Making and Feeding
Grass and Legume Silage
in Western Oregon

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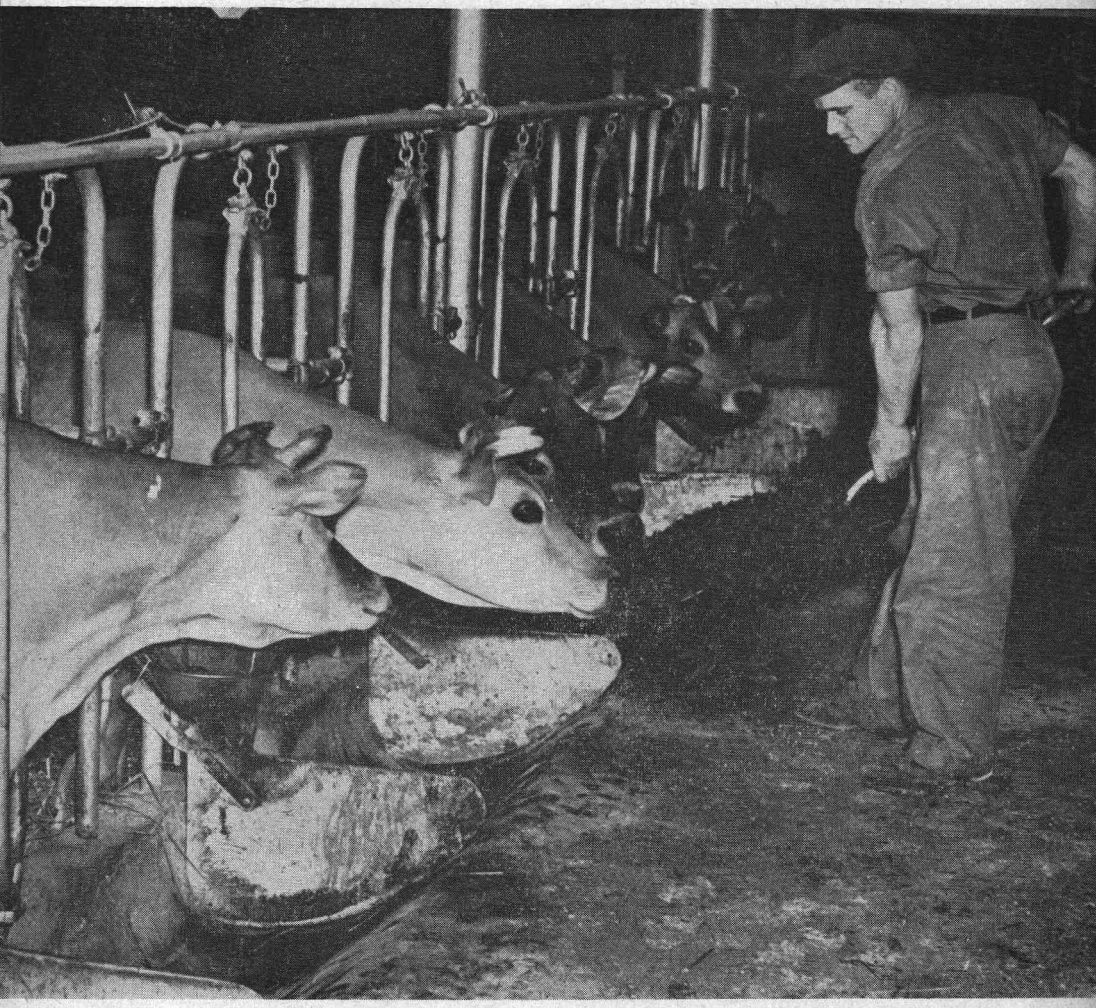

Oregon State System of Higher Education
Federal Cooperative Extension Service
Oregon State College
Extension Bulletin 669 Corvallis June 1946

SUMMARY

1. Increased use of grass and legume silage is important for the Willamette Valley and coastal regions of western Oregon because the usual wet springs make haying hazardous.

2. When put up at an early stage of growth, grass and legume silage has a relatively high protein content. Its use cuts down hay requirements as much as 50 to 75 per cent and reduces the need for expensive protein concentrates.

3. Cattle relish this feed and produce well on it. Users say it is the best substitute for pasture that can be had.

4. Use of grass and legume silage in connection with well-managed pasture reduces the amount of annual plowing and soil working. It also makes possible keeping more livestock on less land. It results in more butterfat per acre without additional changes in the cropping system.

5. Modern harvesting methods greatly reduce the hand labor formerly required in grass silage making.

6. Crops may be planted especially for silage making, or, preferably, first cuttings may be taken from established pastures or hay lands.

7. Early cutting of grass or legumes for silage is highly important as the protein content decreases with maturity. Grasses are usually best cut as the heads emerge from the boot while legumes are cut in the early bloom stage.

8. Control of moisture content in silage is highly important. A 30 to 35 per cent dry-matter content is best. If cut at the proper maturity, just a little wilting will approximate this moisture content.

9. Preservatives are recommended as a safety precaution against spoilage and to increase the nutritive value of the silage. Either molasses or grain may be used.

10. Four basic methods of harvesting are available. These vary from mostly hand work to a fully mechanized outfit that mows, chops, and loads the material in the field in one operation and with only one man.

11. Silos built for corn may need to be reinforced when used for grass or legume silage. Pit silos are not generally recommended, but trench silos have proved reasonably satisfactory.

12. Wooden hoop silos are not recommended, unless treated to prevent decay.

Cover illustration—

Cows relish grass silage and will consume from 40 to 90 pounds daily. Their performance on this feed shows it is the best substitute for pasture.

Making and Feeding
GRASS AND LEGUME SILAGE
in Western Oregon

By

CHESTER E. OTIS, ROGER K. MORSE, and M. G. HUBER*

AN IMPROVED FORAGE PROGRAM

GRASS and legume silage is part of an improved forage program well adapted to dairy farming in the Willamette Valley and coastal regions of Oregon. The complete program also includes the use of more productive and better adapted grasses and legumes, fertilization, irrigation where feasible, and proper pasture management.

Western Oregon, favored as it is with heavy rainfall and moderate temperatures, is particularly well suited to a "grassland" type of agriculture. Because practically all of the rain comes in the late fall, winter, and early spring, however, pastures here reach the peak of their productivity in May and June; fall off in July, August, and September; and are practically nonexistent in midwinter. Thus it is difficult to maintain a proper livestock-pasture balance throughout the year. This has always been a problem to dairymen and often a limiting factor in production. Grass and legume silage offers a solution in enabling dairymen to "can" the surplus pasture for feeding later, thereby leveling off the "hills" and "valleys" of the homegrown feed supply.

