Kamloops District

Forage Manual

BRITISH COLUMBIA

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KAMLOOPS DISTRICT FORAGE MANUAL

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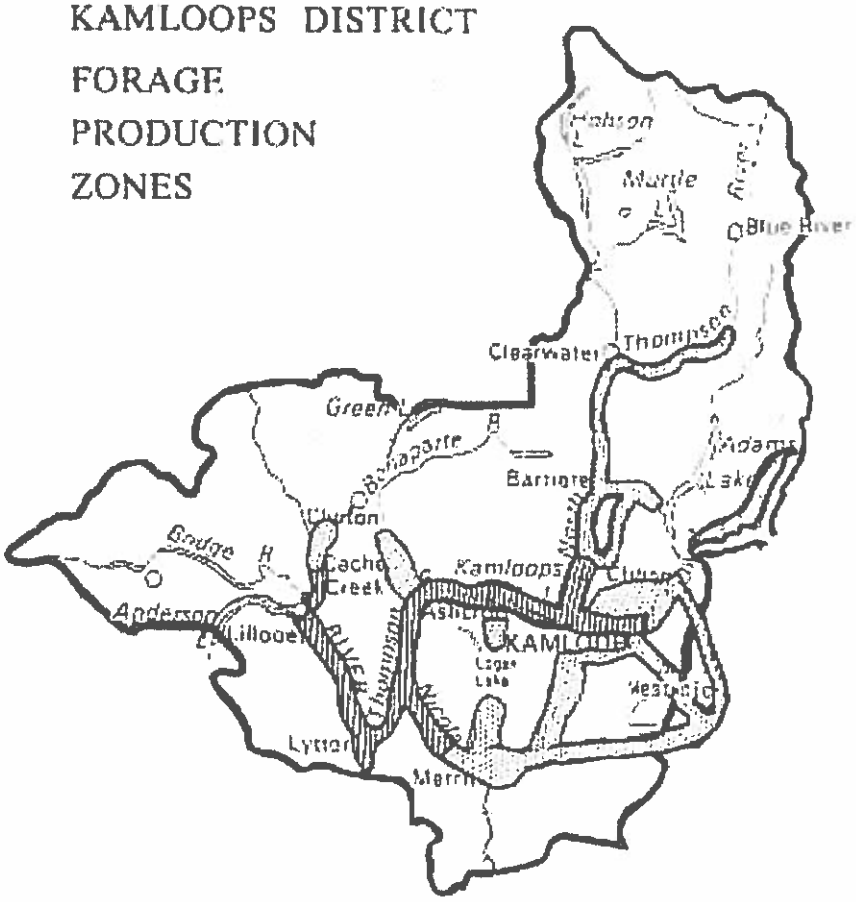
KAMLOOPS DISTRICT
FORAGE
PRODUCTION
ZONES



ZONE 1
ZONE 2
ZONE 3 ALL OTHER AREAS

DISTRICT FORAGE MANUAL

INTRODUCTION

Forage production (hay, silage and pasture) is the most important crop in the Kamloops Agricultural District by any measure – greatest acreage, tonnage, crop value and total investment. The majority of the forage produced occurs on cattle ranches, whose major saleable commodity is beef. As a result, the importance of forage production is often overlooked, but considering the investment in land, irrigation equipment, farm machinery and labour, this crop should receive a high degree of management to optimize your return on investment.

The Kamloops District covers a very diverse area of soils and climate, so that no one forage crop recommendation is suitable for the entire district. In order to improve the value of crop recommendations the District has been divided into 3 major production zones.

Production Zones

Zone I

Valley bottoms and lower benches (to approximately 2000 feet (600 m) elevation) along the North and South Thompson and Fraser Rivers. This zone would extend east to Pritchard along the South Thompson, up the North Thompson to Heffley Creek, west and south to Ashcroft and Lytton. This area is characterized by being a 3+ cut alfalfa area, with sufficient heat units (over 2500 corn heat units) to grow medium to late maturing silage corn varieties, and ample frost free days to double crop barley or other intercropped annuals.

Essentially all cropland in this zone is irrigated, as system annual precipitation is less than 12 inches per year (30 cm). This area is often bare of snow for a good part of the winter and more subject to winterkill.

Zone 2

This would include the North Thompson River Valley from Heffley Creek to Vavenby, Westwold and the Nicola Valley and benches to approximately 2500 feet (762 m) elevation. Although 3 cuts of alfalfa are possible in this area, 2 cuts are more typical with the aftermath being grazed in late fall. However, with more area being seeded to the rapid re-growth alfalfa varieties, the 3 cut alfalfa option is production practice that may be suited to commercial hay growers. In most years this zone has sufficient corn heat units (up to 2500) to grow early-medium silage corn varieties, with sufficient frost-free days to grow barley-annual ryegrass. Zone 2 normally has better winter snow cover than Zone 1, and is therefore less subject to severe winterkill that occasionally occurs in Zone 1. Some dryland production occurs, with annual precipitation in most of this zone ranging from 12 to 18 inches (30-45 cm).

Zone 3

This zone includes areas above 2500 feet (762 m) elevation, such as Clinton, Logan Lake and Knutsford. Typically, this is a 1-2 cut alfalfa area, with more dryland production. Precipitation within this zone covers a greater range from 12-20+ inches (30-50 cm). This zone has a shorter growing season and less total heat units. Neither corn nor double crop barley is feasible in this zone, although one crop of barley followed by annual ryegrass is possible. Some dryland grain is produced in these areas.

Although there is some overlap between these zones due to localized microclimates and the boundaries are not definitive, by identifying the major characteristics of your farm and relating it to one of these zones, the recommendations provided will be of more value.

GENERAL FORAGE MANAGEMENT

PLAN YOUR CROPPING SYSTEM

Long range planning of a total cropping system can provide you with increased returns, reduced risk, a more stable forage supply and different forage qualities to meet the needs of different classes of livestock. Planning a cropping system involves assessing your land base and existing crop (age of stands, types of crop, need for reseeding) identifying problem areas (such as rocks, poor drainage, saline areas) and availability of irrigation. You also need to determine your forage requirements: amount and type of winter feed, need for spring or fall pasture, early weaning and/or cash hay sales.

When you have completed an assessment of what you have and what your forage needs are, you can begin to plan a crop production system. Your planning should be for a minimum of 5 years, as this is the typical length of a stand of irrigated alfalfa, which forms the basis of most forage systems in this area.

Two cropping systems that are commonly used in this area are:

1 .Continuous alfalfa, five year cycle, with 20 per cent reseeded each year to alfalfa with or without a cover crop.

2. A five year cycle, with one-half of new seeding area in annual crops, used to break the continuous alfalfa cycle.

If 20 per cent of your land is reseeded each year, 10 per cent (or one-half of the new seeding) would be seeded to annual forages (e.g. barley/annual ryegrass) and 10 per cent (i.e. the other one-half of new seeding) would go back to alfalfa and a cover crop, if desired. Under this system, a break to the alfalfa production would occur every 2nd cycle (10 years).

By reseeding on a planned basis (e.g. 20 per cent each year) you will have mixed age stands which offer a number of advantages: more uniform total forage production, reseeding a smaller amount each year rather than a large area every 5 years, reduced risk of winter injury, as young stands tend to be more tolerant of harsh winter conditions, and a place to use as a winter feed ground, thus con- centrating manure on the area to be reseeded.

Including annual crops, such as barley-annual ryegrass or corn, provides a number of advantages, including better weed and disease control, improved establishment of subsequent alfalfa seedings, more flexible grazing management, and a source of high quality, non-bloating fall pasture that is excellent for weaning calves early or finishing lambs.

FORAGE MIXES

Irrigated Hay or Silage Mixes

Alfalfa-Grass

Most forage producers do not grow alfalfa in pure stands, but include some seed of a grass species with the alfalfa seed at planting time. Typically the grass seed will make up 15-25 per cent, by weight of the seed mix. Some of the advantages of including a grass in with the alfalfa include extending the life of a stand if the alfalfa suffers from disease or winter injury, reducing bloat risk somewhat when fall pasturing, reduced drying time in the swath and a hay mix that is better suited to the nutritional demands of beef cattle.

Some of the disadvantages of grass legume mixes are differences in maturity, such that one species is ready to harvest before the other; different fertilizer requirement for each species; and reduced options for weed control.

No definite impact on yields has been substantiated, with some studies showing higher yields for grass legume mixtures, while others show a yield advantage for pure alfalfa stands.

Commercial hay producers indicate there is a market demand for a variety of hay types, with pure alfalfa or timothy usually bringing the best price. Other niche markets include the horse

industry or dairy producers (e.g. low potassium hay). See tables on forage species description in this manual for specific characteristics and adaptability.

Recommended mixes for Zone 1 (3 cuts) would include up to 25 per cent by weight of orchardgrass or tall fescue with the alfalfa, although pure alfalfa seedings are common in this zone. When selecting orchardgrass varieties to plant with alfalfa, later maturing varieties are preferred, so that their growth stages match alfalfa growth. Winter hardiness is also of concern as many varieties of orchardgrass will winterkill in this district.

In Zone 2 (2-3 cut areas) orchardgrass is also the most common grass in a mix, but other species, such as timothy, smooth brome, tall fescue, intermediate and pubescent wheatgrass can also be used successfully. Again, choosing late maturing varieties, when available, is recommended. orchardgrass provides the best re-growth after the first cut, whereas timothy, brome and pubescent wheatgrass contribute most of their growth in the first cut, with less re-growth later in the season. Tall fescue yields similar to orchardgrass, but has improved quality in late fall and winter. These species are less competitive with the alfalfa than orchardgrass and may be desired for this reason. Smooth brome and timothy are very winter hardy, whereas intermediate and pubescent wheatgrass are somewhat less hardy.

In Zone 3, winter hardiness becomes a more important selection criteria, therefore smooth brome or timothy are recommended in these areas. Other grass species may be used to fit your particular requirements.

Dryland Mixes

Dryland pasture mixes and range mixes are normally seeded at lower rates (under 10 lb./ac) as moisture is limiting and fewer plants can be supported. Selection of species for dryland pasture is determined by the amount of moisture that is available. For areas receiving less than 12 inches of precipitation a year, crested wheatgrass is the preferred species. Although alfalfa has frequently been included with crested wheatgrass, persistence in the stand is often poor, and may be related to grazing practices. Other grass species that have been seeded with some success in these very dry areas include hard fescue and Sherman big blue grass. Hard fescue may be the best alternative to crested wheatgrass but is slightly later and less palatable in spring. Sherman big blue is considerably lower yielding than fescue or crested wheatgrass.

Only very limited success has been achieved with seedings of altai and Russian wildrye, which have had poor establishment and survival in this region, and are not generally recommended.

In areas of higher precipitation (greater than 12 inches per year) a number of other species can be grown satisfactorily. Pubescent and intermediate wheatgrass, orchardgrass, smooth brome and meadow brome may be considered for these areas of higher precipitation.

SOILS AND FERTILITY MANAGEMENT

Forage crops respond to good management. Correct fertility management combined with proper species selection and irrigation practices can result in yields of 6 to 8 tons per acre in the Kamloops area.

To develop a fertility program a good knowledge of soil properties is required. Fertilizer choices need to be based on soil tests as the proper balance of nutrients is often more important than the level of nutrients applied. Continuous cropping will then result in the depletion of mineral nutrients. It is quite likely that one or more nutrients will become deficient even on fertile soils.

Soil Tests

Soil sampling is not required every year on all fields. A first priority for soil sampling are those fields to be re-seeded. On established forage stands samples can be taken every second or third year to monitor nutrient levels.

Fall sampling is preferred since test results will be available in plenty of time to make decisions

regarding spring seeding and fertilization. It is important that soils that are to be seeded to forage
crops be tested for N (Nitrogen), P (Phosphorus), K (Potassium), Ca (Calcium), Mg (Magnesium), as well as B (Boron) and S (Sulphur).

When fertilizer is applied, on-farm test strips are recommended to provide a visual response to fertilizer on your farm.

Soil Sampling

Detailed information on how to take soil samples is available at Ministry offices. It is especially important that the samples taken be representative of the field being sampled. For this to occur it is recommended that 20 to 30 small samples be taken a depth of 6 inches from the field to be tested. These are then mixed together well; air dried, and approximately one pound is taken for analysis.

Information on laboratories that provide soil analyses is available at Ministry offices.

Soil pH, Soil Organic Matter, Nutrients

Soil pH

The pH of a soil is a measure of its acidity (less than 7.0) or alkalinity (higher than 7.0). Most soils in the Kamloops District are neutral to basic (pH 7.0 or higher) with the exception of areas in the North Thompson which are slightly acidic.

The pH level of a soil has a significant effect on the availability of nutrients. As pH levels drop below 6.0 the availability of plant nutrients such as nitrogen, phosphorus, potassium, sulphur and magnesium become less available. Alternatively as the pH levels rise higher than 7.5 the availability of nitrogen, phosphorus, manganese, boron, copper and zinc is reduced.

Of particular importance to alfalfa production is the effect of low pH soils on the survival of rhizobia. As values drop below 6.0 the growth of alfalfa rhizobia is reduced resulting in lower nitrogen fixation and lower yields.

Soil Organic Matter

The organic matter content of most mineral soils in the Kamloops area range between 3 and 5 per cent. Organic matter is an important component of soil as it improves the physical condition, increases soil moisture holding capacity, improves aeration, and serves as a source of nitrogen and other plant food. It also supports bacteria and fungi, which aid in the release of plant nutrients.

Practices that maintain and replenish organic matter include the application of manure and production of green manure crops. The addition of straw, shavings and sawdust will also increase organic matter levels, however these materials generally require the addition of supplemental nitrogen to encourage breakdown. If you are using these materials a level of 30 pounds of actual nitrogen per ton of materials is suggested.

The following table (Table 1) provides the approximate levels of nutrients in manure that contains a normal quantity of bedding or litter.

Table I **Nutrient Levels in Manure**

	Percent Moisture	Pounds Per Ton* N	P2O5	K2O
Dairy	86	11	3	10
Sheep	68	20	15	8
Steer or Feed Yard	75	12	7	11
Horse	80	13	5	8
Poultry	51	43	58	26

*as applied

When applying manure the rates should not exceed crop uptake levels.

Nitrogen (N)

The requirement for nitrogen will vary depending on the crop to be grown. Properly inoculated legumes such as alfalfa will fix large quantities of atmospheric nitrogen. Nitrogen is

seldom required on pure stands of alfalfa except at time of seeding, as a starter effect in early spring and on soils low in organic matter. This provides nitrogen for rapid growth of the alfalfa seedlings until nodules form on the roots and the rhizobia are able to fix nitrogen.

On mixed stands of grass and legume, as the legume component in the stand decreases the addition of nitrogen is required if yields are to be maintained. If a stand is 50% or more legume, no nitrogen fertilizer is generally required.

The recommended minimum soil test level for nitrogen is 15 ppm with additional amounts required depending on the crops to be grown. High soil test levels (greater than 75 ppm indicate excess nitrogen in the soil, and may result in nitrate leaching. Contact an Agrologist to discuss appropriate management).

Phosphorus (P)

Phosphorus stimulates early growth and root formation. It also hastens maturity and promotes seed production.

Phosphorus is most soluble in soils at a pH level of 6.0. As pH levels go above and below this level phosphorus becomes less available. Phosphorus tends to move very slowly through soil when compared to other nutrients. Under cool conditions there is less uptake of phosphorus by the plants. Purplish coloration on foliage is one sign of a phosphorus deficiency, which can also show up under cool conditions even when soil levels are adequate.

The recommended minimum soil test level for phosphorus is 30 ppm. Levels below this may result in reduced crop yields.

