands often result from their inability to support the weight of the equipment used. Some form of preliminary drainage work, perhaps using a small crawler tractor or blasting with ditching powder (works best under water saturated conditions where the "shock" required to set off successive sticks of powder is carried better), may be required. Timing is critical. It may be necessary to wait for a "dry" year or for winter (if the snow is not too deep) where ground conditions, due to dry soil or sufficient frost, will allow for support of the equipment. Tractive machinery specially equipped to provide additional flotation may be necessary.

There is a limited amount of equipment available commercially for development of these lands. Many pieces of equipment used for land clearing have been designed or improvised by the rancher himself, often by trial and error. Examples are the V-blade cutters (see figure 7) and various other pieces used for ditching and plowing and packing.

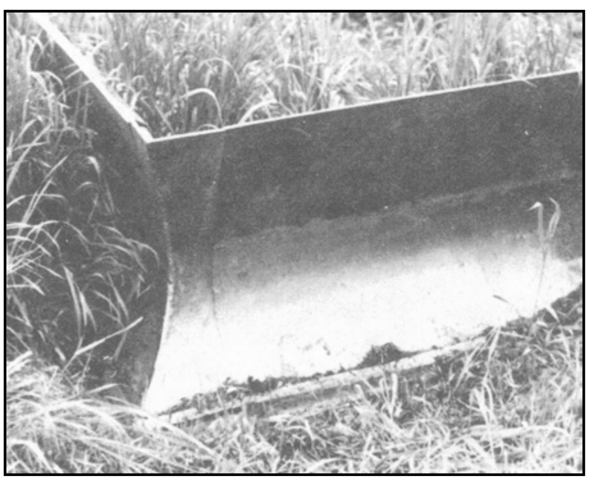


**Figure 7.** Homemade V-blade used for shearing brush growth (Note the cutter bar on the bottom of the blade.)

## ROTARY BRUSH MOWER

Willow, less than 1 m (3ft) high, can be plowed under and mostly buried by using a breaking plow with high clearance. Plowing under brush over 1 m high can result in a rougher surface that requires more discing and floating. Dense willow less than 3 - 3.6 m (10 - 12 ft) high and 5 - 8 cm (2 -3 in) in diameter can be quickly cleared using a rotary brush mower (see figure 8). Power requirements are approximately 25 - 40 kW/m (10 - 15 hp/ft) mower width. A 3-pt hitch mounted brush mower is more desirable than a pull-type due to its manoeuvrability.

**Figure 8.** Rotary brush mower on solid ground.

## CUTTERS

Cutters mounted on crawler tractors such as those commonly used in land clearing on mineral soils can be used to shear tree and brush growth off close to the ground. In light growth, side-cutters provide windrows which are easier to pile. V-cutters are, however, easier on tractor track wear. Keeping the cutting edge sharp will reduce power requirements and improve the cutting action. When working on organic soils with heavy equipment or removing shrubs and trees, try not to disturb the sod. If the clearing equipment is working when conditions are wet, the sod is easily broken. Also take care not to stump out small shrubs or trees as this tends to remove the sod cover as well. Stumps up to 15 cm (6 in) can be turned by the plow. The sod is critical to maintain flotation during ditching and the tillage operations. Once the sod is removed, equipment flotation is lost. In some circumstances the sod will have to reform before equipment can be driven across that area again. The sod can take years to develop to the point where it is thick enough to support equipment.

# SEEDBED PREPARATION

The requirements for seedbed preparation on Organic soils are similar to those required on mineral soils. The existing native growth must be killed and the soil surface layer prepared for proper seed establishment and growth. Maintaining sufficient flotation on equipment is the major consideration.

Plowing is the preferred method of tillage. A large breaking plow with a sod moldboard is required to handle the heavy sods that develop on the wet Organic soils and act like coil springs. It is important to retain the sod layer to provide flotation for equipment, especially in soft conditions. The BCMAFF have developed a breaking plow suitable for use in a wide variety of wet Organic soil conditions (see figures 9 & 10). The single bottom plow cuts a 70 cm (28 inch) wide furrow and has a 1.2 m (4 ft) clearance under the frame. The plow is supported by three large flotation wheels. Each wheel has an independently controlled hydraulic cylinder for vertical adjustment. This level of control is required to maintain a uniform plowing depth and to prevent the plow from becoming stuck in soft soils. The plow is best drawn by a small, low ground pressure (LGP) 50 kW (65hp) crawler. The plow is on-land hitched (off-set) to improve the flotation and traction of the crawler in wet conditions.