In addition to conserving surplus pasture that is often lost, farmers may ensile crops normally cut for hay. Fields of alfalfa, clover, ryegrass and clover, or oats and vetch, may be cut at an immature stage of growth, immediately put in the silo, and thus saved from the rains and a resultant loss of palatability and nutritive value. The logic of this practice is emphasized by the weather records that reveal how risky haying really is between May 20 and June 10 when the first cutting is usually made. By ensiling the crop early, a second growth, except in the case of oats and vetch, comes on later when weather is much more favorable for putting in hay. Of course, the second crop may be pastured or made into silage, too, if the operator desires.

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A. J. Sweet of Tillamook cuts his grass early and then turns his cows on to the field to pasture two weeks later. He makes no hay but buys it all from the Willamette Valley, southern or eastern Oregon. If he did make local hay, he would want it cut in late July or early August to be sure of getting it cured.

ADVANTAGES OF GRASS AND LEGUME SILAGE

1. When ensiled at an early stage of growth, it has a relatively high protein content, so that its use not only cuts down the hay requirement, frequently 50 to 75 per cent, but reduces the amount of expensive protein concentrates needed.

John Kominoth of Bay City has been feeding grass silage from November 1 to April 1, twice in the morning and twice in the afternoon followed by light feedings of hay. Grain is fed according to production.

He now feeds only 25 tons of hay to 40 head of cows where it used to take 100 tons to get through the winter. He says his cows come out in the spring looking as if they had been on grass all winter.

2. The carotene content of grass and legume crops is more fully preserved when these crops are used for silage than when harvested for hay. As a result of the higher carotene content, milk produced on good grass silage has a higher carotene and vitamin A value than when weathered hay is the only roughage.

3. Grass and legume silage is very palatable and is the best substitute there is for excellent, well-managed pasture.

Ben Nielsen, Tillamook, feeds grass silage from October 25 to April 15 at the rate of about 50 pounds a day, or all the cows can eat twice a day. His cows prefer silage to home-grown hay and he feels that silage keeps up the milk flow and causes dry cows to fatten rapidly.

4. The annual plowing and fitting of the soil for silage crops is an expensive process that can be eliminated by permanent seedings of grass. When land is seeded down to proper long-lived mixtures, labor requirements and the cost of producing feed are reduced.

5. Many common weeds and the undesirable, early maturing grasses, such as velvet grass, sweet vernal, and cheatgrass, do not have a chance to mature and scatter their seed if cut for silage. Crops containing weeds not strongly flavored have greater palatability when preserved as silage than when cured as hay.

6. Grass and legume silage contains more digestible protein and other nutrients in less space than other types of roughage and therefore reduces feed storage costs. A cubic foot of grass silage weighs 8 to 9 times as much as a cubic foot of loose hay and contains three or more times as much food value.

7. In putting up silage, modern harvesting methods lower labor requirements and do away with much of the heavy work.

8. More than 20 per cent of farm fire losses are caused by spontaneous ignition of hay. A fire in the haymow is practically impossible to control. Silage containing 60 per cent or more water will not burn, spontaneously or otherwise.

9. Recent experimental work* shows that immature grasses or legumes when ensiled produce more butterfat per acre than when made into hay, *even if drying conditions are perfect.*

PLANTING CROPS FOR SILAGE

Silage can be made from any crop that normally is made into hay. Legumes, grasses, or cereals growing alone or in mixture may be ensiled.

The planting of annual hay-type crops for silage purposes may be economically practical in emergencies or when costs of purchased feedstuffs are high, but as a general rule, the incorporation of the grass and legume silage practice into a permanent, improved pasture and forage program is preferred.

There is room for increased plantings of alfalfa on soil where it will grow. Thousands of acres of upland offer a home to subterranean clover. Lotus ulignosus, or major, is filling a real need on moist, coastal lowlands. Wherever irrigation is feasible, Ladino clover invariably steps up carrying capacities. Alta fescue is longer lived and more productive than many grasses in general use. Several of the newer grasses, such as meadow foxtail for wet land, Tualatin meadow oatgrass, and red creeping fescue, have proved themselves worthy of wide use in pasture mixtures.

* Unpublished work by Dr. R. E. Hodgson, U. S. Department of Agriculture, Washington, D. C.

As a general rule, since good grass and legume silage contains 30 to 35 per cent dry matter and well-cured hays about 90 per cent, the yield of silage will ordinarily approximate three times the tonnage of the same crop if it were cured into hay at that time. If well done the yield of total nutrients would be about equal either as hay or silage, except that fewer nutrients are lost in silage making than in hay making.

TIME OF HARVEST HIGHLY IMPORTANT

Cut early

Pasture time is silage time. The best ensiling process and methods will not make the silage any better than the original material that grew out in the field. For most palatable and highest quality silage, the crop is cut in the immature stage when the amount of protein per acre is the greatest and the moisture content is sufficient for proper preservation. Grasses are best cut before they bloom and preferably as the heads begin to show. Clover, alfalfa, and most legumes are cut in the early bloom stage. Oats and other cereals may best be ensiled when the grain is in the milk or early soft dough. If one follows this stage of growth schedule, silage operations will come between April 15 and May 25, depending on earliness of the season, the locality, and the crop to be cut.

Figure 1. Mowing legumes for silage in the early bloom stage using a swathing attachment. This is preferred over a side delivery rake. *Photograph by courtesy of Papec Machine Company, Shortsville, N. Y.*

Preston Williams, Tillamook, prefers early cutting to give high protein content and also to allow taking the second cutting for either hay or silage in July or August.

He likes to cut his grass when it is about 12 inches high and just before it starts to head. He believes that when cutting the crop, one should not get too far ahead of the hay loader because the material may dry out.

The superior feeding value of early cut material is illustrated in Table 1 developed from results obtained when alfalfa was fed to dairy cows in a controlled experiment at the Huntley Field Station, Huntley, Montana. The figures are a result of trials with hay, but apply generally to silage also.

Table 1. RELATION OF PROTEIN CONTENT TO MATURITY OF ALFALFA HAY

Stage of maturity when harvested	Yield of protein per acre	Yield of butterfat per acre
	Pounds	*Pounds*
Early bloom	1,427	404
One-half bloom	1,381	345
Full bloom	997	331

Moisture content controlled

Moisture content is one of the important factors in determining what kind of feed one will have when he opens the silo, although it is extremely difficult to judge and control. Practically all experimental work has determined 30 to 35 per cent as the best dry matter content of a crop to be ensiled. Forage containing too much moisture may produce slimy, putrid silage and cause excessive leakage of juices from the silo. On the other hand, silage that is too dry cannot be packed well; and as a result it often heats, molds, and spoils.