As phosphorus movement in soils is very slow applications can be made annually or heavier rates applied over longer periods of time. On new seedings phosphorus can be incorporated into the soil prior to planting.

Potassium (K)

The potassium content of forages can be very high with levels exceeding 2.5 per cent in alfalfa grown in the Kamloops area. Potassium levels in many soils in the Kamloops area are adequate. An exception is on light, sandy soils in the North Thompson Valley, which are often low in potassium. When the potassium levels are reduced alfalfa stands can degenerate to grasses and weeds as grasses are able to "out-compete".

The appearance of white spots along the margins of alfalfa leaflets is a classical indication of potassium deficiency. If the deficiency is discovered soon enough, it can be corrected without any severe crop losses.

Studies have indicated that adequate potassium levels contribute to the persistence of alfalfa in a stand. Winter hardiness and the ability of the plants to endure moisture and temperature stress are improved with adequate potassium levels.

The recommended minimum soil test level for potassium is 150 ppm. When potassium is required, application by top dressing on established stands is practical. The plants recover most of the potassium applied this way.

Sulphur (S)

The sulphur content in most soils in the Kamloops area is adequate. The areas where deficiencies are noticed are in the higher rainfall areas. Deficien- cies of sulphur have similar symptoms to nitrogen deficiency - pale yellow or-light green leaves. Sulphur is an important element as it is one of the components of protein.

The recommended minimum soil test level for sulphur is 20 ppm. Caution should be taken when applying sulphur as continuous applications over a period of years will reduce soil pH levels. Tissue samples may also be required to confirm soil sulphur levels.

Boron (B)
Boron is a common deficiency in most soils in the Kamloops area. The levels required by plants are very low with one ton of alfalfa containing only one ounce of boron. Despite such a low requirement by the plant a deficiency can cause a serious reduction in crop yield.

One of the most important functions of boron is in the movement of carbohydrates in the plant. The most rapid movement will occur at the growing
points of the plants and this is where the first signs of a deficiency will show. Under dry or cold conditions boron deficiency will be more evident and the leaves at the growing points of alfalfa will turn yellow and reddish. The lower leaves will remain green.

Boron deficiency symptoms are more evident in alfalfa than grasses as the requirement for boron in alfalfa is much higher.

The recommended minimum soil test level for boron is 1.0 ppm. Boron can be applied once every two or three years if levels are low. When applying boron it can be premixed, applied through a spray, or spread using a granular
formulation such as 'Borate 40' which is 12.5 per cent Boron. Boron should never be applied without a soil analysis confirming deficiency. Excess Born can lead to toxicity.

Fertilizer Terms
The "grade" of fertilizer is expressed as a set of three numbers in order of per cent total nitrogen, (N), available phosphate (as P_2O_5), and soluble potash (as K_2O). A fertilizer such as 5-10-15 contains 5 per cent N, 10 per cent P_2O_5 and 15 per cent K_2O. The remaining 70 per cent of the product consists of other elements such as calcium, chlorine, and oxygen.

With products such as 16:20:0:14, the fourth number (14) represents the percentage of sulphur in the product.

General Fertilizer Recommendations

The most cost- effective use of fertilizer can only be achieved when it is based on a soil test. If a test was not carried out Table II can be used as a guide until such time that sampling is done and the correct balance of nutrients required can be determined.

Table II

Minimum Recommended Soil Test Levels

Nutrient	Soil Test Level
NO_3N	15 (µg/ml)
P_2O_5	30 (µg/ml)
K_2O	150 (µg/ml)
S	20 (µg/ml)
B	1 (µg/ml)

NOTE: (µg/ml=ppm

Table III **Fertilizer Guide**

Crop	Plant Food Requirements Kilograms Per Hectare (Pounds Per Acre) N	P_2O_5	K_2O	S	Comment
Cereals/Grasses	50 (45)	34 (30)	0	0	On irrigated land reapply the same level of nitrogen after the first crop if under-seeded to annual grasses or double cropping cereals.
Alfalfa or Alfalfa/Grass (80-20)	17 (15)	80 (79)	0	0	Apply early in the spring. Boron should be applied at 3 lbs. B per acre if a deficiency was noticed.
Grass/Legume (60/40)	56 (50)	56 (50)			Apply early in the spring. On irrigated land where multiple cuttings are expected reapply 56-84 kg/ha (50-75 lbs./ac) of nitrogen after each cutting.

FORAGE QUALITY MANAGEMENT

Good quality forage provides the nutrients required to meet an expected animal performance. As an example, a medium quality grass hay is an excellent forage for over-wintering beef cows, but high producing dairy cows require early cut high quality legume hay to achieve maximum production.

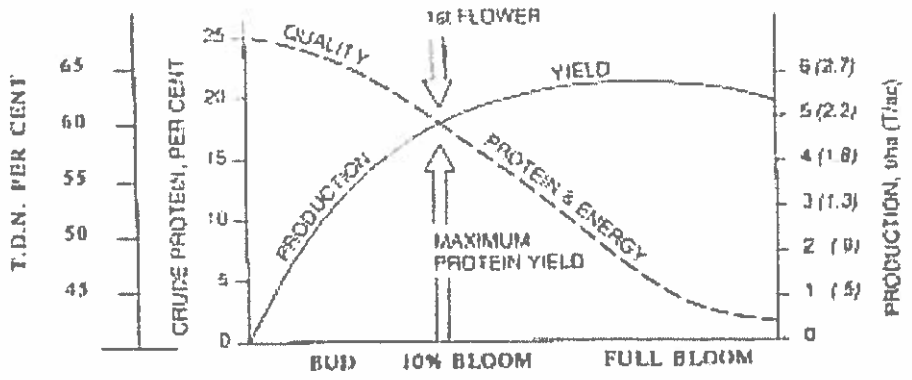
The quality of the forage by the time it is fed will depend on a number of factors including the type of plants grown, the stage of growth when cut, losses incurred by weathering, harvesting and storage, and the form in which it is fed.

Stage of Growth

The palatability, digestibility and the nutrient con-. tent of a forage will all vary depending on the stage of development of the plant when it was cut. As a crop matures its digestibility (TDN), crude protein, and voluntary intake by animals will all decrease. As shown in Figure 1 as the plant matures, forage quality drops while total yield increases. It is the producers objective to harvest at that stage of growth when optimum nutritive quality and optimum yield are achieved.

Note: TDN (Total Digestible Nutrients) is a measure of digestibility and the energy level in a feed. Forages can range between. 45 and 65 percent TDN

Figure 1 - Relationship Between Forage Yield and Forage Quality in Alfalfa



The voluntary intake of the forage will also vary depending on the growth stage at harvest as shown in Table III.

Table III Voluntary Intake Related to Stage of Harvest

Growth Stage at Harvest	TDN %	Crude Protein % Grass	Crude Protein % Legume	Intake (% of Body Wt.)
Vegetative	63	15	21	3.0
Root or Bud	57	11	16	2.5
Bloom	50	7	11	2.0
Mature	44	4	7	1.5

Source: Fisher, L.J. 1980 Agassiz Agriculture Canada Research Station

Perennial Forages

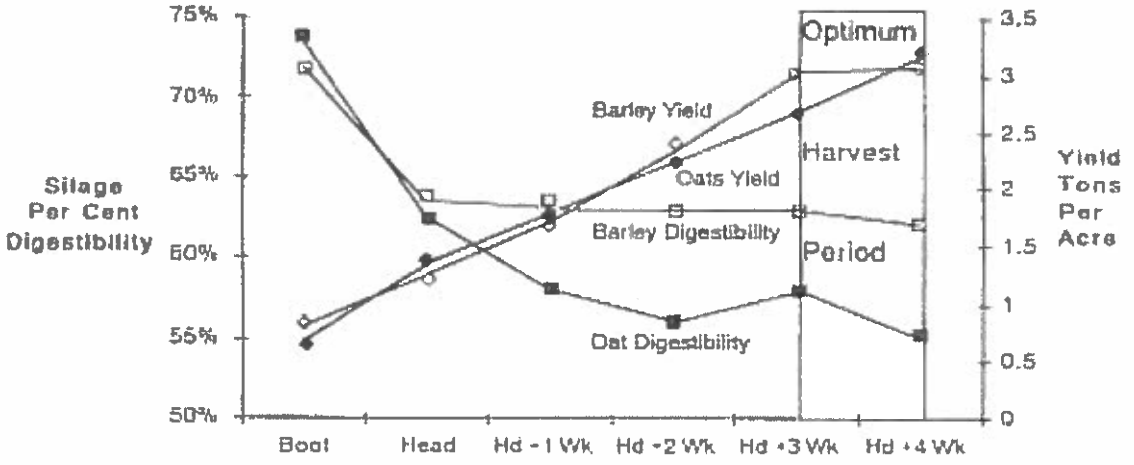
Legumes as shown in Figure I should be harvested from budding to about 10 per cent bloom to obtain maximum yield of total digestible nutrients per acre. Grasses should be harvested at, or shortly after heading. Harvesting at these growth stages is especially important when the forage is used in production rations for growing calves, finishing cattle and lactating rations for cows. Harvesting at a more mature growth stage will allow for a higher yield but a lower quality forage. This type of feed is more suited to maintenance rations for the cow-herd.

Cereal Silage

Oats and barley are the two most common cereals grown in the Kamloops area either as companion crops or grown alone. Cereal silages are generally lower in protein than perennial forages with average protein levels of 10 per cent for barley silages and 9.5 per cent for oats. To raise protein levels in a ration, cereal silages are often fed in combination with higher protein level grasses and legumes.

Figure 2 indicates how the yield and quality of oats and barley change as the plants mature. The opti- mum time to harvest to obtain the greatest yield of TDN per acre occurs when the barley is in the late milk to soft dough stage. Earlier harvest of barley at the boot stage will results in a higher TDN level (70 per cent TDN vs. about 62 per cent TDN at the soft dough stage) but the yield reduction will approach 25 per cent.

Figure 2 Silage Digestibility and Yield Related to Crop Maturity



*Notes: **Oats reached the heading stage in 69 days and barley in 63 days**

Maturity:	Oats:	Hd + 2Wk	Heading plus 2 weeks was medium milk
		Hd + 3Wk	Heading plus 3 weeks was late milk
		Hd + 4Wk	Heading plus 4 weeks was early dough stage.
	Barley:	Hd + 2Wk	Heading plus 2 weeks was watery dough
		Hd + 3Wk	Heading plus 3 weeks was early dough and
		Hd + 4Wk	Heading plus 4 weeks was the soft dough stage.

For ensiling of cereals in horizontal silos it is recommended that the standing crop be cut at 65 per cent moisture. Figure 3 indicates that this stage is reached at the 3rd week after heading for oats and barley. Harvesting at lower moisture levels makes packing difficult in horizontal silos. Harvesting prior to this time reduces overall yield. For plastic wrapped systems, moisture contents as low as 35% (65% DM) can be successful if wrapped soon after baling.

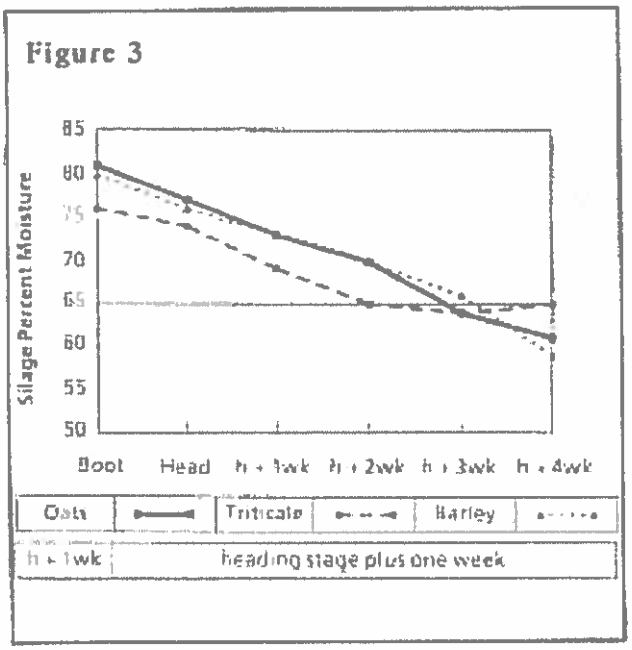


Figure 3 Moisture Content of Cereals

WEED MANAGEMENT STRATEGIES

INTEGRATED WEED MANAGEMENT

Attention must focus on managing threatened resources (crops, livestock, natural areas, landscapes, etc.) to maintain their competitive ability rather than on eradication of weeds once they invade. Control of undesirable plants without improving management is usually futile. A balanced approach to successfully managing the resource must include the following processes:

- managing the resource to **prevent** weeds from invading
- proper **identification and knowledge** of invasive weed species
- **inventory, mapping and monitoring** of weed populations and damage
- making **control decisions** based on knowledge of potential damage, cost of control method and environmental impact of the weed and control decision
- using control strategies that may include a **combination of methods** to reduce the weed population to an acceptable level
- **evaluating** the effectiveness and effects of management decisions

PREVENTATIVE STRATEGIES

Prevention is the most important but often least used control strategy. Wind, water, wild animals, livestock and man are the major agents of weed dispersal. When weeds are spread by natural agents, control is very difficult or impossible. When man is the weed dispersal agent, carelessness or a lack of understanding of his actions is responsible.

- Sow certified crop seeds. In the long run, cheap seed is usually the most expensive. Certified seed has a lower allowable tolerance for noxious weed seeds.
- Clean machinery and vehicles. Wash farm machinery before transport to clean weeds and mud which contains weed seeds. Tarp grain loads to prevent seed spread.
- Cut weed infested crops prior to weed seed production.

Once weeds have seeded out they can remain a problem for many years due to the process of seed dormancy.

Table 3 Weed-Seed Dormancy

Name of Weed	Years Some Seed Remain Viable (Alive) in the Soil
Chickweed	10
Hedge Mustard	10
Canada Thistle	11 - 20
Oxeye Daisy	11 - 20
Lamb's-Quarters	21 - 40
Purslane	21 - 40
Redroot Pigweed	21 - 40
Shepherd's-Purse	35
Dodder	70
Curled Dock	>80

PHYSICAL STRATEGIES

Tillage

Soil is the principle factor of the environment that the farmer manipulates in crop production. Soil tillage enables the farmer to attack many weed survival mechanisms. For annual weeds, the tillage objective is to prevent seed production and deplete current seed reserves in the soil. This is accomplished by encouraging weed seeds to germinate, then subsequently killing them. With perennials, destruction of the underground parts is sought, as well as the prevention of seed production and reduction of seed reserves. Tillage kills weeds by:

- Burial of the entire plant. If complete burial is not accomplished and a small portion of the plant is exposed, life may continue. Burial is usually only effective with seedlings.
- Depleting food reserves. This is accomplished by repeatedly removing top growth whenever it reaches sufficient size. Food manufacture can be halted by cutting off the plant tops or burning them. Tillage that breaks the underground parts into pieces is also very effective. This creates more growing points to use up food, and hastens food depletion.

- Exposure of underground parts to frost. The roots of most plants are killed when left on or near the soil surface during freezing temperatures. Fall cultivation followed by spring-tooth harrowing brings underground parts to the surface.
- Exposure of root systems to drying. If many roots remain under moist soil, growth will continue, therefore tillage must be thorough, with the plants fully exposed on the soil surface.
- Encouraging rotting of underground parts. Physical injury to underground parts due to tillage enables the entry of decay causing bacteria.