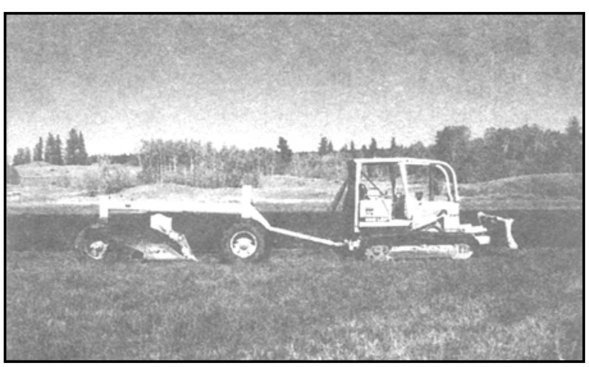


**Figure 9.** BCMAFF flow and low ground pressure crawler

The plow is fitted with two fixed knife-edge coulters. A permanently fixed coulter is welded to the landside and standard of the plow which leans approximately 20° back from vertical. The rear-leaning coulter will cut the thick sod and willow roots while deflecting willow stumps or wood left on the surface away from the lot of smaller standing willow. The layer of sod will sometimes shear off and be pushed ahead of the fixed coulter. In these instances a removable forward leaning knife-edge coulter (about 20° above horizontal) is pinned in place to cut through the sod. The forward leaning coulter, however, can only be used where the surface is free of old tree trunks or other wood too thick for the coulter to cut through. With a very sharp coulter, the plow works well in a wide variety of conditions.

Plowing is preferred over rototilling as it buries most existing vegetation, minimizing the competition with the tame species during establishment of a new crop. Plowing retains the sod layer below the surface, critical to support field machinery. An added benefit of plowing is that it provides some underground drainage along the bottom of the furrow when done parallel to the slope of the land.

Discing (figure 11) the plowed meadow with conventional tractors, either rubber wheeled or crawlers, is difficult when the meadow is soft. Under these conditions, it may be necessary to use a low ground pressure crawler to pull the disc, especially on the first pass. The first pass with the disc should be parallel to the direction of plowing to avoid catching furrows and rolling them back over, leaving the sod face-up. When

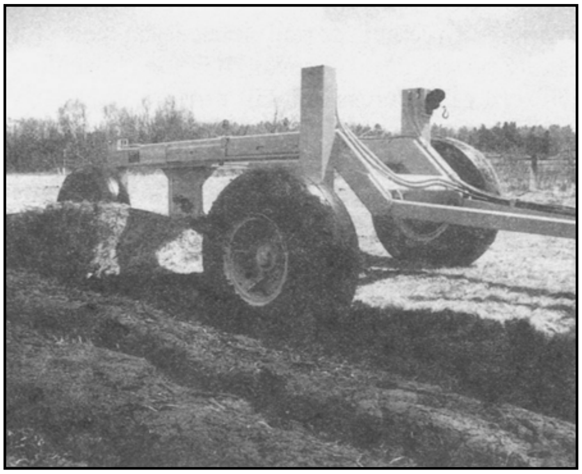


**Figure 10.** BCMAFF breaking plow.

traveling parallel to the furrow with single tractor tires or regular tracks, it is easy to slip between furrows and get stuck. To adapt to varying soil conditions it is advantageous to have a lighter disc and add weights, or have a disc where the gang angle can be adjusted. Drawn discs with extra flotation are useful in wet or soft situations.

The seedbed need not be deep - 8 cm (3 in) to 10 cm (4 in) suffices. The underlying sod should not be broken, thus maintaining best flotation. Under most conditions a double pass with the disc is necessary. Additional passes may be required to level the field especially over the ridges and valleys created when starting and finishing the plowing of an area. Spot use of rotovators may be useful to break up some of the problematic root masses. Floating, harrowing, and finally roller packing a field may be required, particularly for Organic soils to prepare a firm seedbed so that water will move up into the root zone by capillarity action.

**Figure 11.** Discing the plowed ground.

# SEEDING

With adequate water control and fertilizer, most poorly drained lands can be converted to highly productive hay or pasture lands by seeding tame grasses and/or legume species. Reed canarygrass can yield over 6.7 tonnes of hay per hectare (3 tons/acre) on a poorly drained soil that, with good management, may have previously produced only 1.1 tonne/ha (½ ton/acre) of native hay. Reed canarygrass harvested at an appropriate stage of maturity has higher digestibility than does a native hay.

Equipment with large rubber tires, tracks or duals may be required to prevent the machinery from bogging down. Seeding and fertilizing may be done with a conventional drill, or broadcast, if followed by light harrowing. Although the Brillion seeder performs well in mineral soils, on Organic soils the desired effect of the forward roller to form a seed drop site followed by the offset roller to cover and pack the seed is not always realized. There is a tendency for wet clumps of organic material to pack up on the rollers that would normally drop off. Re-packing by rolling is the last very essential operation to firm the seedbed and allow moisture to reach the seedlings if broadcast seeding is used. Late fall seedings can be successful, providing they are done late enough, so that germination will not occur until the following spring. Before seeding reed canarygrass, a germination test should be carried out. Reed canarygrass seeding rates often need to be increased to compensate for poor germination percentages. Reed canarygrass seedlings are susceptible to frost. Thus, late spring frosts can drastically reduce the number of surviving seedlings. This is a disadvantage of fall seeding this species.

