NEW HOLLAND AGRICULTURE

Alfalfa

PRODUCTION GUIDELINES

CROP HANDBOOK

Alfalfa

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Foreword

Alfalfa is the most cultivated forage legume in the world. Worldwide production was around 436 million tons in 2006. In 2009, Alfalfa was grown on approximately 30 million hectares worldwide; of this North America produced 41% (11.9 million hectares), Europe produced 25% (7.12 million hectares), South America produced 23% (7 million hectares), Asia produced 8% (2.23 million hectares), and Africa and Oceania produced the remainder. The US was the largest Alfalfa producer in the world by area in 2009, with 9 million hectares, but considerable production area is found in Argentina (6.9 million hectares), Canada (2 million hectares), Russia (1.8 million hectares), Italy (1.3 million hectares), and China (1.3 million hectares).

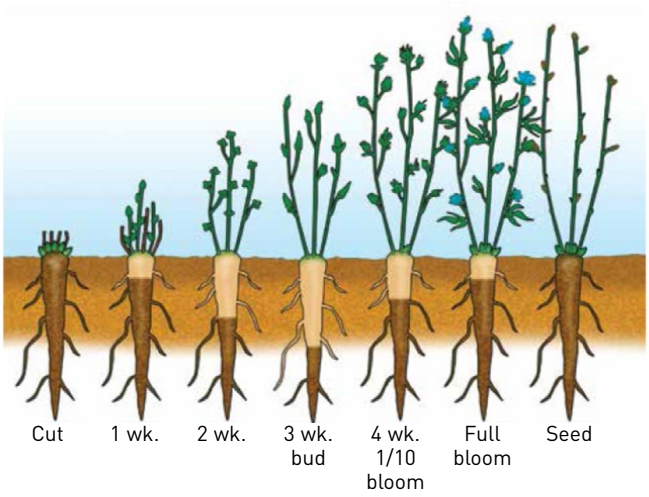
Alfalfa is considered the excellence legume forage crop all around the world. Productivity, longevity, easy processing and conservation, nutritional value of fodder and hay and positive action on structure and fertility of soil make Alfalfa the most important legume forage crop.

Alfalfa can be used as hay, silage, pasture (together with other forage grasses plants) and dehydrated flour or pellet as protein concentrate for cattle.

Production Guidelines

ALFALFA	
OPERATIONS	**AGRONOMICS AND TIMING**
Crop rotation	Can be planted in rotation with any crop except sugar beet following Alfalfa (sprouting problems). No monoculture Useful period of standing 5-6 years
Primary tillage	Conventional tillage (35cm. Depth) Minimum tillage (15cm. Depth max) - Plough - Chisel - Heavy cultivator No-tillage
Secondary tillage	Power harrows, spike harrows, light field cultivators
Planting (Northern Hemisphere)	
Timing	Two planting seasons Spring: Mid-March to Mid-May Summer: from August to September Minimal temp. 8°C, seeding before periods of cool most weather preferred
Population at harvest	500 stems per square meter
Row Spacing	18-33cm
Quantity of seeds	25-35kg/Ha (dependent on field germination)
Depth	1-2cm
Fertilizing (guidelines, to be adjusted on soil analysis base)	
Nitrogen (N) kg/ha	30kg/ha to assist germination and initial growth. No N required after
Phosphorus (P_2O_5) kg/ha	During primary tillage, about 200kg/ha. Then about 100-150kg/ha/year No Phosphorus applications required if soils has high residual P
Potash (K_2O) kg/ha	During primary tillage, about 200kg/ha. Then about 150kg/ha/year
Weed control	Spraying
Pest control	Spraying
Harvesting	First cutting is performed based on bud development. Subsequent cuttings performed when 10%-15% of plants blooming

SEASONAL CARBOHYDRATES ROOT RESERVE



Reserve organs of plant are the crown and the upper part of the taproots.

Stored carbohydrates in taproots are necessary for rapid regrowth, winter survival, and root-rot resistance. This illustration shows the changes occuring as a result of regrowth after cutting. The darker area of the taproot represents the approximate carbohydrate level.