Spring Tillage: Don't till deeper than four inches. Deep tillage buries weed seeds and temporarily minimizes weed problems, but subsequent tillage will bring these seeds to the surface again. Seeds in the soil can germinate many years after burial - sometimes for up to 40 years or more. Tillage should be designed to catch the first flush of weeds prior to sowing the crop. In moister areas tillage may be designed to control more than one flush of weeds prior to seeding. Post-seeding tillage, if practical, should be done in dry, warm, sunny and perhaps windy conditions so that weed seedlings once disturbed are not able to transplant themselves.

Fall Tillage: Tillage after harvest can effectively kill biennials and suppress perennials. Under suitable conditions in the fall, weed germination may be stimulated making the new seedlings susceptible to frost kill.

Hand Weeding

Annual and biennial weeds and non-creeping perennials can be destroyed by simply pulling them out. This is best done when the soil is moist and before seed is produced. This is only practical of course for small patches or individual plants.

Mowing

When weeds are too numerous to hand pull, too large to effectively destroy by cultivation, or in an area where cultivation is impractical or impossible, they can be destroyed by mowing. This should be done before they produce seed and as close to the ground as possible. Perennial weeds usually require several cuttings before the food reserves in the roots are exhausted. If only a single cutting can be made, the best time is just prior to blooming because (1) the reserve food supply in the roots is at its lowest level, and (2) viable seed is often produced just after blooming. Perennial sow-thistle begins producing viable seed only three days after blooming and after nine days, 73 percent of the seeds may be viable.

Grazing

The repeated removal of weed top growth by grazing animals, like close mowing, prevents seed formation and gradually weakens underground parts. Horses, sheep, goats, hogs and cattle are effective in destroying many weeds, if they are properly managed. **Grazing animals should not be turned into pastures too early in the spring** before the pasture grasses have made good growth. If grazing is permitted too early, the grasses do not develop a competitive stand and the weeds tend to take over. Ideally, pasture should be subdivided into two or more lots. This permits pasture areas to be grazed in rotation. If managed correctly, more weeds will be cleaned up than if livestock are allowed to roam over a large area and choose the more desirable forage, leaving the weeds to become rank, unpalatable, and over a period of time the dominant pasture plants. By rotating the pastures, desirable forage is encouraged during its rest period and results in healthier competitive pasture plants. Rotation also permits herbicide treatment with a safety margin, enabling the breakdown of the chemical before returning the pasture to grazing.

Burning

In situations when seed production has already occurred, some of the seeds can be destroyed by burning. The effectiveness of burning depends on the duration and intensity of heat produced, plus the maturity and location of the seeds. Mature, dry seeds are more heat resistant than green seeds, which have a high moisture content. Although intense heat will destroy most seeds remaining in plant heads, only a relatively small number of seeds on or below the soil surface can

be destroyed by burning surface trash. Burning weeds over an extended area destroys valuable surface trash that would normally be returned to the soil through decay or cultivation.

In most farming operations, the most appropriate use of burning would be to selectively burn patches of weeds that have headed out by using a large propane torch. The flame can be directed at the mature heads of the weeds and the undesirable side effects of burning can be largely avoided. This is one of the few effective methods of preventing the dissemination of airborne seeds like Canada thistle, sow thistle, etc. Row crop producers sometimes use flaming machines that selectively burn weed top growth between the rows of specialty crops.

Mulching

The principle of mulching is to exclude light from the tops of the weeds until the reserve food supply in the roots is depleted and the weeds starve. Mulches include clean straw, hay or manure, tar paper, sawdust and black plastic. Black plastic is very effective. When the vegetation under the mulch has been destroyed, the resultant bare patch must be re-seeded with competitive vegetation to prevent new weed introductions.

CULTURAL STRATEGIES

Cultural control uses plant competition or cropping practices to suppress weeds, either through use of smother or competitive crops and crop rotation.

Crop Rotations

Certain groups of weeds are almost always associated with specific crop rotations because:

- They are able to compete well with that crop.
- They are not destroyed by the herbicides and cultivations that normally accompany production of the crop.

Continuous cropping to small grains, for example, results in an increase in weed populations, chiefly annuals. Perennial forage crop plantings or permanent pastures favour development of perennial weeds like Canada thistle and quackgrass. Repeated plantings of the same crop favour the development of insects and diseases that result in weak or patchy stands that are easily invaded by weeds.

Summer annual weeds in grain plantings can be reduced by rotating to perennial forages or to row crop production where practical.

Once perennial forage crops are established and well managed, cutting for hay will suppress annual and perennial weeds, and eventually the competition will eliminate annual weeds.

Fall seeded crops such as fall rye or winter wheat provide increased early season competition to seedling weeds and the early harvest enables a partial summer fallow for the balance of the season.

Despite rotating crops, intensive summer fallow is often the only cultural alternative on land severely infested with perennial weeds such as Canada thistle and quackgrass. Summer fallow is designed to suppress growth, prevent seed production, deplete seed reserves in the soil and starve weed roots.

Plant Competition

The use of plant competition is one of the cheapest and most useful general weed control practices available to all farmers. Competition uses one of nature's oldest laws - survival of the fittest. Weeds are strong competitors by nature. If not, they would fail nature's survival tests. Certain weeds that can best compete under a certain set of circumstances always tend to dominate.

As mentioned earlier, weeds compete with crop plants for light, soil moisture, soil nutrients, carbon dioxide, and space. For example, one mustard plant from germination to maturity uses twice as much nitrogen and phosphorus, four times as much potassium, and four times as much water as one well developed oat plant.

As a general rule, for every pound of weed growth produced, about one less pound of crop growth is produced. Usually, early weed

competition reduces crop yield far greater than late season weed growth. It naturally follows then, that early weed control is exceptionally important. Late season weed growth may not seriously reduce yields, but it can make harvesting difficult, lower crop quality, and add to the reservoir of weed seeds in the soil.

Crop Establishment

As a general rule, the first plants to germinate and emerge in an area tend to exclude all others. Therefore, it is critical when considering plant competition as a weed management tool to establish a vigorous dense crop. Important factors that affect germination and emergence include the viability of the crop seed (percent germination), soil temperature, availability of moisture, and physical resistance to seeding emergence by the soil. These factors are influenced by the soil type, physical condition of the soil, depth of planting, the firmness of soil around the seed, the degree of soil compaction above the seed, and the formation of surface crusts after planting. The final stand will also be influenced by post-emergent stress due to weeds, diseases, insects and adverse weather conditions. Crop germination, if planting has been correctly done, is generally rapid and predictable. If pre-seeding weed growth has been killed, at least a temporary advantage has been gained for the crop. This initial advantage can be lost however, if effective post-seeding herbicide application or tillage is not undertaken to control late emerging weeds.

FACTORS LEADING TO MAXIMUM CROP COMPETITION TO REDUCE WEEDS

Prepare Good Seedbed - Stale Seedbed Technique: A good seedbed is prepared, but no seeds are planted. After a good growth of weeds have emerged, they are killed using a non-selective herbicide with no residual effect in the soil. The crop is then planted with as little disturbance of the soil as possible to avoid bringing fresh weed seeds to the surface. This technique controls the all important first flush of weeds.

Rate of Seeding: Heavier seeding rates can be used to reduce weed competition in areas where sufficient moisture is available. This applies to seeding completed at the regular time, as well as in a delayed seeding program. The recommended heavy seeding rate varies from 25 to 100 percent more seed, depending on the crop and the location. However, it should be remembered that heavy seeding rates should be used together with other cultural and chemical control measures to be most effective.

Date of Seeding: Different weeds have different preferences for germination. Weeds such as many of the mustards and wild oats germinate best in cool conditions and are therefore more of a problem in early sown crops. Redroot pigweed and green foxtail prefer warmer soils and therefore germinate later. Late seeding allows for tillage or pre-seeding herbicide control of early germinating weeds. Early seeding results in crop competition with later germinating weed species. By varying crop seeding dates weeds have difficulty adapting.

Crop Variety: It is important to choose a variety of crop plant that is well adapted to local conditions of soil, water, climate and disease resistance.

Fertilization: The fertility of the soil affects both the vigour of crop plants and the vigour of weeds. Many weeds can utilize fertilizers as well as or better than crop plants. Nevertheless, if most of the weeds are suppressed or killed by tillage or herbicides, the extra vigour given to the crop by fertilizers will make them better competitors. Placement of the fertilizer in the crop rows has an advantage over broadcast fertilization because most of the fertilizer is directly available to the crop.

Cultural Weed Control

Cultural practices aimed at achieving good establishment of new alfalfa seedlings and maintaining the stand in healthy condition are of

paramount importance in reducing losses due to weeds. Cultural controls can be summarized as follows:

1. Eliminate perennial weeds prior to seeding through the use of intensive cultivation, if practical, or by treating with a non-residual herbicide such as Roundup (glyphosate).

2. Use only clean certified seed. Some weeds can lie dormant in the soil for up to 70 years or more so don't sow weed seeds along with alfalfa by purchasing cheaper but weedy seed.

3. Thorough pre-seeding cultivation to destroy weed seedlings.

4. Timely seeding when soil temperature is warm enough to promote quick germination and establishment.

5. Prepare a smooth, even seedbed to promote uniform germination.

6. Mow or clip to prevent annual weed growth and seed set. Mowing will have little effect on perennial weeds whose growing points are close to the ground such as dandelion and weedy grasses.

7. Maintain proper soil fertility.

8. Maintain good soil moisture.

9. Follow a crop rotation. Row crop cultivation can control perennial broadleaved and grassy weeds.

10. Cut crops before weeds go to seed.

11. Avoid overgrazing in early fall. This will aid in preventing depletion of root food reserves needed to minimize winter injury.

FORAGE SPECIES DESCRIPTION : LEGUMES

CROP	ADAPTATION					
(Seeds Per Kilogram)	**Characteristics of the Crop and Area of Adaptation**	**Longevity Under Average BC Conditions**	**Flood Tolerance (when dormant)**	**Salinity Tolerance**	**Drought Tolerance**	**Winter Hardiness**
Alfalfa (484,000)	This crop has a tap root, good crown development and erect stems. - Wide range of climate; well drained soils.	Irrigated 5-7 years Dryland –long life	5-10 days	Fair	Good	Variable with variety poor to good
Sweet Clover (572,000)	First season growth consists of a central, much branched stem. Crown buds produce rapidly growing, tall, coarse stems in second year. Strong tap roots. - Well drained soils	2 years	14 days	Fair	Good	Good
Birdsfoot Trefoil (713,000 – 1,200,000)	Strong deep tap root system with many side branches. Can regenerate crowns from root portions. Fine stemmed but not as erect or tall as alfalfa. - Cool, moist areas; tolerates poor drainage.	Long 10^{+}	14 days	Fair	Fair	Good
Red Clover (550,000)	Short tap roots with side branches. Good stands persist for one to three years depending on variety, soil moisture and temperature. Humid, moderate temperatures; moist soils.	1-3 years	7-14 days	Poor	Poor	Good
Alsike (1,540,000)	A profusely tillering prostrate plant with indeterminate growth habit. - Low lying, moist soils.	2-4 years	14 days	Poor	Poor	Good
Cicer Milkvetch	Vigorous, deep root system; very long lived; recumbent growth habit.	Long 10^{+}	7-14 days	Fair	Medium	Good
Sainfoin (66,000)	Long lived on dryland; Shorter life under irrigation. Short tap roots with many side branches. Top growth to 1m.	Dryland long 10^{+} Irrigated – 3-5 years	Up to 7 days	Low	Good	Good
White/ Ladino Clover (1,760,000)	Ladino – taller and higher yielding than common white. Dutch Clover Ladino is less winter hardy and less tolerant of close grazing than white Dutch. Shallow rooted perennials that spread by stolons.	Short 3^{+} (reseeds naturally)	10-14 days	Low	Poor to Fair	

	PRODUCTION		
pH Range For Optimum Growth	**Period of Major Production**	**Positive Features**	**Negative Features**
6.5 – 8.0	Spring to Fall	Easily established on most soils with good drainage. High yields of good quality forage. Rapid re-growth following grazing or clipping.	Bloat hazard. Requires good drainage. Poor persistence when grazed or clipped frequently.
6.5 – 8.0	Spring of Second Year	Grows under a wide range of soil and climatic conditions. Excellent for soil and drainage improvement. Low coumarin varieties available.	Seedling stands thinned or destroyed by sweet clover weevils. Low palatability unless harvested early. Coumarin content of some varieties can cause feeding problems.
5.5 – 7.5	Spring to Fall	Long-lived. Will grow on wide range of soil conditions. Reseed itself when conditions are favorable. Feed value similar to alfalfa. No bloat hazard.	Poor seedling vigor; poor competitor in weedy stands. Slow to come into full production. Lodges easily. Slow recovery after grazing or clipping.
6.5 – 7.5	Spring	Easy to establish. Tolerates soils wetter and more acidic than alfalfa.	Bloat hazard. Short life span due to a number of crown and root diseases.
5.5 – 7.5	Spring	Tolerant to poor drainage and acid soils.	Bloat hazard. Short life span. Low aftermath yield. May be toxic to horses.
6.0 – 8.0	Late Spring to Fall	Non bloating legume. Good late summer growth. Tolerant of grazing.	Hard seed is common; requires scarification. Slow to establish; slow to grow in spring.
6.5 – 8.5	Spring	Non bloating legume. Long life under dryland conditions. Maintains quality as plant matures.	Less productive than alfalfa. Not competitive in mixtures. Slow to establish.
6.0 – 7.5		Tolerant of heavy grazing. Palatable and nutritious. Very useful in pasture mixes under irrigation.	Lower yielding than other legumes. Can cause bloat.

FORAGE SPECIES DESCRIPTION : GRASSES

CROP	ADAPTATION						
(Seeds Per Kilogram)	**Plant Type**	**Plant Height cm (in)**	**Longevity Under Average Conditions**	**Winter Hardiness**	**Flooding Tolerance**	**Drought Tolerance**	**Salinity Tolerance**
Kentucky Bluegrass (4,840,000)	Creeping, sod-forming	30-75 (12-30) Basal leaves	Long	Excellent	Medium	Good when plant is dormant	Poor
Meadow Bromegrass (176,000)	Bunch, some spreading	60-120 (24-48)	Long	Excellent	Low	Good	Fair
Smooth Bromegrass (297,000)	Creeping, sod-forming	60-120 (24-48)	Long	Excellent	Medium	Good when plant is dormant	Fair
Creeping Red Fescue (1,353,000)	Creeping	60-120 (24-48) Basal leaves	Long	Excellent	Medium	Fair to good	Poor
Meadow Fescue (506,000)	Bunch	35-75 (14-30) Basal leaves	Medium	Good	High	Good	Fair
Orchard-grass (1,430,000)	Bunch	60-120 (24-48)	Medium	Fair-Good (unless protected)	Low	Good	Poor
Reed Canary-grass (1,166,000)	Creeping (short rhizomes)	60-240 (24-96)	Long	Good except where exposed	High	Fair	Fair
Tall Fescue (500,533	Bunch	105-150 (40-60)	Medium	Fair-Good	Medium – Good	Good	Good

	PRODUCTION		
Preferred Climate and Soil Type	**Period of Major Production**	**Positive Features**	**Negative Features**
Cool, humid. 500-1250 mm (20-50 in) precipitation. Will grow on almost any well-drained soil.	Spring Fall	Tolerates close and frequent defoliation. Tolerates wet conditions for short periods of time. Can be regenerated from rhizomes. Useful in erosion control.	Slow to establish. High moisture requirements; dormant in hot, dry weather.
Well drained soils.	Spring Fall	Winter hardy. Better re-growth than smooth brome. Responds well to irrigation and fertilizer. Palatable to livestock.	Slow to establish. Large, light seeds difficult to sow (bridging). Sensitive to spring flooding.
Moist, well drained soils.	Spring	Winter-hardy; drought and heat tolerant. Grows on diversity of soil types. Palatable even at mature growth stages.	Seed light and difficult to sow (bridging). Slow to establish. Becomes sod-bound in absence of nitrogen. Weakened by heavy grazing. Susceptible to winter crown and root rot.
Cool, humid areas. Will grow in wide range of soil types.	Spring Fall	Vigorous seedling. Tolerates low fertility and close grazing. Tolerates areas too dry for timothy. Starts growth fairly early in spring. Grows vigorously late summer to freeze-up.	Palatability fair. Vulnerable to crown and root rots and to snow mold.
Soils with ample moisture and good drainage.	Spring through Fall	Establishes rapidly on wide range of soils. Productive through out entire growing season.	Does not persist under continuous heavy grazing. Susceptible to leaf rusts. Less palatable than most grasses.
Warm, moist areas with over 500 mm (20 in) precipitation. Good drainage.	Spring through Fall	Rapid establishment. Rapid re-growth following harvest. Shade tolerant. Compatible with alfalfa.	Only moderately winter hardy. Requires high nitrogen inputs for high production. Coarse and unpalatable at maturity.
Moist, cool climate; poorly drained areas subject to temporary flooding.	Spring through Summer	Grows well in wet areas and can withstand considerable flooding. Remains productive throughout season. Excellent grass for waterways and areas subject to water erosion.	Seed difficult to sow. Slow to establish a sod. Palatability declines rapidly with advance in maturity. Alkaloids in forage associated with decrease in animal performance.
Widely adaptable	Spring through Fall	High yield, good fall production, maintains quality into winter, good for stockpile grazing	Fairly slow to establish, lower palatability than orchard grass when grown in mixtures. Must use only endophyte free seeds.