In these situations where the field is smooth and free of brush, it may be worth experimenting with a sod seeder (direct, no-till seeder and herbicides) to reseed or rejuvenate a field without carrying out any tillage. Some information on sod seeding is available, however, experience on organic soils with grasses suitable for the Cariboo is limited.

Reed canarygrass is recommended for seeding Organic soils because when well established it is not easily killed by trampling, flooding, freezing or ice sheet formation mainly due to its rhizomatic root system. Its yield is high under optimum fertilization. It forms a dense sod that will support machinery and livestock and it provides reasonable quality forage for hay or silage if harvested prior to full heading as compared to native forage species.

| Per Cent Digestible Dry Matter | | |
|---|---|---|
| Forage | Harvest Date | |
| | July 22 | Sept. 3 |
| Reed Canarygrass | 71.4 | 66.2 |
| Native Grasses | 57.6 | 46.1 |

For best grazing reed canarygrass should not be grazed as close as native meadows. Reed canarygrass may be sown alone at 7-9 kg/ha (6-8 lb/acre or with alsike clover at the rate of 7 kg/ha (6 lb/acre) of reed canarygrass with 3.4 kg/ha (3 lb/acre) of alsike clover. Current varieties of reed canarygrass include Vantage, Paleton, Venture and Rival. Vantage was developed as one of the first varieties to be low in tryptamine alkaloids, harmful to livestock, and yet retain its high yields. The newer varieties, Paleton, Venture and Rival, are still lower in alkaloid levels but are generally 10% lower yielding than Vantage. However, serious alkaloid levels are not likely to occur on poorly drained soils even when fertilized with nitrogen at recommended rates because soil moisture is rarely lacking.

Creeping foxtail is also suitable for seeding poorly drained soils. It is lower yielding than reed canarygrass but will provide very early spring pasture and a fine quality hay. Creeping foxtail is higher in both energy and crude protein than reed canarygrass and timothy. Difficulty may be experienced with lodging of foxtail hay due to weak stems. Excellent water control is necessary to take advantage of the early maturity of creeping foxtail. Seed creeping foxtail at 7-9 kg/ha (6-8 lb/acre) or 7 kg/ha (6 lb/acre) of foxtail with 3 lb/acre of alsike clover.

Timothy and red clover will grow well where flooding is prevented but still will not yield as much forage as reed canarygrass. Early maturing timothy varieties such as Toro or later varieties like Farol, allow one to choose a wide range in maturity. Climax and Alma remain the highest yielding timothy varieties. The red clover variety, Altaswede, remains the highest yielding and hardiest variety of clover.

The use of a legume will improve feed quality over that of timothy alone. Alsike clover varieties, Tetra or Aurora, will tolerate slightly more flooding than red clover. They are also high in feed quality. Be sure to inoculate the legumes with appropriate nitrogen-fixing inoculant before seeing..

Seed timothy alone at11.2 kg/ha ( 10 lb/acre) or with clover at 5.6 kg/ha (5 lb/acre) of timothy, 4.5 kg/ha (4 lb/acre) of red clover and/or 3.4 kg/ha (3 lb/acre) of alsike clover. Another possible mixture for field borders is 7 kg/ha (6 lb/acre) of reed canarygrass, 3.4 kg/ha (3 lb/acre) of timothy and 4.5 kg/ha (4 lb/acre) of Tetra alsike clover. Tetra is better suited to silage or hay as it is more erect than the variety Aurora. Stands of tame grass species may often be successfully overseeded with clovers (alsike, white Dutch), whose survival depends on their natural longevity and on drainage conditions. Broadcast sow in the fall, after there is no chance of germination that year, and follow with a few weeks of grazing to cover at least a portion of the seed by trampling( (the old tramp and rest method of seeding dry land ranges).

# FERTILIZING

## INTRODUCTION

The general relationship between yield and soil nutrient level can be represented by an S - shaped curve (figure 12). It allows for dividing the nutrient level scale into three ranges - deficient, optimum and excess.

Soils that are in the deficient range include those that are naturally deficient or have been intensively cropped for many years with no addition of nutrients. The poorly decomposed organic soils (Fibrisols) as well as most of the moderately decomposed ones (Mesisols, representing the major area of poorly drained soils) fall into the lower deficient range. There is usually little doubt that fertilization in this range at recommended rates would be economical.