Source: NCR-184, Alfalfa Diseas in the Midwest

Plant Stages and Environment Requirements

Alfalfa is a legume perennial plant, with a powerful root system which can reach several meters in depth, stems are 90-100 centimeters tall and they sprout from the basal portion of the plant (crown). Leaves are trifoliate, flowers are united in racemes, color is from violet to yellow, fruits are pods spiral-like. Seeds are yellow brownish, very small, about 500 seeds in a gram. Main growth stages are: Germination, is a biochemical process by which reserve compounds as sugars and proteins are transferred from cotyledons to embryo, which evolves in seedling: cotyledons, as in all legume, are pulled out of soil. First knot is formed above cotyledons and then the first leaf appears. At this stage, the plant begins photosynthesis and is not more dependent on seeds reserves. Moisture and water are critical for germination as well as a proper soil texture in order to avoid crust formation, which hinder the emergence of cotyledons out of soil. Vegetative growth Defined below are the stages of Alfalfa growth (adapted from Alfalfa Management / Diagnostic Guide, 1990, Pioneer Hi-Breed International).

Early vegetative. Stem length measures 0–15 centimeters. No buds, flowers, or seed pods are present.
Mid-vegetative. Stem length measures 15-30 centimeters. No buds, flowers, or seed pods are present.
Late vegetative. Stem length is greater than 30 centimeters, depending on the variety or current growing conditions. No buds, flowers, or seed pods are present.

Early-bud. One node (where branches extend from main stems) per stem will have a small, tight bud. Buds appear as irregularly shaped vegetative masses found at the tip of stems and branches. At this stage, the plant is all green with no flower color showing. It will take approximately 3 to 6 days to reach the next stage, so called mid-bud.
Mid-bud. Stems average 2 nodes with visible buds. The most mature buds begin to open so individual flowers may be easily distinguished, appearing as tiny, green fingers. However, no flower color is visible. It will take approximately 3 to 6 days to reach the next stage, late-bud.
Late-bud. Stems will average 3 or more nodes with visible buds. Although no flowers are open, a tinge of purple color can be spotted at the tips of the most mature buds. It will take approximately 2 to 4 days to reach the next stage, first flower.
First flower. An occasional open flower, less than 10 per 100 stems, can be found. It will take approximately 1 to 2 days to reach the next stage, 10% bloom.
10% bloom. Flowers can be found on 10 of 100 stems.
Full bloom. Stems will average 2 or more nodes with open flowers. No seed pods are present.

Alfalfa is resistant to drought, salinity, and alkalinity, but it is very sensible to ponding and acidity; so, monitoring and managing these soil characteristics is important to obtain satisfactory yields.

For growth, minimal temperature is 5°C: above 35°C alfalfa stops growing. During winter, the crop endures frost up to -20°C. In fertile soils, alfalfa is one of the most productive forage crop and his products have is also high nutritive qualities.

STAGE	NAME	DESCRIPTION
0	**Early vegetative**	Length of stems less than 15cm, no flower bud, or flower or pod
1	**Middle vegetative**	Length of stems between 15 and 30cm, no flower bud, flower or pod
2	**Late vegetative**	Length of stems more than 30cm; no flower bud, flower or pod
3	**First flower bud**	Flower buds present on one or more nodes; no flower or pod
4	**Pre flowering**	Flower buds are present on three nodes or more, no flower or pod
5	**Beginning flowering**	One node presents an open flower; no pod
6	**Full flowering**	Two or more nodes have open flowers, no pod
7	**Beginning pod formation**	Between one and three node present green pods
8	**End pod formation**	Four or more nodes with green pods
9	**Seeds' maturation**	Most of nodes present brown pods

Development chart (Kale and Fick)