FORAGE SPECIES DESCRIPTION : GRASSES

CROP	ADAPTATION						
(Seeds Per Kilogram)	**Plant Type**	**Plant Height cm (in)**	**Longevity Under Average Conditions**	**Winter Hardiness**	**Flooding Tolerance**	**Drought Tolerance**	**Salinity Tolerance**
Timothy (2,700,000)	Bunch	50-100 (20-40)	Medium	Good	High	Poor	Poor
Crested Wheatgrass Diploid (Fairway 704,000) Tetraploid (Nordan 418,000)	Bunch	50-90 (20-36)	Long	Excellent	Low	Excellent (Fairway type goes dormant faster than Nordan)	Fair
Slender Wheatgrass (352,000)	Bunch	60-120 (24-48)	Short (4-5 Years)	Excellent	High	Good	Good
Inermediate Wheatgrass and Pubescent Wheatgrass (194,000)	Creeping (short rhizomes)	90-150 (36-60)	Medium (about 6 years)	Excellent	Medium	Good	Poor
Tall Wheatgrass (174,000) (Tall Fescue)	Bunch (short root-stocks)	90-180 (36-72)	Long	Excellent	High	Poor	Good
Russian Wild Ryegrass (385,000)	Bunch basal leaves 15-45 cm (6-18 in)	50-90 (20-36)	Long	Excellent	Low	Good	Fair
Perennial Ryegrass (500,000)	Bunch	30-60 (12-24)	Short	Fair	Low	Poor	Low

	PRODUCTION		
Preferred Climate and Soil Type	**Period of Major Production**	**Positive Features**	**Negative Features**
Cool, moist areas with good drainage.	Spring through Summer.	Seed plentiful and low priced. Stand establishment is rapid. Offers little competition to the legume in mixtures.	Susceptible to heat and low moisture conditions. Low palatability and feed value at maturity. Weakened by heavy grazing or frequent cutting.
Light soils and areas deficient in moisture. Can be grown on most soils if they do not have high water table.	Spring and Fall	Easily established on wide range of soils. Withstands close grazing and tramping. Palatable in early spring.	Does not tolerate cool, wet soils, (especially tetraploid). Hay quality deteriorates rapidly after heading. Slow re-growth after hay harvest.
Adapted to wide range of soils but prefers sandy loams.	Spring and Early Summer	Good seedling vigor; easily established. Shade tolerant. Forage cures well on stem. High salinity tolerance.	Less competitive and persistent than other wheatgrasses. Not resistant to close or heavy grazing.
Well drained fertile soils with ample moisture.	Spring, Summer and Fall	Easily seeded. Begins growth in early spring. In moister areas out yeilds crested wheatgrass and brome. Good hay grass in association with alfalfa.	Less drought tolerant and winter-hardy than crested wheatgrass. Does not tolerate salinity. Does not persist in areas with poor drainage.
Adapted to saline and imperfectly drained alkali soils. Prefers soils with high water table. Survives flooding for 2 months in spring. Needs 375 mm (15 in) minimum precipitation.		Very tolerant of saline soils. In early heading stage has high protein and TDN ratings.	Slow to establish – poor germination, poor vigor and poor competitive ability. Not as palatable as other wheatgrasses.
Can be grown on a wide range of soil types but is most productive on fertile loams.	Spring through Fall	Early, excellent dryland crop. Roots draw on moisture up to 1.5 m (approx. 5'). Very tolerant of grazing; re-grows quickly. Palatable and nutritious in mature stage. Good salinity tolerance.	Poor seedling vigor, therefore poor competitor in establishment year.
Heavy moist soils. Moderate temperatures.	Spring, Summer and Fall	Quick establishment, rapid re-growth. Very palatable, high quality. Good fall growth.	Poor winter hardiness. Predominantly basal leaves, low growing, makes it hard to harvest mechanically. Low tolerance to high temperatures.

FORAGE SPECIES DESCRIPTION : ANNUAL FORAGES

CROP	ADAPTATION			
	Seeds Per Kilogram (Pounds)	**Plant Type**	**Plant Height cm (in)**	**Drought Tolerance**
Annual Ryegrass - Westerwolds type (not recommended) has become a weed problem	Diploid – 500,000 (227,000) Tetraploid – 200,000 (90,000)	Bunch	50-60 (2-24)	Poor
Annual Ryegrass - Italian Type	Diploid – 500,500 (227,000) Tetraploid – 200,000 (90,000)	Bunch	40-50 (16-20)	Poor
Barley	30,900 (14,000)	Bunch	75-100 (30-40)	Good
Oats	28,700 (13,000)	Bunch	75-150 (30-60)	Fair
Winter Wheat	33,100 (15,000)	Bunch	75-100 (30-40)	Good
Fall Rye	39,700 (18,000)	Bunch	75-150 (30-60)	Good
Peas	6,600 (3,000)	Recumbent Vines	Vines to 2m	Fair
Hairy Vetch (Winter Annual)	44,100 (20,000)	Vines	Vines to 150 cm	Fair
Fababeans	6,600 (3,000)	Erect Growth	100-180 (40-72)	Poor
Sorghum/Sudangrass	60,000-120,000 (27,000-54,000)	Tall Bunch Type	2-3 m	Good

	PRODUCTION		
Preferred Climate and Soil Type	**Period of Major Production**	**Positive Features**	**Negative Features**
Cool, moist areas. Medium to heavy soils.	Late Summer and Fall	High quality, palatable forage. Excellent fall growth. Erect growth.	Poor heat and drought tolerance. More stems and lower digestibility than Italian type ryegrasses.
Cool, moist areas. Medium to heavy soils.	Late Summer and Fall	Leafy, very high quality forage.	Poor heat and drought tolerance. Low growth habit makes mechanical harvesting less efficient.
Adaptable to wide range of well drained soils. Tolerant of salinity and high pH.	Mid-Summer and Fall (if double cropped)	High yield, high quality forage for silage. Well adapted to intensive management and double cropping.	Stiff awns (beards) create some problems when harvested as hay.
Requires more moisture than barley, will tolerate poorer drainage than barley.	Mid-Late Summer	Good yield, easy to grow for hay or silage.	Lower quality than barley. Not as useful in double crop systems.
Adapted to wide range of soils. Good heat and drought tolerance.	Depends when planted. Spring use if Fall planted. Summer and Fall use if Spring planted.	Palatable, good quality spring pasture when planted previous Fall. More drought and heat tolerant than Annual Ryegrass	When planted in Spring, yield is low; but can be useful for Fall pasture.
Adapted to wide range of soils. Good heat and drought tolerance.	Same as Winter Wheat.	Good hardiness when used as winter annual. Makes good Spring pasture.	Feed quality declines rapidly as plant matures.
Cool, moist climate and medium to heavy soils.	Late Summer.	Good quality forage.	Twining growth habit may be difficult to harvest. Does not add significantly to yield. Subject to many fungal diseases.
Broad range of adaptability.	Mid-Summer to Fall.	High quality forage.	Will cause bloat; not hardy as a winter annual in this area. Should be spring planted.
Medium to heavy soils; cool moist growing conditions.	Late Summer.	High quality forage.	Poor competitor with weeds; only fair heat tolerance.
Warm, light soils, high temperatures. Does poorly under cool temperature.	Mid-Summer to Fall.	Good drought tolerance, high yield. Newer varieties offer good forage quality.	Forage quality only fair with older varieties; may contain levels of prussic acid that could be toxic.

SPECIFIC CROP MANAGEMENT RECOMMENDATIONS

TWELVE STEPS TO HIGH ALFALFA YIELDS

Alfalfa is the most important forage crop grown for hay in BC. It has the ability to produce pala table and nutritious forage under a wide variety of climatic and soil conditions.

The livestock industry requires a considerable supply of hay; therefore, it is essential that supplies are increased. This requirement and the increased revenue for the hay grower point out the desirability of increasing yields of alfalfa hay. A high legume content is also required to maintain high forage quality. This publication was prepared to provide specific detailed information giving TWELVE STEPS TO HIGH YIELDS of alfalfa hay in BC

Step 1. Selecting the Field

The best stands of alfalfa are obtained in well-drained, deep, loamy soils that have a high water holding capacity. The best soil pH range for optimum alfalfa production is between 6.5 and 8.0 (near neutral). However, this crop will grow on a wide variety of soil types from sand to fine textured clay. Stands on light, sandy soils require concentrated irrigations or good subsoil moisture for maximum yields.

Unsuitable areas are shallow or extremely compact soils, hardpans, soils with fluctuating water tables, or areas subject to periods of flooding. Saline soils can be used but seedlings are less tolerant to salinity than older plants. Therefore a heavy irrigation prior to planting may help to get a stand established on saline areas. Alfalfa should not be grown on soils with a pH less than 6.0 unless lime is added. Sufficient lime should be added to establish pH of 6.5 to 7.0.

Step 2. Preparing the Seedbed

The ideal seedbed is moist, mellow, and firm so seed that the soil particles are in close contact with the seed. It is free from excessive trash and vegetation, which would interfere with the seeding. A well-prepared seedbed will require considerably less seed to establish a good stand. Many stand failures can be traced directly to poor seedbed preparation.

A good seedbed can be obtained by plowing in the fall, discing several times in the spring, and harrowing to control weeds until planting time. Minimum spring tillage must be practiced to maintain soil moisture for good establishment under dryland conditions.

If the spring plowing is necessary, extra harrowing may be necessary to settle the seedbed.

On most soil types a culti-packer can be of considerable assistance in preparing a good seedbed. On heavy clays and colder soils, however, the seedbed should be left more cloddy and less firm to avoid crusting. In this case, heavier seeding rates would be necessary.

Step 3. Fertilizing

A soil test before seeding and at two year intervals is highly recommended. If test information is not available, however, general information can be used. Refer to Soil and Fertility Management Section.

Step 4. Choosing a Variety

Refer to your seed dealer for the latest varieties. Things to look for when selecting a variety are winter hardiness, disease resistance, and yield.

Step 5. Inoculating the Seed

Alfalfa seed should always be inoculated with Alfalfa inoculum before seeding. Use pre-inoculated seed or follow the instructions on inoculant packages.

Most inoculants sold in BC contain at least 50 per cent of acid-tolerant strains of Rhizobium.

Step 6. Sowing Alfalfa

Seed should be sown in a moist seedbed one-quarter to one-half inch deep in fine-textured soils and one-half to one-inch deep in coarser soils. The best method for accuracy and minimum requirements is a culti-packer seeder (a Brillion type seeder), which gives uniform distribution and good depth control. Alfalfa can be seeded with a drill (with grass-seed

attachment) or by a hand- operated cyclone seeder.

In dry soils, irrigation before seeding is preferred. It firms the seedbed and makes inoculation effective. Alfalfa seedlings have limited food reserves and cannot emerge if planted too deep or where the soil surface crusts.

Step 7. Rate of Seeding

Rates of seeding vary from 6 kg/ha on very dry-land sites up to 20 kg/ha for the coastal region. The rate needed will depend on soil moisture, method of planting, and climatic factors. .

The recommended rate for most areas of the interior is 10- 12 kg/ha. (9 to 10.5 lbs./acre). Less seed is required on a well-prepared seedbed

Step 8. Time of Seeding

Early spring seeding is recommended on both irrigated and dry hay land. This permits seedlings to develop good root systems by mid-summer to endure the hot, dry weather. It also helps considerably to reduce winterkill. Late summer up to mid-September seedings can be very successful, but there is some risk of seedling loss if hit by an early frost. You should have a minimum of 6 weeks of growth before a killing frost. Dormant seedings are generally not recommended as legume seed viability is affected over the winter.

Step 9. Companion Crops

All companion crops seeded with alfalfa will compete for moisture, light and fertility.

If extra yield or weed control is desired and moisture is not a limiting factor, a companion crop may be sown at 40 - 50 kg/ha. Cereal varieties will provide maximum feed value if cut at the soft-dough stage. Alfalfa re-growth before the end of the season will reduce the chance of winterkill.

If moisture is limited, a companion crop should not be grown or taken off early.

Step 10. Irrigating Alfalfa

Irrigation should be frequent enough so that no when stress is put on the plant by lack of moisture. A new stand needs more frequent irrigation because roots are shallower. Alfalfa is a deep-rooted perennial crop, which requires soil moisture to a depth of 4 feet or more for maximum production. This means that a properly designed irrigation system is essential. When a crop is harvested, the top soil should be dry. It is important that a minimum amount of time elapses from water shut-off, just before harvesting, to the resumption of irrigation just after harvesting. Under favorable conditions, the next hay crop will be ready in 30 to 40 days. Late- fall irrigation has proven beneficial in reducing winter losses. Moist soil going into winter helps winter survival.

Step 11. Controlling Weeds

For an alfalfa stand to remain productive it is important that perennial weeds are removed before seeding. Usually annual weeds are a problem when seeding alfalfa. Companion crops or herbicides can be helpful for reducing weed competition. Weeds can be controlled by early clipping or with herbicides. A fact sheet is available on alfalfa weed control for specific weed problems.

Step 12. Stand Management

If all the preceding steps are followed, one good cut of hay (2-3 tons per acre) can be expected during the seeding year. On any alfalfa stand, no cutting or grazing should be made during late August until mid-September. This allows for production and storage of food reserves in the crown and root, giving stronger plants to withstand stress. Cutting or grazing in October is less damaging to the crop than the mid- August to mid-September period. In Zone 3, the time to avoid cutting is somewhat earlier (early to mid-August) with cutting in mid to late September likely to cause less plant stress prior to winter.

Cutting management has a significant effect on winter survival and next year's growth; cutting

management is also site specific and needs to be adapted to your farm. A general rule is to avoid cutting in the period from 6 to 2 weeks prior to killing frost. Recent research has also suggested that the stage of plant growth at the time of 2nd cut is also important. If the second cut is delayed to at least 10 per cent bloom, the plants appear to be more vigorous the following spring.

It is generally recommended that hay be cut when the field is in 1/10th blossom. In the spring, when days are short, alfalfa is slow to bloom. In this season the correct cutting time can be determined by the new buds at the base of the plant. When these buds start to develop it is time to cut.