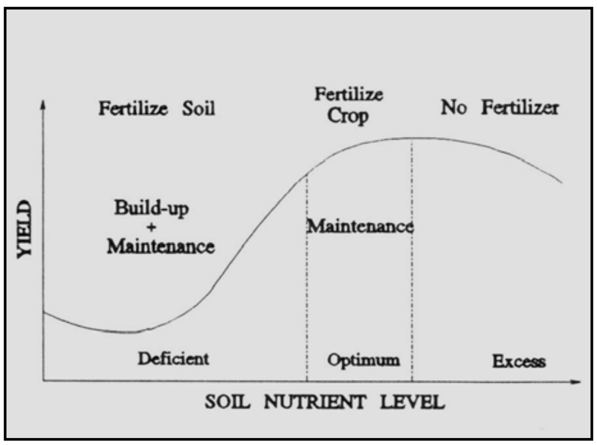



**Figure 12.** General relationship between soil nutrient level and yield.

As the optimum range is approached, careful consideration should be given to selection of a target yield if maximum profit is desired. Estimation of this target yield may be difficult because it depends on the crop grown, weather and soil drainage conditions, as well as soil nutrient level, applied fertilizer and crop. However, reasonable estimates can be made by consulting BCMAFF personnel experienced with previous field fertilizer trials, other producers with similar crops and soils, and finally obtaining a soil test, particularly for phosphorus, potassium or sulphur.
The well decomposed soils, (Humisols, Humic Gleysols particularly the Organic phases), usually have the highest natural soil nutrient levels that approach the optimum range. For such soils and those having received chemical fertilizer or manure, it becomes more difficult to estimate fertilizer requirements. At this point periodic soil tests are the best way to gauge soil nutrient trends which may be confirmed by a small field fertilizer trial.

High fertilizer rates that bring soil nutrient levels into the excess range are not usually recommended for forage crops. They are costly and may contribute to a pollution hazard. Excess nitrogen will be used in decomposition of organic material by micro-organisms and may not be recovered by crop use for several years. Indeed, micro-organisms compete with crops for nitrogen as soon as soils warm up. Thus only enough nitrogen should be applied at one time to satisfy the needs of one crop (i.e. cutting). Phosphorus and potassium, on the other hand, do not suffer this fate to the same extent. Excess of these nutrients will remain in Organic soils, and available for crops for a few years.

There is usually little opportunity for leaching loss of soluble nutrients out of Organic soils because their water permeability is low. With proper water control management, water tables should remain relatively high 0.5m (1.5 ft) to 1.0 m (3 ft) and water from surrounding uplands should be diverted around the poorly drained areas. Nutrient losses are more likely to occur from surface erosion by water on recently cultivated areas before perennial forage crops are established. Again, proper water control should avoid this problem. Much of the water in the poorly drained soils is lost by evapotranspiration during the growing season. Water moves up through the soil profile by capillarity bringing nutrients with it to the surface.

If the soil contains natural salts, evaporation may concentrate them near to the surface. This increased salt content may become detrimental to growth for salt sensitive crops such as reed canarygrass especially at the seedling stage. The excess salts at the surface may be flushed off by periodic flooding if water control structures are adequate.

The maintenance of a high water table markedly reduces decomposition and subsequent subsidence of an Organic soil. Thus this soil resource is best preserved.

If one goes to the expense of building water control structures and establishing tame or domestic forage species, then one must fertilize in order to obtain high yields and adequate forage quality. When tame species of forage are not fertilized with an adequate amount of nutrients, yields will decrease rapidly and native species will again become dominant. Re-fertilization will bring the tame species, especially reed canarygrass, back to dominance. Fertilization is most successful in the fall when meadows are cool and usually the driest. Winter snow will carry the fertilizer into the root zone in time for spring growth. The application of fertilizer in the spring may be impossible because of very wet soil conditions. If the surface be flooded, it is probable that nitrogen would be lost by volatization from shallow pools that warm up rapidly.

Soil testing is an excellent way to determine which nutrients are limiting and should be added to the soil to improve production and economic returns from both native and improved wetlands. Agriculture Canada (Research Station at Kamloops) in cooperation with the BCMAFF and producers have conducted numerous fertilizer trials from 1959 to the present. These fertilizer trials have shown forage yield increases to be expected from a wide variety of native and tame species at different elevations.

The findings have been summarized into two broad categories: native forages and reed canary grass. The native category was further divided into two sub-categories: Organic and Mineral (Gleysolic) soils. The reed canarygrass group's response to fertilizer has been divided into high and low elevational groups. The detailed data are available at the above offices.

## NATIVE FORAGE VEGETATION

### Organic Soils

Native vegetation, fertilized at greater than required rates, produced on average about 3.0 tonnes of dry matter per hectare. Unfertilized native vegetation (control treatment), generally produced about 50 percent or about 1.5 t/ha. Their dry matter yields do not respond to fertilizer to the same degree as those seeded to reed canarygrass. The native vegetation always responded to the addition of nitrogen fertilizer but less to phosphorus or sulphu,r and less still to potassium.

The dry matter yield from the "poorest" native site was 1.9 t/ha at the highest fertilizer rates and the control treatment yielded about half of that. The "poorest" site had an Organic soil that was acidic, shallow and located at a higher elevation and therefore had cooler climate than lower elevation sites.

Coarse sedge (*Carex rostrata*), that must remain flooded to a shallow depth for the first part of the growing season to maintain its vigour, produced on average (3 sites) 70 percent of its maximum fertilized yield (3.3 t/ha). Dry matter yield from the "best" Organic soil was 5.6t/ha at the maximum fertilizer rate and that of the unfertilized control was 2.7 t/ha. The better yields were accounted for by a greater degree of decomposition of this soil and its considerably lower elevation resulting in better climatic conditions for plant growth. These features, together with good water control accounted for the higher yields.