Crop Rotation and Nitrogen Synthesis

- Alfalfa residue improves the structure of soil: roots are deep and they can improve soil structure and capacity for water and air. Content in Nitrogen improves, because N is fixed in soil by bacteria hosted by plant, as much as soybean. The continuous cuttings carried out in order to harvest alfalfa help weeds control, thus cereals as winter wheat, barley and corn are the best crops before and after alfalfa. Avoid a tight rotation with sugarbeet, because both crops are damaged by **Rhizoctonia spp.**
- **Alfalfa can be grown in rotation with any crop except Sugar Beet**
  - Winter wheat grows well in rotation with Alfalfa
  - It is not recommended to grow Sugar beet after Alfalfa as it can cause ryzoctonia.
- **Monoculture is to be avoided**, because symbiosis with Rhizobium bacteria and pest attacks can reduce yield and plant population.
- **Rhizobium** bacteria, present on well-nodulated Alfalfa, **can create enough nitrogen to meet the needs of the growing Alfalfa crop**. Until nodulation occurs, however, Alfalfa seedlings depend on available soil nitrogen for growth (Rhizobium Melitoti).
- **Alfalfa residue improves** the organic matter and Nitrogen content of soil.
- **Alfalfa lasts from 5 to 8 years.**
- **No tillage** required decreasing operational costs and soil compaction while increasing the soil structure improves.
- **Weed control is very effective** due to the continuous cuttings for harvesting the crop.

VARIETY SELECTION

- **Maturity group is not an important criterion** in the choice of a variety, because the difference among varieties is very little.
- **Winter Hardiness** is a better criterion: select varieties with increased cold resistance.
- **Adaptation** to local conditions is also an important criterion. Planting high yielding, adapted varieties not only ensures good yields but also healthy and vigorous stands 1 to 2 years longer than poorly adapted varieties.
- **Alfalfa is resistant to drought**, salinity, and alkalinity, but it is very sensible monitor and manage these soil characteristics where possible.
- It is important to research strains tested in areas with similar ground conditions and climate to ensure productivity and adaptation.
- **In good agronomical conditions**, Alfalfa is the most productive and high quality forage legume plant.

Conventional Tillage

- Tillage for alfalfa is carried out in very different ways, depending on timeliness, region and soil structure. However, we must remember that seeds are extremely small, germination phase is the most critical for the crop and ponding is detrimental. For spring drilling, best season for primary tillage is previous autumn in order to allow wintering of soil and building of a fine texture.
- **A perfect Alfalfa seedbed should have 4 Fs:**
  - Firm to reduce air pockets
  - Fine to obtain an even covering of seed,
  - Flat with no places where water stands
  - Free from weeds that compete with seedlings for moisture and plant nutrients.

  Seedbed preparation is costly, time-consuming, and can reduce valuable soil moisture.
- **In conventional tillage**
  - Ploughing is performed at about 30-50cm of depth
  - Ripping at about 50cm is mandatory where hard pan exists.
- **Seedbed** preparation is carried out with field cultivators, power harrows, disk harrows or spike harrows in order to obtain a proper sizing of clods, which is crucial, because seeds are very thin. Clods must be less than 2cm in diameter to provide proper soil-seed contact.

MINIMUM TILLAGE OR NO-TILL

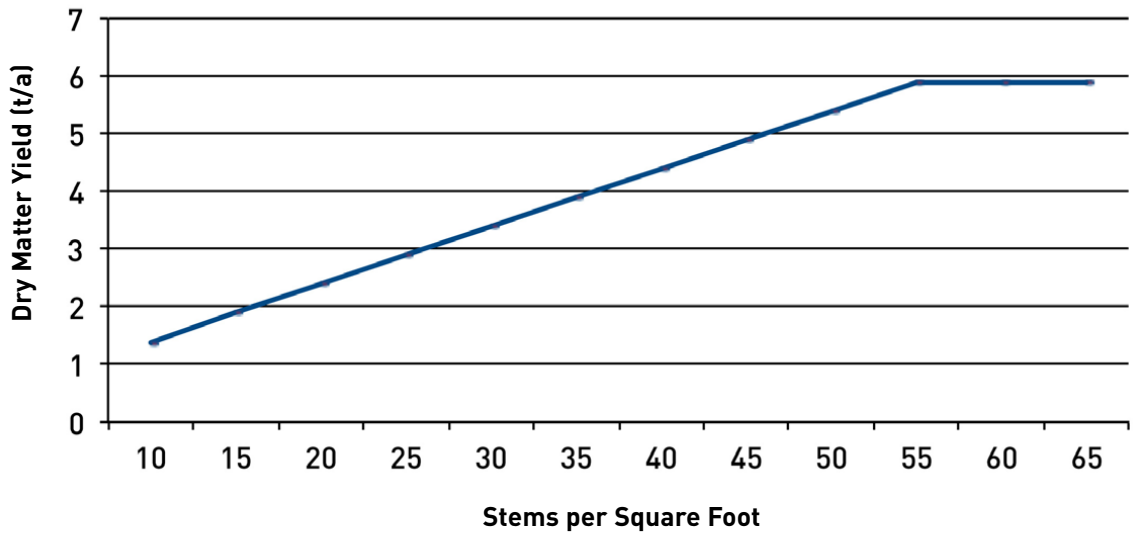
- **There is increased interest** in planting no-till Alfalfa into row-crop stubble in the spring and after small grain cereals or in forage sorghum and silage stubble in late summer.
- **Alfalfa can be planted** no-till into these residues. Most no-till drills can be used effectively to penetrate the standing stubble to obtain good seed-soil contact. In this case, combines should be equipped with straw choppers, in order to chop and spread straw and chaff properly.