When plants have been weakened by winter injury it is best to delay the first spring cutting until full bloom. Many stands are plowed under too soon when they might have recovered. However, if the stand has been badly damaged, it may be advisable to plow and re-seed. Attempts to improve poor stands without complete renovation generally fail.

Refer to the alfalfa disease fact sheet for assistance in recognizing the causes of poor growth.

ALFALFA GRASS PRODUCTION

Alfalfa-grass mixes are more common than stands of pure alfalfa. Some of the advantages of a mix include the following:

Advantages:

- better grazing tolerance than pure alfalfa
- longer productive life
- good nutrient balance, usually better calcium to phosphorous ratio, higher TDN but lower protein; more closely meets the requirements of beef cows.
- may cure quicker in the swath
- alfalfa-grass mixes ensile better than pure alfalfa
- some studies have shown higher yield, but this is quite variable with cutting, grazing and fertilizer management.

Disadvantages:

- to obtain equal or higher yields than pure alfalfa, require more fertilizer, primarily nitrogen
- alfalfa-grass hay is normally priced lower when being sold
- need to select grass species and variety carefully to match with the maturity of your alfalfa variety, as grasses often mature earlier than alfalfa.
- seeding grasses with alfalfa may reduce the productive life of alfalfa, compared to straight seedings of alfalfa.

The major difference in management of alfalfa-grass mixes when compared to straight alfalfa is the fertilizer program. Pure stands of alfalfa require primarily phosphorous and boron fertilizers, while alfalfa-grass mixes will respond most economically to nitrogen fertilizers. In addition, more frequent applications are recommended because of the mobile nature of nitrogen and its rapid uptake by the plants. Broadcast applications in the spring and after first cut of nitrogen or nitrogen-phosphorous fertilizers may produce a yield response.

ALFALFA TROUBLESHOOTING GUIDE

General Symptoms	Possible Cause and Detailed Symptoms	Solution
Stand thin, plants disappearing.	Verticillium Wilt: Individual plants become infected and die. Temporary wilting of upper leaves on warm days followed by more general wilting and leaves that turn white or yellow. At first the stem remains green, later, starting at the base the stem turns grey then black.	Pant resistant varieties.
	Witches Broom: Individual plants infected produce a dwarf, clumped group of shoots. Plants are stunted with small yellowish leaves. Infected plants are more susceptible to winter injury.	When reseeding destroy all volunteer plants. Maintain a vigorous stand.
	Bacterial Wilt: Stunting and yellowing followed by wilting during warm dry weather. Leaves are small and cupped. Dark ring in cross section of root.	Plant resistant varieties.
Slow or no growth in spring.	Winterkill or injury: Roots are soft, outer skin of root peels off easily. Injured buds are dry, discolored, and limp. Viable buds are white, firm, and may be pink tipped. Mature stands should have 5-6 plants per square foot.	Plant winter hardy varieties. Review harvest management.
Plants dying in lower, wet areas. Grass taking over.	Phytophthora Root Rot: Occurs in a wet poorly drained soils during extended periods of rainfall or excessive irrigation. Causes yellowish-brown rotted areas on the roots extending up to the crown. Rotted areas later turn black.	Monitor irrigation use. Correct drainage. Grow phytophthora resistant alfalfa varieties. Manage for grass in area not suited to alfalfa.
	Potassium Deficiency: Alfalfa leaves show oval to round yellow-white spots.	Soil test, fertilize
Under humid conditions leaves are twisted and rolled downwards.	Downy Mildew: Usually does not cause severe damage. Occurs in cool, wet, humid weather during the spring. Light green to yellow blotches appear on leaves. Greyish fungal growth often occurs on the underside of the leaflets.	Crop rotation using cereals if the problems become serious. Use resistant varieties.
Short, yellow topped plants, low yield, especially on dry ridges.	Boron Deficiency: Occurs in areas or patches in the field due to a soil deficiency. Leaves at the growing point turn bronze to yellow. Symptoms more evident under dry conditions.	Soil test, fertilize

CROP PESTS

The following is a brief description of crop pests that can be a problem in the Kamloops District. Infestations are seldom at levels that justify spraying. Spray recommendations for specific pests are available by contacting the District Agrologist.

Pest	Pest Description and Damage	Control
Aphids	Light to dark green soft bodied, about 3 mm long. High populations, which cover the stems and terminal buds, can occur in cool wet seasons. Damage is caused by sucking plant juices causing the plant to wilt.	Usually as drier and warmer weather develops populations are reduced. Under severe conditions prompt cutting or spraying may be required.
Cutworms and Armyworms	Thick, fleshy caterpillars up to 1½ inches long which curl up when disturbed. Feeding damage usually occurs at night. Patches or edges of fields which fail to 'greenup' indicate infestations. Damage usually occurs during the spring, but some species may appear later in the season.	If infestations are severe spraying may be required.
Alfalfa Looper	Pale to olive green caterpillars with a whitish stripe along each side and two light stripes along the back. Larvae move in a characteristic looping motion.	If infestations are severe spraying may be required.
Leafhoppers	Small elongated wedge-shaped insects that vary from 1/16 to 5/8 inch in length. They hop or fly when disturbed. Symptoms include stunting of the plant and yellowing or reddening of leaves in a V-shape form the center of the leaf outward.	Direct damage form feeding is rarely important, but hoppers can transmit viruses that affect alfalfa.
Grasshoppers	In hot dry seasons heavy infestations can occur. Uncultivated areas are preferred by grasshoppers however new seedings of alfalfa can be damaged starting from the field margins.	If infestations are severe spraying may be required.

ANNUAL FORAGES

Annual forage crops include a wide range of plant species, including: silage corn, sorghum-sudangrass, faba beans, peas, vetches, etc. as well as the cereals (barley, oat, wheat, rye) and annual ryegrass.

The major annual crops grown in the Kamloops District include the cereals, silage corn and annual ryegrass. As a separate publication for silage corn (Field Corn Variety Recommendations) is produced each year, corn production will not be included in this publication. Production details will be provided for barley and annual ryegrass combinations.

Annual crops provide a number of advantages in a forage crop system, including better weed and disease control, improved seedbed and establishment of subsequent alfalfa crops, an additional choice of feed quality, especially a higher yield of TDN (energy) as well has high quality fall pasture that is well suited to early weaning calves or finishing lambs. Annual ryegrass is also particularly useful for extending the grazing season in the fall.

(1) Double Crop Barley

Variety Selection

- Need to consider yield, maturity, lodging, resistance, disease resistance

Current recommendations

- Contact an Agrologist for current recommendations

Planting Dates

I) First Crop	- as early as possible - no later than end of April; mid-April recommended
(2) Second Crop	- immediately after harvest - not later than July 15.

Planting Rates

100 lb./acre	- Higher seeding rates may increase yields under conditions of high fertility, but also increase the risk of lodging and fungus disease.

Tillage Requirements

First Crop

- plowing is recommended, especially if the previous crop was an old alfalfa field or at all soddy or weedy. After plowing, disc and pack to obtain a firm seed bed. A firm seedbed is required to obtain rapid and uniform germination.

Second Crop

- Disc stubble under, pack and seed. Keep tillage to minimum to reduce moisture loss and costs.
- Can be time consuming and difficult (hot, dry, dusty) to establish the second crop of barley in mid-summer. Refer to the barley/annual ryegrass system for an alternative.

Fertilizer Requirements

(1) Soil test to determine need for P and K, etc.

(2) Nitrogen - 75 lb./acre actual N for each crop, broadcast prior to planting.
(e.g. 160 lb./acre 46-0-0 or 220 lb./acre 34-0-0).

If broadcast after planting, 34-0-0 is recommended, especially for the second crop, as 46-0-0 is subject to volatile losses under warm, humid conditions.

Harvesting

The optimum time to harvest to obtain the greatest yield of TDN (energy) per acre occurs when the barley is in the late milk to soft dough stage.

Quality

At the soft dough stage for harvest the TDN level should be 62 per cent and a protein level of 10 per cent.

Ensiling

Barley ensiles quite well, but is difficult to pack because of the hollow straw.

- wilt only for a short time (aim for 65-70 per cent moisture)
- chop short (1")
- pack continually while filling pit - place wetter material (e.g. 75-80 per cent moisture) over top of pit to help seal
- cover entire pit with plastic and weight down securely

Losses in a bunker silo can exceed 20 per cent if it is not packed and covered tightly; the crop will not be economical to grow if 20 out of every 100 acres are lost due to spoilage.

(2) Barley-Annual Ryegrass

Variety Selection

Barley: Choose early maturing barley varieties for more ryegrass yield. Later maturing early varieties give higher barley yield.

Ryegrass: Choose only 'Italian type' ryegrasses, **not annuals or westerwold types which become weed problems**. Check with your local seed sales for current Italian ryegrass varieties.

Planting Date

As early as possible in the spring will help to obtain high yields; however, there is more flexibility in managing this crop, as compared to double crop barley, therefore planting dates are not as critical.

Planting Rates

Barley – 50 - 75 pounds per acre
Annual Ryegrass – 15 - 25 pounds per acre

Planting Methods

The barley and annual ryegrass are seeded at the same time in the spring. A number of methods have been tried with best results coming from seeding ryegrass at 90° to barley, or broadcasting ryegrass after barley is seeded.

Three seeding methods:

(1) (Best Method) Broadcast seed after barley has been seeded; follow with roller.
- can seed near surface to obtain better germination
- can apply desired seed rate

Disadvantage
- this method requires another trip over the field

(2) Annual ryegrass in grass seed box
- provides uniform seeding over entire field, seeded at more appropriate depth.

Disadvantage
- small capacity of most grass seed boxes-requires frequent filling
- maximum seed rate with most drills is around 17-18 lb./acre, recommended seed rate is 20-25 lb./acre

(3) Mix the annual ryegrass in the grain box with the barley.

Disadvantages
- annual ryegrass is seeded too deep (i.e. 1 $^{1}/_{2}$" typical desired ^{is} $^{1}/_{2}$")-ryegrass is not evenly seeded over entire field, difficult to maintain uniform mix.

Fertilizer Requirements

First Crop	- 75 pounds N per acre
Second Crop	- 75 pounds N per acre
Third Crop	- 75 pounds N per acre

Annual ryegrass grows best under cooler conditions, so a late N application (i.e. September) takes advantage of this growth characteristic and boosts late season yield.

Harvesting

First Crop Barley

- harvest at boot stage for hay (maximum quality)
- harvest at soft dough stage for silage (maximum yield)

Annual Ryegrass

- for Italian types harvest when 16" – 20" tall; this will usually occur about 5 weeks after barley crop is removed, therefore occurs at middle to end of August
- harvest again at end of September, or use for pasture beginning first week of September.

- can be used for late season grazing (November-December) as it maintains its quality. Soft leaves do not stand up under snow.

Harvest management of annual ryegrass is quite flexible, depending on your needs, however, as with any grass crop, maximum quality is obtained when harvested early (i.e. before head emergence)

Quality

August harvests of annual ryegrass are generally lower in quality (typically 12-14 per cent protein, 60-65 per cent TDN) as compared to growth obtained later in the season. September and October harvests, (if the crop has already been harvested in August) are of high quality, with analyses of 16-20 per cent Protein and 65-70 per cent TDN.

PASTURE MANAGEMENT

Pasture Mixes

Mixes are more common in pasture seedings, and are often more complex, with many species being included on the theory that given the variable con- ditions that often occur in pastures (e.g. wet areas, hilltops, etc.) the species most adapted to a particular part of the pasture will eventually dom- inate. Unfortunately, what usually happens is a great many species will try to grow initially,
usually at the expense of the most productive species. The primary recommendation for pasture mixes is to keep it simple, with no more than 2- 4 species in the mix.

For irrigated pasture for sheep or cattle, orchard-grass with either white or red clover or alfalfa is recommended. Although alfalfa is initially more productive than the clovers, it is less tolerant of grazing and soon disappears from pastures. White or ladino clover, at 25 per cent (maximum) of the seed mix with orchardgrass is recommended for well drained soils.

On heavier more acidic soils, red clover may sur-vive and produce better than white clover, but is shorter lived. In areas with good snow cover, where winterkill is not a problem, perennial ryegrass makes excellent pasture. However, for most parts of this district, it is not reliably winter-hardy.

Tall fescue is a newer grass species for the Kamloops area. Tall fescue is similar to orchardgrass in yield, but has the advantage of maintaining feed quality longer into the fall and winter, making it well suited for extended grazing systems.

One of the disadvantages of tall fescue is lower palatability during the growing season than orchardgrass. It is also important to use only forage variety tall fescue, and not turf varieties. Turf varieties have endophytes (a type of fungus), which increases hardiness and resistance to trampling, but can be toxic to livestock, especially horses.

Regar meadow bromegrass, although not common in this area, has good potential as a pasture grass.

Its main attribute is early spring growth, but it has less late season production than orchardgrass.

For horse pasture, where rate of gain is not the major objective, Kentucky bluegrass/white clover should be considered. Although less productive orchardgrass, it is more tolerant of close grazing and can reduce chances of founder and obesity in horses. The low growth habit of white clover is also well adapted to close grazing.

Intensive Irrigated Pasture Management

Intensive management of irrigated pasture has the potential to provide a good economic return with minimal machinery investment

Intensive management of fertilizer, irrigation and grazing is required to obtain the best returns per unit of land area.

General principles of pasture management are presented below.

1. Orchardgrass seed at 15-20 pounds per acre (with 2-3 pounds of clover or alfalfa) is the main grass species recommended for irrigated pasture in the Kamloops District.

2. Initial fertilizer use should be determined by a soil test prior to seeding.

3. Subsequent fertilization will normally be nitrogen; it is recommended that approximately 50 pounds per acre of nitrogen fertilizer should be applied at monthly intervals throughout the grazing season.

4. Stocking rate varies depending on pasture productivity - productive irrigated pasture in this area should support 2-3 head of yearling cattle for 120- 1 50 days

5. Stock intensity (which is the number of animals per acre at any one time) should be 10 animals per acre or greater to ensure even

utilization of the forage, and to minimize selective grazing.

6. To achieve the recommended stock intensity, pasture subdivision (fencing) is required. Although opinions vary as to the number of pastures required, minimum number recommended to maintain high production is 8 pastures. Fewer than this results in the forage plants being re-grazed too soon, greater numbers of pastures increase fencing costs and require more labour, without necessarily increasing production.

7. Keep grazing management flexible - the grazing rotation time will vary from spring to fall, depending upon the rate of forage growth (fast growth equals fast rotation).

8. Consider supplementary feeding (e.g. grain) when pasture growth slows in late summer, or include annual pastures in the rotation to provide increased grazing in late summer and fall.

9. Match your pasture management system to your livestock requirements - yearling cattle will have different nutritional requirements than cow-calf, therefore different grazing management is required.

EXTENDING THE GRAZING SEASON

GRAZING CORN

Site preparation:

Fall plow if previous crop is perennial forage, or fall spray if planning to no-till. If previous crop was an annual, (e.g. barley, corn etc.), then a minimum amount of spring tillage is recommended, such as 1 or 2 passes with a disc. Time discing to occur just prior to planting for maximum weed control benefits.

Variety Selection:

Many varieties of corn may be used. Initial work in this area was done with Amaizing Graze, a blend of a number of different varieties from the US. The main characteristic of this corn appears to be late maturity. Similar results in yield and quality have been obtained with late maturing silage varieties, which are more readily available.

Planting Methods:

Corn planter, normal row spacing of 30". Modified seed drill, block off every other run for a row spacing of about 15". No-till planter, modified for corn as above; may also require a change in gears to keep corn plant population in the recommended range of about 30,000 plants/acre.