If the crop is cut at the proper stage of maturity as outlined earlier, it needs to lose just a little moisture before going into the silo. This can be accomplished by wilting for two hours on a drying day and up to one-half day in slow drying weather. If the crop becomes overwilted or is overripe and too dry when cut, it will either be necessary to add water at the silo or make it into hay. Silage made in the rain often carries too much moisture unless the crop is overripe and high in dry matter in the first place.

Figure 2. Use of two types of preservatives is illustrated here. *Left,* An electric pump on a molasses barrel, showing arrangement of valves for regulating and shut off. *Right,* Grain is fed from hopper to feed table of stationary cutter.

PRESERVATIVES RECOMMENDED

Because weather conditions at silo-filling time are often far from ideal, making moisture content difficult to control, it is practically a necessity to add preservatives to the green material as it goes into the silo. This makes possible the ensiling of crops that otherwise would be too wet. While a preservative adds to the cost, much of the feed value it originally contains remains usable in the silo, and that which is lost is rather cheap insurance.

Molasses is the first choice as a preservative because it is effective and the cheapest. When molasses is unobtainable, ground or whole grain (corn, wheat, barley, or oats) may be used.

The amount of preservative needed per ton of silage is given in Table 2.

Table 2. PRESERVATIVE NEEDED PER TON OF SILAGE

Crop	Molasses*	Ground or whole grain
	Pounds	*Pounds*
Legumes	60-80	150-200
Legumes and grasses mixed	40-60	125-175
Grasses or cereals	30-40	75-125

* Molasses weighs 11 to 12 pounds per gallon.

An exact amount of preservative is not necessary, but it is safer to err on the side of having too much rather than too little.

Estimating molasses

To gauge application of the molasses, it is necessary to know tonnage of green material, rate of unloading it into the blower, and rate of flow of molasses. One familiar with judging the weight of dry hay can figure that green hay is about three times as heavy. The rate of unloading the green material can easily be clocked, and the rate of flow of molasses can be determined from Table 3.

Table 3. SPEED OF DELIVERY OF MOLASSES

A stream of molasses that will fill a quart bottle in . . .	. . . Will deliver in ten minutes
Seconds	*Pounds*
40	40
30	60
20	80

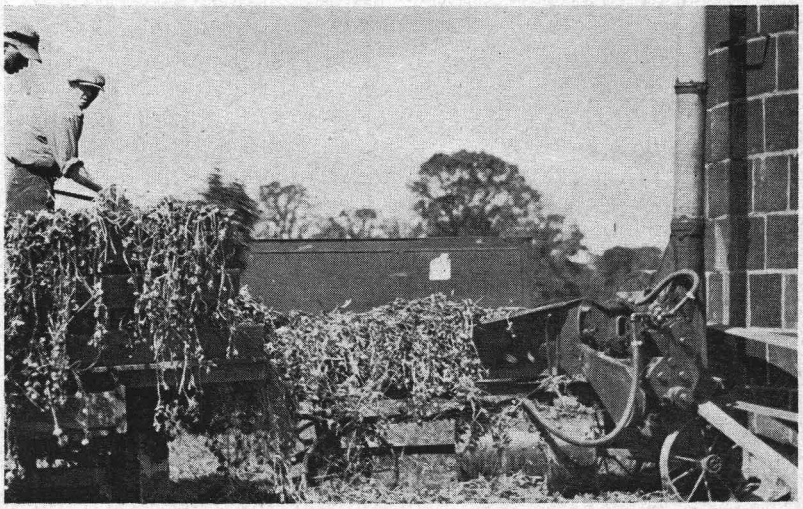

Figure 3. An automatically controlled molasses feeder regulates the flow according to the rise and fall of the feeder roll on the cutter, thus increasing or decreasing the molasses in relation to the amount of silage material going through. This arrangement works satisfactorily when the molasses is 70° F. or warmer. *Photograph by Gehl Brothers Manufacturing Company, West Bend, Wis.*

Molasses pumping experiments

To determine the conditions under which straight molasses can be applied, the Department of Agricultural Engineering conducted a series of experiments pumping molasses under different temperatures and pressures and using a number of pump sizes.

Rotary gear pumps were used for tests. In general, it was found that the size of the pipe, suction and discharge pipes, speed of the pump, and location of the molasses tank to the pump had an important bearing on the rate of delivery.

It was found that the molasses container should be on a level or above the pump so that the molasses will tend to flow into the suction pipe of the pump. The suction pipe should be at least 2 inches in diameter, and reduction in pipe size to the pump inlet should be made at the pump.

The size of pump is important. It appears that gear pumps having an inlet and discharge opening of 1 inch or larger are necessary to permit the flow of molasses without considerable friction loss. The pump speed should be operated at as slow a speed as will give the desired delivery. Gear pumps should be supplied with a

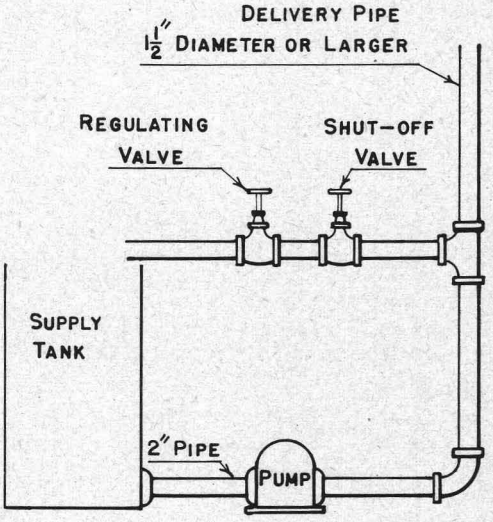

Figure 4. Arrangement for pumping molasses. It is important that the pump be on a level or below the bottom of the supply tank. A pump having an inlet and discharge opening 1 inch or larger is recommended.

safety valve, and a bypass return pipe to the supply tank with a valve for regulating should be used.

When delivering the molasses into the blower pipe at the top of the silo or on the inside at the end of the distributor pipe, the discharge pipe or hose should be at least 1½ inches in diameter or larger. A 1½-inch fire hose has been used and found very satisfactory. A method practiced by some farmers has been the injection of molasses into the elbow of the blower pipe at the top of the silo.