### Gleysolic soils

The Gleysolic mineral soils are generally more fertile than Organics. This is especially true for those with clay minerals. Two Gleysolic soil sites, one underlain by sand, the other by clay produced 79 and 85 percent of their respective maximum fertilized yields of 5.8 and 6.6 t/ha. These soils usually occur at lower elevation and therefore have a longer and warmer growing season than do most Organics. Soils with good water control rarely suffer from drought. Maximum fertilization rates produced between 5.8 and 6.6 tonnes dry matter per hectare and the unfertilized control about 80 percent of that.

## TAME SPECIES (Reed Canarygrass)

Fertilization of reed canarygrass produced dry matter yields averaging 4.9 t/ha compared to 3.0 t/ha for fertilized native vegetation as shown in

Figure 13. High elevation reed canarygrass sites produced significantly less dry matter than did low elevation sites (4.6 compared to 7.7 t/ha) on average. Both groups had very similar nutrient deficiencies with the unfertilized producing about 50 percent of the maximum with fertilizer. One unfertilized Humisol, at 1040 m, produced 65 percent of its fertilized maximum (4.7 t/ha), while a Humisol at 945 m, but subject to early season flooding, produced 55 percent of its maximum (3.1 t/ha). High yielding tame grasses such as reed canary grass are heavy users of soil nutrients and therefore require supplementation with fertilizer to keep the forage stands vigorous. Organic soils are notably low in available nitrogen, phosphorus, potassium and sometimes sulphur. These nutrients must be supplied in the form of fertilizer if the seeded crop is grown to its fullest potential. Initial applications of fertilizer at the time of seeding showed a high return from approximately 80kg/ha N, 55 kg/ha $P_2O_5$, 110 kg/ha $K_2O$, and where required 30 kg/ha sulphur. Application of an additional 80 kg/ha of nitrogen after removal of first crop is required when a second crop is to be harvested. For the second year following a complete fertilizer application often only nitrogen need be applied as the unused phosphorus and potassium will be available. Very little of applied N will carry over to the following year. Following the second year, fertilizer requirements are best determined by collecting representative soil samples and having them tested for available plant nutrients, particularly for phosphorus, potassium, and sulphur as these nutrients are required in addition to nitrogen to maintain top yields.

**Figure 13.** Field trial of reed canarygrass and native vegetation during first crop year.

# NUTRIENT REQUIREMENTS

This field fertilizer trial shown (Figure 13) is situated on an Organic Mesisol at 900 m elevation about 40 km. west of Quesnel. The field, with sedge-grass and light brush, was deep plowed the previous fall, levelled, disced, broadcast seeded to reed canarygrass, and packed by 24 May and harvested August 24. The control (no fertilizer) treatment (dark background plots) yielded 0.07 tons dry matter per hectare (t/ha); N,P,K, 0.7 t/ha; and N,P,K,S 6.7 t/ha. This astounding first crop response was undoubtedly related to the infertile subsoil that was brought (plowed) to the surface. Lime (foreground) did not increase yield on this near neutral (ph=7) soil. In subsequent years the control treatment improved to yield about 2.0 t/ha. The deep plowing, however, allowed for optimum trafficability during and subsequent to renovation due to the sedge grass sod that was kept intact. The photo was taken about one month after seeding at a site near Quanstrum Lake originally developed by Joe Fouty.

Various combinations of commercial fertilizers will meet the necessary nutrient requirements for native and tame species for forage on poorly drained soils. These combinations are determined from soil-testing, experience and the level of maximum yield desired. The following fertilizer program is only a general recommendation to be followed to obtain optimum yield and forage quality on poorly drained soils which should be confirmed with soil testing.

One should periodically confirm the fertilizer recommendation used through field testing by establishing a series of test strips, obtaining harvested yields and relating these to soil test values for soil samples taken in the previous fall. BCMAFF personnel may be able to provide further advice and assistance.

## EXAMPLE NUTRIENT REQUIREMENTS

**Year 1.** Combination A or B will meet the establishment year nutrient requirements if all four major nutrients are deficient (80 N, 55 $P_2O_5$, 110 $K_2O$ and 30 S in kg/ha). Metric calculations:

| **COMBINATION A** | | **Fertilizer Nutrient** | | | |
|---|---|---|---|---|---|
| **Fertilizer Product** | @ kg/ha | Nitrogen (N) | Phosphorus ($P_2O_5$) | Potassium ($K_2O$) | Sulphur (S) |
| 11-55-0 | 112 | 12 | 62 | 0 | 2 |
| 34-0-0-11 | 224 | 76 | 0 | 0 | 25 |
| 0-0-60 | 180 | 0 | 0 | 108 | 0 |
| **Total** | 516 | 88 | 62 | 108 | 27 |

| **COMBINATION B** | | **Fertilizer Nutrient** | | | |
|---|---|---|---|---|---|
| **Fertilizer Product** | @ kg/ha | Nitrogen (N) | Phosphorus ($P_2O_5$) | Potassium ($K_2O$) | Sulphur (S) |
| 16-20-0-15 | 336 | 54 | 67 | 0 | 50 |
| 34-0-0-11 | 112 | 36 | 0 | 0 | 12 |
| 0-0-60 | 180 | 0 | 0 | 108 | 0 |
| **Total** | 628 | 92 | 67 | 108 | 62 |