Drilling

- **Drilling Periods**
  - **Spring Seeding** starts from 15th of March up to mid May, depending on local climate. Minimal soil temperature is 8-10°C.
  - **Summer Seeding** is carried out after the harvesting of wheat, up to early September.
- **Row spacing** between 13 and 25cm.
- **2cm is the Maximum Depth** for small-seeded legumes like Alfalfa. Small seeds are often unable to emerge from deep plantings.
- **Planting rates** vary between 20 to 40kg/ha, because not all seeds germinate and emerge (average 50%). Despite high loss rate, high population is recommended to ensure adequate stands.
- **After drilling** packing of soil is needed.
- **The goal** is to achieve an ideal 500 stems per square meter.

STAND RENOVATION

It is not recommended to replant Alfalfa over an existing stand to thicken the stand as this practice is typically unsuccessful. Alfalfa plants produce a toxic compound that often kills Alfalfa seedlings. The **exception would be newly seeded stands on large unestablished areas** where the seed bed can be prepared before planting. Tillage cultivating to thicken old stands is not recommended as damage to the crown by implements' engaging tools often result in further stand deterioration.



Note: a square foot is 0.092 square meters. A square meters is 10.76 square feet.

Source: Kansas State University

Fertilization

- **Alfalfa responds well to liming**, being very sensitive to acidity of soil. Once Alfalfa is established, there is no opportunity to incorporate lime.
- **Alfalfa responds very well to fertilization** with phosphorus and potassium. Because Alfalfa is a forage crop normally harvested three to five times during the growing season, when nutrient removal can be very high.
- N should be no concern, because bacteria **Rhizobium meliloti** present on well-nodulated Alfalfa, can synthetize enough Nitrogen to meet the needs of the growing Alfalfa crop. Until nodulation occurs, however, Alfalfa seedlings depend on available soil nitrogen for growth.
- P and K fertilizers can be applied in spring or/ and after each cut. Chart below can serve as guideline for needed quantities of fertilizers based on hay production. As for all crops, soil test prior to Alfalfa establishment is essential to determine lime and fertilizer needs. Soil tests should be taken well before seeding, usually during summer and fall, to allow time for incorporation of lime and base fertilizers into the soil.
- If soils are clayish and heavy, then it is possible also to incorporate Phosphorus and Potash during the tillage before the drilling of the crop. The whole rate of P can be incorporated during the tillage. Concerning K, it is possible to incorporate the whole rate during tillage in heavy soils, or spread the annual rate of K after winter in light soils.

NUTRIENTS REMOVED FROM SOIL WITH 10 TONS OF HAY

NUTRIENT	KG
Nitrogen (N)	300
Phosphorus (P_2O_5)	50
Potash (K_2O)	250
Calcium Oxide (CaO)	300
Magnesium (Mg)	50
Sulphur (S)	50

Irrigation

Alfalfa is a deep-rooted, drought-tolerant perennial with a long growing season. In deep, well-aerated soil, roots may extend down to 3 meters. For maximum yields, however, it also is a large water user with seasonal water use in excess of 1.000 millimeters per season, or from 9.000 to 14.000 cubic meters per hectare; in other words, the average seasonal water need for Alfalfa is about 24 millimeters per hectare per ton of product. (University of Kansas).