Molasses at 53° F. was successfully pumped to a height of 25 feet at a delivery rate far beyond that required for silo-filling operations. The arrangement by which this was accomplished, using neither heat nor the addition of water, is illustrated in Figure 4. The molasses can be pumped and delivered in the silo or added at the chopper or blower. When the molasses is colder than 70° F., however, difficulty is encountered in elevating the chopped material when the molasses is added at the chopper or blower. For this reason, it is better practice to add the molasses inside the silo, using for this purpose a hose or pipe extending to the top.

A return pipe to the supply tank with two valves is illustrated in Figure 4. One valve is for regulating the flow, allowing the surplus molasses to return to the supply tank. The other is used as a shut-off valve between loads or during stopping periods. If water is to be mixed with the molasses, this arrangement is ideal in that the molasses and water may be mixed by recirculation.

Figure 5. The modern cylinder rake-bar loader, known as a heavy-duty green-crop loader, is the best type to use in picking up silage material from the swath. *Photograph by courtesy of Papec Machine Company, Shortsville, N. Y.*

Additional studies will be made on other types of pumps to determine their general applications for pumping molasses. For additional information on specific makes of pumps, write to the Extension Agricultural Engineer, Oregon State College, Corvallis.

Grain used as preservative

If ground grain is used as a preservative, it is most easily added by pouring on the feed conveyor of the cutter, while whole grain may be fed to the conveyor by gravity from a hopper. Ground grain is much better for this purpose than whole grain. Mechanical devices for grain delivery are available from manufacturers of silage-making equipment.

SILAGE HARVESTING METHODS

Four basic silage harvesting systems are in use as follows:

1. Mowing, raking, hand loading, hand unloading, and hand feeding to stationary chopper.
2. Mowing, raking, machine loading (loader), hand unloading, and feeding to stationary chopper.
3. Mowing, raking, pickup with field chopper, unloading to blower.
4. Direct cut with field chopper, unloading to blower.

Figure 6. This type cylinder-rope loader may be used for light windrow conditions but will not handle heavier crops except with considerable care in operation.

Hand methods limited

The first method involves time and hard labor. It may be satisfactory in small operations where cash outlay for equipment and labor is inadvisable. The second method will be commonly used until field choppers become more generally available.

When mowing, it is a poor practice to cut down more grass than can be put away the same day. A windrower attached to any mower will do the work of a rake. In addition, stones are less likely to be picked up than when a side-delivery rake is used. In heavy growth, swathing is unnecessary. Sometimes just part of the swather attachment at the outer end of the cutter bar is used.

Heavy-duty loaders used

Modern cylinder rake-bar loaders, commonly known as heavy-duty or green-crop loaders, are the most satisfactory type to use in picking up the crop. Well-built cylinder rope loaders in good condition will handle light crops or small swaths, particularly if the ropes are replaced by a No. 3 welded machine link chain and good hardwood slats.

Almost any type of vehicle is acceptable for moving the green material from the field to the silo. Trucks, trailers, and wagons are all widely used.

Fair sized loads may be built without the care required in loading dry hay. The use of a short, square-shaped rack or dump-truck body eliminates the need for a man on the load, the forage being allowed to fall as it comes from the loader. If a truck is used, the driver can throw the peak of the load forward by a quick stop. By this method of loading, the forage is not so solidly packed and may be dumped at the stationary chopper and fed from the ground without excessive tangling.

If dump bodies are not available, the load may be placed on slings and then slid off at the chopper. Rolling the grass off usually proves unsatisfactory as the green material is then difficult to pull apart.

Recent surveys indicate that an average of about 2.3 man-hours per ton is required by the machine loader method of putting up grass silage. This, however, will vary with the number of men used, length of haul, and type of equipment such as size of cutter, power, wagons or trucks, etc.

Handling stationary choppers

Chopping of the silage is an extremely important phase of the operation often overlooked. Improperly adjusted cutters will slow

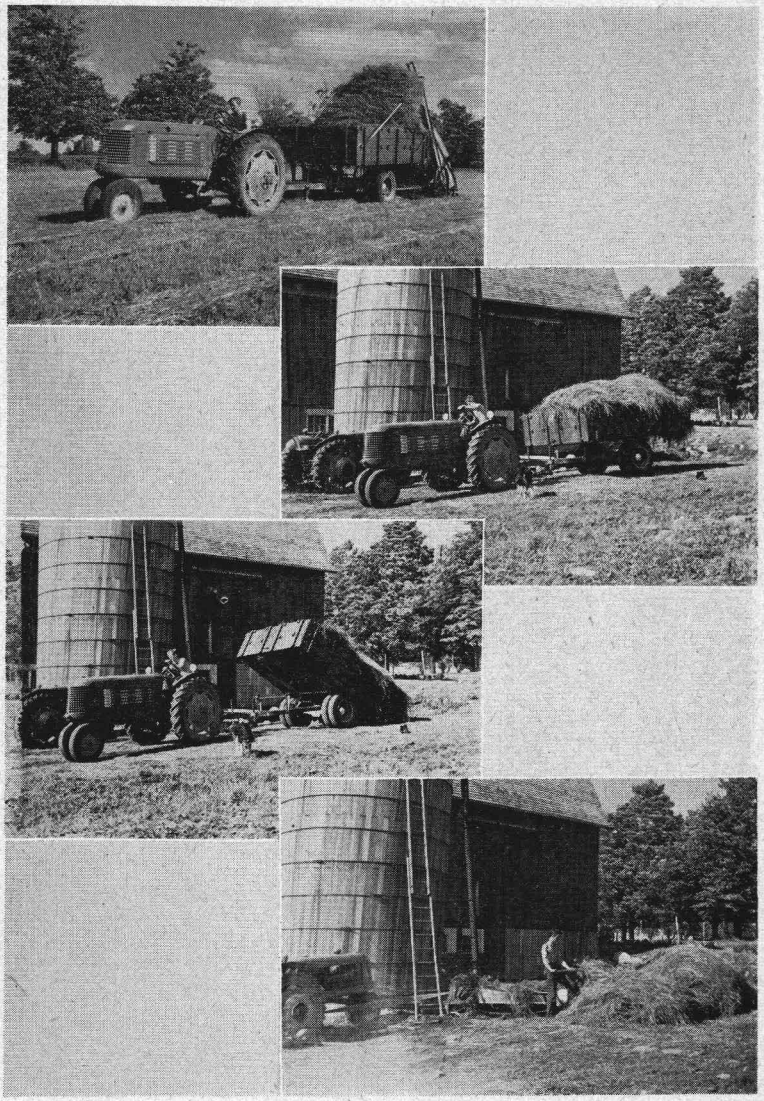

Figure 7. Operation of a one-man loading outfit using small area trailer with heavy-duty loader (top). Delivering and dumping load at silo (center). The dumped load is fed by hand (bottom) to the cutter set low in a pit to make feeding easier. *Photographs by courtesy of Papec Machine Company, Shortsville, N. Y.*

down the work, require extra power, and put out irregular and poorly cut silage.