**Year 2.** After first cut and for the following year when there is adequate carry-over P, K and S:

| **Fertilizer Nutrient** | | | | | |
|---|---|---|---|---|---|
| **Fertilizer Product** | @ kg/ha | Nitrogen (N) | Phosphorus ($P_2O_5$) | Potassium ($K_2O$) | Sulphur (S) |
| 34-0-0 | 250 | 85 | 0 | 0 | 0 |
| 46-0-0 | 180 | 83 | 0 | 0 | 0 |
| if S is still deficient: 34-0-0-11 | 250 | 85 | 0 | 0 | 28 |

*To convert to metric (kg/ha) to imperial (lb/a) multiply by 0.89

Many different types of fertilizer are available and can be blended to give desired amounts of nutrients. The kind of fertilizer to buy depends on nutrient needs and/or fertilizer cost. Specially blended fertilizers are available from some companies to give the desired nutrients, thereby eliminating the need to mix your own on the farm.

### WHEN TO FERTILIZE

Fall fertilization of wetlands has been shown to be advantageous for forage production. In the fall the poorly drained organic soils are generally drier allowing the movement of fertilizer equipment with adequate flotation. Fall fertilization of poorly drained organic soils before appreciable snowfall, has a number of advantages:

1) Poorly drained soils are dry so trafficability problems are less,
2) Time is usually available for the operation,
3) Snowmelt in the spring brings fertilizer into the plant root zone, and
4) Nitrogen fertilizer gives better response, compared to spring applications, under saturated or flooded conditions.

Spring applications of fertilizer have a number of serious disadvantages:

1) Poorly drained soils are usually too wet to support equipment, even with extra flotation devices,
2) Time is more restricted, and
3) The loss of nitrogen by volatilization if fertilized into shallow warm stagnant water results in reduced forage yields.

## FERTILIZER SOURCES

### Organic

Organic sources generally provide the best balance of nutrients but are usually not readily available and/or are expensive to obtain in quantities needed for large areas of forage. Organic sources have the advantage that they decompose slowly, providing a steady supply of nutrients. However, this usually means that large amounts are required initially and, for best results, repeated in yearly applications. Cattle manure has a nitrogen, phosphate and potash content of about 5.5, 2, and 3.5kg/t, respectively. Poultry manure generally has about three times as much nitrogen and phosphate and about the same amount of potash while pig manure is somewhat higher in potash compared to cattle manure. The quality of manures is very dependent on its storage and on the bedding used for the animals in containment.

Incorporation of the organic fertilizer sources is desirable if all nutrients are to be retained. This is of course not possible on perennial forage crops except with highly specialized equipment.

Manure does, however, have an added benefit in that it supplies humus and inoculates the soil with micro-organisms. Decomposition of added organic fertilizers and soil organic matter is greatly accelerated by drainage and aeration. This is not usually desirable for an Organic soil since it will lead to subsidence and its eventual depletion. Addition of Organic matter to an Organic soil is not as beneficial as its addition to a mineral soil that is low in organic matter.

### Chemical Fertilizers

Commercially available chemical fertilizers are very convenient as many of these materials have high concentrations of nutrients. Fertilizers are easiest applied by surface broadcasting in the fall for reasons previously mentioned. There may be an advantage to band nutrients such as phosphorus to increase its availability to the crop because of reduced phosphorus fixation, greater availability and closer placement to the roots.

# HARVESTING

## NATIVE SPECIES FOR GRAZING

Native sedge and grass vegetation stands on poorly drained lands may be damaged by heavy, continuous grazing. Fertilizer will usually increase the yield and can alleviate weakening of the root system caused by excessive grazing. If it is desirable to graze a native wetland early in the spring, good water control is required to keep the water level well below the surface during the grazing period.

Stock should be removed by mid-summer or before water sources dry up. After stock are removed, the water level should be raised to the soil surface if possible. Flooding with a few centimetres of water may be better. If stock have been removed by the end of June, good regrowth should occur. Regrowth may be cut for hay or used for fall pasture after fall frosts have stopped growth. This system will provide good quality spring forage as well as fall range or a light crop of hay and plants are more likely to maintain vigour.

Native stands provide good summer grazing. If summer grazing is desirable, native species should be kept wet or flooded throughout the spring. Before grazing commences, the water level should be lowered to at least 8 cm (3 in.) below the surface. Remove all stock when stubble is 10-15 cm (4-6 in.) in height, usually by mid-August, to allow root reserves to be built up before killing frost occurs.