As for all crops, volumes of water to be delivered to Alfalfa can be calculated. The amount of water initially found into soil is the starting point; a running balance is maintained daily or at short intervals so soil-water storage is known at all times. Volumes of irrigation (water eights) are the difference between water delivering (rain plus irrigation) and water consumption (evapotranspiration of crop).

Both surface systems and sprinkler systems (center pivots) are used for watering Alfalfa. With surface system usually the capacity is large, meaning that volumes of water are big and there is no problem for satisfying crop request.

Center pivot typically spread from 7 to 9 millimeters of water per day, so in hot weather conditions such volumes can be insufficient for fully coverage of crop requirements.

Most critical period for irrigation is after each cutting, because the plant needs much water to re-start the vegetation after harvesting.

Weed Control

More common weeds in Alfalfa fields are annual dicotyledons (lambsquarter, morninglory, pigweed) grasses and also perennial dicoyledons as histle.

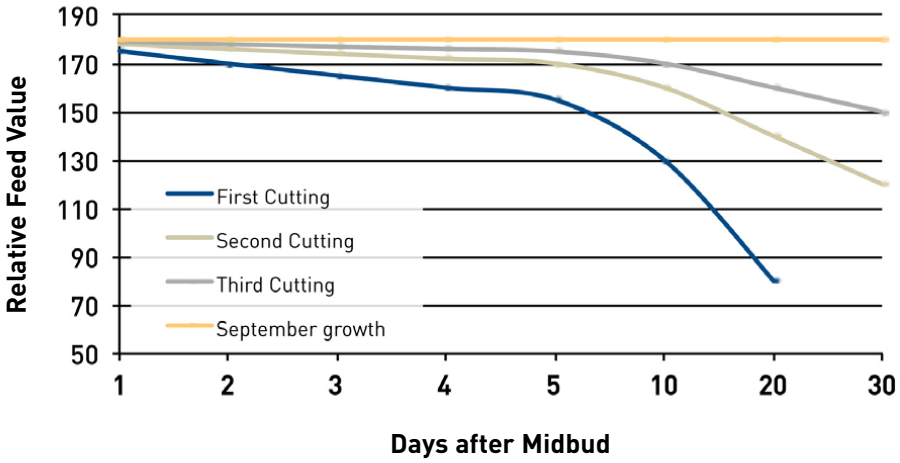
Alfalfa seedling are not competitive with weeds, when good stand of Alfalfa are very competitive, therefore a complete control of weeds before the planting and during the establishment of the crop is crucial. Many herbicides are available for pre-planting and post emergence treatments.

Weeds generally are not a serious problem the first few years after successful establishment of a well-fertilized, insect-free Alfalfa stand. As the Alfalfa stand ages, the population often thins, and weeds begin to invade open areas. Both summer and winter annual weeds can be a problem in established Alfalfa, depending on management, Alfalfa stands, and growing conditions. Several herbicides are available to control weeds in established Alfalfa. The decision to use a herbicide in established Alfalfa should be based on the type and level of weed infestations, Alfalfa-quality needs, and Alfalfa-stand density. Use of herbicides may help improve the quality of a thin, weedy stand of Alfalfa but will not help rejuvenate the crop. Herbicides used in established Alfalfa can be divided into two groups, depending on application timing. Post-emergence herbicide treatments are applied during the Alfalfa growing season, and dormant-season treatments are applied during the winter when the Alfalfa is not actively growing.

(University of Kansas)

Cutting

- **First cutting** has to be decided on the basis of crown buds development.
- **Subsequent cuttings** are made when 10-15% of plants are blooming.
- Later cuttings often produce forage that has lower yield, nutrients, and overall quality.
- **In order to reduce losses of leaves**, cutting height can be also lower than 13cm and swathing better carried out when moisture of bulk is about 25/30%.
- To maintain replenishment of root reserves, make sure that there is at least 20-30cm of foliage or 4 to 6 weeks of growth time before the average first freeze date.