Fertility Management:

Corn has a high nitrogen demand compared to other crops, such as grass/legume mixes or barley. Manure is very beneficial to boost nutrient levels in the soil. Typical nitrogen recommendations call for 100+ lb./acre of actual N. (e.g. 220 lb./acre of 46 0 0). Soil test and fertilize accordingly for P and K.

Weed Control:

Weed control is one of the most critical aspects of corn management. Failure to plan a weed control program is one of the main causes of poor corn production. Ideally, weed control begins the year before by assessing the main weed species present: if perennial weeds, such as couch grass or Canada thistle are present, fall application of Roundup is effective. In the spring, walk your fields before planting to assess weed species and quantity, and be prepared to spray or cultivate to control weed pressure.

Grazing Management and Results:

It is necessary to control livestock access to the corn to reduce waste by trampling. Electric fence can be used successfully. An alley for the electric fence can be make by driving a tractor over the corn to knock it down then placing the fence in the middle of this approximately 2 meter wide alley. This improves visibility of the fence and reduces electrical shorting by keeping corn from contacting the wire. Allow about one week's supply of feed. With good corn growth and management, corn can provide 300 – 400 cow grazing days per acre.

Economics:

A comparison was made of the costs of grazing corn to growing and feeding hay. When all costs are considered, including planting of the corn and feeding out of the hay, (no allowance was made for spreading manure), feeding costs per cow per day:

Hay	Grazing Corn
$1.65	$0.96

CEREAL CROPS FOR SWATH GRAZING

Most of the work on using cereal crops (barley and oats) has been done in Alberta. Locally, a number of producers have tried it, with generally good results. Waste is the primary concern. To minimize waste, some degree of controlled grazing is required, such as electric fence moved regularly. The more frequently moved, the more efficient is the grazing.

Management

As cereal crops require a shorter season than corn, planting date needs to be delayed (e.g. late June-early July) to have the crop at desired stage of growth for fall swathing. Generally, it is best to swath in October; earlier swathing can result in the swaths

spoiling if warm, wet weather occurs in early fall.

Check for nitrate levels any time you swath cereals late in the growing season. Swathed cereals retain nutrient quality quite well under dry, cool conditions, and are readily grazed through snow. Swathing retains quality better than a standing crop, and reduces waste caused by lodging if heavy rain or snow occurs.

SWATH GRAZING-ALFALFA/GRASS

Swath grazing of alfalfa/grass fits into existing production systems better than either corn or cereals, as it does not require annual planting, specialized equipment, etc.

Management

In order to swath graze alfalfa/grass most effectively, you need to start planning for swath grazing in the spring. How you manage the crop throughout the season has an impact on the potential for winter grazing.

As swath grazing eliminates one harvest, the cutting schedule needs to be adjusted. In areas where three crops are normally harvested, only two would be taken with machinery, with the last cut swathed much later, then harvested by the cows. This effectively pushes other harvests later in the season; it also opens up the possibility of spring grazing your hay fields to push the first cut later in the spring. In the Kamloops area, this could mean taking the first cut near the end of June, rather than late May or early June which is normal. The second cut would then be taken in early to mid-August, allowing the crop to grow until the end of the season, typically about mid-October in the southern interior. This allows for 8-10 weeks of growth for the crop that is to be swathed for winter grazing.

Swathing of this crop should be delayed until after the crop is dormant, but before any significant snowfalls are likely. In the Kamloops area, a target date for swathing would be early November. Earlier swathing runs the risk of mild, wet weather which can result in considerable spoilage, while leaving swathing until late November risks snow, or considerable leaf loss due to freezing and thawing. A crop that is swathed around the beginning of November will hold its quality better than a standing crop.

A swathed crop can also reduce losses under snow, compared to a standing crop, which will usually lodge under snow and be less available to grazing livestock.

In the event of heavy snow, or crusting and ice formation, swathed forage will retain quality reasonably well until late winter, when the snow starts to disappear, and can be grazed at this time, providing that the ground is still frozen.

As with other grazed crops, controlling the amount of feed available with electric fence is recommended, as this will help to reduce waste.

Potential advantages of swath grazing

Reduce cost of harvesting (e.g. baling or silaging).

Reduces winter feeding costs and labour during the time the cows are grazing.

Reduces the potential loss of crop quality that often occurs with the typical late summer/early fall harvest due to weather conditions, dew etc. that makes it difficult to dry for hay.

Cattle may be healthier when grazing in a field situation, as compared to a confined winter feeding site.

Manure is spread over the field, reducing costs of spreading, or excess accumulation of manure on a feeding site that may become an environmental risk.

The cutting schedule for swath grazing tends to be "easier" on the perennial plants, as it allows for an extended growth period prior to

the end of the growing season, which generally improves winter hardiness.

Risks

Will reduce the amount of stored feed on hand, however, as the same amount of feed is produced, most or all will be available at some time during the feeding period.

In areas where winters may be mild enough that the ground does not freeze, or the swathed crop must be grazed under mild, wet conditions, damage may occur to the crop by punching or pugging caused by cattle hooves.

Crusted snow or ice can make the swaths difficult to access by stock; however this can be remedied in many cases by driving over the swaths to break the crust, and by having some horses grazing with the cows as they are more effective at pawing through crusted snow.

STOCKPILED FORAGES

Stockpiled forages are similar in management to swath grazing, but without the swathing; livestock graze the standing crop. The best results will come from crops that retain quality well into the winter. Species with good quality after the growing season include tall fescue, creeping red fescue, bluegrass and quack grass; medium quality is retained by orchardgrass, alfalfa and white clover. The bromegrasses (both smooth and meadow bromegrass) and the wheatgrasses tend to be low quality in late fall-winter.

As with swath grazing, to get the most efficient use of stockpiled forage, controlled grazing is recommended. Strip grazing on a daily basis results in the least amount of waste, but may not be practical in all cases. If more than a few days feed is available at one time, the benefits of controlled access diminish, to the point that there may not be enough gain to justify the labour for moving a fence if it is only moved less than once a week. One difference between stockpiled grazing and grazing during the growing season is that there is no re-growth occurring, so no need to worry about re-grazing new growth too soon and stressing the plants, as they are dormant.

Stockpiled forages need to be managed through the grazing season so that they are at an appropriate stage of growth when they stop growing in the fall. Determine the quality of feed required by your livestock and manage the crop accordingly. If grazing is to be done by dry cows in early winter, their nutritional needs are relatively low, so crop quality can be lower, (e.g. more mature), with higher volume. If feeding calves or lactating animals (e.g. fall calvers) then a higher quality feed (less mature) is required. (Refer to the section on cutting management for swath grazing alfalfa/grass for suggestions on when to cut).

WINTER CEREALS

Some preliminary work was conducted in Kamloops on winter cereals (specifically triticale, a cross between winter wheat and fall rye), to assess their potential as forage crops, both as a silage crop during the growing season, and as crops for winter and early spring grazing. Trials included the following:

Spring triticale and winter triticale
Barley and winter triticale
Corn and winter triticale.

Barley alone was also grown as a control or check variety.

In addition, considerable previous information is available on barley and annual ryegrass inter-crop performance.

Results to date only include the silage yields from mid-summer, as well as visual assessment of the re-growth of the winter cereals in the cereal trial, and the growth of the triticale between the corn rows. At this time, the results of growing winter triticale between the corn rows looks promising.

Quality of the triticale in November was very high, (25% CP and 69% TDN), however, the nitrate level in the triticale was also high; some modification of the fertilizer program is necessary. The result of the winter triticale grown in conjunction with the barley or spring triticale was less promising, as late season growth was not sufficient to justify harvesting as silage, but would make high quality fall/winter grazing. These plots will be monitored through to next spring to assess their value for early spring use for just calved cows. Winter cereals probably have some potential for reducing winter feed costs, but more work is required to determine the management required for the best results.

VARIETY SELECTION

ALFALFA VARIETY SELECTION

All forage varieties (and especially alfalfa) change frequently, so specific alfalfa variety recommendations are not included in this manual. For the latest on available varieties, contact your seed retailer and ask for comparative information on the varieties being sold. Another source of information on BC corn and forage variety trails is the website: www.farmwest.com. This site is supported by the Pacific Field Corn Association which is a non-profit society promoting research and education on intensive productions systems for field corn and forages suitable for BC. Important considerations when selecting an alfalfa variety include winter hardiness, disease resistance and yield. This information is available for all certified varieties.

GRASS VARIETY RECOMMENDATIONS

Grass varieties do not change as quickly as alfalfa, so the following information is relevant, but may not include the most recent varieties.

GRASS VARIETY RECOMMENDATIONS

Species	Varieties	Winter[1] Hardiness	Maturity[2]	Comments
Bromegrass, Smooth	Carlton,	5	Medium	Hay types.
	Baylor, Bravo,	5	Medium	Hay types.
	Magna,	5	Early	Pasture type, early spring growth.
	Manchar	5		Good re-growth
	Rebound			
Bromegrass, Meadow	Regar	5	Medium	Suitable for irrigated pasture and hay; early spring growth, better fall growth than smooth brome.
	Fleet			
	Paddock			
Orchardgrass	Amba	3	Medium	Good maturity when grown with alfalfa.
	Chinook	4	Early	Matures too early in alfalfa mix.
	Dactus	3	Medium	
	Frode	3^+	Medium	
	Kay	3^+	Medium Late	Offers good combination of maturity, yield and winter hardiness.
	Mobite	3	Late	Very late maturity, inadequate data to fully evaluate winter hardiness.
	Napier	3^+	Medium	Performs well here.
	Potomac	2	Early	Marginal winter hardiness.
	Arctic	3^+	Medium	
	AC Splendour	3^+	Late	
Tall Fescue	Festorina	3	Intermediate	Good yields, not as hardy as Courtenay
	Barcel	3	Intermediate	Good disease resistance, palatable
	Montebello	3^+		Good winter hardiness
	Courtenay	3^+	Late	High Yields, good winter hardiness. The standard to which others are compared

[1] Grass Winter Hardiness Estimates for Kamloops: 1 – 5 (5 most winter hardy)

[2] Maturity – refers to time required to reach early heading, estimated relative to medium,. Maturity alfalfa varieties:

Early - heads before first flower of alfalfa
Medium - heads approximately same as first flower of alfalfa
Late - heads at full blossom alfalfa

Order seed varieties early. With the numerous varieties available not all are in stock at seed retailers.

GRASS VARIETY RECOMMENDATIONS CON'T.

Species	Varieties	Winter[1] Hardiness	Maturity[2]	Comments
Timothy	Bottnia II	5	Late	High yielding, single cut, hay.
	Champ	5	Med	Early medium maturing variety, short seed heads, good re-growth; pasture type.
	Climax	5	Med – Late	High yielding hay type; long seed heads.
	Farol	5	Late	Latest maturing variety; hay type.
	Richmond	5	Med	Hay or pasture, intermediate maturity between Toro and Climax.
	Salvo	5	Early	Pasture type, good re-growth.
	Timfor	5	Med – Late	High yielding hay type.
	Toro	5	Early	Pasture type, good re-growth.
	Glenmor	5	Med – Late	Hay type.
	Winmor	5	Med – Late	Good disease resistance, hay type.
	Colt	5	Early	Moderate re-growth; excellent hardiness
	Grindstad	5	Medium	Good re-growth
Wheatgrass crested	Fairway	5	Early	Adapted to range and dryland seedings. Short, fine stems; less productive than Nordan or Summit.
	Nordan	5	Early	Tetraploid type, erect growth, good yield.
	Parkway	5	Early	Diploid type, erect; establishes quicker than Nordan or Summit.
	Summit	5	Early	Tetraploid; good yield.
Wheatgrass, Intermediate	Chief	3	Late	High yielding, good mix with alfalfa.
	Clarke	3	Late	Similar yield to Chief, slightly better hardiness.
Wheatgrass, Pubescent	Greenleaf	3+	Late	Similar to intermediate wheatgrass, better adapted to drought and alkaline soils. Palatable to livestock.

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GRASS VARIETY RECOMMENDATIONS CON'T.

Species	Varieties	Winter[1] Hardiness	Maturity[2]	Comments
Reed canarygrass	Palaton	5	Late	Lower alkaloid content and better palatability than Vantage.
	Vantage	5	Late	Low tryptamine; alkaloid content less likely to poison animals than past varieties; high yield.
	Venture	5	Late	Lower alkaloid, higher palatability than Vantage.
Ryegrass, perennial	Numerous varieties	1-2	Early to Late	No reliably winter hardy varieties yet available. Established quickly, high quality forage.
Ryegrass, Italian Italian types 2N = diploid 4N = tetraploid	Lemtal (2N)	N/A	Early	Leafy; excellent pasture variety.
	Maris Ledger (4N)	N/A	Early	More susceptible to over grazing than Lemtal or Barmultra.
	Barmultra			More erect than Lemtal. Satisfactory grazing tolerance.
Ryegrass, annual Westerwold (Not recommended as they set seed very early and have become a weed problem.				

[1] Grass Winter Hardiness Estimates for Kamloops: 1 – 5 (5 most winter hardy)

[2] Maturity – refers to time required to reach early heading, estimated relative to medium,. Maturity alfalfa varieties:

Early - heads before first flower of alfalfa
Medium - heads approximately same as first flower of alfalfa
Late - heads at full blossom alfalfa

Order seed varieties early. With the numerous varieties
Available not all are in stock at seed retailers.

SEEDING RATE RECOMMENDATIONS

One of the most frequent questions that is asked is "How much should I seed?" Although seeding rates are important, especially as they normally represent a significant cash outlay, the ultimate success of a seeding is much more dependent on other factors such as irrigation, fertility and harvest or grazing management.

Seeding rates are expressed in units of weight per unit of area (e.g. kg/ha or lb./acre) but the number of seeds in a given unit of weight varies tremendously (for example alfalfa contains approximately440,000 seed per kg, timothy 2,700,000 seeds per kg). If alfalfa is seeded at 10 pounds per acre this is a density of 46 seeds per square foot; timothy at 10 pounds per acre would have over 2 70 plants per square foot. A medium seeding density is 50 seeds per square foot. Obviously, not all seeds germinate and grow, but in an established alfalfa field, 4 to 5 plants per square foot is normal. It is apparent that following good management practices at seeding time and throughout the establishment year is important to obtain a good stand.

The following seeding rates assume a good seed bed and adequate irrigation and weed control during the establishment season. Higher seeding rates may result in a greater establishment year yield, but research has shown that yield differences are not significant in subsequent years.

Dryland seeding rates are typically lower as fewer plants can be supported by the available moisture.