It is a common practice to graze native stands in late fall and early winter when dry or frozen. The low nutritive value of native species at this time usually requires supplementation to maintain stock condition. Energy supplementation is recommended if mature animals are to graze for an extended period in fall and winter. Removal of up to 80 per cent of the forage in the fall does not appear to affect yields the following season. Removal of the forage and trampling of the snow may result in deeper frost penetration which will delay spring growth.

The tall coarse sedge is a unique plant in that the base of the leaves remain green all winter. If snow can be effectively removed, this relatively nutritious forage is available for livestock and wildlife.

## NATIVE SPECIES FOR HAY

Cut the hay when heads first start to appear around the end of July. A sharp reduction in nutritive value will offset any increase in quantity obtained if cut after this time. At this stage the forage has made about 90 per cent of its potential production for hay. One should also be prepared to make silage if the weather is too wet for curing hay.

Cutting in late summer on an annual basis can be detrimental to plant vigour resulting in a drastic reduction in subsequent years' production. Late summer cutting should not be done any more often than once every three to four4 years.

**Figure 14.** A typical harvesting system.

## TAME SPECIES FOR GRAZING OR HAY

Poorly drained lands seeded to tame species may be managed for hay or pasture in the same way as the native species. Rotation grazing is recommended to avoid continuous heavy grazing or spotty grazing. If yields are greater than the grazing herd requires, the excess forage may be cut for hay or silage (see figure 14). Reed canarygrass should be harvested for hay or silage before heads appear so as not to mature and become fibrous and unpalatable. Palatability and protein content drop very rapidly with the formation of the seed head. If water and fertilizer are adequate and the length of growing season sufficient, a second cutting may be obtained at the lower elevations. Spring grazing of reed canarygrass will produce a dense, leafy growth which may be cut for hay in mid-summer. Reed canarygrass grows from 1.2-2 m (4-7 ft.) tall and smothers legumes seeded with it within two or three years. It provides excellent pasture from early spring to late fall if not allowed to grow tall and coarse or grazed too heavily. Rotational grazing, or a combination of grazing and hay or silage, is recommended. For pasture, keep reed canarygrass 10-38 cm (4-15 in.) high. Under a grazing system, alsike clover would not be smothered as easily, when sown with reed canarygrass, as it would in a hay system.

The last harvesting should not be made until first frosts have begun to mature the forage, usually after the first of September. Up to a two-thirds reduction in yield has been observed in subsequent years because root reserves did not have a chance to build up after harvesting in late summer and before winter dormancy commenced. Vegetation at high elevations is especially subject to damage if harvested in August.

Stubble height can also be important to growth the following season. Ten to 13 cm (4-5 in.) is generally recommended. This allows for better storage of plant nutrients, thus giving a more vigorous re-growth. Incidentally, a tall stubble will keep the mowed hay higher off the ground and allow for better drying.

# BURNING

Burning of forage residues is not normally recommended. Forage which is not harvested is usually valued for incorporation in the soil to maintain and improve soil fertility and structure. However, no great benefit is obtained from the addition of organic matter into an Organic soil.

Mature sedges and grasses are generally unpalatable to livestock and are low in crude protein. This material may be burnt if it cannot be utilized for forage by grazing or cutting. Late fall or early spring burning will remove the mature growth without damaging the plants. Subsequent growth will be of a uniformly high quality, more easily mowed, and more acceptable to grazing animals. Earlier growth is also noted in the spring due to the blackened surface absorbing more heat than a light coloured one insulated with dead plant material.

Care must be taken not to burn when the soil is very dry or when there is danger of burning adjacent upland range or forest. Late summer and fall are the times when poorly drained soils are usually the driest to the greatest depths. Fire can burn the organic soil, leaving only a pile of rocks or mineral subsoil. Burning is best done in spring when only the dead top growth is dry and before the start of the fire season designated by the B.C. Ministry of Forests. Burning can be quite successful when the ground surface and standing water are still frozen but plant growth is dry and combustible.

# WATER MANAGEMENT

Once the outlet has been improved and ditches and water control gates constructed, watertable management is possible. The main objective is to maintain the water levels for optimum forage growth and permit grazing or harvesting of forage during the desired period.

Weather and natural drainage are not always optimal for maximum forage production. Wide variations in weather patterns occur which affect forage production and restrict harvesting at the highest state of maturity. Water control will provide consistently good forage production and enable harvesting when the nutritive value is high. Shallow flooding can draw the frost out of the ground rapidly. Following snowmelt, it may be desirable to use the runoff from the surrounding uplands to provide flooding (with a control gate at the outlet). The watertable should be maintained at an adequate level to prevent drying of the soil surface and to ensure that moisture is available in the rooting zone of the plant.

For optimum hay production of coarse sedge, the area should be flooded with water to depths increasing from 10 to 30 centimetres from the time the snow melts until early June. Initially, lthe shallow water warms up quickly, promoting early growth, and subsequent deeper flooding forces taller growth. Water levels should be dropped beginning in early to mid-June to get the watertable down by mid-July. Evapotranspiration will assist in draining the water off to permit harvesting at optimum nutritive stage.