CUTTING EQUIPMENT COMPARISON

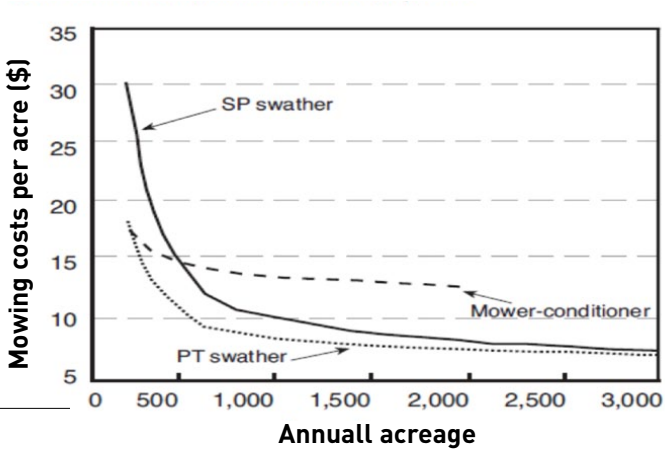
- A farmer needs to make sure that they review all of their operating costs and their future operational plans when owning and operating equipment.
- Example: Oklahoma State University made an evaluation of the costs associated with owning different harvesting systems. In the evaluation, they found.

- For all systems, the cost initially decreases with increased annual acreage then approaches a nearly constant value.
- Side-Pull Mower Conditioner was a cost-effective solution, but only if less than 200 acres (81ha) is harvested annually.
- Eventually, the efficiencies of the SP Swather allow it to overtake the PT Swather.

Testing Parameters

- Self-Propelled Swather, Pull-Type Swather, and Side-Pull Mower-Conditioner (Figure 3) and any support vehicles.
- Annual acreage is the amount of land on which the implement is used each year. If 200 acres (81ha) of Alfalfa are cut four times each year, the annual acreage is 800 (4 × 200) (162ha).

Cost Comparison of Mowing System

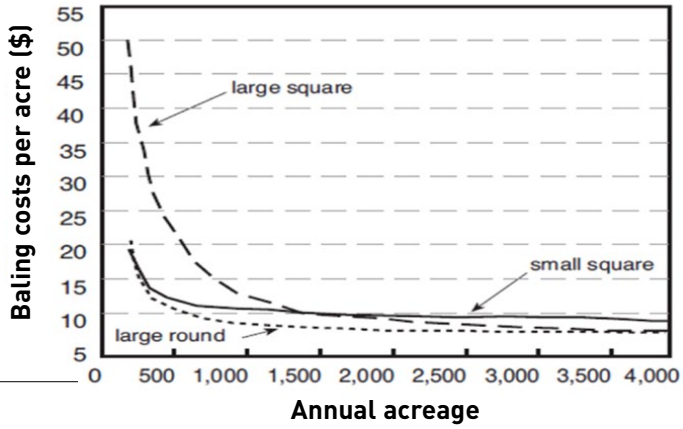


BALING EQUIPMENT COMPARISON

- A similar evaluation was performed for baling equipment (Figure 4).
  - The small square baler proved to be the best choice if <200 acres are harvested per year.
  - At 200 acres, the large round baler becomes more economical.
  - The large square baler becomes more economical than the small square baler at 1500 annual acres and approaches the large round baler at about 3000 annual acres.
  - The extremely high costs associated with the large square baler on low acreage are due to the higher purchase price of the tractor and baler.

Testing Parameters

- The costs presented include baler, tractor, labor, and twine for each system.



Cost Comparison of Baling System

PROPER STORAGE TO MAINTAIN FEED QUALITY

- **Storage losses occur even under barn conditions and cannot be eliminated.**
  - Losses are greatest during unprotected, outside storage of large round bales.
- **Storage losses can be divided into two categories:**
  - Dry-matter loss and Reductions in palatability and digestibility.
- **Dry-matter loss is simply a reduction in bale weight.**
  - This includes hay lost from the bale during handling and any hay lost to rodents.
  - It does not include any reduction in moisture content due to additional drying.
- **Reduced palatability and digestibility usually are caused by weather but can be caused by high-moisture content at baling.**
  - Weathered hay may not be as appealing to livestock as unweathered hay. Feeding losses will increase due to the undesired hay being wasted.
  - Even if livestock consume the weathered hay, they may not be getting any feed value from it. If digestibility is lower, rate of gain also may be lower.
- **Storage method has a tremendous effect on weathering losses. Barn-stored hay suffers significantly less weathering loss than unprotected hay stored outside. Dry-matter losses for barn-stored hay are generally in the 2- to 8-percent range.**

Spraying

INSECTICIDE

Alfalfa Weevil
The 5mm long adult has mouthparts at the end of a snout. Overall adult color is light brown with a middorsal dark line. Eggs are laid inside Alfalfa stems in the fall or spring. They hatch in the spring into small, light-green, black-headed worms or larvae that are legless and have a white stripe down the center of the body.