Here are four essentials to good silage cutting:

1. Right speed
2. Right feed
3. Sharp knives
4. Good ledger or shear plates

Figure 8. Picking up and chopping in one operation but delivering to an accompanying truck. A two-man operation. *Photograph by courtesy of Papec Machine Company, Shortsville, N. Y.*

It is best to operate the cutter at the speed recommended by the manufacturer which is just fast enough to chop the silage and blow it into the silo.

Overfeeding a silage cutter will cause it to slow down, choke, and clog unless adequate reserve power is available to keep the cutter up to speed. A sharp knife not only cuts the feed better, but requires much less power and helps in maintaining uniform speed, thus preventing clogging. The shear or ledger plate is part of the cutting equipment and must be properly adjusted so that the knives will just clear without touching.

Any late model cutter will do good work. A 13-inch throat or wider is recommended. Cutters having feed tables designed for grass feeding are preferred.

For most grass and legume crops, the chopper is best set to cut

½-inch lengths. For pasture clippings, a ¾-inch setting is satisfactory. For mature material or when the crop is being ensiled in temporary silos, a ¼-inch cut is recommended.

Figure 9. A one-man operation, picking up and chopping from swath or windrow. Such labor-saving outfits are helping increase the popularity of grass silage. *Photograph by courtesy of John Deere, Moline, Ill.*

Figure 10. A complete one-man operation—mowing, chopping and loading into trailer at one time. *Photograph by courtesy of Allis, Chalmers Manufacturing Company, Milwaukee, Wis.*

Field chopping speeds work

The field-chopper method, where one man gathers, chops, and loads the crop, is the easiest and fastest way to harvest grass silage. A study conducted in 1945 showed an average of 1.05 man-hours per ton was required to put up grass silage by field-choppers equipped with pickup attachments. This reduces the labor requirement to half

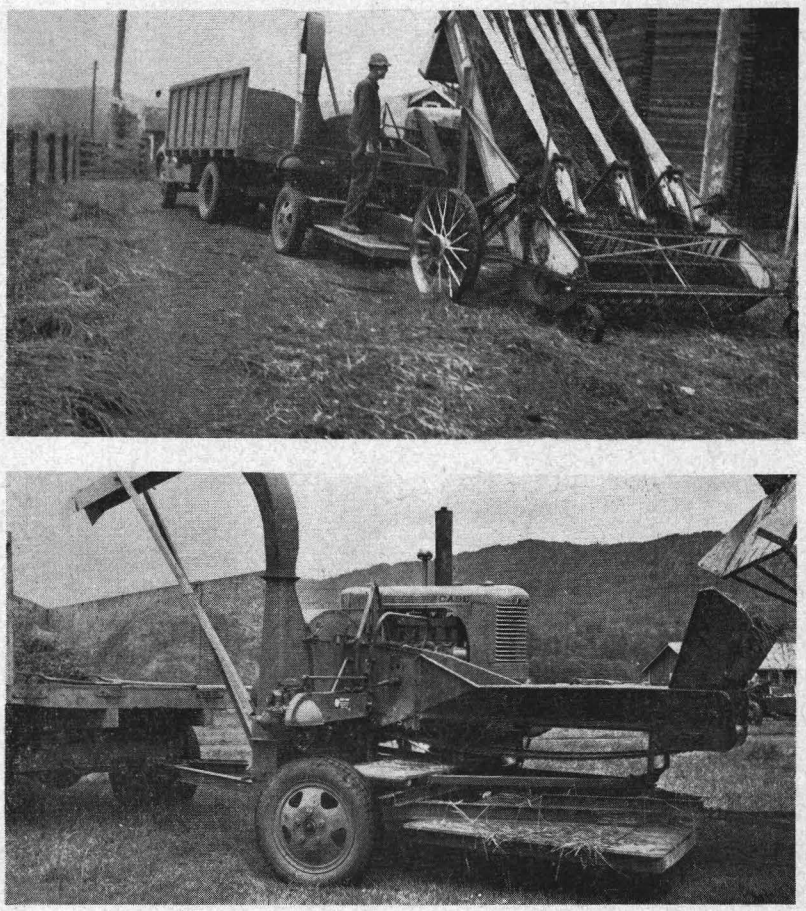

Figure 11. John Schilds constructed a field harvester by placing a stationary chopper on a two-wheeled trailer. The heavy duty hay loader was attached behind the trailer and towed by a truck which also collected the chopped material. This was a two-man outfit, one man to drive the truck and one man to even out the feeding to the chopper. Said John Schilds: "This beats the pitchfork." Most of the work was done in his own shop.

that required by the green feed loader system and in addition takes the hard work out of the silage operation.

Wagons, trucks, or trailers with good, tight boxes about 14 or 16 feet long, within the legal width limit for use on highways, will meet most capacity requirements. These are loaded only to a depth of three or four feet. Rubber-tired vehicles are particularly satisfactory for fast highway travel and are pulled more easily over rough and soft ground.

If, to eliminate some labor, a trailer is towed behind the field chopper, a tongue hitch that will allow easy and rapid switching from chopper to tractor and vice versa is desirable.

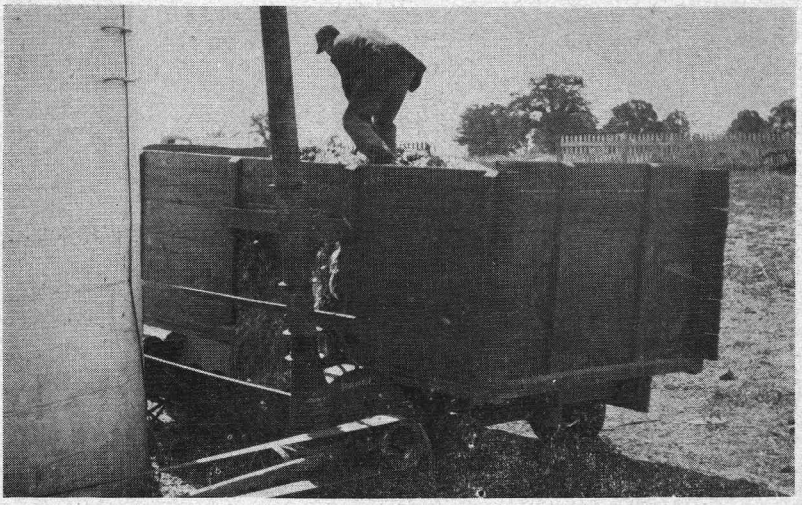

Figure 12. Unloading chopped grass through side opening on trailer or truck directly into bed of blower. *Photograph by courtesy of Papec Machine Company, Shortsville, N. Y.*

Unloading methods given

Different unloading methods can be described as follows:

1. The load may be pitched off at a rear or side opening.
2. It may be dumped directly into the blower hopper by using a dump truck.
3. It may be pulled off by means of a tractor or winch attached by cable to a false front that pushes the load directly into the blower. This method may require two men if a tractor is used.