If the area is left in its native vegetation, the control of flooding will not be so critical. Native coarse sedges grow best if the soil surface is flooded in the spring. Finer sedges, tame grass and legume species can tolerate some flooding while dormant, but will grow better if flooding is minimized in the growing season.

After the hay has been taken off, it is necessary to back up the water at the control gate to prevent over-drying of the Organic soil during late summer and fall. In low rainfall areas this procedure may have to be practiced every year to prevent the run-off of rain and melting snow in the spring. Maintaining high water levels throughout the winter will ensure a minimum of settling of the land surface.

# DITCH MAINTENANCE

A land improvement licence or an approval letter authorizes the landowner to permanently alter or annually maintain a stream. Licences and approvals are issued by the Comptroller of Water Rights through the regional office of the Water Management Branch of the Ministry of Environment, Lands and Parks.

It is important to continue this annual maintenance to keep the legal ditch status of the watercourse. If a ditch is a newly constructed, it is advisable to install a fish screen at the outlet to prevent fish from occupying the ditch.

Beaver dams on streams create an attractive habitat for waterfowl. However, these dams may also cause flooding of agricultural land. If a farmer has problems with beavers and their dams, the local conservation officer of the Fish and Wildlife Branch, should be contacted to assist in the beaver removal.

Clearing willow and brush from at least one side of the stream assists in identifying active beaver areas. Leaving brush cover on one side can provide shade for fish habitat. If beavers are persistent, it may be advantageous to remove all brush in the area, thus removing food and dam material.

# ECONOMIC CONSIDERATIONS

To determine whether or not development and improvement of poorly drained lands should be pursued, the pertinent costs should be considered. Development costs such as brush clearing, ditching, seedbed preparation, fertilizer and seed costs all need to be evaluated and budgeted. Short term goals of expanding the forage base where economically feasible and long term objectives of flexibility to expand the enterprise in the future are important.

Consider the quality and quantity of wild hay produced presently on these lands versus the potential yield with development. The third alternative is to purchase either a better quality supplement or better quality hay to meet the requirements of the class of livestock being fed.

A working format has been outlined below for calculating costs of development versus the cost of buying. This will enable an accurate comparison to be made for decision making.

One method used to evaluate whether a meadow should be developed is by means of a partial budget as indicated on the next page. With this approach only the changes that would occur as a result of improving and seeding the meadow to tame grass are included in the calculation. The resulting bottom line is the estimated increase or decrease in net farm income. A positive result indicates an increase in the ranch's net farm income.

Determine the cost of buying hay of equal quality. Take into account freight and other delivery costs associated with acquiring hay.

The development of meadows for forage production may impact other resources such as fish and wildlife. Effects on other resources should be considered when planning development.

## FINANCING

The BCMAFF's Agriculture Land Development Act (ALDA) program provides low interest loans for all aspects of meadow development. Land clearing, ditching, water control, seedbed preparation and seeding are all eligible. Contact your local District Agriculturist for an application form and further information.

| Costs / Acre of Development and Establishment | | |
|---|---|---|
| Operation | Example Cost | Your Cost |
| Ditching & Water Control | *$75 | |
| Brush Clearing | **$75 | |
| Plowing | $115 | |
| Discing | $32 | |
| Seeding, Harrowing & Packing | $30 | |
| Seed | $50 | |
| Fertilizer | $70 | |
| Total Establishment Costs Per Acre | $447 | |

*Based on Farm Lab Study - Ditching & Water Control Costs = $3,000 on a 40 acre meadow
**Assumes 25% of land requires clearing @ $300/acre

# PARTIAL BUDGET

Proposed: Develop 1 acre of poorly drained meadow and seed it to a suitable mixture of grasses. The cost of establishing the stand is $447 per acre and will produce an average yield increase of three tons per acre over a ten year period. The value of the purchased hay which will be replaced by this project is $80 per ton.

| ADVANTAGES ($/Acre) | | |
|---|---|---|
| Item | Example Cost | Your Cost |
| 1) Reduced Expense<br>Hay (3 tons per acre) | 240 | |
| 2) Additional Income | | |
| **Total Advantage** (Value of 3 tons of hay landed on the farm ) | 240 | |

| DISADVANTAGES ($/Acre) | | |
|---|---|---|
| Item | Example Cost | Your Cost |
| 1) Additional Expense<br>Fertilizer ( 160 lbs 46-0-0 ) | 23 | |
| Twine | 8 | |
| Repairs & Maintenance | 14 | |
| Fuel & Lube | 15 | |
| Labor | 24 | |
| Operating Interest ( $84 x 10% ) | 8 | |
| Annual Cost of Forage Establishment Principal ( $447/10 yrs ) | 45 | |
| Average Annual Interest [ ( $447 + 0 ) /2 ] x 10% | 23 | |
| 2) Reduced Income | 0 | |
| **Total Disadvantage** ( cost of producing 3 tons hay ) | 160 | |

| | | |
|---|---|---|
| **Net Advantage** | $80 | |

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