Damage typically occurs during the first cutting; however, both larvae and adults can suppress yields by delaying regrowth.

INSECT CONTROL

The larvae feed for about 3 weeks and become slightly more than 60mm long at maturity.
Most damage is confined to terminal and other upper leaves. As feeding continues and increases, the drying, tattered foliage gives fields a gray, frosted appearance. If infestations are heavy enough, all foliage may be destroyed. Severe damage to the first cutting may result in indirect losses through delayed growth and reduced production in several later cuttings. Control measures should not be delayed on 5 to 15cm tall Alfalfa when larvae are numerous and the top 2.5cm of growth is showing some feeding damage unless loss of the top growth from a late frost is expected. Two treatments spaced approximately 2 weeks apart may be necessary. Control measures should be applied to 20 to 35cm tall Alfalfa if larvae are numerous and skeletonizing the top 2 to 5cm of growth on 20-50% of terminals.

Alfalfa weevil larva (inset) and injury to leaves. Larger photo courtesy Matt Montgomery.

Harvesting

DISC MOWER & SICKLE MOWER-CONDITIONERS PULL TYPE

Customer values proposition

- Fast Cutting
- High-quality conditioning
- Cleaner cutting (lower profile design)
- Shock protection (cut-out clutch)
- Maximum flexibility (Easy no-tools adjustment)
- Perfect contour following (adjustable springs)
- Rugged and reliable

Customer values proposition

- Economic cutting operation
- Plug-free conditioning (roll-pressure system)
- Perfect Cut (full header floatation, lateral and radial)
- Easy set up (no tools to change from windrow to swath)
- Superior quality conditioning
  (Chevron design rolls, Easy no-tools adjustment)
- Rugged and reliable design
- Efficency and simplicity

SP WINDROWERS CUTTING, CONDITIONING AND SWATHING

Customer values proposition

- Accurate cutting
  (improved steering control, hydraulics)
- Real all terrain (new tyres, rear axle supports,
  higher ground clearance)
- Comfortable rides (cab suspension)
- Easy operations (touch screen, autoguidance)
- All crops operations (full header range, adapter kits)
- Reliable and Rugged (improved header hydraulics
  circuit, new hydro pumps)

Crop suggestions

- Grass and Alfalfa
- Light crops
- Not tall crops
- For smooth, clean, hay cutting
- Conditioning and fast dry down of the crops

HARVESTING EQUIPMENT SELECTION

- When selecting a hay harvesting-storage-feeding system, the following questions must be considered:
  - **What are the costs associated with the system?**
  - **What are quality considerations?**
  - **Is the harvesting system compatible with present and future equipment, facilities, and operations?**
- Labor has been a major factor in the adoption of various hay-harvesting systems.
  - **More labor is needed for small square bales when they are handled manually than for any other system.**
  - **Bale accumulators and automatic bale wagons reduce labor requirements.**
  - **Increased labor requirements increase production costs, but the cost of the entire system should be considered when making a decision.**

Haymaking

RAKES

Customer applications

- Small fields and large surfaces
- Cooperatives, big farms
- Hay growers

Customer values proposition

- Rugged (reinforced, articulated main frame)
- Easy transportation mode
- High field clearance (high flotation, contour following)
- Adaptable (independent wheels, adjustable springs, adjustable front wheels, hydraulic raking angle control)

Self-Propelled Forage Harvester

Customer applications

- Used for creating silage/haylage
- Traditional customers are Contractors, Large Feedlots or Dairies
- Corn, Wheat, Sorgum, Hay
- Requires large acreage to benefit from efficiency

Balers

LARGE ROUND AND SQUARE BALES

Customer applications

- Large Farms and cooperatives
- Large livestock operations
- Contractors
- Perfect for dry crops
- Straw and hay baling
- Silage operations

Customer applications

- Large Farms and cooperatives
- Contractors
- All crops, all conditions

AT YOUR OWN DEALER

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