4. The load may be slid off by a power-driven unloading conveyor built into the bed of the hauling vehicle. This has been proved to be the most satisfactory method. Two types of conveyors have been used and found satisfactory. The canvas bottom on one type winds on a shaft mounted to the rear of the vehicle bed. This shaft may be either a 2½-inch pipe mounted with a bearing on each end or a solid shafting of 1½-inch diameter. The shaft on one end extends through the bearing and may be either splined or

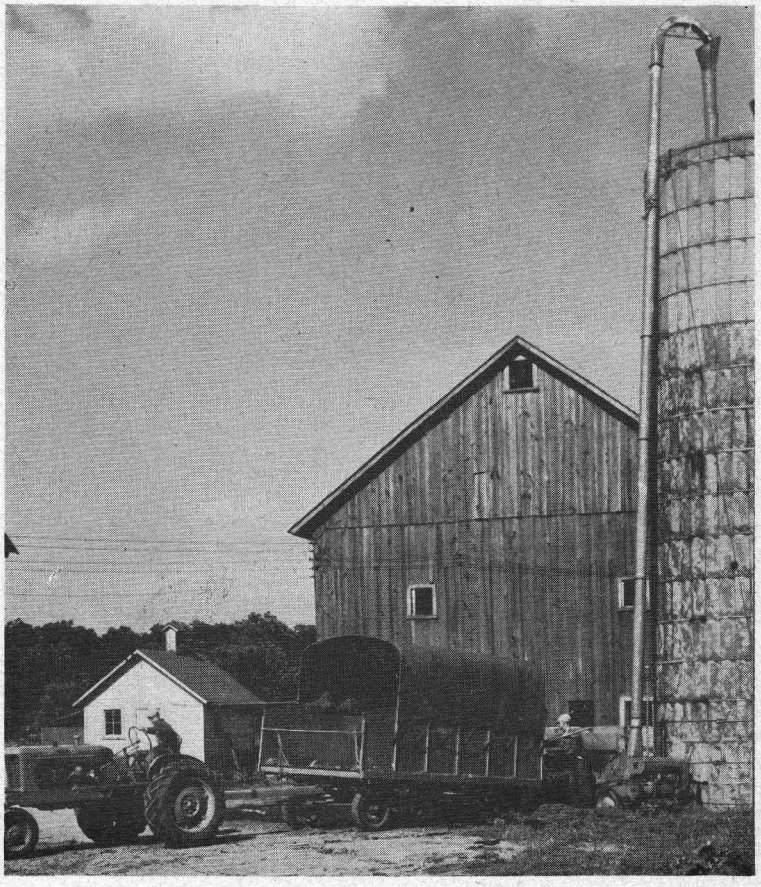

Figure 13. This trailer is equipped with a movable endgate operated by a power takeoff from tractor, thus pushing the entire load off the back as rapidly as desired. *Photograph by courtsey of Allis, Chalmers Manufacturing Company, Milwaukee, Wis.*

square to hook up with the power drive for unloading. The canvas is held to the shaft by fastening a $\frac{1}{8}$x$\frac{3}{4}$-inch band over the end. Holes are tapped every 4 inches in the shaft and countersunk stove bolts are used. Canvas the full width

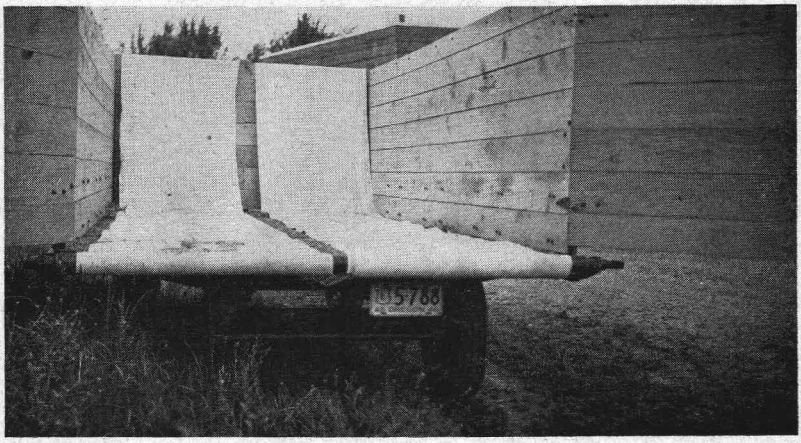

Figure 14. A trailer equipped with canvas aprons used at Oregon State College during 1946. Two pieces of canvas were used, as a full-width piece was unobtainable.

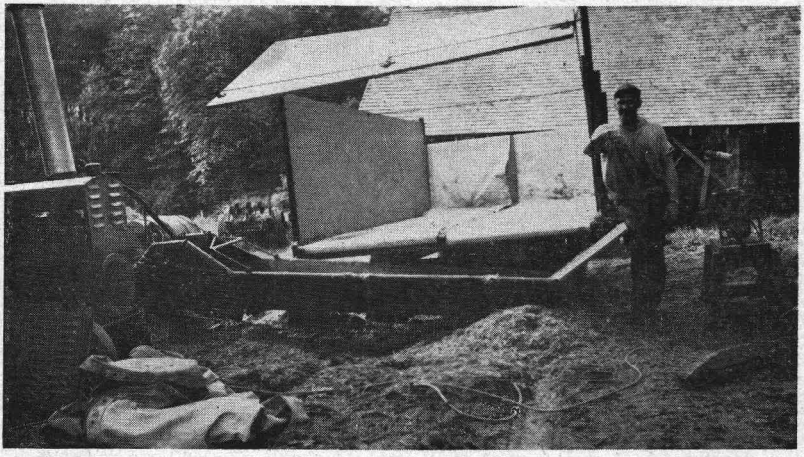

Figure 15. Art Johnson, Astoria, stands beside one of his trailers. He operated a field chopper on grass and legume silage, filling many of the neighbors' silos.

is desirable. If two pieces are used, they should not be sewed in the center.