Kamloops - Forage Seeding Rate Recommendations

		Seeding Rates (lb./ac)	
Precipitation Range	**Species**	**Silage or Hay**	**Pasture**
Non-irrigated			
Under 330mm	Crested wheatgrass	5	5
300-375mm	Crested wheatgrass + alfalfa	6 + 5	6 + 2
Over 375mm	(a) Crested wheatgrass + bromegrass + alfalfa	0 + 0 + 10	3 + 5 + 2
	(b) Bromegrass + alfalfa	0 + 10	8 + 2
Over 450mm sub-irrigated or high water table	(a) Bromegrass + orchardgrass + white clover (low)	4 + 16 + 1	4 + 12 + 1
	(b) Perennial ryegrass + white clover (tall)	15 + 1/2 to 1	
	(c) Timothy + Alsike clover + white clover (tall)	6 + 4 + 1/2 to 1	
Areas subject to flooding	(a) Reed canarygrass + Alsike Clover	10 + 2	
	(b) Meadow foxtail	10 to 15	

Precipitation Range	Species	Seeding Rates (lb/ac) Silage or Hay	Pasture
Irrigated			
	(a) Meadow bromegrass + alfalfa		10 + 2
	(a) Orchardgrass + white clover (tall)		10 to 15 + 1/2 to 1
	(b) Perennial ryegrass + white clover (tall)		20 + 1/2-1
	(c) Alfalfa	10	
	(d) Alfalfa + smooth bromegrass	8 + 4	
	(e) Alfalfa + orchardgrass	8 + 4	2 + 12
	(f) Alfalfa + intermediate wheatgrass	6 + 8	
	(g) Alfalfa + pubescent wheatgrass	6 + 8	
Horse Pasture			
	(a) Orchardgrass + white clover		10 to 15 + 1/2 to 1
	(b) Kentucky bluegrass + white clover		10 + 1/2 to 1

Annual Crops For Hay, Pasture or Silage	Species	Seeding Rates (lb./ac)
	(a) Oats, barley or wheat (alone or mixed)	100
	(b) Double Crop Barley	100
	(c) Barley/Annual Ryegrass	80 + 20 to 30
	(d) Annual or Italian ryegrass	20 to 25
	(e) Field corn (silage only) for var. see field corn recommendations	75,000 to 90,000 seeds/ha
	(f) Sorghum or sorghum-sudangrass hybrids - 18 to 35 cm rows	15 to 30
	(g) Faba beans (silage only) 15 to 20 cm rows	125 to 150
	(h) Fall rye (pasture only)	100
	(i) Spring planted winter wheat	80

Note: (lbs/acre x = kg/ha

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

SUMMARY OF COSTS AND RETURNS

IINCOME	**Alfalfa/Grass Establishment (Year 1)**					**Alfalfa/Grass (Year 2 – 6)**				
	Yield		**Units**	**Per Acre**	**Per Ton**	**Yield**	**Price**	**Units**	**Per Acre**	**Per Ton**
Oat Hay	2.0	80.00	Ton	160.00				Ton		
Alfalfa First Cut	1.0	110.00	Ton	110.00		2.0	110.00	Ton	220.00	
Alfalfa Second Cut		110.00	Ton			1.5	110.00	Ton	165.00	
Total Income	3.0			**270.00**	**90.00**	3.5			**385.00**	**110.00**
DIRECT COSTS			**Units**					**Units**		
Supplies and Materials	**Quantity**	**Cost/ Unit**	**Used**	**Cost/Ac**		**Quantity**	**Cost/ Unit**	**Used**	**Cost/Ac**	
Certified Seed: Alfalfa	8.0	3.25	Lbs.	26.00		0.0	0.00	Lbs.	0.00	
: Orchard Grass	4.0	2.60	Lbs.	10.40		0.0	0.00	Lbs.	0.00	
: Bromegrass	2.0	1.90	Lbs.	3.80		0.0	0.00	Lbs.	0.00	
: Oats	60.0	0.22	Lbs.	12.93		0.0	0.00	Lbs.	0.00	
Fertilizer: 11 52 00	100.0	0.22	Lbs.	21.82		100.0	0.22	Lbs.	21.82	
: 46 00 00	100.0	0.18	Lbs.	18.38		0.0	0.18	Lbs.	0.00	
Twine	3.0	1.92	ton of hay	5.77		3.5	1.92	ton of hay	6.73	
Irrigation Power	5.0	2.40	Time	12.00		5.0	2.40	Time	12.00	
Total Supplies and Materials				**111.10**					**40.55**	
Fuel & Lube Costs				20.63					9.53	
Machine Repairs				32.08					19.27	
Total Direct Costs				**163.82**	**54.61**				**69.35**	**19.82**
Contribution Margin				**106.18**	**35.39**				**315.65**	**90.18**
INDIRECT COSTS										
Depreciation Buildings & Equipment				76.13	25.38				76.13	21.75
Labour				39.12	13.04				25.25	7.21
Total Indirect Costs				**115.25**	**38.42**				**101.37**	**28.96**
Total Direct and Indirect Costs				**279.07**	**93.02**				**170.73**	**48.78**
Gross Operating Profit				**-9.07**	**-3.02**				**214.27**	**61.22**
OPPORTUNITY COSTS										
Interest on Direct Costs				6.55	2.18				2.77	0.79
Land Rental Cost				60.00	20.00				60.00	17.14
Interest on Buildings & Equipment				86.90	28.97				86.90	24.83
Total Opportunity Costs				**153.45**	**51.15**				**149.67**	**42.76**
TOTAL ECONOMIC COSTS				**432.52**	**144.17**				**320.40**	**91.54**

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

AVERAGE PRODUCTION COSTS FOR ALL YEARS

REVENUE	Average Six Years		
	Yield	Per Acre	Per Ton
Oat Hay	0.33	26.67	80.00
Alfalfa First Cut	1.83	201.67	110.00
Alfalfa Second Cut	1.25	137.50	110.00
Total Revenue	3.42	**365.83**	**107.07**
DIRECT COSTS			
Seed		6.70	1.96
Fertilizer		24.89	7.28
Twine		6.57	1.92
Irrigation		12.00	3.51
Total Supplies and Materials		52.31	15.31
Fuel & Lube Costs		11.38	3.33
Machine Repairs		21.41	6.27
Total Direct Costs		**85.10**	**24.91**
Contribution Margin		**280.74**	**82.17**
INDIRECT COSTS			
Depreciation Buildings & Equipment		76.13	22.28
Labour		27.56	8.07
Total Indirect Costs		**103.69**	**30.35**
Total Direct and Indirect Costs		**188.78**	**55.25**
Gross Operating Profit		**177.05**	**51.82**
OPPORTUNITY COSTS			
Interest on Direct Costs		3.40	1.00
Land Rental Cost		60.00	17.56
Interest on Buildings & Equipment		86.90	25.43
Total Opportunity Costs		**150.30**	**43.99**
TOTAL ECONOMIC COSTS		**339.09**	**99.25**

Cost Per Ton of Hay Produced

		Acres of Hay Production Year				
		100	150	200	250	300
Yield/ Acre	2.5	151.24	128.69	117.83	111.65	107.80
	3.0	131.34	111.92	102.57	97.25	93.93
	3.5	116.29	99.25	91.03	86.36	83.45
	4.0	104.52	89.32	82.00	77.83	75.24
	4.5	95.05	81.35	74.74	70.98	68.64

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

ALFALFA/GRASS ESTABLISHMENT (Year 1)

OPERATIONS TABLE

Production 30 **Acres**

OPERATION DESCRIPTION		MACHINE NUMBER	Times Done	Acres per Hour Machine	Acres per Hour Labour	Per Acre Machine Costs Repair	Per Acre Machine Costs Fuel	Hours Labour	Labour Cost	TOTAL Operating Cost
Plowing	2	4	1	1.20 ac/hr	1.20 ac/hr	7.18	6.12	0.83	8.33	21.63
Discing	2	5	2	5.00 ac/hr	5.00 ac/hr	3.42	2.94	0.40	4.00	10.35
Harrowing	1	6	2	18.00 ac/hr	18.00 ac/hr	0.38	0.62	0.11	1.11	2.11
						0.00	0.00	0.00	0.00	0.00
Seed & Fert	1	8	1	4.50 ac/hr	4.50 ac/hr	1.57	1.23	0.22	2.22	5.03
Irrigating	14		5.0	0.73 ac/hr	5.30 ac/hr	6.16	0.00	0.94	9.43	15.60
Swathing/Conditioning	1	10	2	5.50 ac/hr	5.50 ac/hr	3.53	2.02	0.36	3.64	9.18
Raking	1	11	2	5.50 ac/hr	5.50 ac/hr	1.69	2.02	0.36	3.64	7.35
Baling first cut	2	12	1	4.00 ac/hr	4.00 ac/hr	3.76	1.83	0.25	2.50	8.09
Baling second cut	2	12	1	8.00 ac/hr	8.00 ac/hr	1.88	0.92	0.13	1.25	4.04
						0.00	0.00	0.00	0.00	0.00
				Total hours per operation						
Stacking first cut	2	13	1	6.00 hrs	6.00 hrs	1.26	1.47	0.20	2.00	4.73
Stacking second cut	2	13	1	3.00 hrs	3.00 hrs	1.26	1.47	0.10	1.00	3.73
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
					TOTAL COSTS	**32.08**	**20.63**	**3.91**	**39.12**	**91.84**

	Repair	Fuel	Total
Preharvest	18.71	10.90	29.61
Harvest	13.37	9.73	23.10
Harvest / Ton	4.46	3.24	7.70

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

ALFALFA/GRASS ESTABLISHMENT (Year 2 – 6)

OPERATIONS TABLE

Production 150 Acres

OPERATION DESCRIPTION		MACHINE NUMBER	Times Done	Acres per Hour Machine	Acres per Hour Labour	Per Acre Machine Costs Repair	Fuel	Hours Labour	Labour Cost	TOTAL Operating. Cost
Fertilizer Application	2	13	1	15.00 ac/hr	15.00 ac/hr	0.42	0.49	0.07	0.67	1.58
Irrigating	14		5	0.73 ac/hr	5.30 ac/hr	6.16	0.00	0.94	9.43	15.60
						0.00	0.00	0.00	0.00	0.00
Swathing/Conditioning	1	10	2	5.50 ac/hr	5.50 ac/hr	3.53	2.02	0.36	3.64	9.18
Raking	1	11	2	5.50 ac/hr	5.50 ac/hr	1.69	2.02	0.36	3.64	7.35
Baling first cut	1	12	1	4.00 ac/hr	4.00 ac/hr	3.01	1.39	0.25	2.50	6.89
Baling second cut	1	12	1	5.33 ac/hr	5.33 ac/hr	2.25	1.04	0.19	1.88	5.17
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
				Total hours per operation						
Stacking first cut	2	13	1	30.00 hrs	30.00 hrs	1.26	1.47	0.20	2.00	4.73
Stacking second cut	2	13	1	22.50 hrs	22.50 hrs	0.95	1.10	0.15	1.50	3.55
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
					TOTAL COSTS	**19.27**	**9.53**	**2.52**	**25.25**	**54.05**

		Repair	Fuel	Total	Labour	Ttl Harvest
	Pre Harvest	6.58	0.49	7.07	10.10	17.17
First Cut	Swathing & raking	2.61	2.02	4.63	3.64	8.27
	Baling & Stacking	4.27	2.86	7.12	4.50	11.62
	Baling & Stacking / Ton	2.13	1.43	3.56	2.25	5.81
	Harvesting Cost Per Acre	6.88	4.88	11.75	8.14	19.89
Second Cut	Swathing & raking	2.61	2.02	4.63	3.64	8.27
	Baling & Stacking	3.20	2.14	5.34	3.38	8.72
	Baling and Stacking / Ton	2.13	1.43	3.56	2.25	5.81
	Harvesting Cost Per Acre	5.81	4.16	9.97	7.01	16.98
	Total Cost Per Acre	19.27	9.53	28.80	25.25	54.05

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

ASSUMPTIONS AND PRICE DATA – January 2002

	Alfalfa/Grass Establishment				Alfalfa/Grass			
RETURNS	**Yield**	**Price**	**Unit**	**Return**	**Yield**	**Price**	**Unit**	**Return**
Oat Hay	2.0	80.00	Ton	160.00				0.00
Alfalfa First Cut	1.0	110.00	Ton	110.00	2.0	110.00	Ton	220.00
Alfalfa Second Cut		110.00	Ton		1.5	110.00	Ton	165.00
TOTAL RETURNS	3.0	90.00		270.00	3.5	110.00		385.00

DIRECT COSTS

Supplies & Materials	**Purchase Price**			**Units**	**Alfalfa/Grass Establishment**			**Alfalfa Grass**		
Item	**Quantity**	**Unit**	**Price**	**Used**	**Quantity**	**Cost/ Unit**	**Cost/Ac**	**Quantity**	**Cost/Unit**	**Cost/Ac**
Certified Seed: Alfalfa	1	Lb.	3.25	Lbs.	8.0	3.25	26.00			0.00
: Orchard Grass	1	Lb.	2.60	Lbs.	4.0	2.60	10.40			0.00
: Bromegrass	1	Lb.	1.90	Lbs.	2.0	1.90	3.80			0.00
: Oats	1	Lb.	0.22	Lbs.	60	0.22	12.93			0.00
Fertilizer: 11 52 00	1	tonne	481.00	Lbs.	100.0	0.22	21.82	100.0	0.22	21.82
: 46 00 00	1	tonne	405.00	Lbs.	100.0	0.18	18.38	0.0	0.18	0.00
Twine	1	Bale	25.00	ton of hay	3.0	1.92	5.77	3.5	1.92	6.73
Irrigation Power	1	$/irrigation	2.40	Time	5.0	2.40	12.00	5.0	2.40	12.00
TOTAL	**Supplies and Materials**						**111.10**			**40.55**

OTHER COSTS

Land Taxes	: Per Acre	12.00
Hired Labor Cost	: Per Hour	10.00
INTEREST COSTS	: Operating Capital	8.00%
	: Buildings & Equip	8.00%
LAND	: Land Rental Cost	60.00
	: Value per acre	1000

BUILDINGS	**Size**	**Cost Sq. Ft.**	**Total Cost**	**Allotted To Crops**
Hay Shed	3500	7.20	25200	100%
Workshop	750	25.00	18750	50%
Machine Storage	1500	12.00	18000	50%

POWERED EQUIPMENT

Tractor	**Data**	**------ FUEL ------**	
No.	H.P.	Factor	Cost / lt.
#1	53 hp	0.215	0.424
#2	70 hp	0.215	0.424
#3		0.215	0.424
Pick up	Litre/Hr.	8	0.43
Truck	Litre/Hr.	30	0.43
Equip	Litre/Hr.		0.43

KAMLOOPS ALFALFA/GRASS PRODUCTION – 2 CUT ROUND BALE

MACHINERY COMPLEMENT SET

MACHINE LIST: NO.			Replacement Value	Current Value Total	Crops	Depreciation Rate	Annual Depreciation	Cost per Hour Repair Code	Cost per Hour Operating Repair	Cost per Hour Fuel
									0	0
1	Tractor #1	53 hp	25,000	16,250	8,125	10.0%	813	1.0	2.50	5.56
2	Tractor #2	70 hp	55,000	35,750	17,875	10.0%	1,788	1.0	5.50	7.34
3	Tractor #3		0	0	0	10.0%	0	1.0	0.00	0.00
4	Plow 3 btm		8,000	5,200	5,200	5.0%	260	3.9	3.12	
5	Disc 10 ft		16,000	10,400	10,400	5.0%	520	1.9	3.04	
6	Harrows 30 ft		3,000	1,950	1,950	10.0%	195	3.0	0.90	
7	Fertilizer Spreader		4,000	2,600	2,600	10.0%	260	10.0	4.00	
8	Drill 10 ft		12,000	7,800	7,800	7.0%	546	3.8	4.56	
9	Manure Spreader		7,500	4,875	4,875	5.0%	244	2.5	1.88	
10	Swather /Conditioner		20,000	13,000	13,000	10.0%	1,300	3.6	7.20	
11	Rotary Rake		6,000	3,900	3,900	7.0%	273	3.6	2.16	
12	Baler Round		28,000	18,200	18,200	10.0%	1,820	3.4	9.52	
13	Bale Wagon		4,000	2,600	2,600	10.0%	260	2.0	0.80	
14	Irrigation system		90,000	58,500	58,500	5.0%	2,925	0.1	0.90	
15					0		0		0.00	
16					0	10.0%	0		0.00	
17	Pick up		35,000	15,000	7,500	10.0%	750	3.0	10.50	3.44
18	Truck				0	10.0%	0	3.0	0.00	12.90
19	Equip				0		0		0.00	0.00
20	Small tools		5,000	2,000	2,000	10.0%	200	0.0	0.00	
21	Hay Shed		25,200	20,000	20,000	5.0%	1,000	0.0	0.00	
22	Workshop		18,750	12,000	6,000	5.0%	300	0.0	0.00	
23	Machine Storage		18,000	10,000	5,000	5.0%	250	0	0.00	
	Current Investment =			240,025	195,525	**Depreciation**	13,703			
	Equipment			198,025	164,525	Equipment	12,153			
	Buildings			42,000	31,000	Buildings	1,550			
	Total Cultivated Acres				180					
	Investment Per Acre				1,086	Deprec. Per Acre	76			

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

SUMMARY OF COSTS AND RETURNS

INCOME	**Alfalfa/Grass Establishment (Year 1)**					**Alfalfa/Grass (Year 2 – 6)**				
	Yield		**Units**	**Per Acre**	**Per Ton**	**Yield**	**Price**	**Units**	**Per Acre**	**Per Ton**
Oat Hay / First Cut	2.0	80.00	Ton	160.00		2.0	110.00	Ton	220.00	
Alfalfa Second Cut	1.5	100.00	Ton	150.00		1.5	120.00	Ton	180.00	
Alfalfa Third Cut		100.00	Ton			1.5	120.00	Ton	180.00	
Total Income	3.5			**310.00**	**88.57**	5.0			**580.00**	**116.00**
DIRECT COSTS			**Units**					**Units**		
Supplies and Materials	**Quantity**	**Cost/ Unit**	**Used**	**Cost/Ac**		**Quantity**	**Cost/ Unit**	**Used**	**Cost/Ac**	
Certified Seed: Alfalfa	8.0	3.25	Lbs.	26.00		0.0	0.00	Lbs.	0.00	
: Orchard Grass	4.0	2.60	Lbs.	10.40		0.0	0.00	Lbs.	0.00	
: Bromegrass	2.0	1.90	Lbs.	3.80		0.0	0.00	Lbs.	0.00	
:Oats	60.0	0.22	Lbs.	12.93		0.0	0.00	Lbs.	0.00	
Fertilizer: 11 52 00	100.0	0.22	Lbs.	21.82		150.0	0.22	Lbs.	32.74	
: 46 00 00	200.0	0.18	Lbs.	36.75		0.0	0.18	Lbs.	0.00	
Twine	3.5	1.92	ton of hay	6.73		5.0	1.92	ton of hay	9.62	
Irrigation Power	8.0	2.40	Time	19.20		8.0	2.40	Time	19.20	
Total Supplies and Materials				**137.64**					**61.55**	
Fuel & Lube Costs				21.09					13.69	
Machine Repairs				36.71					26.28	
Total Direct Costs				**195.44**	**55.84**				**101.53**	**20.31**
Contribution Margin				**114.56**	**32.73**				**478.47**	**95.69**
INDIRECT COSTS										
Depreciation Buildings & Equipment				77.93	22.27				77.93	15.59
Labour				45.91	13.12				34.15	6.83
Total Indirect Costs				**123.84**	**35.38**				**112.08**	**22.42**
Total Direct and Indirect Costs				**319.28**	**91.22**				**213.61**	**42.72**
Gross Operating Profit				**-9.28**	**-2.65**				**366.39**	**73.28**
OPPORTUNITY COSTS										
Interest on Direct Costs				7.82	2.23				4.06	0.81
Land Rental Cost				90.00	25.71				90.00	18.00
Interest on Buildings & Equipment				88.34	25.24				88.34	17.67
Total Opportunity Costs				**186.16**	**53.19**				**182.41**	**36.48**
TOTAL ECONOMIC COSTS				**505.44**	**144.41**				**396.01**	**79.20**

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

AVERAGE PRODUCTION COSTS FOR ALL YEARS

REVENUE	Average Six Years Yield	Per Acre	Per Ton
Oat Hay / First Cut	2.00	210.00	105.00
Alfalfa Second Cut	1.50	175.00	116.67
Alfalfa Third Cut	1.25	150.00	120.00
Total Revenue	4.75	**535.00**	**112.63**
DIRECT COSTS			
Seed		6.70	1.41
Fertiliser		37.04	7.80
Twine		9.13	1.92
Irrigation		19.20	4.04
Total Supplies and Materials		74.23	15.63
Fuel & Lube Costs		14.93	3.14
Machine Repairs		28.02	5.90
Total Direct Costs		**117.18**	**24.67**
Contribution Margin		**417.82**	**87.96**
INDIRECT COSTS			
Depreciation Buildings & Equipment		77.93	16.41
Labour		36.11	7.60
Total Indirect Costs		**114.04**	**24.01**
Total Direct and Indirect Costs		**231.22**	**48.68**
Gross Operating Profit		**303.78**	**63.95**
OPPORTUNITY COSTS			
Interest on Direct Costs		4.69	0.99
Land Rental Cost		90.00	18.95
Interest on Buildings & Equipment		88.34	18.60
Total Opportunity Costs		**183.03**	**38.53**
TOTAL ECONOMIC COSTS		**414.25**	**87.21**

Cost Per Ton of Hay Produced

Yield// Acre	Acres of Hay Production Year 100	150	200	250	300
2.5	165.32	149.16	140.03	134.32	130.53
3.0	145.88	130.07	121.29	115.84	112.23
3.5	130.72	115.53	107.21	102.08	98.68
4.0	118.56	104.08	96.24	91.42	88.25
4.5	108.60	94.83	87.45	82.94	79.97

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

ALFALFA/GRASS ESTABLISHMENT (Year 1)

OPERATIONS TABLE

Production 30 Acres

OPERATION DESCRIPTION		MACHINE NUMBER	Times Done	Acres per Hour Machine	Acres per Hour Labour	Per Acre Machine Costs Repair	Per Acre Machine Costs Fuel	Hours Labour	Labour Cost	TOTAL Operating Cost
Plowing	2	4	1	1.20 ac/hr	1.20 ac/hr	7.18	6.12	0.83	8.33	21.63
Discing	2	5	2	5.00 ac/hr	5.00 ac/hr	3.42	2.94	0.40	4.00	10.35
Harrowing	1	6	2	18.00 ac/hr	18.00 ac/hr	0.38	0.62	0.11	1.11	2.11
						0.00	0.00	0.00	0.00	0.00
Seed & Fert	1	8	1	4.50 ac/hr	4.50 ac/hr	1.57	1.23	0.22	2.22	5.03
Irrigating	14		8	0.73 ac/hr	5.30 ac/hr	9.86	0.00	1.51	15.09	24.96
Swathing/Conditioning	1	10	2	5.50 ac/hr	5.50 ac/hr	3.53	2.02	0.36	3.64	9.18
Raking	1	11	2	5.50 ac/hr	5.50 ac/hr	1.69	2.02	0.36	3.64	7.35
Baling first cut	2	12	1	4.00 ac/hr	4.00 ac/hr	3.25	1.83	0.25	2.50	7.58
Baling second cut	2	12	1	5.33 ac/hr	5.33 ac/hr	2.43	1.38	0.19	1.88	5.68
				Total hours per operation						
Stacking first cut	2	13	1	6.00 hrs	6.00 hrs	1.70	1.47	0.20	2.00	5.17
Stacking second cut	2	13	1	4.50 hrs	4.50 hrs	1.70	1.47	0.15	1.50	4.67
						0.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
				TOTAL COSTS		**36.71**	**21.09**	**4.59**	**45.91**	**103.71**

	Repair	Fuel	Total
Preharvest	22.41	10.90	33.31
Harvest	12.60	8.72	21.32
Harvest / Ton	3.60	2.49	6.09

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

ALFALFA/GRASS ESTABLISHMENT (Year 2 – 6)

OPERATIONS TABLE

Production 150 **Acres**

OPERATION DESCRIPTION		MACHINE NUMBER	Times Done	Acres per Hour Machine	Acres per Hour Labour	Per Acre Machine Costs Repair	Fuel	Hours Labour	Labour Cost	TOTAL Operating Cost
Fertilizer Application	2	13	1	15.00 ac/hr	15.00 ac/hr	0.57	0.49	0.07	0.67	1.72
Irrigating	14		6	0.73 ac/hr	5.30 ac/hr	7.40	0.00	1.13	11.32	18.72
						0.00	0.00	0.00	0.00	0.00
Swathing/Conditioning	1	10	3	5.50 ac/hr	5.50 ac/hr	5.29	3.03	0.55	5.45	13.78
Raking	1	11	3	5.50 ac/hr	5.50 ac/hr	2.54	3.03	0.55	5.45	11.03
Baling first cut	1	12	1	4.00 ac/hr	4.00 ac/hr	2.50	1.39	0.25	2.50	6.38
Baling second cut	1	12	1	5.33 ac/hr	5.33 ac/hr	1.87	1.04	0.19	1.88	4.79
Baling third cut	1	12	1	5.33 ac/hr	5.33 ac/hr	1.87	1.04	0.19	1.88	4.79
				Total hours per operation						
Stacking first cut	2	13	1	30.00 hrs	30.00 hrs	1.70	1.47	0.20	2.00	5.17
Stacking second cut	2	13	1	22.50 hrs	22.50 hrs	1.28	1.10	0.15	1.50	3.88
Stacking third cut	2	13	1	22.50 hrs	22.50 hrs	1.28	1.10	0.15	1.50	3.88
						0.00	0.00	0.00	0.00	0.00
					TOTAL COSTS	**26.28**	**13.69**	**3.41**	**34.15**	**74.12**

		Repair	Fuel	Total	Labour	TOTAL Operating.
	Pre Harvest	7.96	0.49	8.45	11.99	20.44
First Cut	Swathing & raking	2.61	2.02	4.63	3.64	8.27
	Baling & Stacking	4.20	2.86	7.05	4.50	11.55
	Baling & Stacking / Ton	2.80	1.90	4.70	3.00	7.70
	Harvesting Cost Per Acre	6.81	4.88	11.68	8.14	19.82
Second and Third	Swathing & raking	2.61	2.02	4.63	3.64	8.27
Cost Per Cut	Baling & Stacking	3.15	2.14	5.29	3.38	8.66
	Baling and Stacking / Ton	2.10	1.43	3.53	2.25	5.78
	Harvesting Cost Per Acre	5.76	4.16	9.92	7.01	16.93
	Total Cost Per Acre	26.28	13.69	39.98	34.15	74.12

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

ASSUMPTIONS AND PRICE DATA – JANUARY 2002

	Alfalfa/Grass Establishment				Alfalfa/Grass			
RETURNS	**Yield**	**Price**	**Unit**	**Return**	**Yield**	**Price**	**Unit**	**Return**
Oat Hay / First Cut	2.0	80.00	Ton	160.00	2.0	110.00	Ton	220.00
Alfalfa Second Cut	1.5	100.00	Ton	150.00	1.5	120.00	Ton	180.00
Alfalfa Third Cut		100.00	Ton		1.5	120.00	Ton	180.00
TOTAL RETURNS	3.5	88.57		310.00	5.0	116.00		580.00

DIRECT COSTS

Supplies & Materials	**Purchase Price**			**Units**	**Alfalfa/Grass Establishment**			**Alfalfa/Grass**		
Item	**Quantity**	**Unit**	**Price**	**Used**	**Quantity**	**Cost/ Unit**	**Cost/Ac**	**Quantity**	**Cost/Unit**	**Cost/Ac**
Certified Seed: Alfalfa	1	Lb.	3.25	Lbs.	8.0	3.25	26.00			0.00
: Orchard Grass	1	Lb.	2.60	Lbs.	4.0	2.60	10.40			0.00
: Bromegrass	1	Lb.	1.90	Lbs.	2.0	1.90	3.80			0.00
:Oats	1	Lb.	0.22	Lbs.	60	0.22	12.93			0.00
Fertilizer: 11 52 00	1	tonne	481.00	Lbs.	100.0	0.22	21.82	150.0	0.22	32.74
: 46 00 00	1	tonne	405.00	Lbs.	200.0	0.18	36.75		0.18	0.00
Twine	1	Bale	25.00	ton of hay	3.5	1.92	6.73	5.0	1.92	9.62
Irrigation Power	1	$/irrigation	2.40	Time	8.0	2.40	19.20	8.0	2.40	19.20
TOTAL	**Supplies and Materials**						**137.64**			**61.55**

OTHER COSTS

Land Taxes	: Per Acre	12.00
Hired Labor Cost	: Per Hour	10.00
INTEREST COSTS	: Operating Capital	8.00%
	: Buildings & Equip	8.00%
LAND	: Land Rental Cost	90.00
	: Value per acre	1800

BUILDINGS	**Size**	**Cost Sq. Ft.**	**Total Cost**	**Alloted To Crops**
Hay Shed	3500	7.20	25200	100%
Workshop	750	25.00	18750	50%
Machine Storage	1500	12.00	18000	50%

POWERED EQUIPMENT

Tractor	**Data**	**------ Fuel ------**	
No.	**H.P.**	**Factor**	**Cost / lt.**
#1	53 hp	0.215	0.424
#2	70 hp	0.215	0.424
#3		0.215	0.424
Pick up	Litre/Hr.	8	0.43
Truck	Litre/Hr.	30	0.43
Equip	Litre/Hr.		0.43

KAMLOOPS ALFALFA/GRASS PRODUCTION – 3 CUT SQUARE BALE

MACHINERY COMPLEMENT SET

MACHINE LIST: NO.			Replacement Value	Current Value Total	Crops	Deprec. Rate	Annual Deprec	Cost per Hour Repair Code	Operating Repair	Fuel
0									0	0
1	Tractor #1	53 hp	25,000	16,250	8,125	10.0%	813	1.0	2.50	5.56
2	Tractor #2	70 hp	55,000	35,750	17,875	10.0%	1,788	1.0	5.50	7.34
3	Tractor #3		0	0	0	10.0%	0	1.0	0.00	0.00
4	Plow 3 btm		8,000	5,200	5,200	5.0%	260	3.9	3.12	
5	Disc 10 ft		16,000	10,400	10,400	5.0%	520	1.9	3.04	
6	Harrows 30 ft		3,000	1,950	1,950	10.0%	195	3.0	0.90	
7	Fertilizer Spreader		4,000	2,600	2,600	10.0%	260	10.0	4.00	
8	Drill 10 ft		12,000	7,800	7,800	7.0%	546	3.8	4.56	
9	Manure Spreader		7,500	4,875	4,875	5.0%	244	2.5	1.88	
10	Swather /Conditioner		20,000	13,000	13,000	10.0%	1,300	3.6	7.20	
11	Rotary Rake		6,000	3,900	3,900	7.0%	273	3.6	2.16	
12	Baler Small Square		22,000	14,300	14,300	10.0%	1,430	3.4	7.48	
13	Bale Wagon		15,000	9,750	9,750	10.0%	975	2.0	3.00	
14	Irrigation system		90,000	58,500	58,500	5.0%	2,925	0.1	0.90	
15					0		0		0.00	
16					0		0		0.00	
17	Pick up		35,000	15,000	7,500	10.0%	750	3.0	10.50	3.44
18	Truck				0	10.0%	0	3.0	0.00	12.90
19	Equip				0		0		0.00	0.00
20	Small tools		5,000	2,000	2,000	10.0%	200	0.0	0.00	
21	Hay Shed		25,200	20,000	20,000	5.0%	1,000	0.0	0.00	
22	Workshop		18,750	12,000	6,000	5.0%	300	0.0	0.00	
23	Machine Storage		18,000	10,000	5,000	5.0%	250	0	0.00	
	Current Investment	=		243,275	198,775	**Depreciation**	14,028			
	Equipment			201,275	167,775	Equipment	12,478			
	Buildings			42,000	31,000	Buildings	1,550			
	Total Cultivated Acres				180					
	Investment Per Acre				1,104	Depr Per Acre	78			