The canvas should move about 2 feet per minute, or a better plan would be to use a car transmission to provide

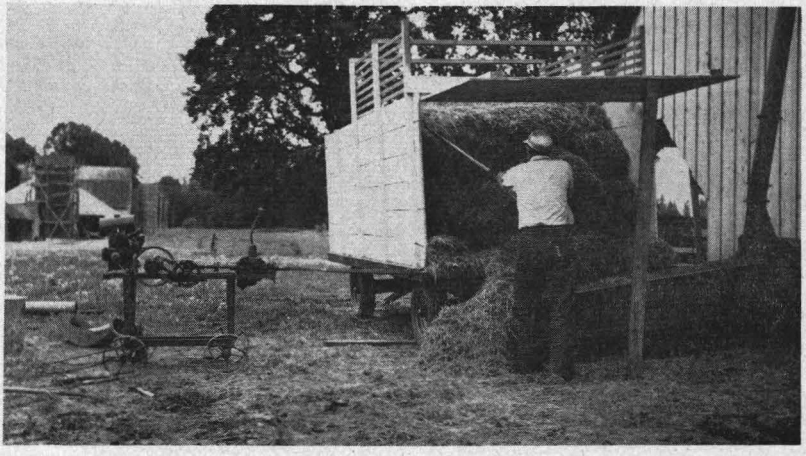

Figure 16. Robert Clark, Aurora, unloads chopped hay from a trailer using a canvas conveyor. The power is supplied by a small gas engine that is usable in any location. This unloading method works equally for all kinds of chopped materials. One man is required to feed the material into the blower.

Figure 17. John Neaglei, Tillamook, uses a continuous apron in the trailer for unloading chopped hay. The reduction drive unit is located on the right. Molasses is added by gravity at the blower.

three speeds, having the slow speed at about 1 foot per minute.

Another type of endless slate-type conveyor is shown in Figure 17. The canvas bottom apron has the disadvantage that it must be returned and placed in position after every load. It has the advantage of being easily attached to any existing vehicle beds requiring only two bearing supports on the rear of the bed.

Blowers elevate material

A blower is best used for elevating grass silage into the upright silo. Most other elevators, such as portable drag types, usually are not long enough to reach the top of the average silo. When storing in bin or trench-type silos, drag-type conveyors or slings may be used for unloading. Slings are so placed during the loading operations that two or three slingfuls make up a load. Stationary choppers are also used, with the knives removed, for elevating the field-chopped grasses.

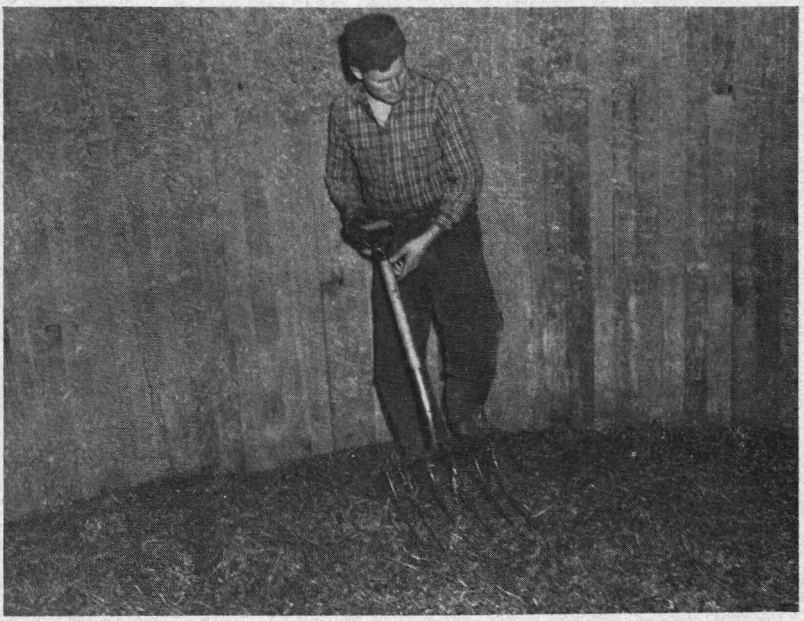

Figure 18. Proper distribution and trampling of silage within the silo is important, especially if the material is fairly mature, but little of this old-style hand-and-foot work is necessary if distribution can be controlled from the pipe at the top of the silo.

Distributing and tramping in silo

To avoid spoilage and loss due to the presence of air pockets in the silage, it is essential to distribute the chopped grass uniformly during the filling operation, keeping the material level or slightly higher at the center. It may not be necessary to tramp material harvested at an immature stage and cut in short lengths, except to see that the top is carefully leveled and well packed whenever cutting is stopped.

Legumes and grasses that may have matured beyond the desirable ensilage stage need extra tramping during filling and should be cut in ¼-inch lengths.

Sealing is necessary to avoid spoilage. To do this, the top is leveled after filling and tramped daily around the outer edge until settling stops. This will keep the outer edge from shrinking away from the silo wall. Any poor quality chopped green material may then be used as a seal and save much of the more valuable material from spoiling.

The best seal is obtained by using a layer of roofing paper, lapped three inches, after which any material available such as weeds, wet-cut straw, sawdust, or low-grade grass can be placed over the paper. Keeping the top of the silo well tramped and adding water to prevent the top from drying out will also help make a good seal.

SILO CONSTRUCTION

The upright silo is the cheapest and best type for grass silage. Because grass silage exerts 1½ to 1¾ times as much pressure on the silo walls as does corn silage, silos built for grass silage need adequate reinforcement with steel; old silos designed for corn require additional hoops before they are filled with grass silage.

Wooden-hoop type doubtful

Wooden-hoop silos are not recommended in the humid regions of western Oregon unless both staves and hoops are treated for decay or are protected from weather. These have been known to break after nine or ten years unless the outside surface is covered. In these cases, the hoops and the places where the staves and hoops were in contact were seriously decayed.

Upright silos preferred

Among the upright silos that are satisfactory are wooden stave, with steel hoops, concrete with a protective inside coating, brick, tile, and metal with protective inside coating.

Silos built with concrete flooring need several drains through

the foundation wall or one drain from the center floor. They may be above ground to be plugged or capped after drainage ceases.

On tidelands and river bottom lands where it is difficult to obtain good footing, the floor is best omitted. The construction of a foundation in such areas requires special attention and perhaps technical assistance.

Anyone expecting to build a new silo or remodel an old one might well refer to U. S. Department of Agriculture Farmers' Bulletin 1820, *Silos—Types and Construction.* This is available from county agents' offices and the Extension Service at Oregon State College.

The pit silo is not recommended for western Oregon conditions since the average water table is too high during the storage period.

Trench silo useful

The trench or box type silo is used on some farms. Its chief advantage is that it can be built out of concrete or lumber that is usually available and may be lower in original cost.

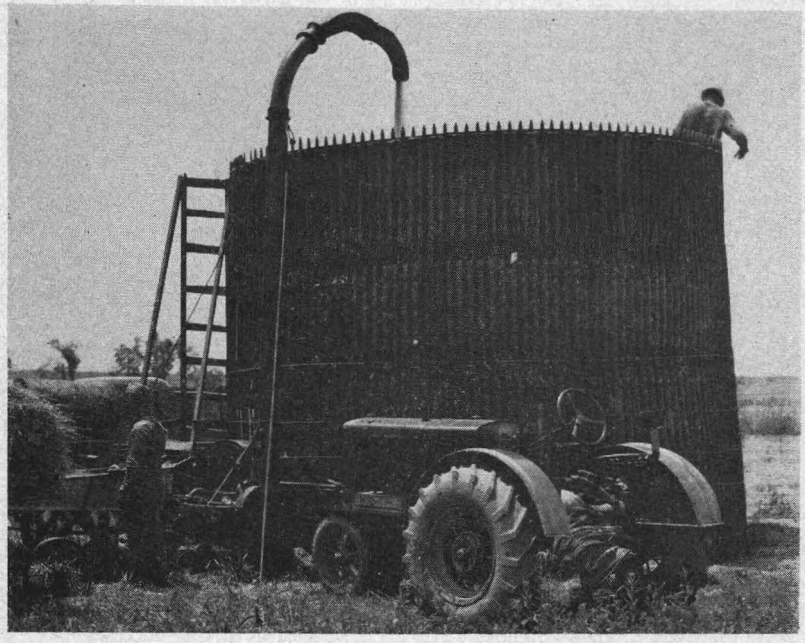

Figure 19. Temporary silo being filled with grass silage through a conventional stationary cutter. Temporary silos such as this are lined with a strong fiber-filled paper to reduce spoilage. *Photograph by courtesy of Papec Machine Company, Shortsville, N. Y.*

The trench silo is an excavated trench in the ground with sloping sides that may be lined with concrete or other material. The box type silo may be a combination with the trench silo in that part of the silo extends below ground level with additional height built above ground. Some silos are built of wooden construction in a rectangular shape of miscellaneous sizes and heights. The sides generally slope in at the bottom so that the silage compacts itself as it settles. While this type of silo may be justified under some circumstances, it is probable that the well-constructed, upright silo is the most satisfactory in the long run.

Other temporary silos

Temporary silos made of woven wire, picket fencing, or snow fencing are used in emergencies to store surplus feed and supplement permanent silos. They are not practical unless lined with a double thickness of heavy fiber-paper such as Kraft paper. Lining materially reduces the spoilage. Additional information on temporary silos is available in the farmers' bulletin previously mentioned.

Grass silage as viewed from the building angle has a number of advantages. It makes possible savings in storage construction costs. The cost of hay storage in a barn is about the same per cubic foot as the cost of silage storage in a silo, but each cubic foot in a silo stores about three times as much dry matter (Table 4).

Table 4. COMPARISON OF SPACES USED BY FORAGE IN DIFFERENT FORMS

	Whole hay	Chopped or baled hay	Grass silage	Corn silage
Feed stored per cubic foot	4 pounds	8 pounds	45 pounds	40 pounds
Dry matter stored per cubic foot	3.6 pounds	7.2 pounds	13.5 pounds	12 pounds
Cubic feet per ton of feed	500	250	44	50
Cubic feet per ton of dry matter	555	278	148	167

SILAGE VALUE AND FEEDING METHODS

Many statements have been made regarding the value of grass and legume silage. Farmers need always bear in mind that the silage will be no better than the material ensiled. Silage with the highest percentage of protein will be made of legumes and grasses put into the silo at the stage at which they would be most palatable to livestock as a pasture crop. Put up then, the grass and legume silage is very palatable and relatively high in digestible protein. The more mature the forage the lower the protein and the less valuable it is for feed. The actual percentage of protein in a particular lot of silage varies

with the maturity of the grass and legumes and with the dry matter content of the silage. For this reason, the percentage of crude protein is usually expressed on a dry basis.

Frank Judd, Mohler, has his barn constructed so that he has ample room to operate a tractor and trailer in front of the mangers to reduce the work in feeding. He drives along throwing off silage to the cows as they stand in their stanchions.

A neighbor reports that Mr. Judd feeds as many cows off 11 acres by putting up silage as he did off 50 acres by putting up hay.

The highest yield of protein per acre is usually obtained when grass is cut as heads emerge from the boot and when legumes are cut in the early bloom stage. Put up at this stage, silage will have about the same percentage of protein as excellent legume hay.

Three pounds of silage equal one of hay

Grass silage can replace legume hay in the dairy ration at the rate of about three pounds of silage to one pound of hay. Dairy cattle have been fed grass silage as the only roughage for a considerable length of time with no bad results. Many dairymen feed a small amount of hay and then give the cows all of the grass silage that they will clean up. Where there is plenty of well-made grass silage available, it is common practice to feed 60 to 70 pounds a day. Some cows will consume up to 90 pounds.

Silage fed before or during milking often imparts a feed flavor to the milk. To avoid this, feed in the manger or in a feed trough in the yard or a covered shed after milking.

Many dairymen with dry land pastures start feeding silage as soon as the pastures start to dry up in July or August. It is the best substitute there is for good lush pasture.

Alfred Long, Mohler, who is cheese maker at the local plant, reports that in the usual slack season of January 1945 his plant handled 6,300 pounds of milk a day as compared with 4,500 pounds in January 1944. He says that this amount of milk was from approximately the same number of cows and that he attributes most of the increase to grass silage.

Good silage is cheap feed

When properly made, it is not only a cheap feed for dairy cows, but provides the nutrients needed for milk production, using only farm-grown grains as concentrates. This is going to be particularly important during periods when grain and high-protein concentrates are scarce.

Silage good for beef cattle

Beef cows wintered at the Northrup Creek Experimental area in Clatsop County consumed about 50 pounds of grass silage per day and came through the winter in good condition with no hay or grain being fed.

Beef steers in the same feeding test made good gains consuming 35 to 40 pounds of grass silage, a very small amount of hay, and about eight pounds of grain for yearlings and seven pounds for weaners.

Cooperative Extension Work in Agriculture and Home Economics
Wm. A. Schoenfeld, Director
Oregon State College and United States Department of Agriculture, Cooperating
Printed and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914